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Natural resources and economic development: the role of national innovation system

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Abstract

The focus of this paper is to test whether the quality of the national innovation system can change the curse of natural resources into a blessing. To examine the above question, this paper uses the global innovation index and its two sub-indices to proxy the national innovation system. Using data from 98 sample countries over the period 2009–2019, the pooled OLS and IV estimates suggest that the negative growth effects of resource rents may turn positive in countries with strong national innovation systems.

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1. Introduction

Natural resources have long been a topic of debate among economists in terms of their importance and impact on the economy. Two opposing viewpoints define this debate: natural resources either promote or impede economic growth. Each explanation has proponents who can back up their claims with empirical and historical evidence. However, the conditional curse is a third viewpoint that challenges the conventional wisdom of curse or blessing (Damette and Seghir, 2018). In the literature on the natural resources curse, the conditional curse, which is defined as the impact of natural resources on economic growth dependent on country-specific characteristics, is more intuitive and allows reconciling the competing ideas. The poor quality of economic and political institutions, in particular, has been identified as one of the critical factors contributing to the failure of resource-rich economies to achieve sustained growth (Arezki and van der Ploeg, 2010; Boschini et al., 2013, 2007; Kolstad, 2009; Mehlum et al., 2006; Robinson et al., 2006). Among the key findings of these studies is that natural resource revenues are curse rather than blessing in countries with low-quality institutions.

Previous studies examining the association between institutional quality and growth in resource-dependent countries mainly consider political or economic intuitions (Havranek et al., 2016; Khan et al., 2022). Since technological innovation drives growth (Schumpeter, 1934), the role of innovation-promoting institutions deserves particular attention. The characteristics of innovation suggest that it results from numerous interactions between key organizations and groups in the economy, such as universities, government, enterprises, and other institutions, which together form an innovation system (Sabah, 2013; Wilson, 2011). In this paper, we demonstrate that natural resource rents' impact on growth depends on the quality of the national innovation system (NIS). We base our theoretical argument on a body of literature that studies the crowding-out effect of natural resources on innovation or entrepreneurship. Researchers point out that wage privilege in the resource sector may draw away the human capital and create disincentives for learning, entrepreneurship, and innovation in other sectors, making it difficult for them to compete (Papyrakis and Gerlagh, 2004; Sachs and Warner, 2001). This paper aims to test whether a strong national innovation system that helps develop a diversified economy, protects property rights, provides the knowledge base and human capital, promotes a favourable business-market environment, can turn the resource curse into a blessing. It is, to our knowledge, the first research to investigate the conditioning role of the national innovation system. The findings suggest that resource rents can be a blessing in an economy with a strong national innovation system but a curse in an economy with a weak national innovation system. The results are robust to various specifications, estimation methods, and different measures of national innovation systems.

The rest of this paper is organized as follows. The data and estimation methods are described in Section II. Section III presents the main results, and Section IV concludes.

2. Data and Methodology

We use a dataset with a cross-sectional dimension of 98 countries and a time dimension of all years from 2009-2019. We restrict our dataset to 2009-2019 due to the availability of the data on our moderating variable, the national innovation system. Following resource curse literature, we estimate pooled OLS as our baseline specification. The equation below shows the primary regression model for our analysis.

$$\text{Economic Dev.} = \beta_0 + \beta_1 NRR + \beta_2 NIS + \beta_3 NRR*NIS + \beta_4 X + \varepsilon \quad (1)$$

There are numerous variations of indicators of economic development, but for this paper, we use the growth rate of real GDP per capita as our dependent variable. Data for this variable is retrieved from the World Development Indicators (WDI). Bhattacharyya & Collier (2014) and Dollar & Kraay (2003) note that annual fluctuations in GDP per capita and other macroeconomic variables are noisy indicators of the true underlying changes in these variables. Therefore, estimating the above model using noisy annual data will likely yield biased estimates. To tackle the measurement error adequately, we estimated our models using period average data and three-year averaging of macroeconomic variables. For robustness purposes, we also estimate our model using annual data. Our natural resource rent measure is the ratio of total natural resource rents to GDP, obtained from the World Bank Adjusted Net Savings database. We use the overall global innovation index by INSEAD and WIPO to proxy the national innovation system. This index takes a possible value between 0 and 100, where higher index values correspond to a higher quality of the national innovation system.[1] The overall GII is an aggregation of two equally-weighted sub-indices: the Innovation Input Sub-Index, and the Innovation Output Sub-Index, which further comprises of several indicators from different areas of innovation activities that include institutions, infrastructure, human capital, market and business sophistication, creative outputs, knowledge and technology outputs. Thus, it is a comprehensive measure of the national innovation system that captures all important elements of the national economy that promote innovation activities. We use the overall GII index to represent the national innovation system.

We control for other determinants of economic development most commonly used in the literature: initial income level (GDPPC71), foreign direct investment inflow (FDIINF), gross fixed capital formation (GFC), trade openness (OPEN), inflation (INF), military expenditures (MEXP) and population density (POPD) obtained from the world development indicators (WDI).

3. Empirical Results

Table I reports the results from pooled OLS. First, we estimated the model to identify the relationship between natural resource rent and economic development (without yet controlling for NIS or interaction terms), and the results are reported in columns (1) to (3) of table I. Taken together, the results indicate that natural resource rent is negatively associated with economic development. These findings are consistent with the theoretical and empirical literature on resource curse. Regressions (4) to (6) account for the role of NIS, suggesting positive implications for economic performance. Finally, regressions (6) to (9) include the interaction terms together with NRRENT and NIS. The results show that natural resource rent has a negative and statistically significant coefficient, whereas the national innovation system and interactive term coefficients carry significantly positive signs. These findings imply that natural resource rent undermines economic development, hereby suggesting a resource curse. In contrast, the national innovation system augments economic development and positively moderates the relationship between natural resource rent and economic development. In other words, these results suggest that a quality national innovation system can change the curse of natural resources into blessings for economic development.

[1] For ease of interpretation, we have normalised this indicator between zero and one. We use linear interpolation to impute missing data and all variables are winsorized at top and bottom 1 percent of their distributions.

Table I. Baseline Results

	(1) GDP_11 Years Average	(2) GDP_3 Years Average	(3) GDP_Annual	(4) GDP_11 Years Average	(5) GDP_3 Years Average	(6) GDP_Annual	(7) GDP_11 Years Average	(8) GDP_3 Years Average	(9) GDP_Annual
NRRENT	-1.970***	-1.952***	-1.898***	-0.617	-0.859**	-0.928***	-5.669***	-4.490***	-3.439***
	(0.6827)	(0.3596)	(0.2090)	(0.7210)	(0.3496)	(0.2086)	(1.6666)	(0.8147)	(0.5237)
NIS				2.471***	2.255***	2.033***	2.301***	2.052***	1.863***
				(0.4145)	(0.1953)	(0.1190)	(0.3563)	(0.1823)	(0.1163)
NRRENT*NIS							14.256***	9.959***	6.870***
							(3.9298)	(2.1068)	(1.3064)
GDPPC71	0.898***	0.898***	0.903***	0.600***	0.626***	0.658***	0.550***	0.604***	0.646***
	(0.0453)	(0.0214)	(0.0125)	(0.0622)	(0.0297)	(0.0187)	(0.0590)	(0.0287)	(0.0185)
FDIINF	-0.682	-0.391	-0.316	-1.737	-0.894**	-0.666***	-1.190	-0.683**	-0.542***
	(1.3180)	(0.4365)	(0.2088)	(1.1189)	(0.3812)	(0.1815)	(0.9865)	(0.3459)	(0.1712)
GCF	3.359**	2.754***	2.546***	1.875**	1.729***	1.733***	1.198	1.529***	1.598***
	(1.4849)	(0.6387)	(0.3716)	(0.9298)	(0.4092)	(0.2512)	(0.8840)	(0.3889)	(0.2444)
OPEN	0.275**	0.263***	0.263***	0.245**	0.183***	0.184***	0.233**	0.189***	0.192***
	(0.1342)	(0.0526)	(0.0307)	(0.1092)	(0.0424)	(0.0253)	(0.0999)	(0.0399)	(0.0244)
INF	-4.717*	-3.941***	-3.171***	-1.961	-2.462***	-1.962***	-1.877	-2.519***	-1.981***
	(2.3882)	(0.9679)	(0.4839)	(1.9868)	(0.8525)	(0.4264)	(1.9053)	(0.8310)	(0.4202)
MEXP	0.712	0.598	0.639	2.655	2.944*	2.699***	0.257	1.683	1.714
	(3.8798)	(1.8565)	(1.1013)	(3.3054)	(1.6459)	(1.0066)	(3.4818)	(1.7388)	(1.0731)
POPD	0.020	0.018	0.019	-0.012	-0.008	-0.004	-0.010	-0.005	-0.001
	(0.0398)	(0.0198)	(0.0119)	(0.0323)	(0.0165)	(0.0102)	(0.0301)	(0.0158)	(0.0099)
_cons	0.713	0.841***	0.804***	2.452***	2.401***	2.181***	3.125***	2.728***	2.396***
	(0.6296)	(0.2826)	(0.1640)	(0.5455)	(0.2525)	(0.1550)	(0.5489)	(0.2525)	(0.1579)
N	98	392	1078	98	392	1078	98	392	1078
Adj. R^2	0.886	0.886	0.886	0.922	0.920	0.917	0.929	0.925	0.920

Note: * p < 0.1, ** p < 0.05, *** p < 0.01. Dependent variable is growth rate of real GDP per capita. Robust Standard errors in parentheses, all regressions include the controls (initial income level as a natural log of real GDP per capita in 1971, net inflows of foreign direct investment as a share of GDP, gross fixed capital formation as a share of GDP, openness indicates sum of imports and exports as a share of GDP, inflation as consumer price index, military expenditure as a share of GDP and log of population density per sq. km of land area).

To address the potential concerns of endogeneity and omitted variables in our model, we use an instrumental variable approach to identify the real effect of natural resource rent on economic development and the moderating role of the innovation system in this context. As is often the case, finding strong and valid instruments is not an easy task. Keeping this issue in mind, we instrument natural resource rent, national innovation system, and interaction term by geography, history, and nature-related exogenous variables. [2] These variables are obtained from the CIA World Factbook, Gallup et al. (1999) and La Porta et al. (1999).

Table II. IV Estimates

	(1) GDP_11 Years Average	(2) GDP_3 Years Average	(3) GDP_Annual
NRRENT	-12.457***	-12.255***	-11.787***
	(4.046)	(3.966)	(3.825)
NIS	1.426	1.329	1.290
	(1.103)	(1.106)	(1.119)
NRRENT*NIS	35.401***	34.431***	32.711***
	(11.301)	(10.797)	(10.196)
Controls	Yes	Yes	Yes
Year FE	No	Yes	Yes
_cons	3.727***	3.366***	3.274***
	(1.105)	(0.887)	(0.847)
Kleibergen–Paap rk LM statistic	15.441 (0.009)	14.929 (0.011)	14.588 (0.012)
Cragg–Donald Wald statistic	2.260	8.214†	20.654†††
Kleibergen–Paap rk Wald F statistic	2.641	2.776	2.761
Hansen J-statistic	2.286 (0.683)	2.055 (0.726)	2.107 (0.716)
Sargan- Hansen C statistic	11.928 (0.008)	12.516 (0.006)	12.526 (0.006)
N	90	360	990
Adj. R^2	0.903	0.891	0.880

Note: * p < 0.1, ** p < 0.05, *** p < 0.01. Dependent variable is growth rate of real GDP per capita. Robust standard errors clustered at country level are shown in parentheses, control variables are included but not reported for brevity. P-values of Kleibergen–Paap rk LM, Hansen J, and Sargan-Hansen C statistics are in parenthesis. Stock–Yogo critical values for weak identification tests (used for Cragg–Donald Wald and Kleibergen-Paap rk Wald F statistics) are 13.95 for 5%, 8.50 for 10% and 5.56 for 20% maximal relative bias. These critical values are for three endogenous regressor, and they constitute more conservative thresholds (higher than they should be) in the case of more than one endogenous variable. ††† denotes significance at 5%, †† denotes significance at 10% and † denotes significance at 20% according to Stock–Yogo critical values.

In table II, we again explore the moderating role of the national innovation system with the instrumental variable approach. Results presented in columns (1) to (3) show that the coefficient on the interaction term is positive and strongly significant, even though the coefficient on natural resource rent is negative and significant. The results indicate that the quality of the national innovation system moderates the negative impact of natural resource rent on economic development. The bottom part of the table provides the test statistics that assess the appropriateness of the instruments. Based on these statistics, we strongly reject the null hypothesis that endogenous regressor tested are exogenous (Sargan- Hansen C statistic), the null hypothesis

[2] Following Fagerberg and Srholec (2008), we use geography, nature and history related variables to instrument national innovation system (latitude of country centroid, log of the number of people killed in natural disasters per capita, % land area in geographical tropics and % Land area within 100 km of ice-free coast, legal origin), proven crude oil reserves is used to instrument natural resource rents.

of under-identification (Kleibergen–Paap rk LM statistic), and accept the null that instruments are exogenous (Hansen J-statistic). However, IV regression results should be treated with caution because the overall evidence of a strong instrument is not overwhelming (Cragg–Donald Wald statistic, Kleibergen–Paap rk Wald F statistic).

For further robustness check, we used the sub-indices of the global innovation index (Innovation Input Sub-Index, and the Innovation Output Sub-Index) as a proxy for the national innovation system. The results remained fundamentally unchanged (available on request), with the interaction term coefficient continuing to carry a significantly positive sign.

4. Conclusion

This article investigated the impact of the interaction of natural resource rents and the national innovation system on economic development. Our empirical findings show that a strong national innovation system can change the curse of natural resources into blessings. We concur with the interesting article by Sæther et al. (2011) that countries can benefit from their natural resources in the presence of a well-functioning national innovation system.

From a policy perspective, the crucial difference which allows some countries to escape the resource curse is learning and innovation. Countries that coupled the exploitation of natural resources with the development of knowledge-based factors, technology and innovation infrastructure, and invested in learning and higher education institutions tended to develop better than those that relied on a weak knowledge base and with an institutional set-up that did not support processes of learning.

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