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Are resources a curse or blessings? Evidence from panel ARDL model

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Abstract. *The present study investigates the resource curse hypothesis in mining-rich districts of Odisha by taking variables such as natural resource abundance, economic growth, investment, human resource development, financial development and institutional quality over the period 1995-2015. The panel ARDL model is applied in order to estimate the long-rum relationship among variables based on three alternative estimators such MG, PMG and DFE. The study finds that there is a negative relationship between natural resource abundance and economic growth in the long-run. The results confirm the existence of natural resource curse in Odisha possibly because of weak institutions and lack of appropriate policies.*

Keywords: natural resource abundance, economic growth, panel ARDL, Odisha.

JEL Classification: Q2, O47, C23

1. Introduction

Whether natural resources are curse or blessing for economic development has become a subject of debate over the last two decades (van der Ploeg, 2011). Prior to the late 1980s, most of the economists and geographer advocated a positive relationship between natural resource abundance and economic development. For example, geographer Ginsburg argued that “the procession of a sizeable and diversified natural resource endowment is a major advantage to any country embarking upon a period of rapid economic growth” (Rosser, 2006). According to development theorists Rostow (1961) “the natural resource endowments would enable developing countries to make the transition from underdevelopment to industrial take-off’. Similar positive arguments are put forward by neoliberal economists such as Balassa (1980), Krueger (1980) and Drake (1972). However, after the late 1980s, a large number of literatures has challenged this conventional wisdom and demonstrated that natural resource abundance has become a curse rather than a blessing for economic development (Davis and Tilton, 2005).

The concept of resource curse was first introduced by Richard Auty in 1993. Resource curse or the “Paradox of plenty” is a phenomena where the countries well endowed with rich natural resources experience stagnant growth or even negative economic growth. Many African countries such as Angola, Nigeria, Sudan, and the Congo are rich in oil, diamonds and other minerals, yet they have become development failures in terms of per capita income and quality of life. On the other hand, the East Asian economies Japan, Korea, Taiwan, Singapore and Hong Kong have performed well despite their rocky islands and no exportable natural resources (Frankel, 2010). Between 1960 and 1990, the resource poor countries were able to raise their per capita incomes two to three times faster than the per capita income of resource abundant countries (Auty, 2001). The whole OPEC countries have experienced on average 1.3 percent declines in their gross national product per capita from 1965 to 1998. In contrast to it rest of the developing countries have been able to attain on average 2.2 percent per capita growth (Gylfason, 2001).

The distribution of natural resources varies across different Indian states. For example, the states like Odisha, Jharkhand and Chhattisgarh are endowed with rich natural resources that together account for 70 percent of India’s coal reserves, 80 percent of high-grade iron ore, 60 percent of bauxite and almost all the chromites reserve (Centre for Science and Environment, 2008). These three states also contribute significantly to the total royalties on minerals in the country. Further, these states are endowed with rich forest resources and ground water. However, it is observed that the resource-rich states have performed less well both in terms of per capita income and rate of growth of state domestic product compared to the resource-poor states like Kerala, Tamil Nadu, Maharashtra, and Punjab (Behera and Mishra, 2012). The extent of poverty is low in many of the resource-poor states whereas the problem is quite alarming in Odisha and Chhattisgarh. Further, it is reported that the benefits from resource extraction are not reaching to all sections of society within a resource-rich state. Half of rural tribal people in Bihar, Chhattisgarh, Madhya Pradesh, Jharkhand and Odisha live below the poverty line and the ratio is higher than the national average.

Odisha is a mineral-rich state which is richly endowed with large varieties of metallic and non-metallic minerals such as chromite, bauxite, graphite, iron ore, manganese ore, coal etc. it is reported that about 93 per cent of Chromite and Nickel, 52 per cent of bauxite, 44 per cent of Manganese, 33 per cent of Iron Ore, 24 per cent of Coal deposits of India are found in Odisha. The contribution of mining and quarrying sector in the Gross State Domestic Product of Odisha is about 6.3 per cent in 2014-2015. In recent years, Odisha ranks highest in India in terms of value of output of minerals. The share of Odisha in total value of mineral output in India is 11.16 per cent (Odisha Economic Survey, 2014-2015).

In spite of all its rich mineral resources Odisha is considered to be one of the most underdeveloped states in India. Though the real per capita Net State Domestic Product for Odisha has increased from 2004-05 to 2014-15, still Odisha lags far behind compared to other faster growing states and national average (Odisha Economic Survey, 2014-2015). Further, in terms of Human Development Index Odisha performs very poorly in comparison to other states (Human Development Report, 2004, Government of Odisha). For example, Odisha has a human development index (HDI) index of 0.404 while Kerala, a resource-poor state has a HDI of 0.638. Most of the mining-rich districts of Odisha such as Jaipur, Keonjhar, Sundergarh, Angul, Koraput, Jharsuguda and Mayurbhanj perform very poorly. Most of them are tribal dominated except Jaipur and Angul. More than 50 per cent of the populations are tribals in Sundergarh, Koraput and Mayurbhanj. Keonjhar alone accounts for more than 44 per cent of the tribal population. Human Development Report of the State shows that between 1993-94 and 199-2000, the poverty ratio has increased in the southern and northern regions of the state that includes mining districts like Koraput, Sundergarh, Keonjhar, Angul and Mayurbhanj. It is reported that 75 per cent of the state's poor live in these southern and northern regions. 62 per cent of the population lives below the poverty line in Keonjhar, the most mined district of Odisha. In Koraput which is known as the bauxite capital of India, the figure is higher at 79 per cent (Centre for Science and Environment, 2008).

The performances of the mining districts in terms of HDI are disappointing. Jaipur, Keonjhar and Koraput have HDI rank of 22, 24 and 27 respectively. However, some of the mining districts have performed well. Jharsuguda ranks 2, Sundergarh ranks 4th and Angul ranks 6th respectively. The reason for these differences in HDI ranking among mining districts is that Angul and Jharsuguda are coal-rich districts and coal mines in the state are under the public sector while in other mining districts mining is in the hands of the private sector. The per capita incomes of these coal-rich districts are higher than other mining districts. All the mineral-rich districts have occupied a place in the list of the 150 most backward districts of the country (Centre for Science and Environment, 2008).

Structuralists, dependency theorists, and some Marxist theories of imperialism have advocated their views on resource-led growth. In the 1940s and 50s, the Structuralists such as Prebish and Singer (1950) argued that the resource-based growth alone would be ineffective because the world prices of primary exports relative to manufacturers show a deep tendency towards secular decline. Further, Hirschman (1958), Seers (1964), and Baldwin (1966) opined that primary exports have small forward and backward linkages to the rest of the economy. According to dependency theorists, if foreign multinationals are allowed to dominate resource extraction then natural resources will fail to stimulate economic growth. Marxists, such as Paul Baran opined that local elites dominated the governments in poor economics and they joined their hands with foreign multinationals instead of promoting national development (John, 2011).

At the macro/country level Sachs and Warner, 1995 study is considered as the pioneering work that find a negative correlation between resource abundance and GDP growth. Using the similar methodology, Leite and Weidmann (1999); Gylfason et al. (1999); Sala-i-Martin (1997) finds similar results. However, the results are not conclusive. The recent empirical works by Alexeev and Conrad (2011); Alexeev and Conrad (2009); Brunnschweiler and Bulte (2008), Brunnschweiler (2008); van der Pkloeg and Poelhekke (2009) find a positive relationship between growth and resource abundance. The basic difference between these two categories of literature lies in the proxy of natural resource abundance taken by them. Those studies who find resource curse evidence have taken ratio of resource exports to GDP as the proxy while latter studies that do not find resource curse evidence have taken stock-based proxy of resource abundance such as reserve in the ground.

The cross-country studies have several limitations. First problem is related with the export-based proxy of natural resource abundance taken by the previous studies. It is argued that the export-based proxy suffers from the endogeneity problems. When natural resource exports are expressed as shares of GDP, the denominator measures the magnitude of other economic activities in the economy. Therefore the numerator variable is dependent on the economic policies and the institutions that produce them (Brunnschweiler and Bulte, 2008). Second, the empirical work will suffer from omitted variable biases. Different countries are endowed with different history, culture, geography, institutional quality and macroeconomic policies. It is very difficult to measure all these differences. Third reverse causality is another problem suffers by cross-country studies. Any measure with GDP in the denominator is subject to reverse causality. Suppose a country has low GDP due to some reasons that are not related to natural resources. But it would seem that low GDP and other problems related to low GDP are the result of large natural resource wealth while in reality it is the low GDP that causes natural resource wealth to appear to be high (Alexeev and Conrad, 2011). Fourth the impacts of resource abundance at the national level are different to that of local level. For example, the impact of extractive industries demand for inputs can be felt in particular local markets.

In the recent time few studies have focused on the within-country studies. Among the within-country study Papyrakis and Gerlagh (2007) study is considered as the first study. They find that resource abundance put negative effect on growth by lowering levels of investment, schooling, Openness and research and development and increasing corruption in US Employing similar method James and Aadland (2011) find similar negative effects of resource abundance on growth in US countries. Douglas and Walker (2013) again find similar results in US countries by using similar methodology and more disaggregated data. Shuai and Zhongying (2009) examined the relationship between energy exploitation and economic growth in China over 1991-2006. They find that energy exploitation impeded growth through indirect transmissions channels by lowering human capital input and R & D, and weakening institution. Zuo and Jack (2014) also find the same results in Chinese and tested two transmission channels such as crowding-out and institutional channels. They find resource curse evidence which is transmitted through crowding-out channel rather than institution channel. Education and R & D are two main crowding-out channels. However, the former Chinese 10 western provinces while the latter study focuses on all Chinese provinces.

Black et al., 2005 in US, Marchand, 2012 in Westen Canada, Fleming and Measham, 2014 in Australia, Michaels, 2011 in Southern US find that resources boom generate positive employment spillovers and don't crowed other industries (manufacturing). Recently Jacobsen and Parker, extend Black et al.' study to Western US and Allcott and Keniston, 2013 extend Michaels (2011) study to rural countries in the entire US and find the same results.

The above within country studies suffer from two important limitations. First they provide limited information about the effects on real income or other measures of welfare. Second these studies have focused on developed countries such as the US, Canada, Brazil and Peru. Recent works by Caselli and Michaels, 2013 in Brazil, Aragon and Rud, 2013 in Peru, Brollo et al., 2013, Kotsadam and Toloren, 2014, Loayza et al., 2013 have started to fill up this gap in the literature. Within this literature, the present study is closely related to Zuo and Jack (2014) and Shuai and QI (2009). Thus like the cross-country studies the local recourse curse literature also provide the conflicting results on resource curse.

Most of the resource curse studies have focused on cross-country analysis and comparisons because of better availability of data. However, only a few studies have examined the resource curse hypothesis across states or regions within a country. Whatever within country evidence are available that have concentrated on a few countries, such as the US, Canada, Brazil and Peru. Research in other resource-rich contexts such as Asia is needed to increase the external validity of these results and to better inform policy-makers and practitioners. In India it is still a research question. Although Damania and Gupta (undated) and Behera and Mishra (2012) have tried to examine the resource curse phenomena in Indian states, the methodology, measurement of the variables and coverage of the resource base they have taken require serious scrutiny. Therefore, the present study attempts to fill up these gaps.

4. Modeling framework, methodology and data source

4.1. Testing Pesaran cross section dependence test

In order to test the validity of Resource Curse Hypothesis in the Odisha context, the present study has followed Pesaran (2004). The first empirical work of the present study is to check the cross-sectional dependence among Net District Domestic Product (NDDP), Total Mineral Production (TMP), Investment (INT), Human Resource Development (HRD), Financial Development (FD) and Institutional Quality Index (IQ).

Pesaran (2004) proposed CD test which is based on the average of the pair correlation coefficients $(\rho)_{ij}$ of OLS residuals regressions. Pesaran (2004) considered the following model.

$$y_{it} = \mu_i + \beta_i x_{i,t} + \mathrm{u}_{i,t} \tag{1}$$

where:
μ_i – intercept of the individual district *i;*
β_i – slope coefficient of individual district *i;*
t – 1, 2, 3,…, T is the total time period;
i – 1, 2, 3,…, 16 Corresponding 16 districts;
$x_{i,t}$ is vector of observing time varying regressions;
y_{it} follows íid (0 6_i^2) for all $i\ t$.

Pesaran (2004) proposed following CD statistic

$$CD_p = \sqrt{\frac{2T}{N\,(N-1)}}\ \sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{P}_{i,j} \tag{2}$$

Where: e_{it} the OLS are estimates of $u_{i,t}$ $\hat{p}_{i,j}$ is the sample estimate of the pair-wise correlation of residuals.

$$\hat{p}_{i,j} = \hat{p}_{i,j} = \frac{\sum_{t=1}^{T} e_{i,t}e_{j,t}}{\left(\sum_{t=1}^{T} e_{i,t}^2\right)^{1/2}} = \frac{\sum_{t=1}^{T} e_{i,t}\, e_{j,t}}{\left(\sum_{t=1}^{T} e_{i,t}^2\right)^{1/2}\sum_{t=1}^{T}\left(e_{j,t}^2\right)^{1/2}}$$

4.2. Pesaran's cross-sectional augmented Dickey-Fuller (CADF) test

After confirming cross-sectional dependence, in order to understand the stationary properties of the variables we have applied Pesaran CADF test (Pesaran, 2007). The presence of cross sectional dependence among the variables can be solved by augmenting the standard Dickey-fuller regression with cross sectional average of lagged levels and first differences of the individual series (Pesaran, 2007). The main Pesaran CADF equation follows as

$$\Delta\, y_{i,t} = \alpha_i + \beta_i y_{i,t-1} + y_i \bar{y}_{t-1} + Q_i\, \Delta\bar{y}_t \varepsilon_{i,t} \tag{3}$$

where the unit root test hypothesis will be tested based on the OLS results derived from Eq. (3) with t ratio by $t_i(N,T)$. The Pesaran CADF test is

$$\mathrm{CADF} = t_i(N,T) = \frac{\Delta y_i' \bar{M}_w y_{i-1}}{\hat{\delta}\left(y_{i,-1}' \bar{M}_w y_{i-1}\right)^{1/2}} \tag{4}$$

Where:

$\Delta y_i = \left(\Delta y_{i,1}\Delta y_{i,2}, \dots, \Delta y_{i,2}, \dots, \Delta y_{i,T}\right)'$, $y_{i-1} = \left(y_{i,0}y_{i,1}, \dots, y_{i,T-1}\right)'$, $\tau_T = (1,1 \dots .1)'$,

$M_w = I_T - \bar{W}(W'\bar{W})^{-1}\bar{W}', \bar{W} = \tau(\Delta\bar{y}), \bar{y}_{-1}$

$\Delta\bar{y} = (\Delta\bar{y}_1, \bar{y}_2, \dots, \Delta\bar{y}_T)', \bar{y}_{-1} = (\bar{y}_0, \bar{y}_1, \dots \bar{y}_{t-1})'$

$\hat{6}_i^2\ \frac{\Delta y_i' M_{i,w}\Delta y_i}{T-4}$ $M_{i,w} = I_t$ - $\left(G_i(G_i'G_i)\right)^{-1}G_i'$ and $G_i = (\bar{W}, y_{i-1})$

4.3. Panel Autoregressive Distributed Lag Model (P-ARDL)

The present study has applied panel autoregressive distributed lag model in order to estimate the long-rum relationship among variables based on three alternative estimators such mean group estimator (MG), pooled mean group estimator (PMG) and dynamic fixed effects (DFE). According to Pesaran et al. (1999), an ARDL dynamic heterogeneous panel regression can be written by using ARDL (p, q) approach where "p" is the lags of dependent variable and "q" is the lags of independent variables. The equation can be written as

$$PNDDP_{it} = \sum_{j=1}^{p} \lambda_{ij} PNDDP_{i,t-j} + \sum_{j=0}^{q} \delta'_{ij} TMP_{i,t-j} + \sum_{j=0}^{q} \alpha'_{ij} PNT_{i,t-j}$$
$$\sum_{j=0}^{q} \beta'_{ij} HRD_{i,t-j} + \sum_{j=0}^{q} \Psi'_{ij} FD_{i,t-j} + \sum_{j=0}^{q} \Phi'_{ij} IQ_{i,t-j} + \mu_i + \varepsilon_{it} \quad (5)$$

Where: i = 1, 2, 3,…, N number of cross sectional (Here i = N = 16);

t = 1, 2, 3,..., T total time period (T = 17);

$TMP_{i,t}$, $PNT_{i,t}$, $HRD_{i,t}$, $FD_{i,t}$, $IQ_{i,t}$ are $k \times 1$ vector of the explanatory variables; δ'_{ij}, α'_{ij}, β'_{ij}, Ψ'_{ij}, Φ'_{ij} are the $k \times 1$ coefficient variables; λ_{ij} are the scalars; and μ_i is the cross-section effects. If the variables in Eq. (5) are $I(1)$ and cointegrated, then the error term should follow $I\ (0)$ order in all cross-sections to have long-run equilibrium relationship between the variables. The principal feature of cointegrated variables is that their time paths are influenced by the extent of any deviation from long-run equilibrium. This explain that an error correction model in which the short-run dynamics of the variables in the system can be influenced by the deviation from equilibrium. Here it is necessary to reparametrize Eq. (5) into an error correction equation.

$$\Delta PNNDDP_{it} = \phi_i \left(PNDDP_{i,t-1} - \Theta'_t PMT_{it} \right) + \sum_{j=1}^{p-1} \lambda^*_{ij}\, \Delta PNDDP_{i,t-j} +$$
$$\sum_{j=0}^{q-1} \delta'^*_{ij}\, \Delta TMP_{i,t-j} + \sum_{j=0}^{q-1} \Psi'^*_{ij}\, \Delta PNT_{i,t-j} \sum_{j=0}^{q-1} \alpha'^*_{ij}\, \Delta HRD_{i,t-j} + \sum_{j=0}^{q-1} \beta'^*_{ij}\, \Delta FD_{i,t-j} +$$
$$\sum_{j=0}^{q-1} \Omega'^*_{ij}\, \Delta IQ_{i,t-j} \quad (6)$$

Where:

$\Phi = -\left(1 - \sum_{j=1}^{p} \lambda_{ij}\right)$, $\Theta_i = \frac{\sum_{j=0}^{q} \delta_{ij}}{(1 - \Sigma k \lambda_{ik})}$

$\lambda^*_{ij} = - \sum_{m=j+1}^{p} \lambda_{im}$,

$j = 1, 2,\ldots, p - j$

$\delta^*_{ij} = - \sum_{m=j+1}^{q} \delta_{im} \qquad j = 1, 2, 3, \ldots, q - 1$

$\Psi^*_{ij} = - \sum_{m=j+1}^{q} \delta_{im} \qquad j = 1, 2, 3, \ldots, q - 1$

$\alpha^*_{ij} = - \sum_{m=j+1}^{q} \alpha_{im} \qquad j = 1, 2, 3, \ldots, q - 1$

$\beta^*_{ij} = - \sum_{m=j+1}^{q} \alpha_{im} \qquad j = 1, 2, 3, \ldots, q - 1$

$\Omega^*_{ij} = - \sum_{m=j+1}^{q} \Omega_{im} \qquad j = 1, 2, 3, \ldots, q - 1.$

The ϕ_i is speed of adjustment parameter. The speed of adjustment parameter must be non-zero. If $\theta_i = 0$, then there would be no long-run relationship. This parameter is expected to be negative sigh with statistical significance under the assumption of bringing back the variables to the long-run equilibrium. But more recently Pesaran, Shin and Smith (1997, 1999) propose a PMG estimator which combines both averaging and polling the residuals. This test incorporates the intercept, short-run coefficients, and different error variances across the groups (like the MG estimator). However, it holds the long-run coefficients to be equal across the groups (like FE estimators).

$$\hat{\phi} = N^{-1} \sum_{i=1}^{N} \hat{\phi}_i \tag{7}$$

With the variance

$$\hat{\Delta}_{\hat{\phi}} = \frac{1}{N(N-1)} \sum_{i=1}^{N} \left(\hat{\phi}_i \hat{\phi}\right)^2 \tag{8}$$

The Eq. (6) can be estimated by three different estimators such as mean group estimator of Pesaran and Smith (1995), pooled mean group estimator developed by Pesaran et al. (1999) and dynamic fixed effects estimator. According to Pesaran and Shin (1999), Panel ARDL can be applied even if the variables follow different order of integration, i.e. $I(0)$ and $I(1)$ or a mixture of both.

The present study has collected annual data covering the period 1995-2015 for 16 districts of Odisha. Data on Net District Domestic Product (NDDP) has been collected from the income cell department of the Directorate of Economics and Statistics Odisha. Data on total mineral production (TMP) has been collected from the Directorate of Mine Odisha. Data on human capital investment (HRD), financial development (FD), investment (INV), and institutional quality (IQ) have been collected from the various publication of District Statistical handbook of the Directorate of Economics and Statistics Odisha, Bhubaneswar. An institutional quality index is constructed as the proxy of institutional quality by taking incidence of crimes such as murder, dacoity, robbery, burglary, theft, rioting, swindling and cheating, rap, kidnapping and miscellaneous through Principal Component Analysis. Data on all variables are available up to 2015. All the variables are transferred into natural logarithm.

5. Results and discussions

The traditional unit root tests do not address the cross sectional dependence which might lead to an incorrect interpretation towards the stationary properties large panel data. To address this problem, the present study has applied CD (Pesaran, 2004) test to check cross section interdependence between Net District Domestic Product (NDDP), Total Mineral Production (TMP), Investment (INT), Human Resource Development (HRD) Financial Development (FD) and Institutional Quality Index (IQ). The CD test is based on the average of the pair correction coefficients of OLS residuals regression. CD test result is reported in Table 1 which rejects the null hypothesis of no cross-dependence between the variables. It means there is high dependence between Net District Domestic Product (NDDP), Total Mineral Production (TMP), Investment (INT), Human Resource Development (HRD), Financial Development (FD) and Institutional Quality Index (IQ) in the districts of Odisha.

Table 1. *Pesaran Cross-section Dependency tests*

Test	Statistics	P-value
CD	32.457	0.0000

After confirming cross sectional dependence among the variables, the present study has employed Pesaran Cross Sectional Augmented Dickey-Fuller (PCADF) unit root tests to check stationary properties of variables. In order to test the panel cointegration among variables, the first step is to examine the unit roots properties of the data, because the variables must be integrated of the same order. The PCADF test results are reported in Table 2. The results show that NDDP, TMP, INT, HRD, FD, and IQ follow I (0) and I (1) orders respectively.

Table 2. *Pesaran's Cross-sectional Augmented Dickey-Fuller (CADF) test results*

variables	Constant		Constant & Trend	
	T Bar	P-value	T Bar	P-value
lnNDDP	-1.489	0.859	-2.416	0.324
lnTMP	-2.714	0.000***	-3.078	0.000***
lnINT	-2.330	0.008**	-2.639	0.079
lnHRD	-2.121	0.063	-2.147	0.759
lnFD	-3.825	0.000***	-4.437	0.000***
lnIQ	-1.766	0.474	-2.035	0.882
ΔlnNDDP	-3.088	0.000***	-3.062	0.001**
ΔlnTMP	-4.057	0.000***	-4.332	0.000***
ΔlnINT	-3.103	0.000***	-3.135	0.000***
ΔlnHRD	-3.034	0.000***	-3.087	0.001**
ΔlnFD	-4.525	0.000***	-4.266	0.000***
ΔlnIQ	-2.860	0.000***	-3.115	0.000***

Note: The critical values are -2.340, -2.170, and 2.070 at 1%, 5%, and 10% respectively with constant. 2.880, -2.690, and -2.590 at 1%, 5%, and 10% respectively with constant and trend. The ***, **, and * indicate 1%, 5%, and 10% level of significance.

The results of the pooled mean group (PMG), mean group (MG) and dynamic fixed effects (DFE) are reported in Table 3.

Table 3. *Panel ARDL Model Results (Pooled Mean Group and Mean Group Estimates) (Dependent Variable: ΔlnNDDP)*

	Pool Mean Group		Mean Group		Dynamic Fixed Effects	
Variables	Coefficients	Std. error	Coefficients	Std. error	Coefficients	Std. error
Long-run						
lnTMP	-0.217**	0.084	0.009	0.069	-0.016	0.025
lnINT	0.200	0.121	0.466**	0.248	0.213**	0.070
lnHRD	-0.435	0.597	-0.663	0.538	0.371	0.291
lnFD	-0.022	0.0683	0.005	0.234	0.017	0.021
lnIQ	0.106	0.141	0.807	0.424	0.173	0.066
Error Correction	0.011	0.058	0.323***	0.089	0.396	0.214
Short-run Coefficients						
ΔlnTMP	-0.010	0.008	-0.065	0.056	-0.010	0.007
ΔlnINT	0.115	0.091	0.113	0.089	0.049	0.035
ΔlnHRD	0.048	0.312	0.000	0.108	0.041	0.105
ΔlnFD	0.001	0.010	0.089	0.100	-0.003	0.009
ΔlnIQ	-0.023	0.022	0.184	0.203	0.015	0.026
Intercept						
No. of Districts	16					
Observations	320					

Note: Δ is first difference operator; ***, **, and * indicate 1%, 5%, and 10% level of significance; PMG means pooled mean group; MG means mean group; EC is error correction term.

According to PMG estimator, TMP has a negative and significant impact on NDDP in the long-run. However, in the short-run, although TMP has a negative coefficient but it is not statistically significant. According to MG estimator, TMP has a positive coefficient, but it is not significant. INT has positive impact on NDDP in the long-run. In the short-run, although TMP has negative coefficient but it is not statistically significant. DFE estimators do not support any short-run and long-run causality between variables. INT has positive and significant impact on NDDP.

However, in order to measure efficiency and consistency among the estimators (PMG, MG and DFE) the Hausman test has been applied. The results of the Hausman test are reported in Table 4.

Table 4. *Hausman Test*
(Dependent Variable: lnNDDP)

	MG	PMG			MG	DFE		
	Coefficients	Coefficients	Difference	S.E	Coefficients	Coefficients	Difference	S.E
lnTMP	0.009	-0.217	0.227	0.083	0.009	-0.016	0.025	0.832
lnINT	0.466	0.200	0.266	0.409	0.466	0.213	0.252	2.999
lnHRD	-0.663	-0.435	-0.227	0.704	-0.663	0.371	-1.034	6.487
lnFD	0.005	-0.022	0.027	0.397	0.005	0.017	-0.012	2.832
lnIQ	0.807	0.106	0.701	0.715	0.807	0.173	0.633	5.123
Chi-2	47.38	P-Value	0.0000		Chi-2	0.11	P-value	0.9998

The Hausman test results accept the null hypothesis of homogeneity restrictions on the long-run regressors. This indicates that PMG is a more efficient estimator than MG or DFE. From the overall panel ARDL model, we found that there is a negative relationship between natural resource abundance and economic growth in the long-run. However, in the short-run, although TMP has a negative coefficient but it is not statistically significant. The results confirm the existence of natural resource curse in the mineral-rich districts of Odisha.

6. Conclusion and policy implications

This study investigates the presence of resource curse hypothesis in mineral-rich districts of Odisha, India. Pesaran (2004) CD test has been employed by the present study to check the cross-sectional dependence among variables and the results of this test shows that there is high dependence among variables. After confirming cross sectional dependence among the variables, the next step is to check stationary properties of variables and for this the present study has employed Pesaran Cross Sectional Augmented Dickey-Fuller (PCADF) unit root test. The results show that NDDP, TMP, INT, HRD, FD, and IQ follow I (0) and I (1) orders respectively.

After that the ARDL model has been applied in order to estimate the long-rum relationship among variables based on three alternative estimators such mean group estimator (MG), pooled mean group estimator (PMG) and dynamic fixed effects (DFE). The study finds that there is a negative relationship between natural resource abundance and economic growth in the long-run. The results confirm the existence of natural resource curse in the mineral-rich districts of Odisha. Government should launch environmental friendly policies to explore natural resources & attain maximum benefit. Financial development and trade openness should be used as policy tools to exploit natural resources which in turn, will enhance domestic production and hence economic growth.

The study suggests that further in depth research is needed to understand the relationship between natural resource abundance and economic growth at the micro level. Further, a deeper understanding of determinants of the relationship or the so-called transmission channels with adequate focus on policies and institutions is required. In this regard as suggested by Behera and Mishra (2012) the development of a more comprehensive index of natural resource abundance that can adequately capture the various proxies such as, share of mining production in GDP, land per capita, share of natural resources export in GDP, share of labour force in the primary sector and mining employment might be a problem. To avoid this problem the future research can take into consideration of all the proxies which are used to measure natural resource abundance in a principal component analysis to make a single comprehensive index of natural resource abundance.

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