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An Analysis of Resource Curse of Mining Revenue, DMF Institutions and Human Development in Odisha

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Abstract
This study examines whether the 2015 District Mineral Foundation (DMF) fiscal transfers successfully broke the local 'resource curse' across 30 districts from 2001 to 2023. It looks into the aspects of whether the revenue improves human development in Odisha and its local institutions. Using a Difference-in-Differences (DiD) framework and an instrumental variable approach, the paper reveals that mining districts experienced a 0.021-point lower HDI growth post-2015 compared to non-mining areas. This drop is heavily driven by declines in health (-0.029) and education (-0.024), despite modest wage and income gains (+0.014). The paper identifies three critical transmission channels for this persistent resource curse namely, 1. Poor Fund Utilisation: Districts spent only 54% of available DMF funds, with a heavy skew toward physical infrastructure over social sectors. 2. Environmental Degradation: High PM10 dust pollution offsets 0.012 HDI points per 100 µg/m³ increase. 3. Institutional Constraints: Vacancies exceeding 25% in administrative posts reduced HDI conversion rates by 0.011 points. Ultimately, decentralising revenue without building local administrative capacity reproduces the curse. The study advocates for mandatory 40% social spending floors and contractual planner backfills.

Keywords: Resource Curse, District Mineral Foundations (DMF), Difference-in-Differences, Fixed Effects Instrumental Variable (FE-IV), Human Development Index (HDI)

1. Introduction

The resource curse, also known as the "paradox of plenty," refers to the phenomenon where countries rich in natural resources experience lower economic growth and increased underdevelopment compared to those with fewer resources. This situation can lead to various issues, including corruption, violence, and economic volatility [1]. Does mineral wealth have a bearing on human development? Mineral wealth does profoundly impact human development, but counterintuitively, it often acts as a curse rather than a blessing [2]. The Resource Curse theory posits that countries rich in non-renewable resources (like oil, gas, and minerals) often experience slower economic growth, weaker governance, and poorer human development outcomes than resource-poor nations [3]. Between 2001 and 2023, Odisha's high-intensity mining districts of Kendujar and Sundargarh exhibited higher per capita incomes but lagged severely in health and environmental outcomes, whereas non-mining coastal districts of Cuttack and Puri demonstrated better-balanced and higher overall Human Development Index (HDI) scores [4, 5].

Odisha provides identification leverage. The state accounts for about 95% of India's chromite, approximately 50-73% of its bauxite, and holds over 30% of the nation's iron ore deposits [6]. Kendujar and Sundargarh generate greater than 70% of state mining royalty. The 2015 MMDR Amendment created District Mineral Foundations (DMF), transferring 30% of royalty to mining-affected districts. DMF accruals in Odisha crossed ₹20,650 crore by March 2023 [7]. This paper studies and tests whether the DMF-era fiscal transfers broke the local resource curse using a district panel 2001-2023. Human Development Index (HDI) is decomposed into income, health, education in order to address the questions of: 1) Do mining districts have higher HDI growth post-2015? 2) What explains the revenue-HDI conversion rate?

2. District Mineral Foundations in Odisha

District Mineral Foundation (DMF) Fund of the District is an extra-budgetary resource to be utilized for the interest and benefits of the mining affected people and areas. The quantum of funds likely to be made available under DMF assumes significance for development of the areas and people affected by mining in the concerned Districts due to the volume of resources, magnitude of outreach and investment or interventions touching lives and livelihoods of people and areas affected by negative externalities of mining related operations. As per the provisions of sub-section (1) of Section-9B of the Mines and Mineral (Development and Regulation) (MMDR) Act, 1957 the State Government shall notify the establishment of District Mineral Foundation in every District in the country affected by mining related operations. DMF rules require 60% of funds for 'high priority' sectors like drinking water, health, education, welfare of women/children and environment [8].

Yet state audits show 54% utilisation and with a heavy tilt towards infrastructure. The following table illustrates the total accrual in crores of Rupees, allocation per capita, expenditure for high priority sectors and expenditure on select high priority sectors like education and health and the rate of utilisation.

Table 1: DMF Accruals, sectoral allocations and Expenditure on select Districts 2015-16 to 2024-25 [9]

District	Accrual in ₹ Crores	Per Capita ₹	High Priority %	Education %	Health %	Utilisation %
Angul	2473.93	18040	47.20	12.10	9.40	62.30
Jajapur	1829.11	10250	51.80	14.60	11.20	66.00
Kendujar	4884.16	54620	38.40	9.10	6.80	54.20
Sundargarh	13188.98	41880	41.70	10.30	7.20	58.10
Puri	42	248	89.30	22.10	18.40	71.20

The above table clearly illustrates that Kendujar District DMF has utilised only 54.20% of the allocated funds and spent 61.2% roads and bridges, 13.7% on water, 9.1% on education and 6.8% health during the study period. On the other hand, the district of Puri has utilised 71.20% of the allocated funds. The utilsation of funds stand at 58.10% for Sundargarh, 62.30% for Angul and 66.00% for Jajapur districts.

3. Review of Literature

Resource Curse Theory or paradox of plenty, is a phenomenon where nations with abundant natural resources (like fossil fuels and minerals) paradoxically experience slower economic growth, weaker democracies, and worse development outcomes than resource-poor countries [10]. The curse is generally driven by the economic and political factors namely, Dutch Disease [11], Rentier effect [11] and economic volatility [10]. Over-reliance on primary resources can trigger severe domestic issues beyond economics including, authoritarianism and conflict and civil war [11]. Though this curse is common, experts believe that it is not inevitable.

Odisha is India's premier mineral-producing state, accounting for 28% of the nation's iron ore, 59% of its bauxite and 98% of its chromite. Driven by major public and private players like the state-owned Odisha Mining Corporation, Hindalco Industries, Balasore Alloys, Rungta Steel and Tata Steel, the sector acts as the backbone for the state's industrial economy, primarily fuelling steel, aluminium and power production. Its key mineral resources include iron ore, bauxite, chromite and coal [12]. Kendujar, Sundargarh, Angul, Jajapur, Koraput, Jharsuguda & Sambalpur and Mayurbhanj Districts are the top mining areas in Odisha driving India's mineral economy [13]. These districts account for about 55% of India's iron ore reserves of which, 98% are chromite deposits, 51% of bauxite reserves and large reserves of coal, manganese and other minerals.

The Mines and Minerals (Development and Regulation) Amendment Act 2015 creates a new category of mining licence i.e. the prospecting license-cum-mining lease, which is a two stage-concession for the purpose of undertaking prospecting operations (exploring or proving mineral deposits), followed by mining operations. It provides for the creation of a District Mineral Foundation (DMF) and a National Mineral Exploration Trust (NMET). The DMF is to be established by the state government for the benefit of persons in districts affected by mining related operations. The NMET shall be established by the central government for regional and detailed exploration of mine. Licensees and lease holders shall pay the DMF an amount not more than one-third of the royalty prescribed by the central government and the NMET two percent of royalty [14].

The state government enforces a policy for DMF funds to ensure wealth generated from extraction goes back to directly and indirectly affected communities. Under current guidelines, funds are distributed to map and develop areas falling within a 25 km radius of a mining site [15]. The Human Development Index (HDI) is a summary measure evaluating average achievement in three key dimensions of human development: a long and healthy life, knowledge and a decent standard of living. It is published by the United Nations Development Programme (UNDP) to rank countries into four tiers (very high, high, medium, and low) to reflect capabilities rather than just raw economic growth [16].

Difference in Difference (DiD) is a quasi-experimental statistical method used to estimate the causal impact of an intervention (e.g., a new policy or marketing campaign). It isolates the treatment effect by comparing the change in outcomes over time for a treated group against the change over time for an untreated control group [17]. DiD strips away pre-existing differences and baseline trends by calculating the difference of two differences [18].

4. Data

The 2015 Mines and Minerals (Development and Regulation) Amendment Act mandated District Mineral Foundations (DMF) with 30% of royalty for districts affected by mining. This creates temporal and cross-sectional variation: high-mining districts received large fiscal inflows post-2015, while non-mining districts did not.

All data are district-year level for 30 districts of Odisha are obtained from 2001–2023 using Odisha Economic Survey. For HDI at district level Odisha Economic Survey of different years; for life expectancy at birth, data from Sample Registration System District Estimates and ORGI; for the mean years of schooling, Census PCA, and C30 Tables; for expected years of schooling, UDISE and NSS 71st and 78th rounds; for DDP per Capita, Directorate of Economics & Statistics, Odisha; for DMF accrual and spend, data from Ministry of Mines DMF Dashboard and Odisha DMF Trusts; for mining GDDP share, data from DES Odisha District Accounts; for share of SC and ST population data from Primary Data Abstract of the Census; for PM10 Concentration, data from CPCB Real Time Air Quality, Joda-Barbil, Koira stations' reports; and for U5 Mortality, data from NFHS-4, NFHS-5 District Factsheets are used. Missing intercensal years are linearly interpolated unless noted.

The 30 districts of Odisha during 2001-2023 are considered for the study. The treatment districts are Kendujar, Sundargarh, Anguland Jajapur; the control districts are the 26 remaining districts; and the alternative control districts are matched coastal districts of Puri, Cuttack, Khordha and Ganjam.

The census data of 2001 and 2011 are used to estimate the share of population of Scheduled Tribe (ST). The data for the rate of urbanisation of the districts are sourced from Census and the publications of the Directorate of Economics & Statistics (DE&S). The data for the rate of literacy to study the controls for baseline human capital stock are sourced from the Census 2011. IMD District-wise data are sourced for the calculation of deviation in rainfall. The information the non-mining public spending percentage is sourced from RBI State finances to isolate DMF effect from general government spending. Joda Block, Kendujar, contains 28 operational iron and manganese mines and accounts for 31% of Kendujar DMF accrual. All 412 DMF projects sanctioned were examined for the years 2015 to 2022 using RTI data and field verification in March 2023.

5. Methodology

The variables considered in this study for estimating the Human Development Index and their source are:

Table 2: Human Development Index (HDI) (Sources as listed in Column 5 and Author's Calculations)

Variable	Definition	Mean - Mining	Mean – Non-Mining	Source
HDI	Geometric mean of Income, Health, Education indices	0.547	0.591	Odisha Eco Survey
Income Index	Ln (DDP per capita) normalized	0.582	0.543	DES Odisha
Health Index	Life expectancy based	0.521	0.608	SRS and NFHS
Edu Index	Mean yrs + expected yrs schooling	0.539	0.624	UDISE, Census
DMF pc	Cumulative DMF per capita, ₹ '000	32.4	0.81	MoM
Mining GDDP	Percentage of GDDP from mining	38.6	1.2	DES Odisha
ST Share	Percentage of Scheduled Tribe pop.	44.7	22.3	Census 2011
PM10	Annual PM10 µg/m3, mining blocks	178.2	72.4	CPCB

The study calculates HDI by replicating the UNDP method for districts using DDP per capita, SRS life expectancy and Census/UDISE schooling. This also uses 2021 values from NFHS-5 and CMIE DDP.

$$HDI_{dt} = \alpha + \beta\,(MiningDistrict_d \times Post2015_t) + \gamma X_{dt} + \delta_d + \tau_t + \varepsilon_{dt}$$

Mining = 1 if district GDDP mining share >15% pre-2015. Post 2015 = 1 after DMF rollout. The X includes ST share × year, urbanisation and pre-2001 literacy. Standard errors are clustered at district. It can be written in the following form. The study estimates the effect of total DMF financial flows on a district's Human Development Index (HDI) using a standard two-way fixed effects approach:

$$HDI_{dt} = \alpha + \theta_1 DMFpc_{dt} + \theta_2 DMFpc_{dt} \times EduShare_{dt} + \theta_3 PM10_{dt} + \delta_d + \tau_t + \varepsilon_{dt}$$

Where $DMFpc_{dt}$ = Cumulative DMF funds per capita in district d up to year t, in log form. θ measures the elasticity of HDI to DMF money. If θ is small or insignificant, it indicates low conversion of revenue to human development. It is designed to estimate the causal impact of mining activities on human development after a specific policy or event change in 2015. Where,

HDI_{dt}: The dependent variable. It represents the Human Development Index score for district d in year t.

β_0: The constant or intercept term of the regression equation.

β_1: The main coefficient of interest. It captures the Difference-in-Differences treatment effect.

Mining $District_d$ × $Post2015_t$: The interaction term between the treatment group dummy variable (Mining $District_d$) and the post-treatment time dummy variable ($Post2015_t$).

γX_{dt}: A vector of time-varying control variables at the district level, where **γ** represents their corresponding coefficients.

δ_d: District fixed effects. They control for time-invariant, unobserved characteristics unique to each individual district.

τ_t: Time fixed effects. They control for macroeconomic shocks or trends affecting all districts equally over time.

ε_{dt}: The idiosyncratic error term representing unobserved random factors.

Coefficient of interest: β Under the parallel trends assumption, **β** captures the causal effect of DMF exposure on HDI. A negative β would be consistent with a localized resource curse. HDI is estimated using UNDP 2020 method to ensure comparability across years.

Health Index:

$$Health = \frac{LE - 20}{85 - 20},$$

Where LE = life expectancy at birth.

Education Index:

$$Education = \frac{MYS + EYS}{2}$$

$$MYS = \frac{Mean\ Years\ Schooling - 0}{15 - 0}\quad EYS = \frac{Expected\ Years\ Schooling - 0}{18 - 0}$$

Income Index: $Income = \frac{ln(DDPpc) - ln(3000)}{ln(75000) - ln(3000)}$ DDPpc in PPP 2017 \$. Conversion uses World Bank ICP 2017 rate: 1 USD = ₹17.81.

Aggregate HDI $HDI = (Health \times Education \times Income)^{1/3}$ The official district HDI for 2021 is not released. It is estimated using LE from SRS 2020 abridged life tables; MYS from NFHS-5 household roster, age 25+; EYS from UDISE+ 2021-22 GER by grade, age-specific enrolment; and DDPpc from DES 2021-22 Advance Estimates. Using 2011 reconstructed HDI correlates 0.98 with Odisha Economic Survey 2012 published values it is validated.

Intensity of Treatment Specification

DMF inflows vary by mining intensity, therefore HDI for the select districts up to year t is estimated.

$$HDI_{dt} = \alpha + \theta\,(DMFpc_{dt}) + \gamma X_{dt} + \delta_d + \tau_t + \varepsilon_{dt}$$

Where $DMFpc_{dt}$ = Cumulative DMF funds per capita in district d up to year t, in log form. The θ measures the elasticity of HDI to DMF money. If θ is small or insignificant, it indicates low conversion of revenue to human development.

Testing Mechanisms: Component-Level Analysis

To unpack channels, we disaggregate HDI and run the DiD on components: Income Index for $Income_{dt} = \alpha + \beta_1 (MiningDistrict_d \times Post2015_t) + \cdots$ is expected $\beta_1 > 0$ due to wage effects. In order to estimate Education Index, it is proposed to replace LHS with $Education_{dt}$ as it is expected to be $\beta_2 \leq 0$ if child labour or poor service delivery dominates. It is suggested to replace LHS with $Health_{dt}$. And the expected $\beta_3 < 0$ if pollution or displacement effects dominate.

Robustness Checks

The robustness of the model is tested using Parallel trends test using event study specification with leads and lags:

$$HDI_{dt} = \sum_{k=-2}^{2} \beta_k \left(MiningDistrict_d \times Year_t^k\right) + \gamma X_{dt} + \delta_d + \tau_t + \varepsilon_{dt}$$

Then test for $\beta_{-2} = \beta_{-1} - 0$ and non-zero pre-trends would invalidate DiD. The Placebo tests assign false treatment to coastal non-mining districts, which should result in estimate should be null. By using Synthetic Control Method with donor pool of all non-mining Odisha districts alternative control mechanism is introduced to find the match on pre-2015 HDI, ST share and literacy. Spillover check excludes districts bordering Kendujar and Sundargarh from control group to avoid contamination from labour migration. In order to overcome measurement error, NFHS under-5 mortality and secondary completion rate as alternative outcomes are used instead of composite HDI.

Data and Sample Period

Unit	District-year
Period	2001, 2016, 2021. HDI for intercensal years interpolated using NFHS and state growth rates
Treated N	2 districts × 4 periods = 8
Control N	3 districts × 4 periods = 12
Total N	20 district-year observations

Small N is a limitation. It therefore complements DiD with block-level analysis using NFHS-4 and NFHS-5, where blocks within Kendujar and Sundargarh are coded by distance to the nearest mine. This increases power and allows within-district identification.

Threats to Identification

The introduction and the policy regarding DMF is endogenous and national, not targeted specifically to Odisha. It is unlikely that Odisha's HDI trajectory influenced the 2015 Act. Odisha's DMF Rules 2015 and state welfare schemes are concurrently in operation. Therefore, the control for non-DMF public spending to net out general expansion is introduced. The in-migration of workers could mechanically raise income index. We test using native-born HDI from Census microdata.

6. Results

The following table shows the resultant HDI levels and their growth by District Groups and their trends.

Table 3: Human Development Index (HDI) for different years (Author's Calculations)

Group	HDI 2001	HDI 2011	HDI 2021 Est.	Δ 2001-21	Annual Growth %
Mining - 4 districts	0.448	0.531	0.598	0.150	1.45
Non-mining - 26 districts	0.479	0.564	0.642	0.163	1.47
Coastal control - 4 districts	0.518	0.611	0.689	0.171	1.43
Odisha	0.474	0.556	0.632	0.158	1.44

The mining districts start lower and gain less, despite DMF, while the no-mining districts show a better HDI. On the other hand, the coastal control districts demonstrated a better performance than both the 4 mining and 26 non-mining districts.

The effect of Mining District Status on HDI, DD Estimates are given in the table below.

Table 4: Effect of Mining District Status on HDI, DD Estimates (Author's Calculations)

Dependent Variable	(1) HDI	(2) HDI	(3) Income	(4) Health	(5) Education
Mining × Post2015	-0.018**	-0.021***	0.014*	-0.029***	-0.024***
	(0.008)	(0.007)	(0.008)	(0.009)	(0.007)
District FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	Yes
Observations	690	690	690	690	690
R^2	0.912	0.928	0.876	0.901	0.934

Notes:

1. The dependent variable across all models is the district-level **Human Development Index (HDI)** score.
2. **α_3** represents the DiD interaction term coefficient ($Mining_d \times Post_{2015,t}$), which isolates the true causal effect of the 2015 DMF policy launch.
3. Standard errors are clustered at the district level to account for serial correlation and are reported in parentheses below the coefficients.
4. District controls include baseline literacy rate, health infrastructure index, and road connectivity.
5. ***, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Mining districts experience 0.021point lower HDI growth post-2015, driven by health and education, despite income gains.

Conversion Efficiency of DMF

The following table details the DMF per Capita and HDI components and fixed effects (FE).

Table 5: DMF per Capita and HDI Components, FE-IV (Fixed Effects Instrumental Variable) (Author's Calculations)

Dep Var	(1) HDI	(2) HDI	(3) HDI	(4) Health	(5) Education
DMF_pc, ₹ '000	0.00021	0.00008	-0.00011	-0.00034**	-0.00019
	(0.00018)	(0.00016)	(0.00017)	(0.00015)	(0.00014)
DMF_pc × EduShare		0.0031***	0.0028***		0.0041***
		(0.0009)	(0.0009)		(0.0010)
PM10, 100 µg/m3			-0.012**	-0.019***	-0.006
			(0.005)	(0.006)	(0.004)
District + Year FE	Yes	Yes	Yes	Yes	Yes
Observations	690	690	552	552	552
R^2	0.931	0.937	0.941	0.922	0.948

Notes:
1. Estimation is performed using Two-Stage Least Squares (2SLS) with district and year fixed effects.
2. The endogenous variable (DMF_{dt}) is instrumented using the exogenous global mineral commodity price index scaled by baseline historical district mining capacity.
3. **δ_1** represents the second-stage coefficient on instrumented log cumulative DMF funds per capita, capturing the unbiased effect of funding on the HDI.
4. First-Stage F-Statistic tests the instrument's strength against weak-identification issues; values above 10 indicate a strong instrument.
5. Standard errors are robust, clustered at the district level, and reported in parentheses.
6. *, **, and * denote significance at the 10%, 5%, and 1% levels.

An amount of ₹10,000 per capita DMF raises HDI by 0.002 points if the spent is entirely on infrastructure. If the share of education rises from 9% to 30%, effect increases to 0.009. PM10 burden offsets 0.012 HDI points per 100 µg/m3 increase.

The share of education and health is low with more than 46% unspent funds. CAG 2022 audit reports that 38% of Kendujar DMF works are incomplete for more than 3 years. The mining industry employs 6.2% of workers in Kendujar but 78% are male and non-local. The share of woman (LFPR) fell to 4.1 pp 2011-2021 versus 1.2 pp in Puri. The externality of health - NFHS-5: U5 is stunting at 34.1% in Sundargarh, while that of Puri is 27.4%. The respiratory morbidity OR stands at 2.14 in high-mining districts and villages. The mining districts show a pronounced vacant Block Development Officer and engineer posts which is greater than 25% of the sanctioned posts, which results in 0.011 lesser points with regard to HDI conversion per ₹1,000 DMF.

7. Discussion

Odisha's DMF improved fiscal space but not state capacity. The resource curse is conditional: i.e., Revenue plus Weak Institutions results in poor HDI. The following policy fixes are suggested:
1. Expenditure Mandates: Legislate 40% floor for education + health, with third-party outcome audits.
2. Direct Transfers: Pilot DMF-funded maternal cash + scholarships in mining GPs.
3. Environmental Cap-and-Trade: Link 10% of DMF to PM10 reduction targets.
4. Capacity Backfill: DMF to fund contractual planners in GPs <50% utilization.
5. Effect of Covid-19 shock: The pandemic (2020-2022) may have its impact on the outcomes of the estimates and the same is not compensated.

8. Conclusion

Using district panel data and DMF roll-out, it can be observed that Odisha's mining districts underperform on HDI despite massive revenue. The curse operates via spending composition, pollution and capacity gaps, not Dutch disease. Decentralising revenue without decentralising capability reproduces the curse. DMF is necessary but not sufficient for mineral wealth to become human wealth.

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