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Development Achievement and Resource Abundance- Study of Resource Curse in Indian States

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Abstract

The study attempts to establish the resource curse theory in Indian resource-rich states by examining the contribution of mineral royalty revenues and mineral production value to social and human development outcomes. It further tries to understand the development achievement of resource abundant states through comparative descriptive analysis. Three indicators of development achievement, Human Development Index (HDI) and Sustainable Development Goal (SDG) Index and Social Progress Index (SPI) are considered in the analysis and two indicators of mineral resource abundance, production value (PV) of total minerals (fuel, metallic and non-metallic) and royalty (R) received from mineral products by the state, have been taken. Further, the study uses a moderation model to mitigate the impact of resource curse. The moderating variables is state DMF and the model estimates the relationship between SPI, royalty revenue, and DMF expenditure. A cross-sectional data of 15 mineral-rich Indian states are taken. The analysis establishes resource curse in Indian rich resource states by giving a negative association between resource abundance and development achievement variables. The comparative descriptive analysis concludes that the distribution of development achievements of states with higher resource concentration are relatively lower than those with relatively less resources. DMF fail to exhibit statistically significant moderation, suggesting that resource abundance alone is insufficient to ensure inclusive development and even the DMF fund cannot moderates the negative effect. It is important that along with DMF fund strong institutional effectiveness, efficient implementation, and sustainability-oriented governance is created.

Keywords: Resource Abundance, Development Achievement, Resource Curse, District Mineral Foundation, Institution

1. Introduction

The relationship between resource endowment and development is not straight forward. Resource-rich countries like Botswana, Australia, Canada and Norway have proved to be growth gainers. On the contrary, many other resource-rich countries suffer from macroeconomic instability, high level of poverty, rampant corruption, deindustrialization, persistent authoritarianism and inclination towards conflict. Nigeria, Zambia, Sierra Leone, Angola, Venezuela and Saudi Arabia are lagging in terms of growth and development. Lack of resources may not also be a serious impediment to development as demonstrated by the

impressive development trajectory of resource-poor countries like Korea, Hong Kong, Singapore and Taiwan. Such contradictory empirical evidence has led to a debate whether natural resource is a curse or a blessing.

The discussion on the phenomena of many of the resource-rich countries having negative development outcomes, termed as “Resource Curse”, started in 1980s.It received formal recognition with the work of Sach and Warner (1995). Their inter-country empirical study revealed that resource rich economies, with high natural resource exports to GDP ratio, experience low growth rates. Plethora of studies has been conducted subsequently, with variations in context and methodology, to understand whether natural resource abundance is really a curse.

Despite India being a resource-rich country, there are limited studies on the phenomena of natural resource curse. It is well known that per capita income and growth rates of resource-rich states, like, Jharkhand, Orissa and Chhattisgarh are worse than that of resource-poor states like Kerala, Tamil Nadu, Punjab and Maharashtra. Scant literature available for India indicates that there could be problems of efficient resource use in Indian states. This problem, perhaps, centres around three broad issues: (a) the quality of institutions in the resource rich states that allocate and utilize resource rents for economic development, (b) large-scale rent seeking activities as a result of weak institutions, and (c) unfavourable investment policy of the state government that discourage investors to invest in resource exploitation (Behera& Pulak, 2012). Nonetheless, effective dealing with these issues requires a deeper understanding of the relationship between abundance of natural resources and economic development across Indian states and the determinants of this relationship with adequate focus on policies and institutions. In this context, a study on natural resource curse in India assumes significance.

The objective of the paper is to identify resource curse in Indian rich resource states and to understand the development achievement of resource abundant states. The paper also tries to o examine whether District Mineral Foundation Fund helps in improving development achievements

In this regard, the paper attempts to examine the contribution of mineral royalty revenue and mineral production value to social and human development outcomes, in order to assess resource curse theory in Indian states. Further develops a moderation model to examine whether District Mineral Foundation (DMF) fund helps in improving the development indicators of the states. The findings reveal a negative association between resource abundance

and development achievement of Indian states, hence establishing resource curse in Indian resource-rich states. Further, the development statistics of states with higher resource concentration are relatively lower than those with relatively less resources. Finally, the presence of DMF fund alone does not automatically improve social development of mining affected regions

The paper is divided in different sections. Section1 gives literature review on conceptual and theoretical aspects of resource curse. Section 2 explains the research methodology, section 3 discusses the data analysis and interpretation and lastly, recommendation and conclusion is given.

2. Literature Review

The literature review section explains the conceptual and theoretical aspects wherein the concept of resources, resource curse and the major theoretical paradigm are discussed.

2.1 Concept of Resources and Resource Curse

In a typical production function, natural resource can appear explicitly as an input in the following manner (The World Trade Report 2010):

Y = f {K, L, N)

Where, N - Natural Resources (NR); K- Capital; L- Labour

Firstly, natural resources can be bifurcated as factors of Production and as goods that is directly traded. Minerals, oil, fuels, ores and other mineral, fish, forestry products and non-ferrous metals are considered as factors of production. Agricultural land, climate, scenery, water and land fall under the category of resources which are directly traded. Second, the characteristics of natural resource share the feature of exhaustibility, uneven distribution, externalities, dominance and volatility[1].

[1]*Exhaustibility* is true for both renewable, like, fisheries and forestry and non-renewable, like, fossils, fuels, mineral deposits. Uneven distribution of resources refers to the location of 90% of proved oil reserves just in 15 countries and 10% of oil reserve located in 40 countries. *Externalities* are concerned with negative externality that arises from the extraction and consumption of resources. *Dominance* refers to the dominant position of natural resource in nations where economy rely mainly on the export of the products produced from natural resources. It has been noted that the countries which have high export concentration scores also have a high share of natural resources in total exports. Extreme price *volatility* in some of the major natural resource, like fuels and minerals is, therefore, an important concern.

Third, natural resources can be further classified as point and diffuse resource. Point resource is confined to a narrow geographical area which can be controlled at a relatively low cost. Oilfields, plantations and mineral resource are point resources. Diffuse resource is produced over a wide geographical area, like, agricultural products and food (Isham et al.,2005). Management of point resource can suffer from rentier effects, repression effects, and worse institutions. This is because, point resources are spatially concentrated and can easily controlled at a moderate cost. Abundant point resources are generally associated with power inequality, division of surplus inequality and vertical relationship between agents (managers, labourers and shareholders). On the contrary, diffuse resource is thinly spread and is characterized by horizontal and equal relationship between agents and has a weaker control of the government. In a cross-sectional regression analysis, Isham (2005) showed that point resources have a negative impact on various government measures, like, corruption, rule of law, regulatory framework, and government effectiveness. But in diffuse resource, the negative impact is not very strong. Bulte et al., (2005) supported these findings and their findings also show a negative impact of point resource on rule of law and government effectiveness.

2.2 Theoretical Paradigm

Theoretical explanations for the phenomena of natural resource curse include Dutch disease models, rent-seeking dels and institutional explanations.

Dutch Disease Model states that resource boom diverts the country's resources away from the activities that are more conducive to long run growth. This problem is called 'Dutch Disease' referring to a crisis which the Netherlands faced in its manufacturing sector due to inflow of gas resources from North Sea (John, 2011). The rise in the volume of export of natural resources and price shocks in the international market led to fall in terms of trade for primary goods. This brings sudden inflow of foreign capital into the country which appreciates the exchange rate. It renders other export items relatively expensive and uncompetitive. Therefore, it leads to a contraction of the manufacturing exports and withdraws labour and capital away from manufacturing sector to resource boom sector, thus causing stagnation in the manufacturing sector. The non-resource sector becomes increasingly non-existent.

The booms and busts caused by price volatility of natural resources also lead to precarious macroeconomic policies and high export concentration of natural resource. The known remedy to the harm caused was prudent fiscal stance with stable macroeconomic policies. Some economist like, Barro, Sala-i-Martin and Mendoza (1997) have shown that Terms of Trade

(TOT) is a strong determinant of economic growth and a reduction in TOT for primary goods leads to much of resource curse problem. However, a study by Cuddington (1992) shows that TOT may have a negative impact at global level but if studied at individual state level, it shows positive trends for some commodities. Again, according to Neary and Van Wijnbergen (1986) it is possible that growth in the resource boom sector can offset the stagnation in the manufacturing sector. Hence, findings for the impact of natural resource on economic growth, attributed to Dutch disease explanation, is debatable.

The political economy school's *Rent-seeking models* are based on the assumption that resource rents are easily accessible and lead to bribes, distortion in public policies and diversion of labor away from productive activities and towards seeking public favors (Torvik, 2002). The explanation for resource curse spins around the probable vicious role of rent-seeking in resource-rich countries. The basic rent-seeking model has been enriched with multiple equilibria that make it possible to carry out comparative statics on specific equilibrium and study the effect of resource abundance on growth with context-specific conditions (Acemoglu, 1990; Baland& Francois, 2000).

Institutional Explanations connect resources with institutions. There is a growing understanding that the phenomenon of "natural resource curse" is not "unconditional". It is conditional upon the quality of institutions. Leite and Weidmann (2002) suggest that there is no direct effect of resource abundance on economic growth but there do exists an indirect effect through the variable like, corruption, as resource affects the corruption level of a country which in turn determines the growth. Isham et al., (2003) and Sala-I-Martin and Subramanian (2003) have found other dimensions of institutional quality that indirectly affect growth in the presence of abundant resources.

Many natural resource-rich countries are rentier economies. Institutional development can be an issue in rentier economies. The reasons for resource curse, in such economies, can be classified as rentier effect, taxation effect, government spending effect and group formation effect. Rentier effect points out to the reduction of the need of the government to impose taxes. This in turn led to taxation effect wherein the citizen demands less accountability of the government for economic development and good governance with strong institution. Government spending effect hints on the casual spending of the easily earned resource revenues that lead to corruption. Lastly, the group formation effect hints on the government prevention

measures towards the formation of special interest groups which may put pressure on the government to improve their accountability (Ross, 2001).

The need of the time was macroeconomic stability with strong fiscal policies but this was difficult with unfavourable political economy that was identified as unaccountable social contracts between citizens and governments, weak institutions and misuse of windfall revenues from abundant natural resource by the bureaucrats. Transparent governance is very important to avoid the diversion of funds in notorious activities and to reduce corruption. The resource rich countries which rely heavily on rents from natural resource, generally performs poorly in the Open Budget Survey that measures budget transparency and accountability around the world.

Ploeg (2011) find that countries with bad institutions, lack of rule of law, corruption, presidential democracies and underdeveloped financial systems have adverse effects of abundance resources. They not only fail to convert their abundant resources into productive assets but also reinforces, rent grabbing and civil conflicts. Research findings on role of institutionalism point out that strong institution building is important to control the effects of booms and bust caused by natural resource richness in the country.

Paying attention to right institutions, some countries have made their abundant natural resource as blessings by adopting factors called as blessing threshold. Countries like, Zambia and Congo have converted their abundant resource of minerals into blessings by adopting few steps like, entering into a renegotiation of mining contracts when they are unfavourable, increasing the bargaining power of States as against the multinationals and strengthening the transparency policy of mineral extraction to reduce illegal transaction. They are able to increase their tax revenue despite of abundant resource. Further, countries like, Malaysia, Indonesia, China and Mauritius, have adopted dual-track growth strategy as a last threshold. It introduces an emerging dynamic sector which promotes competition and risk-taking along with provision of subsidies for inefficient producers in manufacturing and agricultural sectors in order to reduce social tension and maintain political stability. Such a dual track strategy reduces the rentier effect, creates competitive diversification and builds a pro-reform political constituency. The ownership structure of the exporting countries also has a threshold effect on blessing. For example, in countries like Mexico and Indonesia, the non-mineral export oriented private sector is strong enough to counter the effect of the fall in export due to appreciation of real exchange rate resulting from the sudden influx of foreign capital in the presence of abundant resource,

and creates a lobby group that advocate exchange rate and other policies to promote export-led growth with stable macroeconomic policy and high growth rates. Further, human capital formation has also been considered as an important condition for efficient management of resources which will encourage the absorption of technology and development of valuable new economic sectors. In the absence of rich human capital, resource curse is likely to happen. Strengthening of international economic integration and increase in human capital stock will facilitate economic growth provided public policy changes in favour of economic openness and human capital formation (Marcus and Sarah,2011)

In continuation, Brunnschweiler and Bulte (2006) showed that resource abundance, constitutions and institutions determine resource dependence. Further, resource dependence does not affect growth but resource abundance has a positive effect on growth and institutional quality. The institutional perspectives were getting evolved and the direction of property rights, transaction cost and contracts were studied. This led to the origination of a new area of research: the sustainable utilization of natural resources (NRM) and Neo-Institutional Economies (NIE).

Ostrom (1994, 2003, 2007 and 2017) has developed the concept of social capital and mentioned institutions as one of the important forms of social capital. She introduced an Institutional Analysis and Development (IAD) Framework to understand the behaviour of institutions in different situations and at multiple levels. The difference between policy decision and operational decision was highlighted. The former is taken within the constraint of rules and the latter is taken by individual at the place of action which has the impact on the physical world. The role of institution becomes more important if the convergence between the two decisions is required. The Social Ecological System (SES) framework was investigated to develop a common platform for understanding diverse backgrounds of different resource sectors and their influences in the outcomes of different empirical settings. The importance of SES became more strident to deal with social-ecological traps, referring to a situation where social and ecological feedbacks together create an undesirable state that is hard to escape. Rahman et al., (2017) have introduced Inter-Institutional Gap (IIG) Framework as an approach to conceptualize the interconnection between various rules of formal and informal institutions. IIG facilitate governance mechanism at various levels and tries to fill the hidden gaps between different rules that is operated among different institutions which are involved in governing a single system

The local and community level NRM challenges and strategies were discussed to reverse the social-ecological traps (Dana, Baker and Andrew, 2018). Non-cooperative game theory was

applied to understand community level NRM institutions (Kim, 2018). All these researches were directing to the emergence of the study of institutions as a robust cause of natural resource curse.

It can be stated that there is ample research work to support the argument of resource curse but there are also few works that has put a question mark on it. However, a clarity that evolves from the literature is the channels that link natural resource with growth of the country. One of the identified channels is the quality of institutions that links the activities pertaining with natural resource abundance to per capita growth of the country.

At this point, it can be said that natural resource curse is conditional upon social, political and economic institutions of the country. A country with good governance and better institutional quality would use the resource wealth prudently and make it contribute to economic growth and development. It leads to the concept of conditional and unconditional natural resource curse with quality of institutions as a major role.

The paper identifies that India, though being a resource-rich states, there has been a research gap in understanding the dynamics of resource curse and finding out the reasons for it. Hence based on the identified gap, the paper develops the following hypothesis

H1: Mining royalty revenue significantly influences development indicators in Indian states.

H2: Mining Production value significantly influences development indicators in Indian states.

H3: District Mineral Foundation finance positively moderates the relationship between mining royalty revenue and social progress.

3. Research Methodology

3.1 Definition of Variables and Data collection

This analysis pertains to only 15 major states. These are taken after removing the special category states (Arunachal Pradesh, Assam, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura and Uttarakhand), Union Territories (Andaman & Nicobar Islands, Chandigarh, Daman and Diu, Delhi, Jammu & Kashmir, Ladakh, Lakshadweep, Puducherry) and states with very low mineral importance/ small states/ data issues - Goa, Himachal Pradesh, Punjab and Haryana.

Two indicators of mineral resource abundance, production value (PV) of total minerals (fuel, metallic and non-metallic) and royalty (R) received from mineral products by the state, have

been taken. The data for production value of minerals is from 2014-15 to 2021-22 and the source is Indian Mineral at a Glance,2020-21, Indian Bureau of Mines (compiled by Indiastat.com) Royalty received by the states for all minerals and coal have been taken from the Annual Report of various years of the Ministry of Mines, GoI, and added to obtain total royalty received. The royalty values are revised (2018-19, 2019-20, 2022-23) and provisional (2023-24 and 2024-25) for certain years.

Three indicators of development achievement, Human Development Index (HDI) and Sustainable Development Goal (SDG) Index and Social Progress Index (SPI) are considered in the analysis. HDI is taken from two different sources: MOSPI (2020) and Mukherjee and Jadhav (2026) (MJ, hereafter). Ministry of Statistics and Programme Implementation (MOSPI) has constructed HDI for 2011-12 and 2017-18 and MJ provides HDI for 2011-12 and 2022-23. SDG Index for 2023-24 is from NITI Aayog (2024). SPI Index for 2022 is from Institute for Competitiveness, Economic Advisory Committee to Prime Minister, Center for Inclusive Growth

MOSPI has calculated HDI based on four dimensions, Life Expectancy at Birth for Health, Expected years of Schooling and Mean years of Schooling for Education and Per-capita GSDP at Constant prices for Income. MJ have calculated HDI based on monthly per-capita consumption expenditure for consumption, literacy rate and adjusted intensity of formal education (calculated as a ratio of average enrolment to total enrolment from class I to XII) for education attainment, Life Expectancy at age one and inverse of infant mortality rate for Health. The SDG is a composite indicator taken for 15 out of 16 SDG goals, excluding SDG 14: Life Below Water. SPI is also a composite indicator taken for three dimensions, namely, State level Basic Human Needs (BHN), Foundation of Well-Being (FWB) and Opportunity (O). Under each dimension, there are four components. In BHN, the variables taken into consideration are nutrition and basic medical care, water and sanitation, shelter, and personal safety. In FWB, the variables taken are access to basic knowledge, access to information and communication, health and welfare and environmental quality. In Opportunity, the variables taken are, personal rights, personal freedom and choice, inclusiveness and access to advanced education.

The association between resource concentration, in terms of PV and R, with development indicators (HDI, SDG and SPI) is attempted subsequently by making some adjustments in the data. Production and royalty values are converted to Rupees in millions. The average value of

PV and R for the period 2014-15 to 2021-22 are considered, as data for a few years are not available for Andhra Pradesh (2020-21,2021-22) and West Bengal (2016-17 to 2021-22) or to deal with year-wise fluctuations, if any, due to COVID/ prices etc. Apart from an analysis based on absolute values, categorization of states as per higher or lower than median is also attempted. Median of the PV and R (of the average for 2014-15 to 2021-22) is considered for creating dummy variable for PV and R, respectively, by assigning '0' to states with lower and '1' to states with higher in comparison to the median value.

The District Mineral Foundation (DMF) fund is created by taking certain percentage of royalty share from the mine owners to the state government. It is to be utilize for the development of mining affected region and people. The variable DMF_Ratio is obtained as a ratio of fund spent by the fund allocated in the respective mineral-rich states (Table 4 in Appendix)

Note the limitation of the study is the unavailability of data for all the years from 2014-15 to 2021-2022 for mineral production value and royalty due to which the averages are considered.

Table1: Variable Definition

Sl.No	Variables	Abbreviation	Type	Description
1	Production Value	PV	Explanatory Variable	Production Value (PV) of total minerals (fuel, metallic and non-metallic)
2	Royalty	R	Explanatory Variable	royalty (R) received from mineral products by the state, have been taken.
3	Human Development Index	HDI	Dependent Variable	Indicator of development achievement
4	Sustainable Development Goals	SDG	Dependent Variable	Indicator of development achievement
5	Social Progress Index	SPI	Dependent Variable	Indicator of development achievement

6	District Mineral Foundation	DMF_Ratio	Moderating variable	It is the ratio of DMF fund spent by the DMF fund allocated.
7	District Mineral Foundation * Royalty	DMR_Ratio*R	Interaction Variable	Moderation Term

3.2 Data Analysis

Bivariate analysis of different combination of explanatory variables and dependent variables are done by using scatter plots with regression for H1 and H2. The regression of PV and R on HDI (figure 1 to 8) is done on four HDI indicators defined by the four different time periods 2011-12(MOSPI), 2017-18(MOSPI), 2011-12(MJ) and 2022-23(MJ). Bivariate analysis of PV and R on SDG is done for 2023-24(figure 9 and 10) and bivariate analysis of PV and R on SPI is done for 2022(Figure 11 and 12).

Box diagram of PV dummy and R dummy with HDI (Figure 13 to 16) is done using stata for four HDI indicators defined by the four different time periods 2011-12(MOSPI), 2017-18(MOSPI), 2011-12(MJ) and 2022-23(MJ). Box diagram of PV dummy and R dummy with one SDG indicator for 2023-24(figure 17 and 18) and box diagram of PV dummy and R dummy with one SPI indicator for 2022(figure 19 and 20) are also done to understand the development achievement with mineral resource concentration.

For Hypothesis 3, Regression Model with DMF as Moderator is run in stata software. The model is given as: $SPI = \beta0 + \beta1(Royalty) + \beta2(DMF) + \beta3(Royalty \times DMF) + \varepsilon$

Here the independent variables are mean-centered to reduces non-essential multicollinearity between the interaction term and its constituent variables and facilitates meaningful interpretation of regression coefficients. Robust standard errors were employed to account for potential heteroskedasticity arising from substantial variation in mineral royalty revenues and DMF utilization ratio across states. The use of robust estimation ensures statistically reliable standard errors and significance tests without altering the estimated coefficients.

4. Findings and Interpretation

On the basis of the analyses, following observations are made for Hypothesis 1 and 2

On the basis of bivariate analyses, a negative association between resource abundance and development achievement is indicated as all the scatter plots show a negative relationship and the regression coefficients of PV/ R in all the models are negative.

The dummy variables for resource abundance, on the basis of PV and Royalty, were created. On the basis of median PV (average of 2014-15 to 2021-22), Andhra Pradesh, Bihar, Gujarat, Kerala, Maharashtra, Tamil Nadu, Telangana, Uttar Pradesh, and have relatively less resources. Chhattisgarh, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Rajasthan and West Bengal, and have relatively high resource. Similarly, on the basis of median royalty, Andhra Pradesh, Bihar, Gujarat, Kerala, Maharashtra, Tamil Nadu Uttar Pradesh, and West Bengal have relatively less resources. Chhattisgarh, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Rajasthan and Telangana have relatively high resources. The difference of result in the categorization of higher and lower resource states is only with Telangana and West Bengal. According to median PV, Telangana fall under less resource state and West Bengal falls under high resource state. On the other hand, according to median royalty, Telangana falls under high resource state and West Bengal falls under less resource states. Table 1 and Box diagrams (Figures 13 to 20) reveal that the distribution of development achievements of states with higher resource concentration are relatively lower than those with relatively less resources.

It is observed the minimum PV was received by state of Bihar, 184 million and highest PV recipient is Odisha, 283001 million. Similarly, minimum royalty was received by Bihar, 43 million and highest royalty by Odisha, 81192 million

However, these inferences are only indicative of the larger pattern of the relationship between development achievement and resource abundance. The following observations are important to note:

First, it is only indicative of association and not causality.

Second, except the association of royalty with HDI (MJ 2011-12) and SPI (2022), which is significant at 10 per cent level (Table 3), the negative association between resource abundance and development achievement, i.e. concept of resource curse is not statistically significant in 10 out of 12 models. However, statistical significance of resource curse with SPI,2022 and royalty can be an important observation

Figure 1: Production Value and HDI 2011-12 (MOSPI)

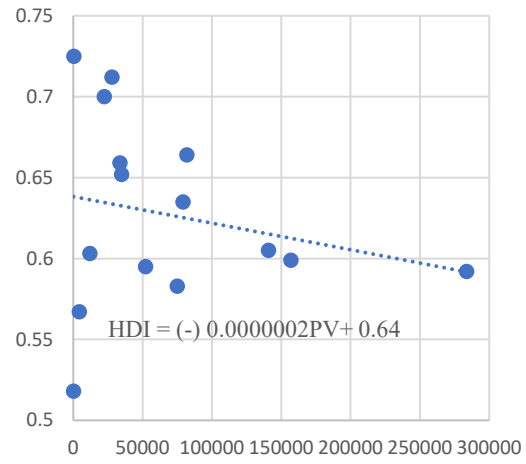


Figure 2: Production Value and HDI 2017-18 (MOSPI)

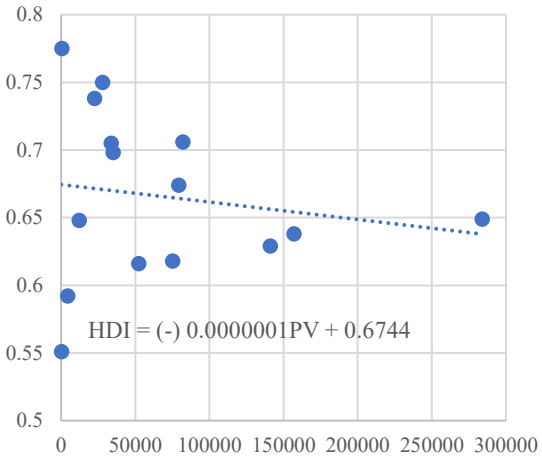


Figure 3 Production Value and HDI 2011-12 (MJ)

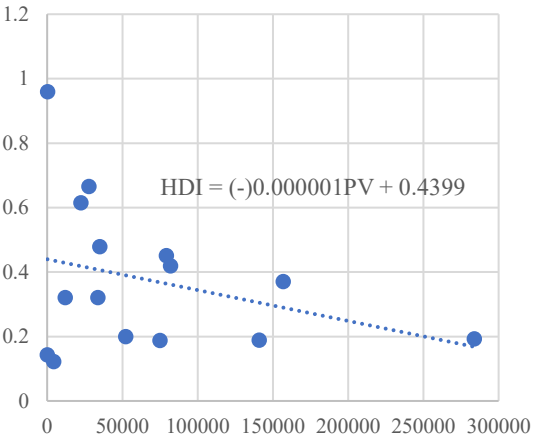


Figure 4: Production Value and HDI 2022-23(MJ)

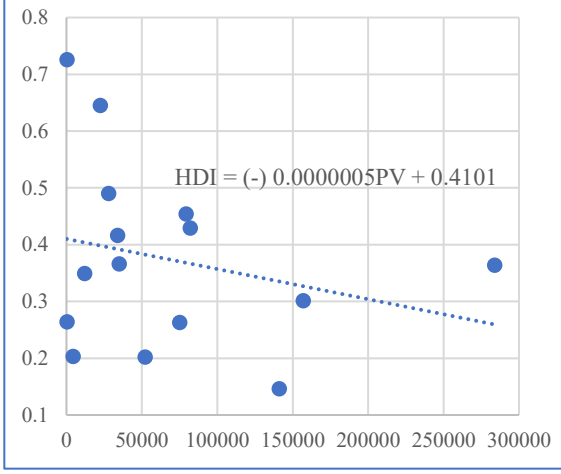


Figure 5 Royalty and HDI 2011-12 (MOSPI)

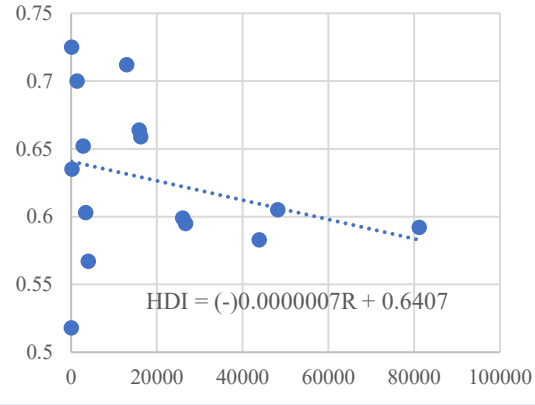


Figure 6: Royalty and HDI 2017-18(MOSPI)

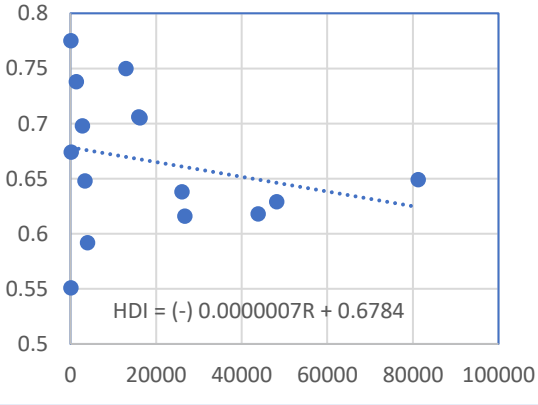


Figure 7: Royalty and HDI 2011-12 (MJ)

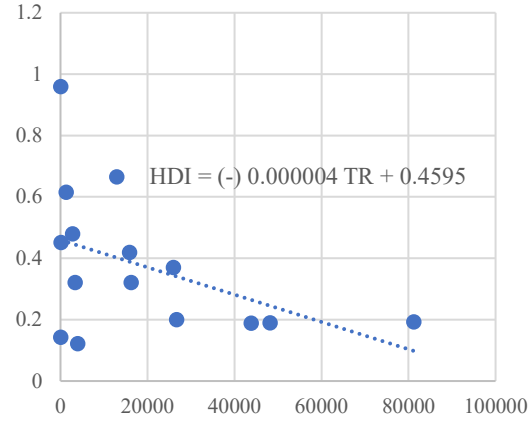


Figure 8: Royalty and HDI 2022-23 (MJ)

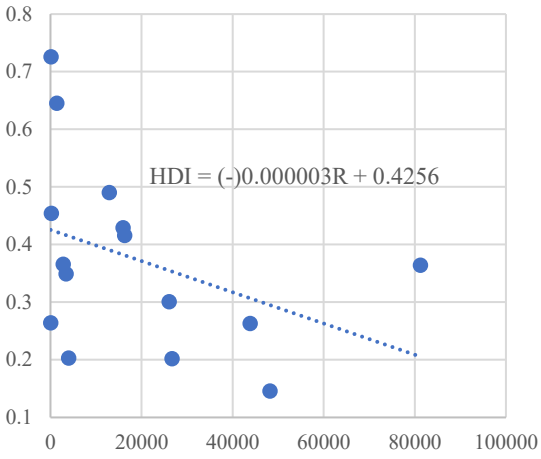


Figure 9 Production Value and SDG 2023-24 (NITI Aayog)

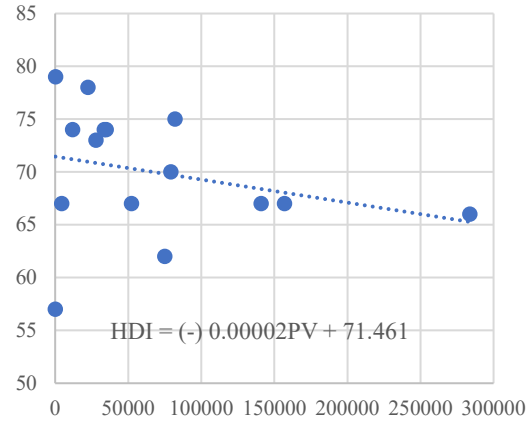


Figure 10: Royalty and SDG,2023-24 (NITI Aayog)

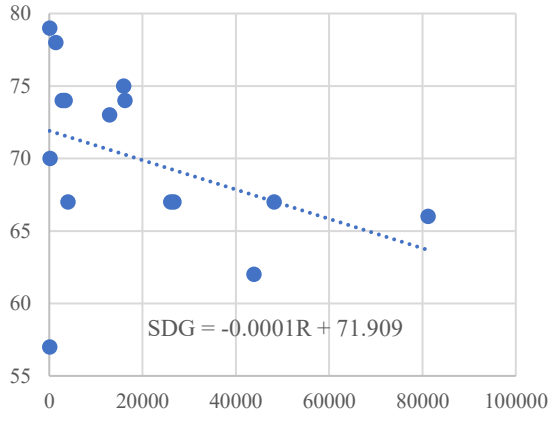


Figure 11:Production Value and SPI, 2022

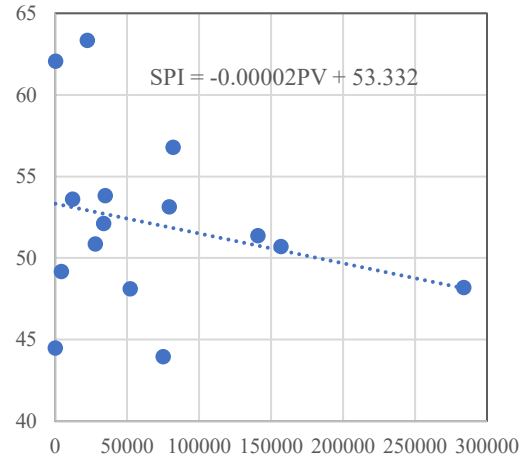


Figure 12:Royalty and SPI, 2022

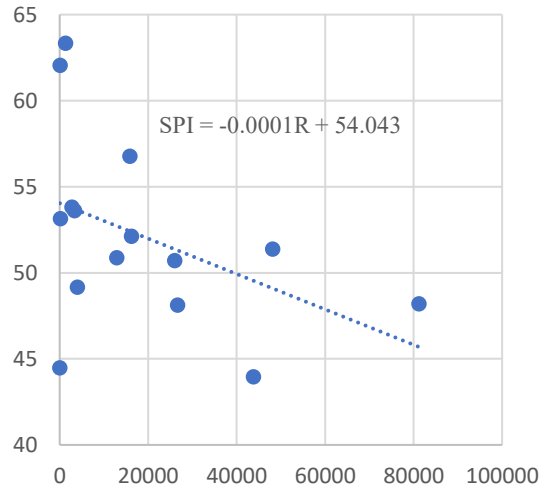


Table1: Development Achievement by Resource Abundance

	Resource Abundance	Minimum	Maximum	Median	Minimum	Maximum	Median
PV Dummy		**HDI, MOSPI 2011-12**			**HDI, MJ 2011-12**		
	Lower	0.52	0.73	0.66	0.12	0.96	0.40
	Higher	0.58	0.66	0.60	0.19	0.45	0.20
		HDI, MOSPI 2017-18			HDI, MJ 2022-23		
	Lower	0.55	0.78	0.70	0.20	0.73	0.39
	Higher	0.62	0.71	0.64	0.15	0.45	0.30
		SDG, NITI 2024-25			**SPI,2022**		
	Lower	57	79	74	44.47	63.33	52.86
	Higher	62	75	67	43.95	56.77	50.69
Royalty Dummy		HDI, MOSPI 2011-12			HDI, MJ 2011-12		
	Lower	0.52	0.73	0.64	0.12	0.96	0.47
	Higher	0.58	0.66	0.60	0.18	0.42	0.20
		HDI, MOSPI 2017-18			**HDI, MJ 2022-23**		
	Lower	0.55	0.78	0.69	0.20	0.73	0.41
	Higher	0.62	0.71	0.64	0.15	0.43	0.30
		SDG, NITI 2024-25			**SPI, 2022**		
	Lower	57	79	73.5	44.47	63.33	53.37
	Higher	62	75	67	43.95	56.77	50.69

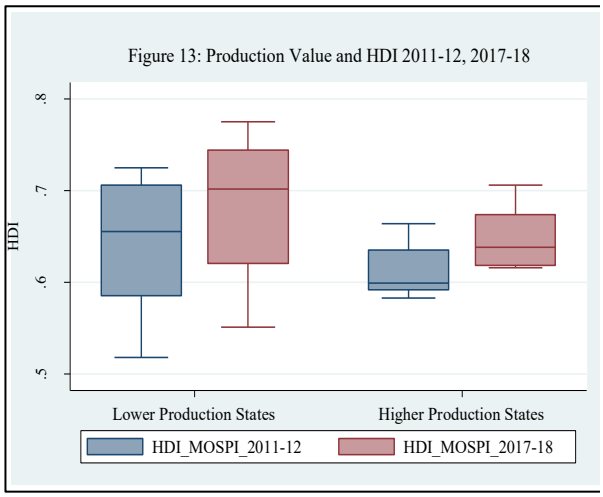


Figure 13: Production Value and HDI 2011-12, 2017-18

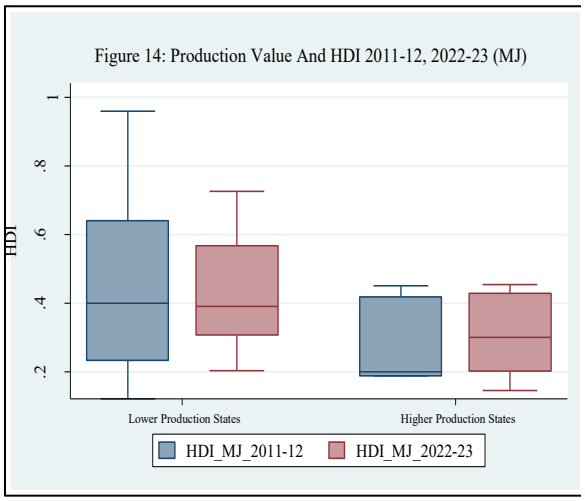
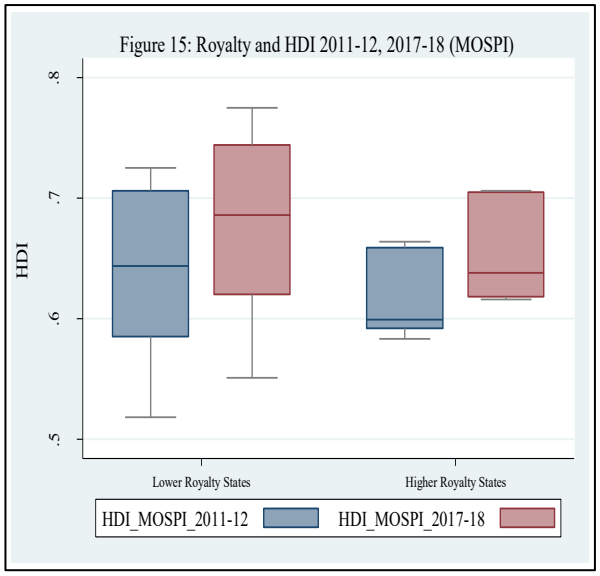
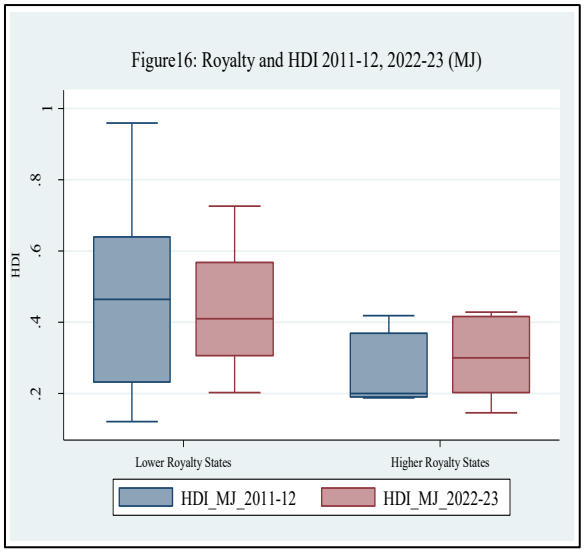
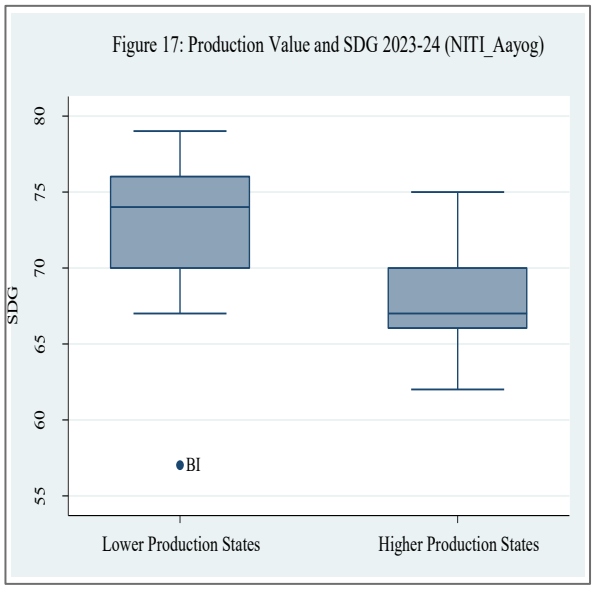
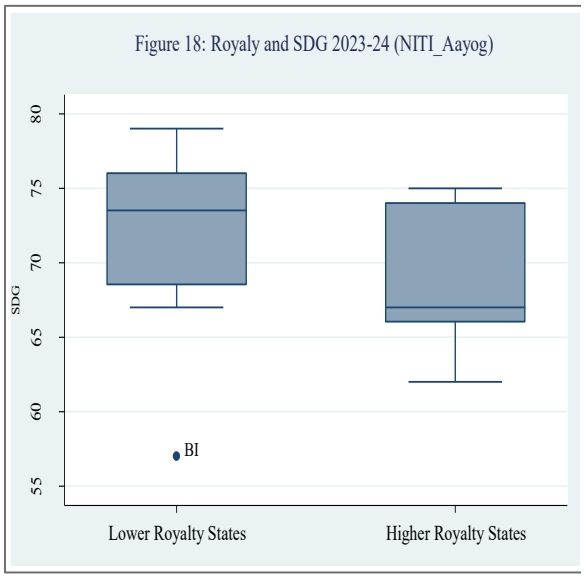


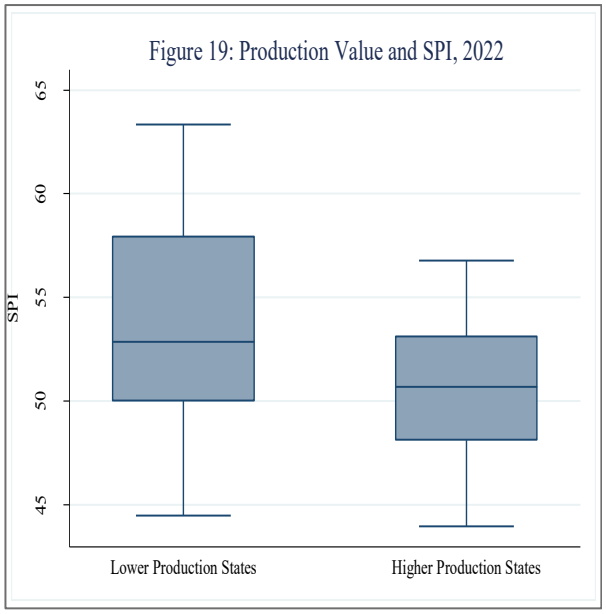
Figure 14: Production Value And HDI 2011-12, 2022-23 (MJ)

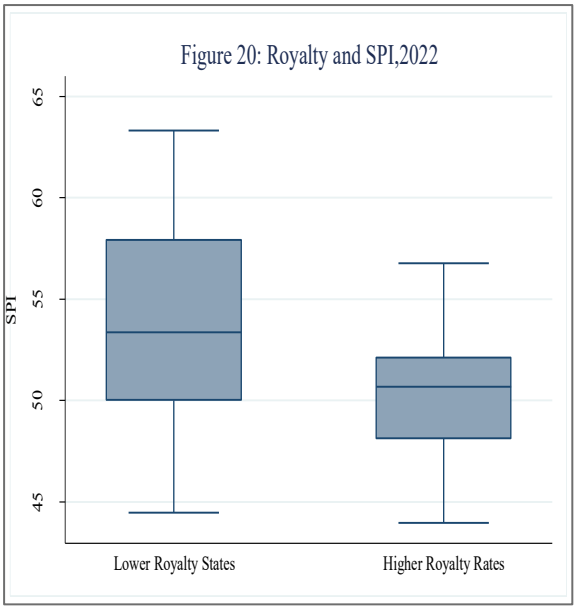

Figure 15: Royalty and HDI 2011-12, 2017-18 (MOSPI)
HDI
.5
.6
.7
.8
Lower Royalty States
Higher Royalty States
HDI_MOSPI_2011-12
HDI_MOSPI_2017-18


Figure16: Royalty and HDI 2011-12, 2022-23 (MJ)
HDI
.2
.4
.6
.8
1
Lower Royalty States
Higher Royalty States
HDI_MJ_2011-12
HDI_MJ_2022-23


Figure 17: Production Value and SDG 2023-24 (NITI_Aayog)
SDG
55
60
65
70
75
80
BI
Lower Production States
Higher Production States


Figure 18: Royaly and SDG 2023-24 (NITI_Aayog)
SDG
55
60
65
70
75
80
BI
Lower Royalty States
Higher Royalty States





On the basis of the analyses, following observations are made for Hypothesis 3

Findings for Hypothesis 3

Moderating Model: SPI = β0 + β1(Royalty) – β2(DMF Ratio) + β3(Royalty × DMF Ratio) + ε

Stata Output

Variable	**Coefficient**	**p-value**
Royalty	0.0000355	0.533
DMF	0.1141	0.296
Royalty× DMF	0.00000778	0.163
Constant	51.7652	0.000
R^2	0.1158	
F-Statistic	0.82	
Prob>F	0.5105	
No. of Observation	15	

The above regression model is statistically insignificant. The combined effect of royalty, DMF ratio and the interaction term does not statistically explain the social progress across states.

Mining royalty revenues shows a positive but statistically insignificant relationship with social progress. If compared to the initial bivariate analysis between SPI and R, a change is observed. Initially the relation was negative and have supported resource curse but here it is positive when DMF is taken into consideration along with royalty. This implies, there is a possibility that inclusion of DMF can cause positive impact of royalty on social progress.

DMF ratio shows positive but insignificant effect on SPI. This indicates that the presence of DMF funds alone does not automatically improve social development outcomes. Again, the interaction term between royalty revenue and DMF expenditure is positive but statistically insignificant. Therefore, DMF does not significantly moderate the relationship between mining revenues and social progress.

These findings imply that although DMF was institutionally designed to improve developmental outcomes in mining-affected regions, existing implementation mechanisms may not yet be sufficiently effective to convert mining revenues into measurable social progress. The hint is on improving governance quality, implementation efficiency, and accountability. The targets of expenditure may be more important than expenditure levels alone. The results further suggest that social development depends on broader institutional capabilities and policy effectiveness rather than merely on the magnitude of resource revenues.

5. Conclusion

The study contributes to the growing literature of resource curse by showing negative relation between resource variables and development achievement variables in Indian States. It further explains the relationship between development achievements and resource-richness of the Indian states through box-plots. Further, moderating model is used for the examination of the DMF mechanism as a process to strengthen the developmental impact of mineral royalty revenues in India. However, DMF fail to demonstrate statistically significant moderating effects. Hence, the results indicate that royalty revenues alone do not significantly improve social progress outcomes. It reinforces the argument that resource abundance is not synonymous with development. The transformation of mineral wealth into social progress requires effective institutions, accountable governance, efficient public investment, and sustainability-oriented policy frameworks. Consequently, reducing the resource curse demands institutional transformation rather than merely increasing extraction revenues or public expenditure.

The findings generate several important policy implications such as strengthen institutional capacity, improve transparency in mining-dependent states, resource revenue allocation should be properly monitored and accountability mechanisms should be practiced to strengthen the institutional capacity. DMF implementation should prioritize, community participation, social auditing, outcome-based budgeting, transparent reporting systems. Investing in human capital should be prioritized. A larger share of mining revenues should be directed toward education, healthcare, skill development, nutrition and sanitation. Mining Governance should be linked with Sustainable Development Goals (SDG) and Mining revenue management should be aligned with SDG 1 (No Poverty), SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), SDG 10 (Reduced Inequalities), SDG 16 (Peace, Justice and Strong Institutions).

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Appendix

Table 2: Comparison between Average Total Royalty, Average Production value of Minerals (2014-15 to 2021-22) with the Economic Indicator HDI ,SDG and SPI (Figure in Million)

State	TR_A* 2014-15 2021-22 Million	PV_A* 2014-15 2021-22 Million	HDI_MOSPI2011-12	HDI_MOSPI 2017-18	HDI_MJ 2011-12	HDI_MJ 2022-23	SDG_NITI 2023_24	SPI_2022
Andhra Pradesh	3383	12021	0.603	0.648	0.321	0.349	74	53.6
Bihar	43	184	0.518	0.551	0.143	0.264	57	44.47
Chhattisgarh	48165	140891	0.605	0.629	0.189	0.146	67	51.36
Gujarat	2764	34888	0.652	0.698	0.479	0.366	74	53.81
Jharkhand	43823	75042	0.583	0.618	0.188	0.263	62	43.95
Karnataka	15896	81973	0.664	0.706	0.419	0.429	75	56.77
Kerala	78	365	0.725	0.775	0.959	0.726	79	62.05
Madhya Pradesh	26675	52159	0.595	0.616	0.2	0.202	67	48.11
Maharashtra	12916	27824	0.712	0.75	0.665	0.49	73	50.86
Odisha	81192	283801	0.592	0.649	0.193	0.364	66	48.19
Rajasthan	25994	156907	0.599	0.638	0.37	0.301	67	50.69
TamilNadu	1346	22430	0.7	0.738	0.615	0.645	78	63.33
Telangana	16225	33718	0.659	0.705	0.321	0.416	74	52.11
Uttar Pradesh	3979	4408	0.567	0.592	0.122	0.203	67	49.16
West Bengal	167	79192	0.635	0.674	0.451	0.454	70	53.13

Source: Indiastat.com, MOSPI, NIPFP, NITI Aayog, Annual Report of Ministry of Mines, GoI(Various Years)

**TR_A: Total royalty Average including all Minerals and Coal PV_A*: Total production Value Average*

Table 3: P-Values of Regression between the Variables

Regression	P-Value
HDI_MOSPI_2011-12 and PV_AVG_2014-15_2021-22	0.43
HDI_MOSPI_2017-18 and PV_AVG_2014-15_2021-22	0.57
HDI_MJ_2011-12 and PV_AVG_2014-15_2021-22	0.25
HDI_MJ_2022-23 and PV_AVG_2014-15_2021-22	0.36
SDG_NITI_2023-24 and PV_AVG_2014-15_2021-22	0.32
HDI_MOSPI_2011-12 and Royalty_AVG_2014-15_2021-22	0.30
HDI_MOSPI_2017-18 and Royalty_AVG_2014-15_2021-22	0.37
HDI_MJ_2011-12 and Royalty_AVG_2014-15_2021-22	0.09
HDI_MJ_2022-23 and Royalty_AVG_2014-15_2021-22	0.15
SDG_NITI_2023-24 and Royalty_AVG_2014-15_2021-22	0.15
SPI_2022 and Royalty_AVG_2014-15_2021-22	0.10
SPI_2022 and PV_AVG_2014-15_2021-22	0.36

Source: Compiled by the author from the regression results of STATA

Table 4: DMF Ratio of Amount Spent to Amount Allocated

State	**Social Progress Index_2022**	**DMF Amount Allocated (A)(Million)**	**DMF Amount Spent (S)(Million)**	**DMF Ratio of S/A**	**R_2014-15_2021-22_Million (R)**	**DMF_Ratio*R**
Andhra Pradesh	44.47	19366.8	8592.3	44.37	3382.72	150078.20
Bihar	43.95	677.8	573.4	84.60	42.878	3627.36
Chhattisgarh	53.13	142244.7	103601	72.83	48164.6	3507969.52
Gujarat	53.81	14606	7448.6	51.00	2763.69	140939.49
Jharkhand	63.33	102315.8	66577.6	65.07	43822.8	2851579.96
Karnataka	49.16	40867	23005.2	56.29	15895.5	894803.04
Kerala	53.6	0	0	0.00	77.598	0.00
Madhya Pradesh	50.86	43872.8	32124.8	73.22	26674.8	1953197.92
Maharashtra	56.77	36413.9	21978.7	60.36	12915.5	779553.69
Odisha	52.11	267320.4	163934	61.32	81191.8	4979079.99
Rajasthan	48.19	97069.9	47142.3	48.57	25994.3	1262421.30
TamilNadu	48.11	10319.7	8785.6	85.13	1346.21	114608.59
Telangana	50.69	62061.5	39517	63.67	16225.1	1033115.98
Uttar Pradesh	62.05	10536.3	8026.9	76.18	3979.06	303137.88
West Bengal	51.36	569.5	439	77.09	167.212	12889.56

Source: Compiled and Calculated by the Author. https://dmfindia.mines.gov.in/.