What are the key factors of economic growth that affect rural development in India?

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ABSTRACT

The aim of this research is to identify and analyse the key factors that have a correlation with rural development, specifically focusing on rural India. This paper employs a rigorous econometric approach, including correlation analysis, regression analysis, and Pearson tests in order to formulate equations pertaining to key factors identified as well as a multivariable equation. It finds that households with access to gas and electricity, literacy rate, school electrification, access to sanitation facilities, and the availability of treated tap water show a high correlation with rural development, and hence theorize the reasons behind each factor. These findings are shown to hold largely true through the Pearson tests, and are assumed to be largely generalizable due to the data taken across states and for multiple years.

1.INTRODUCTION

India has experienced significant economic growth over the past few decades, with GDP increasing at an impressive rate of around 7% per year, in spite of the challenges posed by the global economic downturn and other factors. However, this growth has not been evenly distributed throughout the country. Rural areas, in particular, have struggled to keep up with the pace of development seen in urban areas, leading to a growing divide between rural and urban India. One indicator of this is the fact that rural poverty declined from 26.3% in 2011 to 11.6% in 2019, while the decline in urban areas was from 14.2% to 6.3% in the same period, according to World Bank.

The divide between urban and rural India is a primary concern for policymakers as it poses a significant threat to the country's overall economic growth and development. The rural population in India accounts for nearly 65% of the country's total population, and their well-being is a critical factor in the country's economic success. Therefore, achieving sustainable economic growth in rural areas is a priority for policymakers as it is crucial for reducing poverty, increasing agricultural productivity, and improving rural populations' overall quality of life.

However, achieving sustainable economic growth in rural areas is complex, and requires a deep understanding of the factors that contribute to economic growth and how they interact with one another. This research paper aims to identify the key factors that contribute to economic growth in rural areas of India and how they impact rural development. By analysing these factors, this paper hopes to provide insights into how policymakers can better support and promote economic growth in rural India.

This paper will examine a range of factors, including but not limited to access to electricity, water, education, healthcare, and employment. It will also consider how these factors interact with one another and how they can be leveraged to promote sustainable economic growth in rural areas. For instance, increased education may result in trained and more productive labour, which may increase the output of a village and of that particular household.

Furthermore, improved healthcare may lead to more productivity, lower working days lost due to sickness, and increased household income as a result. This was done through a combination of correlation analysis and regression analysis, then the findings were tested through a Pearson test, and the researcher finally hypothesized as to why this effect occurs.

Overall, this research paper seeks to shed light on the complex relationship between the economic growth of villages and rural development in India and to identify focus on areas that could promote sustainable economic growth in rural areas. By doing so, this paper estimate to contribute to a deeper understanding of the challenges and opportunities facing rural India and support policymakers in their efforts to promote inclusive economic growth and development.

2.LITERATURE REVIEW

Previous literature has explored specific parameters of rural development, often focusing on various infrastructure factors including education and electricity, and often analysing their impacts on specific areas or policies. For example, Thomas, Harish Kennedy and Uprplainen (Sept 2020) employ a rigorous variable approach to investigate the impacts of rural electrification in India at the household level. By utilizing robust econometric methods, the study offers insights into the causal relationships between electrification, socio-economic outcomes, and quality of life indicators within rural communities. The authors used a survey amongst households both eligible and not for electrification in the area selected and subsequently analysed the data provided, ensuring it is generalisable by comparing it with census data across Uttar Pradesh and India. Performing regression analysis and taking control factors into account, and subsequently analyses their impact utilizing t-tests. The authors claim that expenditure, appliance usage, and household activity all increase with the electrification of a household, which is further proved through the testing, and henceforth present their arguments on why they believe this occurs. This work contributes to the understanding of how improved access to electricity affects diverse aspects of rural households' lives, especially considering time usage- whether it be time taken by household tasks or time used to generate income and finally concludes by stating that the improvement occurs only in the long run.

Another example of specification is J.G. Sreekanthachari (2013) which provides a comprehensive analysis of the challenges and opportunities within the country's rural education landscape. Through a meticulous examination of existing literature and empirical studies, the review delves into issues such as limited access to quality education, inadequate infrastructure, teacher shortages, and socioeconomic disparities that persistently hinder educational equity in rural areas. Additionally, the review highlights innovative interventions, policy initiatives, and community-driven efforts aimed at addressing these challenges and enhancing educational outcomes. After evaluating all of these factors, the study identifies the setbacks and reasons for failure in the rural development sector. Finally, it proposes actions that can be made within the field.

Ghosh's (2017) research offers an exploration of the intricate relationship between infrastructure development and rural progress. Ghosh’s work examines the state and impact of rural infrastructure across 16 states, by taking into account 5 key input factors, and 3 composite measures. By first covering relevant literature and analysing the state of rural infrastructure, the authors obtain their results by examining the impact of physical and social infrastructure on agricultural growth, human development, and rural industrialization, Ghosh's work outlines the roles of each factor, emphasizing the importance of electricity, irrigation, and roads in order to increase agricultural output. This is done with the use of correlation and analysing and creating compound indices. They suggest that the government should prioritise additional investments in infrastructure towards electricity, roads, irrigation, housing and telecommunications for achieving growth in agricultural productivity and output, improvements in literacy and life expectancy and reductions in poverty and infant mortality. The study also addresses challenges and bottlenecks, highlighting the need for participatory planning, sustainable investment, and gender-sensitive approaches to ensure the effectiveness and equity of infrastructure initiatives.

These works contribute greatly to this paper, which further builds on Thomas et al.’s (2020) work by comparing the level of household and school electrification across states as one of my input parameters, and further reflecting on how it affects other key output parameters. The work provides significant input as to the reasons behind my results shown, as it analyses these factors on a more specific and microeconomic level, while mine is much broader and more macroeconomic. Meanwhile, J.G. Sreekanthachari’s work contributes to my understanding of the specific impacts and challenges affecting rural education, as well as the policies, programs, and potential improvements that could further develop the field. Finally, since my paper focuses on statistics relating to the factors used within Ghosh’s work, such as electricity, literacy, and healthcare, I am able to derive valuable discussion points and link my results to those of that study, as well as analyse their proposed reasoning.

Some papers, however, take a more holistic view, one which can be seen in my analysis as well. Ashley and Maxwell’s (2001) "Rethinking Rural Development" critically examines traditional economic perspectives regarding rural development and offers alternative strategies to address rural communities' challenges. The paper highlights the limitations of the conventional approaches to rural development, which often ignore the input and participation of local communities. Instead, the authors advocate for a more participatory approach that involves collaboration between government agencies, NGOs, and local stakeholders, aiming to tackle rural development on local levels to contribute to the larger scheme of things. They stress the importance of understanding of rural development as a complex, context-specific process that considers each rural area's unique challenges and opportunities. They emphasize the significance of involving local residents in decision-making, due to their awareness on a personal level about their own needs and resources. Their work highlights the importance of empowering local actors, fostering sustainable livelihoods, and integrating social, economic, and environmental dimensions to create more resilient and inclusive rural development trajectories.

Hazell and Thorat (2000) investigate the interaction between government spending, economic growth, and poverty reduction in rural India. Using state-level data from 1970 to 1993, they developed a simultaneous equations model to estimate the direct and indirect effects of different types of government expenditure on rural poverty and productivity growth in India. Through a comprehensive analysis, the authors delve into the effectiveness of government expenditures in fostering rural development, particularly their impact on economic growth and poverty alleviation. Utilizing a set of 19 formulae that they have developed through their modelling, the researchers show that government spending on productivity-enhancing investments targeted directly to the rural poor- such as roads, electricity and agricultural development, have all contributed to reductions in rural poverty, and most have also contributed to growth in agricultural productivity. They find that government expenditures on roads and R&D have by far the largest impacts on poverty reduction and growth in agricultural productivity, and government spending on education has the third largest impact on rural poverty and productivity growth. Meanwhile, irrigation investment has had a much smaller scale of impact, even after longer periods of time, which also applies to spending on soil, water, land, and community development in rural areas. Investment in healthcare, surprisingly, had no impact on productivity growth and minimal effect on poverty reduction.

Banakar and Patil (2018) present a fresh approach to gauging rural development in India. They assert that conventional metrics like income and education inadequately capture the essence of rural progress. Instead, the authors advocate for a novel Rural Development Index (RDI), encompassing economy, education health environment culture and leisure. The authors emphasise their limited scope in reflecting the comprehensive factors pivotal for rural advancement by critiquing prevalent indicators like the Human Development Index (HDI) and Multidimensional Poverty Index (MPI). Their proposed RDI model incorporates a wide array of facets and establishes a Cause Index and Result Index, yielding a comprehensive assessment of rural development that can serve as an alternate and perhaps more accurate measure than existing ones.

Ashley and Maxwell's paper provides levels of understanding regarding conventional and proposed models of rural development, as well as inspiring some key questions that come into play during my discussion. The key variables used in "Government Spending, Growth, and Poverty in Rural India" come into play among my input parameters. This paper builds on their work by analysing the factors themselves, as opposed to the investment into it, and as a result, use it to recommend possible investment. Finally, Banakar and Patil provide insight into the measures of rural development, as well as key ideas on how some inputs are valued and compared numerically.

3.METHODOLOGY

A correlation analysis, linear regression, and Pearson tests were used to discern the factors that exert the most significant influence on rural development. To achieve this objective, a structured approach was undertaken, encompassing input parameters spanning areas such as education, facilities, and healthcare, which are believed to be associated with rural development. These input parameters were evaluated against a set of output parameters that serve as indicators for assessing rural development.

The initial step involves data collection, wherein relevant data points were extracted from sources, primarily including government data from censuses and surveys. The researchers give careful consideration to ensure that key variables are incorporated in order to construct a dataset that accurately represents the rural development landscape.

The chosen input parameters are systematically defined, covering key dimensions that shape rural development. Correspondingly, the selected output parameters act as indicators of rural development outcomes.

The data analysis includes correlation analysis, identifying the relationships between the chosen output parameters and the input parameters using the collected data. The data taken for the primary correlations and for constructing equations was taken from the 2011 census/survey data, and the data used to validate the equations was taken from the year 2018. This process enables the identification of potential causative links and the extent of their impact.

Subsequently, the input parameters were ranked based on the strength of their correlation coefficients, elucidating their respective contributions to rural development outcomes. A regression analysis was then performed on the identified key input and output parameters, yielding a regression-based equation that depicts the interplay between these parameters. The key input parameters were chosen based on whether their correlation coefficient is significant, and the key output parameters were chosen by performing a correlation amongst themselves and hence choosing the output parameter that correlates the most with each of the others.

To validate the findings, the constructed equations were tested using Pearson correlation tests, employing data from 2018 as a basis for assessment; this was done by inserting those values into the equations to determine the fit, and then comparing the computed values with the values from the census.

Finally, a comprehensive model was developed by employing multiple linear regressions: all key input parameters were taken versus the output parameter chosen. This combined model was validated using another Pearson correlation test, ensuring its reliability.

4.DATA ANALYSIS AND RESULTS

The data used has been collected from government websites such as the IDFC India Rural Development Report based on Census 2011, the Ministry of Rural Development and rural development statistics from The National Institute of Rural Development and Panchayati Raj. It can be divided into 4 key sections- education, healthcare, facilities and other factors.

The data taken for each section is as follows:

1. Education: (Table 8.2)
    a. The net attendance rate for primary, middle, secondary, and higher secondary students.
    b. The pupil-to-teacher ratio for primary and upper primary schools.
    c. Literacy rates for males, females, and the average.
    d. School facilities, such as drinking water, girls' toilets, and electricity connections.
    e. Expenditure per student.

2. Facilities – (Table 8.3)
    a. Households electrified
    b. Villages electrified
    c. Source of water
    d. Open defecation
    e. Cooking fuels

3. Healthcare- with reference to Community Health Centres (CHC) – (Table 8.4)
    a. Percentage of CHCs with a supply of electricity.
    b. Percentage of CHCs with an operation theatre.
    c. Percentage of CHCs with at least 4 beds.
    d. Percentage of CHCs with all four specialists- physicians, gynaecologists, surgeons, and paediatricians.
    e. Percentage of CHCs with a labour room

4. Other (Table 8.5)
    a. Share of agricultural employment
    b. Irrigation vs NCA

For each input parameter, correlation analysis has been performed with the rural HDI data, and have hence found the correlation coefficient. The correlation is considered valid when there is a coefficient of over 0.6, with a high correlation greater than or equal to 0.7, and a very high correlation above 0.8.

Furthermore, to identify the key output parameter, the researcher has performed a correlation analysis between 4 output parameters- the percentage of people below the poverty line, rural HDI, rural poverty ratio, and the monthly income of the highest-earning member of the household- and have taken the one with the highest degree of correlation against the others, which was rural HDI. The correlations between output parameters is shown in Table 8.6 and 8.7.

Based on the correlation, the top 10 parameters were identified out of the 27 chosen as shown in Table 4.0. Correlation coefficcients for other parameters are shown in Table 8.1.

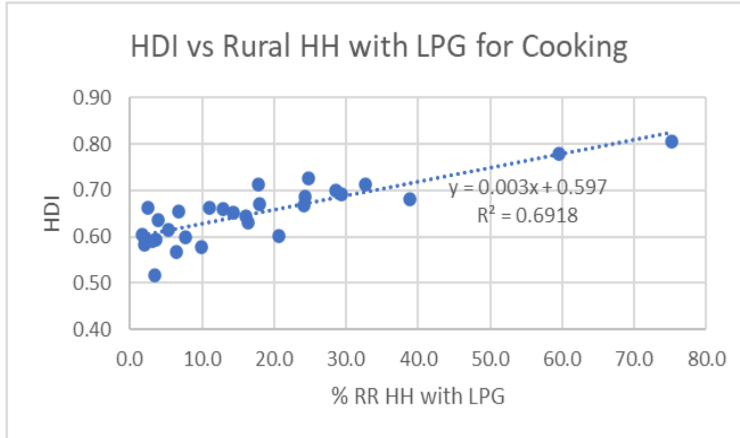
Table 4.0

Input Parameters	Correlation	Degree of correlation
Rural cooking fuel in households	0.83	very high
Households electrified	0.79	high
Overall literacy rate	0.72	high
Schools with electricity	0.71	high
Female literacy rate	0.69	moderate
Male literacy rate	0.69	moderate
% Open defecation	-0.62	moderate
% Households with treated tap water	0.6	moderate
Govt. expenditure per student	0.6	moderate
Higher secondary NAR	0.58	moderate

Of the top 10 parameters, 6 will be evaluated (overall literacy covers male literacy and female literacy) for further analysis. Data for Government expenditure per student and Secondary school net attendance rate is unavailable for the analysis period.

4.1. Rural Cooking Fuel in Households

This is defined as the percentage of rural households that have Liquefied Petroleum Gas (LPG) or Piped Natural Gas(PNG). LPG is a healthier cooking fuel and access to the same increases available household time for income generating activities. This has a correlation of 0.83 to HDI; which is the highest amongst all parameters.

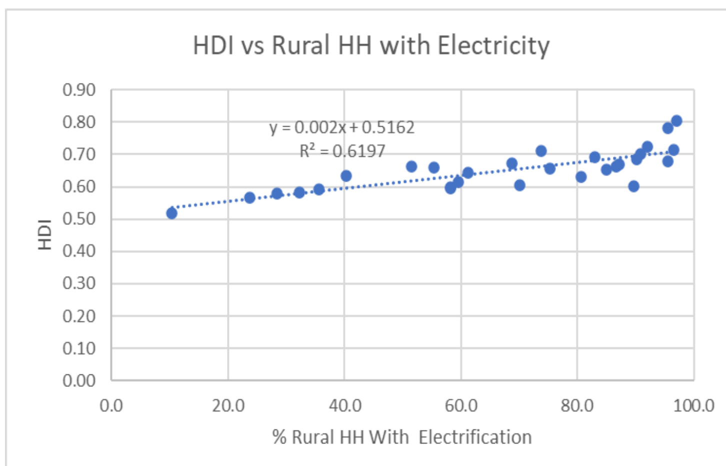


The equation for the parameter impacting HDI is: $HDI = 0.003G\% + 0.597$, where G% is the percentage of households using Gas- LPG or PNG. The coefficient of regression is R^2 = 0.6918.

4.2. Percentage of Households Electrified

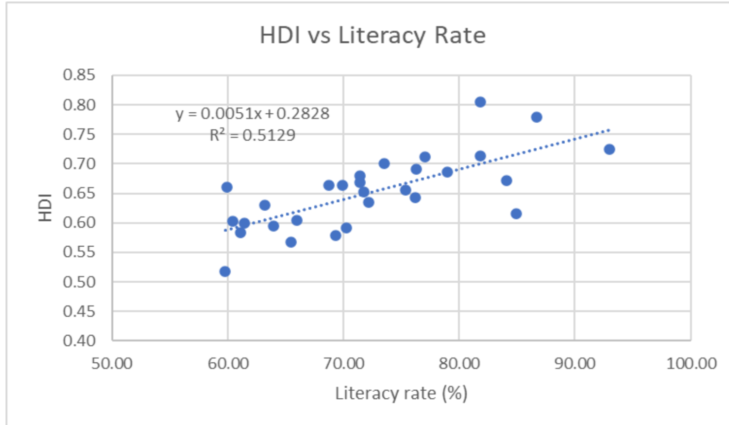
The percentage of rural households electrified focuses specifically on households that obtain electricity within their homes, as opposed to households that have access to electricity or villages electrified. This input variable was chosen based on previous literature's findings on the improvement of the various household factors when they receive electrification. The correlation of HDI with the parameter is high at 0.79.

The equation for the parameter impacting HDI is $HDI = 0.002E(hh) + 0.5162$, where E(hh) is the percentage of households electrified and R^2 = 0.6197



4.3. Overall Literacy Rate

The overall rural literacy rate was taken in order to measure the degree of education in these rural areas. Since literacy is often key to finding employment and income and has been mentioned as a factor in many research papers, this paper has taken it as an input factor. Literacy rate is proven to be highly related to HDI, with a correlation coefficient of 0.72.

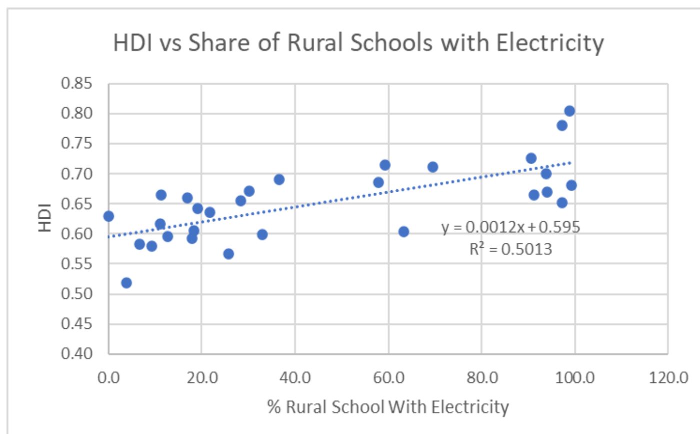


The equation for the parameter is $HDI = 0.0051LR + 0.2828$. The regression coefficient is $R^2 = 0.5129$

Both male and female literacy rates also have moderate correlation with HDI, 0.69 each, but for the purpose of this analysis, this has been taken as a subset of the overall literacy rate.

4.4. Schools with Electricity

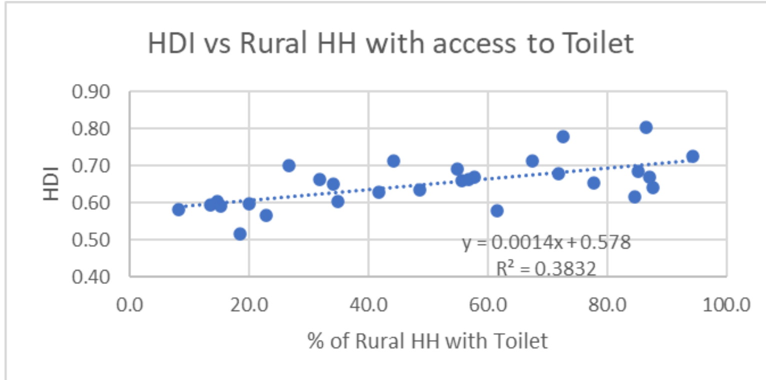
Availability of electricity at schools enables access to productive education tools such as internet, allows more hours on education and has been quoted to improve the quality of education, making it a key input factor. With a correlation of 0.71, this is shown to be highly correlated to the rural HDI.



The equation for this parameter is $HDI = 0.0012E(s) + 0.595$, where E(s) is the percentage of rural schools with electricity. The regression coefficient is $R^2 = 0.5013$

4.5. Percentage of people with access to toilets.

Toilets are a key facility in any living situation and contribute to sanitation and health. Open defecation is a reverse measure of access to toilets. Hence, a correlation coefficient for the percentage of people who open defecate has been taken, which shows a moderate correlation of -0.62 with HDI. The graph for those with access to toilets- is determined by $T = 1 - Def$ (People who open defecate).

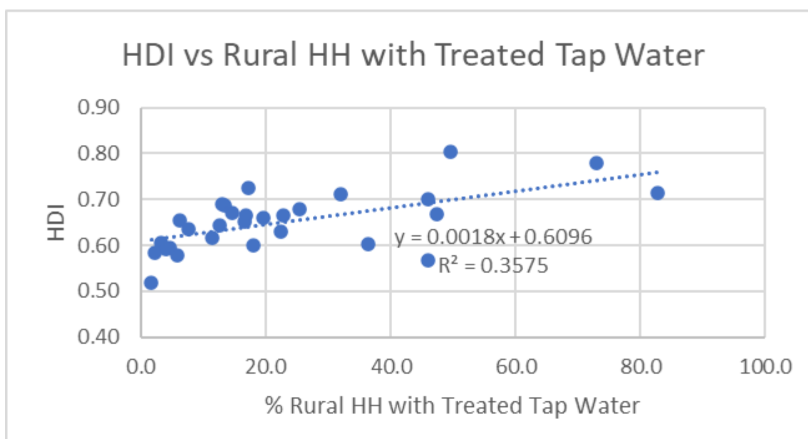


It is presumed that those who are not openly defecating have access to a toilet, eliminating the need for it, yet whether or not the toilet was in the household is unknown, and hence it hasn't been taken as "households with toilets".

The equation found based on this graph is $HDI = 0.0014T + 0.578$, in which $R^2 = 0.3832$.

4.6. Percentage of Households with Treated Tap Water

Access to water is critical to human life. Treated tap water is especially important, considering the degree of waterborne illnesses spread in India. Previous studies have shown access to tap water as a key influencer of healthcare and sanitation. Availability of tap water in households correlates moderately with the HDI, the coefficient being 0.6.



The equation identified for this parameter is $HDI = 0.0018TTW + 0.6096$, and has a regression coefficient of $R^2 = 0.3575$.

5. MODELS AND TESTS

The 6 regression models identified are:

Equation 1: HDI = 0. 003G% + 0. 597 (HDI vs % Households which have LPG/PNG)

Equation 2: HDI = 0. 002$E(hh)$ + 0. 5162 (HDI vs % Household Electrification)

Equation 3: HDI = 0. 0051LR + 0. 2828 (HDI vs Literacy rate)

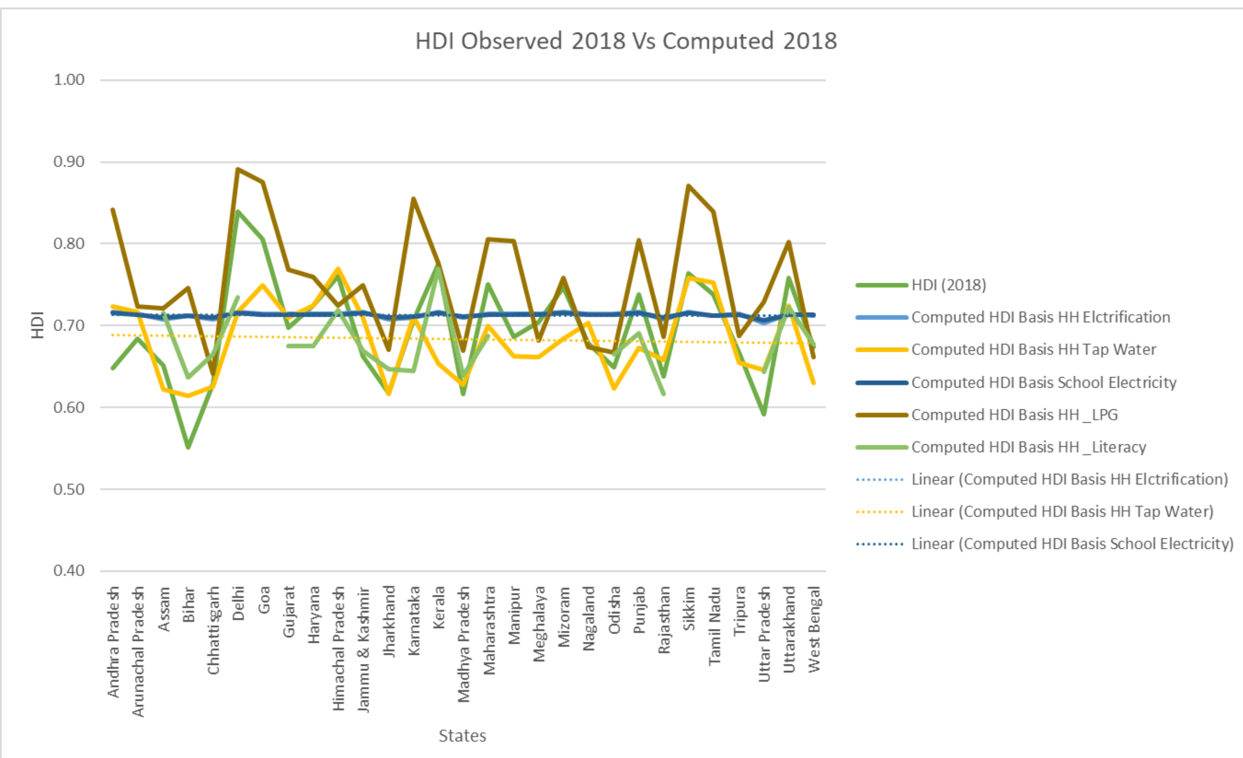
Equation 4: HDI = 0. 0012$E(s)$ + 0. 595 (HDI vs % School Electrification)

Equation 5: HDI = 0. 0014T + 0. 578 (HDI vs % Access to Toilets)

Equation 6: HDI = 0. 0018TTW + 0. 6096 (HDI vs %Households with Treated Tap Water)

To understand the efficacy of the equations derived above, the expected HDI based on input parameters in 2018 was computed.

The derived values of 2018 as calculated was compared with the actual HDI values for 2018, and used a Pearson statistical test in order to find the accuracy (quality of fit) of the model, with a higher coefficient relating to better quality of fit.



The Pearson Coefficient found for the values at hand are as follows:

Equation 1: 0.65
Equation 2: 0.62
Equation 3: 0.75
Equation 4: 0.62
Equation 5: 0.28
Equation 6: 0.69

Finally, a multi-variable regression model was found using all key input parameters to estimate HDI. The regression equation is as follows:

$$HDI = (9.32176E-05)TTW + (1.92E-05)T + (2.05E-05)E(s) + (0.002253)LR + (0.000799)E(hh) + (0.001525)G\% + 0.402821$$

Upon performing a Pearson test based on computed HDI for 2018 versus the true HDI values, the Pearson coefficient is 0.806084618, which shows the very high accuracy of the equation.

As parameters change over time, it may therefore be possible to use the equation to plot expected HDI with the estimated impact of government or policy initiatives on input variables. The analysis, however, will need a refresh to arrive at an updated equation at a defined period.

6. DISCUSSION

Since the key factors that show a key correlation with rural development were identified, further reasoning as to why these factors show this degree of correlation can be done. Although the data doesn't show a perfect correlation with any one of the factors, this can be attributed to the fact that each small factor plays a role; since in real-life situations, there is no *ceteris paribus.* This can be assumed by seeing the correlation- however small- with all 27 initial parameters. Furthermore, when taking the Pearson coefficients for the models with separate factors versus the combined model, the equation has a much higher goodness in the multivariable model. The validity increases as more factors are taken into play.

6.1. Cooking fuels

The choice of cooking fuels in rural India holds critical implications for both safety and development. While Liquefied Petroleum Gases (LPGs) present a safer option, the prevalent reliance on biofuels or traditional sources presents sustainability challenges. These alternatives burn less efficiently and take time to collect and prepare for usage, diverting from income-generating activities. Moreover, they entail increased health risks such as carbon monoxide poisoning, leading to reduced life expectancy, greater absenteeism from work and school, and ultimately lowering the rural HDI. The unavailability of affordable and accessible LPGs makes them a luxury attainable only for the privileged, which increases wealth disparities due to income loss from sick days and hours lost to fuel collection efforts. The lack of awareness regarding the advantages of cleaner cooking fuels further perpetuates this, alongside practical obstacles like distance to refill points and taste considerations. To rectify these issues, investments in making LPGs more economical and widespread, coupled with awareness campaigns regarding the benefits of clean fuel, have the potential to drive increased usage, substantially benefiting rural communities.

The primary barrier to widespread LPG adoption among households is affordability, exacerbated by reduced government subsidies due to COVID-related economic challenges. In the past decade, India has made significant strides in enhancing household access to clean cooking fuel. Integrating the LPG program with broader social assistance and rural development initiatives is recommended to raise rural incomes, facilitating the transition from biomass to LPG and enabling women to engage in income-generating activities. Integrating the LPG program with social assistance and rural development initiatives is imperative, and schemes like the Mahatma Gandhi National Rural Employment Guarantee Act could empower women economically and address their limited influence in LPG purchase decisions. Furthermore, the introduction of the Pradhan Mantri Ujjwala Yojana (PMUY) in 2016 aimed to provide clean cooking fuel to rural and underprivileged households by offering cash assistance and free LPG gas connections. However, despite reported progress indicating 99.8% coverage of LPG fuel as of April 2021, there exists a substantial gap between these figures and ground realities. Research indicates that households often use a mix of clean and unclean fuels, even among PMUY beneficiaries.

6.2. Household electrification

The process of household electrification carries significant implications, as highlighted by the authors. According to their findings, the introduction of electricity leads to a surge in household expenditure, heightened appliance usage, and increased domestic activity. This shift towards electrification not only brings about reliable lighting for homes but also extends the scope for completing domestic tasks and chores during nighttime, thereby freeing up daytime hours for income-generating pursuits. The adoption of electric appliances and lighting options presents a cleaner alternative compared to traditional fuel sources, ultimately improving household health and consequently boosting overall productivity. Moreover, the availability of electricity enables households to invest in time-saving appliances, streamlining domestic work. An additional advantage lies in the potential cost-effectiveness of electricity compared to other fuel sources, particularly in heating, cooking, and energy-intensive activities. This cost reduction can prompt households to either increase fuel consumption or allocate the saved funds to other essential areas, leading to increased expenditures. The benefits of household electrification are twofold. Firstly, enhanced lighting facilitates greater household activity post-sunset, facilitating activities like reading, studying, and leisure engagements. Secondly, access to electricity amplifies the rewards of leisure activities, making home-based pursuits more appealing due to the presence of appliances like radios and televisions, which can surpass the allure of public spaces.

One scheme that aimed to bring electricity to rural villages is the Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY), which was launched by the central government in 2014, aiming to

electrify every village in India. Although announcing that they had achieved their goal in 2018; many households in those villages were not electrified- with the project considering 10% of the households being electrified as the village being electrified. As such, very little progress was truly made in the front of rural electrification. To bridge the gap, in October 2017, the government launched the Pradhan Mantri Sahaj Bijli Har Ghar Yojana–Saubhagya for the electrification of the remaining households.
The Ministry of Power launched an app to track progress and funding allocated on this front, but the app was made unavailable, which limits transparency and data regarding this issue. However, the Ministry of Power claimed that all households were reported electrified under Saubhagya except 18,734 households in some areas of Chhattisgarh as of March 2019. This does not hold true for the region of Jammu and Kashmir, where multiple villages did not have access to electricity whatsoever at the time. Additionally, many villages have inconsistent electricity, or power lines without transformers. These villages are essentially electrified only on paper, rather than acting as such.

6.3. Literacy rate

The literacy rate holds substantial implications for the progress of societies, particularly in rural areas. Education empowers rural communities to embrace fresh knowledge and integrate advanced technologies and methodologies into their enterprises, subsequently elevating the nation's per capita income and ameliorating poverty levels. This educational foundation fosters heightened productivity, ushering in new innovations and fostering a deeper comprehension of various subjects, which hence encourages growth through rural earnings, both to rural enterprises and to households. The exploitation of workers can be disrupted through literacy, as people would become more aware of their own rights and autonomy, leading to enhanced income sources, happiness, and improved living standards. Tackling illiteracy has many advantages, including the potential to alleviate poverty and hunger, which are often associated with rural settings. Illiteracy presents a barrier to rural development and food security, impeding productivity and health while constraining opportunities for livelihood improvement and gender equality advancement.

This disparity is particularly evident among rural girls and women. In addition to these socioeconomic advantages, an improved literacy rate can contribute to reduced crime rates, further emphasizing the transformative impact that education can have on rural communities and society at large.

The government has introduced various programs to advance education in rural areas. The Samagra Shiksha scheme, initiated in 2018-19, provides integrated education from pre-school to class XII with the aim of ensuring equitable and quality education across the nation. The Shiksha Karmi Project, dating back to 1987 in Rajasthan, focuses on universalizing primary education in socio-economically disadvantaged villages by adapting education to local needs. Similarly, the Lok Jambish Pariyojana, established in Rajasthan in 1992, aims to achieve universal elementary education through mass mobilization and child-centred learning. Additionally, the government employs digital initiatives like e-PATHSHALA, Diksha, MOOC, SWAYAM PRABHA, and the National Digital Library to address challenges such as attendance, teacher commitment, infrastructure, and education quality, making these resources accessible throughout the country.

6.4. School electrification

Access to electricity within schools plays a pivotal role in enhancing educational opportunities, and hence income of graduates. The introduction of artificial lighting extends the potential for teaching and studying hours, a crucial aspect in rural settings where students often assist with family farming during daylight hours. This extended learning time has the potential to enhance educational outcomes by enabling students to devote more time to their studies. Additionally, the availability of electricity could lead to an increase in both the quantity and quality of teachers, particularly in rural schools that face challenges in attracting and retaining skilled educators. This electrification not only facilitates conventional learning but also opens the doors to online education, computer-based learning, and access to a wealth of knowledge available through digital resources. Moreover, electrification has the potential to make schools more appealing and encourage regular attendance, contributing to the overall improvement of education in underserved areas. By providing access to electricity, schools can contribute to the cultivation of higher human capital within less-developed regions, by narrowing the educational divide between areas characterized by varying levels of urbanization. Overall, this can not only increase employment and employment opportunities but also improve the types of jobs- as many may shift from agriculture to something more technical- and income obtained through them.

6.5. Access to toilets

Access to toilets can be both improved by rural development and can work to increase it; it works as an upward cycle. The availability of proper sanitation facilities, including toilets, holds a critical significance in ensuring public health and hygiene. Inadequate access to toilets can lead to the rampant spread of diseases such as cholera, typhoid, and diarrhoea, posing a particularly grave risk to vulnerable populations like children and the elderly. Women, in particular, face heightened challenges when sanitation facilities are lacking, affecting their overall well-being. The tangible consequences of lacking home toilets extend to poor menstrual hygiene management, the deprivation of essential resources like food and water due to the absence of privacy, and the subsequent risks of undernourishment, reproductive infections, and bladder complications. Pregnant women are especially vulnerable to these adverse health effects. By promoting access to toilets, the prevalence of diseases decreases, leading to reduced instances of missed working hours and school days due to illness. Beyond the physical implications, the absence of proper sanitation facilities engenders a sense of stigma, stress, and anxiety among affected individuals. This issue can be mitigated through improved income levels, government expenditure on building toilets, and rural development, as increased resources and available income(due to not losing hours at work because of illness) enable more individuals and communities to afford private toilets or communal sanitation facilities.

The Swachh Bharat Mission was launched by the Indian Prime Minister on October 2, 2014, and aims to achieve universal sanitation coverage and safe sanitation by 2019, in commemoration of Mahatma Gandhi's 150th Birth Anniversary. This initiative focuses on improving cleanliness levels in rural areas through Solid and Liquid Waste Management while making Gram Panchayats Open Defecation Free (ODF), clean, and sanitized. The World Bank is supporting the mission through the 'Swachh Bharat Mission Support Operation,' involving performance incentives for sanitation improvement and technical assistance for capacity building and monitoring. The World Bank measures states' performance based on four disbursement-linked indicators, including reduction in open defecation prevalence, ODF sustainability, increased access to waste management, and operationalization of incentive schemes. An Independent Verification Agency (IVA) was appointed to conduct the National Annual Rural Sanitation Survey (NARSS) to assess state performance, as outlined in the report based on NARSS Round 2 (2017-18).

6.6. Treated Tap Water

Investment and the spread of Treated tap water in households can alleviate many challenges associated with access to clean water and sanitation facilities, and can both contribute to and increase rural development. Improved development enables communities to afford vital resources like Reverse Osmosis (RO) systems and other means of accessing safe water, contributing to better health and hygiene conditions. The consequences of unsafe water sources extend beyond time constraints, as they also engender health problems, hamper productivity, and result in income loss due to waterborne diseases. A significant aspect of this is the reduction of the burden placed on individuals, particularly women, who often bear the responsibility of travelling long distances to fetch water. This necessity of water collection can disrupt education and employment opportunities, creating opportunity costs in terms of time. This situation disproportionately affects women, who are frequently tasked with water retrieval and thus deprived of educational and economic prospects. All of this can be minimized by investing in ensuring households have treated tap water, and hence can often propel rural development significantly. Furthermore, these rural development efforts mitigate environmental strains by lessening the impact on groundwater and soil health, subsequently benefiting agricultural productivity.

A noteworthy initiative addressing these challenges is the Jal Jeevan Mission established in 2019, aimed at combatting water scarcity and enhancing household access to clean drinking water. The Jal Jeevan Mission employs technology to ensure effective service delivery, transparency, accountability, and resource optimization, as evidenced by geo-tagging for each water supply asset and the use of hydro-geo morphological (HGM) maps to identify water sources and design aquifer recharge structures for single village projects. At the time of the Jal Jeevan Mission’s inception, barely 3.23 million rural families, or 17% of the rural population, had access to drinking water from taps. Women and young girls bore the brunt of arranging water for everyday household needs. Significant progress was seen in this area since the introduction of the Jal Jeevan Mission and the improvement in access to tap water connections, and as of 10 August 2022, out of a total of 19.32 crore rural households in the country, 9,99,43,358 (52.20%) households have the provision of tap water supply in their homes. Furthermore, in response to Prime Minister Narendra Modi's 100-day campaign, initiated by Union Minister for Jal Shakti, Gajendra Singh Shekhawat, on October 2, 2020, 82% of schools (8.46 lakh) and 78% of Anganwadi centres (8.67 lakh) nationwide now have access to clean tap water for various purposes. Moreover, numerous rainwater harvesting facilities and greywater reuse structures have been established in schools, amounting to 93 thousand and 1.08 lakh, respectively.

7. CONCLUSION

This research paper delved into an in-depth exploration of factors influencing rural development in India, intending to pinpoint key determinants that could serve as effective catalysts for progress. Through a meticulous analysis of 27 carefully selected factors that had been said to impact rural development, this investigation identified the top 10 factors, achieved via a correlation analysis using rural data by state.

Subsequently, from this refined pool, 6 factors were found that exhibit a high potential to shape rural development dynamics. These factors include households with access to gas and electricity, literacy rate, school electrification, access to sanitation facilities, and the availability of treated tap water.

Our analysis derived 6 equations to model each of these 6 factors, most of which exhibited a commendable degree of goodness of fit, which was identified through Pearson testing. Notably, although the equation on access to toilets displayed a relatively lower degree of goodness of fit, its significance as a component of rural development cannot be understated, especially considering the high correlation.

Furthermore, this investigation extended its purview to encompass a multivariable analysis, which in turn developed an equation encompassing all key factors taken against rural HDI. This multivariable equation demonstrated a high degree of goodness of fit, which can be said to affirm the impact of these factors, while still acknowledging that other factors may affect development. In essence, these findings underscore that targeted policy interventions aimed at enhancing electricity access for households and schools, bolstering literacy rates, and ensuring access to clean water and toilets, stand as promising pathways to elevate human development indices in rural areas.

The generalizability of these findings across rural India was taken into account by using data for each state. The comprehensive data collection spanning every state lends a broad and holistic perspective, making these results appropriate for national-scale policy decisions. This further accentuates their applicability to rural policy-making and the designing of development initiatives. In this light, this research contributes insights to the discourse on rural development, providing a guide for policymakers, researchers, and practitioners striving to help improve rural India's landscape.

8. APPENDIX

Table 8.1: Correlation Coefficients for Input Parameters

Input Parameters	Correlation	Degree of correlation
Rural cooking fuel in households	0.83	very high
Households electrified	0.79	high
Overall literacy rate	0.72	high
Schools with electricity	0.71	high
Female literacy rate	0.69	moderate
Male literacy rate	0.69	moderate
% Open defecation	-0.62	moderate
% Households with treated tap water	0.6	moderate
Govt. expenditure per student	0.6	moderate
Higher secondary NAR	0.58	moderate
Secondary NAR	0.57	moderate
Share of employment in agriculture	-0.52	moderate
PTR primary	-0.44	low
PTR upper primary	-0.44	low
CHC electric supply	0.42	low
Schools with girl's toilets	0.41	low
Access to banking services	0.39	low
Middle NAR	0.36	low
Villages Electrifed	0.28	very low
Schools with drinking water	0.28	very low
CHC with operation theatre	0.28	very low
CHC with 4+ beds	0.22	very low
CHC with water supply	0.2	very low
CHC with all 4 specialists	0.15	very low
CHC with labour room	0.11	very low
Primary NAR	-0.04	very low
Irrigation vs NCA	0.01	very low

Table 8.2: Statewise Rural School Education Parameters (2011)

Census 2011	HDI (2011)	Schools having drinking water facility (%)	Schools having girls' toilets (%)	Schools with electricity connection (%)	Primary (Net Attendance Rate)	Middle (Net Attendance Rate)	Secondary(Net Attendance Rate)	Higher secondary(NAR)	Pupil Teacher Ratio - Primary	Pupil Teacher Ratio - Upper Primary	Literacy Males	Literacy Females	Literacy Persons
Andhra Pradesh	0.60	89.6	55.3	63.3	84.0	56.0	47.0	47.0	14.0	4.2	69.4	51.5	60.4
Arunachal Pradesh	0.66	77.3	28.6	16.8	44.0	34.0	34.0	22.0	18.1	12.7	67.4	52.0	59.9
Assam	0.58	75.4	38.9	9.3	77.0	64.0	56.0	15.0	41.6	11.1	75.4	63.0	69.3
Bihar	0.52	92.0	37.6	3.9	63.0	36.0	33.0	22.0	88.9	89.2	69.7	49.0	59.8
Chhattisgarh	0.61	93.5	34.0	18.3	85.0	57.0	45.0	29.0	27.8	17.1	77.0	55.1	66.0
Delhi	0.81	100.0	80.4	98.8	48.0	40.0	69.0	37.0	67.9	42.2	89.4	73.1	81.9
Goa	0.78	98.9	66.9	97.3	84.0	71.0	76.0	85.0	11.0	17.3	91.7	81.6	86.6
Gujarat	0.65	97.6	71.5	97.2	73.0	51.0	40.0	21.0	35.9	21.5	81.6	61.4	71.7
Haryana	0.67	98.9	85.2	94.1	86.0	60.0	41.0	32.0	50.3	12.8	81.6	60.0	71.4
Himachal Pradesh	0.71	97.5	65.9	59.4	87.0	76.0	56.0	47.0	5.8	5.7	89.1	74.6	81.9
Jammu & Kashmir	0.63	85.7	22.4	0.0	90.0	60.0	50.0	32.0	8.9	5.0	73.8	51.6	63.2
Jharkhand	0.58	87.5	59.8	6.7	63.0	43.0	36.0	19.0	66.7	63.1	72.9	48.9	61.1
Karnataka	0.66	94.1	73.4	91.2	84.0	64.0	69.0	39.0	18.6	17.4	77.6	59.7	68.7
Kerala	0.73	99.4	77.5	90.6	72.0	66.0	77.0	56.0	12.8	7.2	95.4	90.8	93.0
Madhya Pradesh	0.60	90.5	34.8	12.7	75.0	59.0	33.0	21.0	54.7	45.1	74.7	52.4	63.9
Maharashtra	0.71	90.7	68.9	69.6	82.0	65.0	65.0	42.0	23.0	19.7	85.1	68.5	77.0
Manipur	0.64	87.9	23.2	19.2	57.0	54.0	69.0	34.0	22.2	15.4	83.4	68.9	76.2
Meghalaya	0.68	57.2	22.8	11.4	56.0	59.0	41.0	20.0	13.9	3.5	71.5	68.4	69.9
Mizoram	0.67	82.0	58.3	30.2	86.0	67.0	60.0	13.0	21.5	1.9	88.2	79.8	84.1
Nagaland	0.66	73.7	67.2	28.4	79.0	58.0	37.0	18.0	19.5	13.5	79.0	71.5	75.3
Odisha	0.59	88.6	38.1	17.9	85.0	54.0	61.0	29.0	46.2	35.0	79.6	60.7	70.2
Punjab	0.68	99.8	90.2	99.3	86.0	59.0	39.0	27.0	27.4	4.5	76.6	65.7	71.4
Rajasthan	0.60	94.3	91.8	33.0	80.0	53.0	31.0	18.0	39.9	25.2	76.2	45.8	61.4
Sikkim	0.69	98.1	75.2	57.8	91.0	55.0	28.0	15.0	1.4	1.3	84.6	72.4	78.9
Tamil Nadu	0.70	100.0	67.3	93.8	87.0	75.0	68.0	61.0	28.1	32.3	82.0	65.0	73.5
Tripura	0.62	81.3	42.0	11.0	96.0	62.0	41.0	17.0	14.4	12.7	90.1	79.5	84.9
Uttar Pradesh	0.57	98.1	76.0	25.8	82.0	49.0	39.0	21.0	65.5	49.9	76.3	53.7	65.5
Uttarakhand	0.69	92.5	50.9	36.6	93.0	58.0	46.0	25.0	23.1	13.0	86.6	66.2	76.3
West Bengal	0.64	95.1	47.8	21.8	75.0	67.0	39.0	21.0	42.1	41.0	78.4	65.5	72.1
All-India		**92.1**	**58.2**	**37.3**	**78.0**	**55.0**	**44.0**	**29.0**	**42.0**	**31.3**	**77.2**	**57.9**	**67.8**
Corelation Co efficient against HDI2011		**0.28**	**0.41**	**0.71**	**-0.04**	**0.36**	**0.57**	**0.58**	**-0.44**	**-0.44**	**0.69**	**0.69**	**0.72**

Table 8.3: Statewise Rural Facilities (2011)

Census 2011	HDI (2011)	Villages electrified (%) (till June 2013)	HHs electrified (%) (till 2011)	Source of drinking water (%) _Tapwater from treated source	Rural Cooking Fuel_LPG/ PNG	Open Defecation
Andhra Pradesh	0.60	100.0	89.7	36.4	20.6	65.1
Arunachal Pradesh	0.66	75.5	55.5	19.7	13.0	44.3
Assam	0.58	96.1	28.4	5.8	9.9	38.5
Bihar	0.52	95.3	10.4	1.6	3.4	81.4
Chhattisgarh	0.61	97.1	70.0	3.3	1.6	85.2
Delhi	0.81	100.0	97.0	49.6	75.2	13.5
Goa	0.78	100.0	95.6	72.9	59.5	27.4
Gujarat	0.65	99.8	85.0	16.7	14.3	65.8
Haryana	0.67	100.0	87.2	47.4	24.1	42.3
Himachal Pradesh	0.71	99.9	96.6	82.7	32.7	32.5
Jammu & Kashmir	0.63	98.2	80.7	22.3	16.3	58.3
Jharkhand	0.58	89.2	32.3	2.1	1.9	91.7
Karnataka	0.66	99.95	86.7	22.9	11.0	68.1
Kerala	0.73	100.0	92.1	17.2	24.7	5.6
Madhya Pradesh	0.60	97.6	58.3	4.7	3.5	86.4
Maharashtra	0.71	99.9	73.8	32.0	17.9	55.8
Manipur	0.64	86.3	61.2	12.7	16.0	12.3
Meghalaya	0.66	86.3	51.6	16.7	2.6	43.1
Mizoram	0.67	93.5	68.8	14.6	17.9	12.9
Nagaland	0.66	70.1	75.2	6.1	6.7	22.3
Odisha	0.59	78.9	35.6	4.0	3.1	84.7
Punjab	0.68	100.0	95.5	25.3	38.9	28.1
Rajasthan	0.60	97.6	58.3	17.9	7.7	79.9
Sikkim	0.69	100.0	90.2	13.4	24.3	14.9
Tamil Nadu	0.70	100.0	90.8	46.1	28.6	73.3
Tripura	0.62	92.9	59.5	11.4	5.3	15.4
Uttar Pradesh	0.57	88.9	23.8	46.0	6.4	77.1
Uttarakhand	0.69	98.9	83.1	13.1	29.4	45.0
West Bengal	0.64	99.99	40.3	7.6	4.0	51.3
All-India		**94.5**	**55.2**	**17.9**	**11.4**	**67.3**
Corelation Co efficient against HDI2011		**0.28**	**0.79**	**0.60**	**0.83**	**-0.62**

Table 8.4: Community Health Center Facilities

Census 2011	HDI (2011)	CHC with All 4 specialists _2012	CHC_Labour Room	CHC Operation Theatre	CHC At least 4 beds	CHC_Regular water supply	CHC_Electric supply	CHC All-weather motorable approach road
Andhra Pradesh	0.60	59.4	100.0	100.0	100.0	100.0	100.0	100.0
Arunachal Pradesh	0.66	0.0	69.1	11.3	60.8	70.1	68.0	88.7
Assam	0.58	2.8	70.4	3.4	52.4	72.6	73.8	93.1
Bihar	0.52	25.7	25.8	25.8	28.6	98.0	98.7	98.8
Chhattisgarh	0.61	8.7	58.0	29.5	44.9	58.5	72.5	84.8
Delhi	0.81							
Goa	0.78	100.0	68.4	68.4	68.4	100.0	100.0	100.0
Gujarat	0.65	100.0	97.0	97.0	100.0	100.0	100.0	97.8
Haryana	0.67	3.7	94.4	23.1	67.5	94.1	99.1	100.0
Himachal Pradesh	0.71	0.0	35.0	28.8	33.7	93.2	98.5	92.6
Jammu & Kashmir	0.63	32.1	60.4	17.7	76.0	81.1	90.4	87.1
Jharkhand	0.58	2.7	44.2	7.0	27.0	42.4	43.9	90.3
Karnataka	0.66	1.1	73.2	73.2	73.2	100.0	100.0	100.0
Kerala	0.73	2.8	7.7	7.4	31.0	100.0	100.0	94.1
Madhya Pradesh	0.60	0.0	79.8	0.0	67.4	81.8	100.0	83.4
Maharashtra	0.71	5.0	87.2	83.8	100.0	89.3	98.8	81.7
Manipur	0.64	0.0	47.5	0.0	23.8	31.3	81.3	85.0
Meghalaya	0.66	0.0	100.0	0.0	100.0	88.1	96.3	45.9
Mizoram	0.67	100.0	100.0	100.0	100.0	0.0	100.0	100.0
Nagaland	0.66	0.0	81.0	31.0	97.6	84.1	85.7	75.4
Odisha	0.59	9.5	82.6	0.0	0.0	75.1	88.5	99.5
Punjab	0.68	24.2	59.9	22.7	58.4	100.0	99.1	100.0
Rajasthan	0.60	8.6	100.0	35.1	100.0	100.0	100.0	100.0
Sikkim	0.69	0.0	100.0	91.7	100.0	95.8	100.0	95.8
Tamil Nadu	0.70	0.0	100.0	5.5	69.7	100.0	100.0	100.0
Tripura	0.62	NA	88.6	26.6	79.7	72.2	81.0	86.1
Uttar Pradesh	0.57	35.3	19.1	NA	64.7	81.2	75.6	91.9
Uttarakhand	0.69	16.9	47.5	37.7	63.4	94.2	94.2	91.1
West Bengal	0.64	0.0	100.0	18.2	92.6	100.0	96.5	100.0
All-India		**18.4**	**65.9**	**34.4**	**67.0**	**89.3**	**92.0**	**94.2**
Corelation Co efficient against HDI2011		**0.15**	**0.11**	**0.28**	**0.22**	**0.20**	**0.42**	**0.00**

** CHC: Community Health Center*

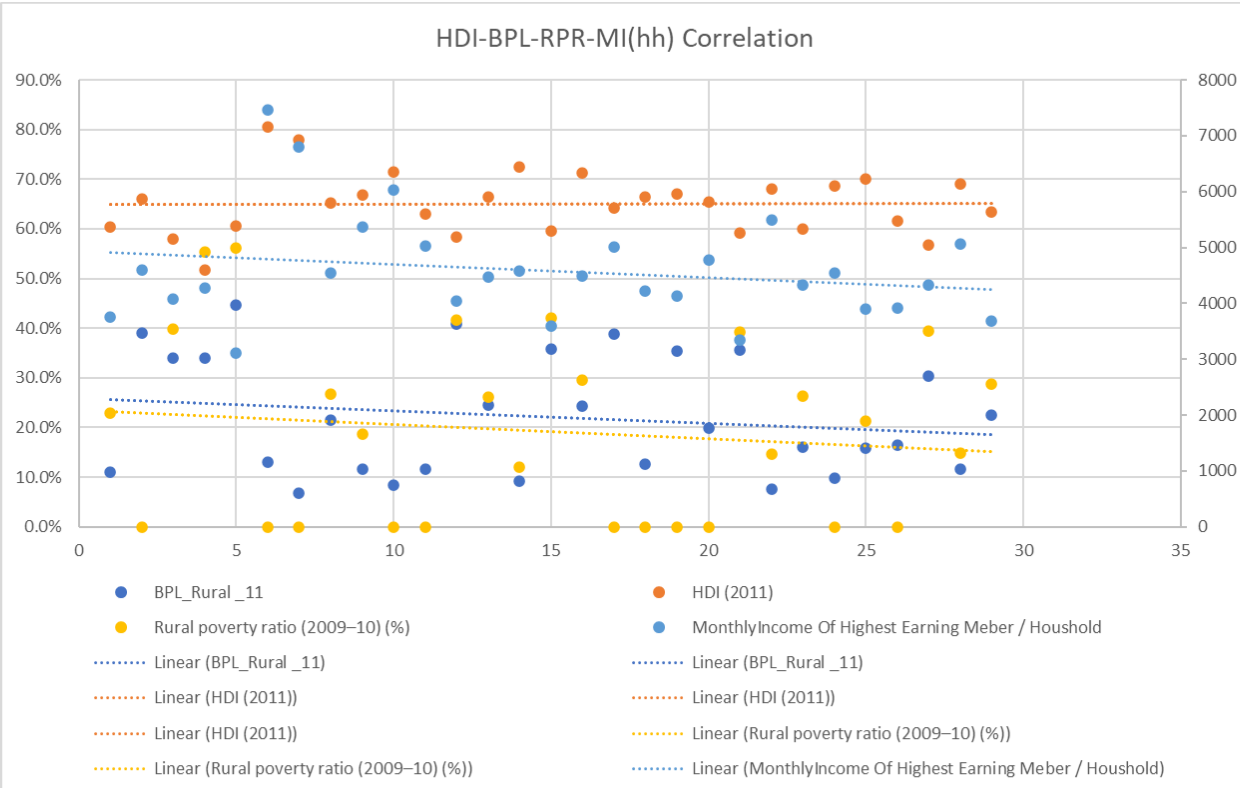
Table 8.5: Statewise Other Parameters

Census 2011	HDI (2011)	MonthlyIncome Of Highest Earning Meber / Houshold	Share Of Agriculture In Rural Employement	Proportion of Rural Households Availing Banking Services (%)_2011	Irrigation Vs Net Cropped Area
Andhra Pradesh	0.60	3752	68.7	50.4	48.4
Arunachal Pradesh	0.66	4603	75.7	43.1	
Assam	0.58	4084	70.5	38.3	
Bihar	0.52	4282	66.9	42.3	80.1
Chhattisgarh	0.61	3117	84.9	46.1	19.9
Delhi	0.81	7462	0.0		
Goa	0.78	6805	23.9	84.9	
Gujarat	0.65	4545	78.3	51.3	37.9
Haryana	0.67	5364	59.8	65.9	75.3
Himachal Pradesh	0.71	6039	62.9	89.1	
Jammu & Kashmir	0.63	5029	58.7	65.4	
Jharkhand	0.58	4046	54.8	47.4	24.3
Karnataka	0.66	4477	75.7	58.9	27.3
Kerala	0.73	4575	35.7	73.9	37.8
Madhya Pradesh	0.60	3587	82.4	40.7	40.4
Maharashtra	0.71	4495	79.4	62.9	33.4
Manipur	0.64	5007	53.4	23.5	
Meghalaya	0.66	4215	70.7	28.2	
Mizoram	0.67	4136	80.6	35.9	
Nagaland	0.66	4774	74.1	23.1	
Odisha	0.59	3338	67.6	41.0	18.7
Punjab	0.68	5496	61.8	62.8	104.3
Rajasthan	0.60	4322	63.3	68.2	30.3
Sikkim	0.69	4545	53.9	63.5	
Tamil Nadu	0.70	3898	63.7	45.2	65.7
Tripura	0.62	3908	30.6	78.2	
Uttar Pradesh	0.57	4326	68.9	73.6	79.3
Uttarakhand	0.69	5065	69.5	80.3	
West Bengal	0.64	3677	56.3	39.8	67.2
All-India		4185	67.9	54.4	**49.1**
Corelation Co efficient against HDI2011			**-0.52**	**0.39**	**0.01**

Table 8.6: Output Parameters Correlation

Census 2011	HDI (2011)	BPL_Rural _11	Rural poverty ratio (2009–10) (%)	MonthlyIncome Of Highest Earning Meber / Houshold
Andhra Pradesh	0.60	11.0%	0.2	3752
Arunachal Pradesh	0.66	38.9%		4603
Assam	0.58	33.9%	0.4	4084
Bihar	0.52	34.1%	0.6	4282
Chhattisgarh	0.61	44.6%	0.6	3117
Delhi	0.81	12.9%		7462
Goa	0.78	6.8%		6805
Gujarat	0.65	21.5%	0.3	4545
Haryana	0.67	11.6%	0.2	5364
Himachal Pradesh	0.71	8.5%		6039
Jammu & Kashmir	0.63	11.5%		5029
Jharkhand	0.58	40.8%	0.4	4046
Karnataka	0.66	24.5%	0.3	4477
Kerala	0.73	9.1%	0.1	4575
Madhya Pradesh	0.60	35.7%	0.4	3587
Maharashtra	0.71	24.2%	0.3	4495
Manipur	0.64	38.8%		5002
Meghalaya	0.66	12.5%		4215
Mizoram	0.67	35.4%		4136
Nagaland	0.66	19.9%		4774
Odisha	0.59	35.7%	0.4	3338
Punjab	0.68	7.7%	0.1	5496
Rajasthan	0.60	16.1%	0.3	4322
Sikkim	0.69	9.9%		4545
Tamil Nadu	0.70	15.8%	0.2	3898
Tripura	0.62	16.5%		3908
Uttar Pradesh	0.57	30.4%	0.4	4326
Uttarakhand	0.69	11.6%	0.1	5065
West Bengal	0.64	22.5%	0.3	3677
All-India		25.7%	0.3	4185
Corelation Co efficient against HDI 2011	**1.00**	**-0.59**	**-0.80**	**0.73**
Corelation Co efficient against Income 2011	**0.73**	**-0.61**	**-0.70**	**1.00**
Corelation Co efficient against BPL 2011	**-0.85**	**1.00**	**0.99**	**0.28**

Table 8.7: Output parameters graph



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