

Empirical Validation of the Digvijay Poverty Measure: Evidence from India's Household Consumption Expenditure Survey 2023–24

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ABSTRACT

Poverty measurement plays an important role in identifying deprived populations and designing effective policy interventions. Traditional poverty measures such as the Headcount Ratio, Foster–Greer–Thorbecke (FGT) indices, and Sen Poverty Measure provide useful information on different dimensions of poverty; however, their sensitivity to severe deprivation varies. This study presents an empirical evaluation of the Digvijay Poverty Measure using data from the Household Consumption Expenditure Survey (HCES) 2023–24 of India. The analysis is based on Monthly Per Capita Consumption Expenditure (MPCE) and employs a relative poverty line defined as 50% of the weighted median MPCE. Poverty estimates are obtained at the national, rural–urban, and state levels and are compared with conventional poverty measures. The results show that the proposed measure is consistent with existing measures in identifying high- and low-poverty regions while providing greater sensitivity to severe deprivation through its deprivation parameter. The rural–urban analysis reveals substantially higher poverty in rural areas, and the state-wise analysis highlights significant regional disparities. Sensitivity analysis further demonstrates the robustness of the measure across alternative poverty thresholds. The findings suggest that the Digvijay Poverty Measure offers a flexible framework for poverty assessment and provides additional insights into the depth and severity of poverty in India.

Keywords- Poverty Measurement; Digvijay Poverty Measure; Sen Poverty Measure; HCES 2023–24; India; Poverty Severity.

I. INTRODUCTION

Poverty remains one of the major challenges faced by both developed and developing countries. Although many countries have achieved significant economic growth, a large number of people still lack adequate resources to maintain a minimum standard of living. Poverty affects health, education, nutrition, and overall quality of life. Therefore, its proper measurement is important for understanding the extent of deprivation and for designing effective public policies.

In India, poverty measurement has received considerable attention because of the country's large population and regional diversity. Significant differences in living standards exist across states as well as between rural and urban areas. Reliable poverty measures help policymakers identify vulnerable groups and allocate resources more effectively. For this reason, the development of appropriate poverty measures has remained an important area of research.

The simplest and most widely used poverty measure is the Head Count Ratio (HCR), which measures the proportion of individuals living below the poverty line. While the measure is easy to understand and calculate, it does not consider how poor the poor actually are. Individuals just below and far below the poverty line are treated equally. As a result, the Head Count Ratio provides information only about the incidence of poverty.

To overcome the limitations of the Head Count Ratio, poverty gap measures were developed to account for the shortfall of income from the poverty line. An important contribution was made by Foster, Greer and Thorbecke (1984), who

proposed the FGT class of poverty measures. These measures introduced a parameter that allows poverty estimates to become sensitive to the depth and severity of deprivation. However, they do not explicitly capture inequality among poor individuals. Recognizing the importance of distributional concerns, Sen (1976) proposed a poverty measure that combines incidence, intensity, and inequality among the poor within a single framework. Sen's measure assigns greater weight to poorer individuals and therefore reflects differences in the distribution of deprivation within the poor population. Building on these contributions, several researchers further refined poverty measurement. Thon (1979), Kakwani (1980), Chakravarty (1983), and Shorrocks (1995) proposed alternative formulations and extensions that strengthened the theoretical foundations of poverty measurement and highlighted the importance of considering inequality among the poor alongside the incidence and depth of poverty.

Recently, the Digvijay Poverty Measure was proposed by Singh (2026) as a generalization of Sen's framework. The measure replaces the linear deprivation function used in Sen's index with a power-weighted deprivation function while retaining the rank-based weighting structure among the poor. This modification allows greater sensitivity to severe deprivation and provides additional flexibility in poverty assessment. The theoretical properties and axiomatic foundations of the measure have already been established in earlier work.

Despite the availability of several poverty measures, their empirical performance may differ when applied to actual data. In particular, poverty rankings can change when greater importance is assigned to severe deprivation. Therefore, it is important to examine how the proposed measure behaves in a real-world setting and whether it provides additional insights compared to existing measures.

The present study applies the Digvijay Poverty Measure to the Household Consumption Expenditure Survey (HCES) 2023–24 data for India. Poverty estimates are obtained at the national, rural–urban, and state levels. The results are compared with those obtained from the Head Count Ratio, the Foster–Greer–Thorbecke measure, and Sen's poverty measure. The study also examines the sensitivity of poverty estimates and state poverty estimates under different values of the severity parameter.

This study makes two main contributions. First, it provides an empirical application of the Digvijay Poverty Measure using recent nationally representative data from India. Second, it evaluates the extent to which poverty estimates and state rankings change when poverty severity is given greater importance. The findings may help in obtaining a more comprehensive understanding of poverty across regions.

The remainder of the paper is organized as follows. Section 2 describes the data and methodology. Section 3 presents the empirical results, including descriptive statistics, national poverty estimates, rural–urban poverty patterns, sensitivity and dominance analysis, and state-wise poverty estimates. Section 4 discusses the main findings of the study. Finally, Section 5 concludes the paper.

II. DATA AND METHODOLOGY

2.1 Data Source

This study uses unit-level data from the Household Consumption Expenditure Survey (HCES) 2023–24 conducted by the National Sample Survey Office (NSSO), Ministry of Statistics and Programme Implementation, Government of India. This survey contains detailed data regarding monthly consumption expenditure of households in both rural and urban parts of all states and Union Territories of India.

Information about Monthly Household Consumption Expenditure (MHCE), household size, sector, state, and survey weight is available for each individual household. Monthly Per Capita Consumption Expenditure (MPCE) was calculated by dividing the monthly household consumption expenditure by household size. MPCE was used as the welfare indicator for estimating poverty due to the greater stability of consumption expenditure compared to that of income.

All the estimates presented in this study have been calculated based on the survey weights available in the data set.

2.2 Poverty Measures

To examine the performance of the proposed measure, poverty estimates obtained from the Digvijay Poverty Measure are compared with those obtained from three widely used income-based poverty measures: the Head Count Ratio (HCR), the Foster–Greer–Thorbecke (FGT) measure, and Sen's Poverty Measure. Let us suppose that a group has n individual and out of them m ($\leq n$) individuals are poor. Suppose the income vector y is of the form

$$y_1 \leq y_2 \leq \dots \leq y_m < z \leq y_{m+1} \leq y_{m+2} \leq \dots \leq y_n \text{ where } z \text{ is equal to poverty line}$$

2.3.1 Head Count Ratio

The Head Count Ratio (HR) measures the proportion of individuals whose consumption expenditure falls below the poverty line. It is defined as

$$H = \frac{m}{n}$$

2.3.2 Foster–Greer–Thorbecke Measure

The Foster–Greer–Thorbecke (FGT) poverty measure is given by

$$FGT_{\alpha} = \frac{1}{n} \sum_{i=1}^q \left(\frac{z - y_i}{z} \right)^{\alpha}$$

2.3.3 Sen Poverty Measure

Sen's poverty measure, P_s combines poverty incidence, intensity, and inequality among the poor in a single framework. The measure assigns larger weights to poorer individuals and therefore reflects the distribution of deprivation within the poor population.

$$P_s = \frac{2}{n(m+1)z} \sum_{i=1}^m (z - y_i)(m+1-i)$$

2.3.4 Digvijay Poverty Measure

The Digvijay Poverty Measure (P_D) is a generalized form of Sen's poverty measure in which the linear deprivation function is replaced by a power-weighted deprivation function (Singh, 2026). The measure is defined as

$$P_D = \left[\frac{2(z - \bar{y}_p)}{nz(m+1)} \right]^{1-\lambda} \sum_{i=1}^m (z - y_i)^{\lambda}(m+1-i)$$

where λ is the severity parameter controlling the sensitivity of the measure to deprivation among the poor. When $\lambda=1$, the measure reduces to Sen's poverty measure.

2.4 Analytical Framework

Empirical analysis has been done in four stages. First stage involves estimation of poverty measures in India as a whole. Next step involved estimation of poverty measures for rural and urban sectors separately to study sectoral variations in poverty measures. Third stage involves estimation of poverty measures at the level of states on the basis of a common national poverty line. Fourth and final step included the estimation of Digvijay Poverty Measure for different values of the deprivation parameter (λ) to see the impact of sensitivity to deprivation.

III. RESULTS

3.1 Descriptive Statistics of MPCE

The analysis is based on 785,859 households from the HCES 2023–24 after excluding observations with missing values. Table 1 presents the descriptive statistics of Monthly Per Capita Consumption Expenditure (MPCE). The weighted mean and median MPCE were ₹3,559.25 and ₹2,819.33, respectively. The difference between the mean and median indicates inequality in consumption expenditure. The coefficient of variation exceeded 75 percent, suggesting substantial variation across households.

The MPCE distribution was positively skewed, with a small proportion of households reporting very high consumption expenditure. Figure 1 confirms that most households were concentrated at lower levels of consumption expenditure, while a long right tail was formed by a relatively small number of high-expenditure households.

Overall, the distribution exhibits considerable heterogeneity in household consumption expenditure, providing a suitable basis for poverty analysis.

Table 1-Descriptive Statistics of Monthly Per Capita Consumption Expenditure (MPCE)

Statistic	Unweighted	Weighted
Mean	3624.65	3559.25
Median	3000	2819.33
Standard Deviation	2738.18	2728.99
Coefficient of Variation (%)	75.54	76.67
Skewness	3.58	3.43
Minimum	48.89	48.89
Maximum	90000	90000

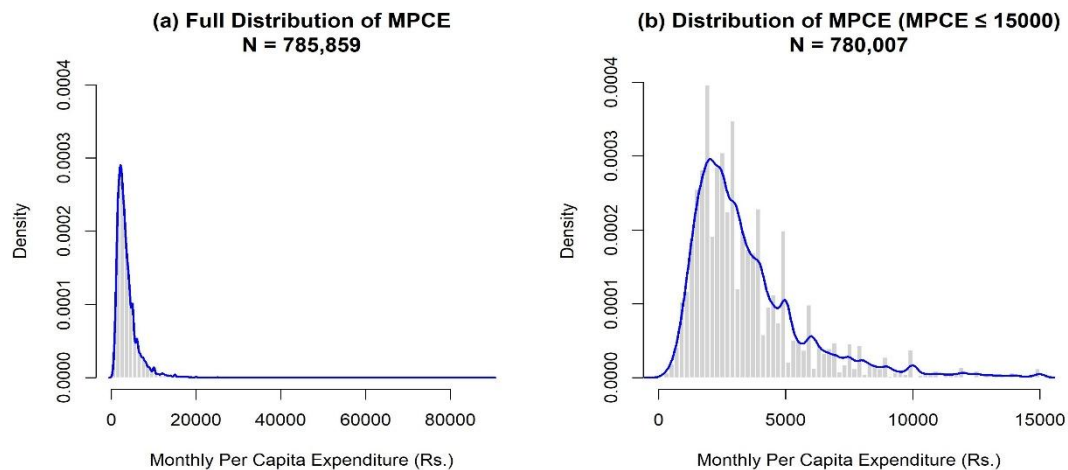


Figure 1- Distribution of Monthly Per Capita Consumption Expenditure (MPCE)

3.2 National Poverty Estimates

Table 2 presents the national poverty estimates obtained using alternative relative poverty lines. The poverty line was defined as 30%, 40%, 50%, 60%, 70%, and 80% of the median MPCE. As expected, all poverty measures increase monotonically with the poverty line, indicating that a larger proportion of households are classified as poor at higher thresholds.

The Headcount Ratio increases from 0.0177 at the 30 percent poverty line to 0.3570 at the 80 percent poverty line. Similar increasing patterns are observed for FGT1, FGT2, Sen's poverty measure, and the Digvijay Poverty Measure (P_D). These results indicate that both the depth and severity of poverty rise as the poverty threshold increases.

An important finding is that the P_D yields values identical to Sen's poverty measure when $\lambda=1$, confirming that Sen's measure is a special case of the proposed framework. As the value of λ increases, the P_D assigns greater weight to households experiencing larger consumption shortfalls and consequently produces higher poverty estimates. For example, at the 50 percent poverty line, the P_D increases from 0.0274 for $\lambda=0.5$ to 0.1445 for $\lambda=3$.

Overall, the results show that the P_D responds consistently to changes in the poverty line while allowing different degrees of sensitivity to poverty severity. This flexibility makes it useful for examining not only the incidence of poverty but also the distribution of deprivation among poor households.

Table 2- National Poverty Estimates under Alternative Relative Poverty Lines (Weighted Estimates)

Poverty Line (z) in ₹	HR (FGT0)	FGT 1	FGT 2	P_S	$P_D(0.5)$	$P_D(1)$	$P_D(2)$	$P_D(3)$
845.8	0.0177	0.0043	0.0018	0.0063	0.005	0.0063	0.0122	0.0277
1127.73	0.0491	0.011	0.0042	0.0161	0.0128	0.0161	0.0317	0.075
1409.67	0.1031	0.0236	0.0088	0.0341	0.0274	0.0341	0.0642	0.1445
1691.6	0.1792	0.0429	0.0162	0.0613	0.0495	0.0613	0.1112	0.2376
1973.53	0.2475	0.0681	0.0266	0.0933	0.0777	0.0933	0.1541	0.2919
2255.47	0.357	0.0984	0.0399	0.1378	0.1136	0.1378	0.2319	0.4441

3.3 Rural–Urban Poverty Comparison

Table 3 compares poverty estimates for rural and urban India using a common national poverty line of ₹1409.67. The mean MPCE was substantially higher in urban areas (₹5122.66) than in rural areas (₹2769.51). Although consumption inequality was higher in urban India, as indicated by a larger Gini coefficient, poverty levels were considerably lower.

The Headcount Ratio was 13.64 percent in rural areas compared with 3.73 percent in urban areas. Similar differences were observed for FGT1 and FGT2, indicating that both the depth and severity of poverty were higher in the rural sector.

Sen's poverty measure also showed substantially higher poverty in rural India (0.0447) than in urban India (0.0132). The Digvijay Poverty Measure produced similar results for all values of λ . As the value of λ increased, the gap between rural and urban poverty became more pronounced. For example, P_D increased from 0.0358 to 0.1911 in rural areas and from 0.0107 to 0.0522 in urban areas when λ increased from 0.5 to 3.

Overall, the results indicate that poverty is both more widespread and more severe in rural India. The increasing rural–urban gap under higher values of λ suggests that severe deprivation is more concentrated in rural households.

Table 3 -Rural–Urban Comparison of Poverty Measures (Weighted Estimates)

Measure	Rural	Urban
Mean MPCE (₹)	2769.51	5122.66
Poverty Line (₹)	1409.67	1409.67
Gini Coefficient	0.2879	0.3426
HR (FGT 0)	0.1364	0.0373
FGT 1	0.031	0.009
FGT 2	0.0115	0.0035
P_s	0.0447	0.0132
$P_D(0.5)$	0.0358	0.0107
$P_D(1)$	0.0447	0.0132
$P_D(2)$	0.0843	0.0244
$P_D(3)$	0.1911	0.0522

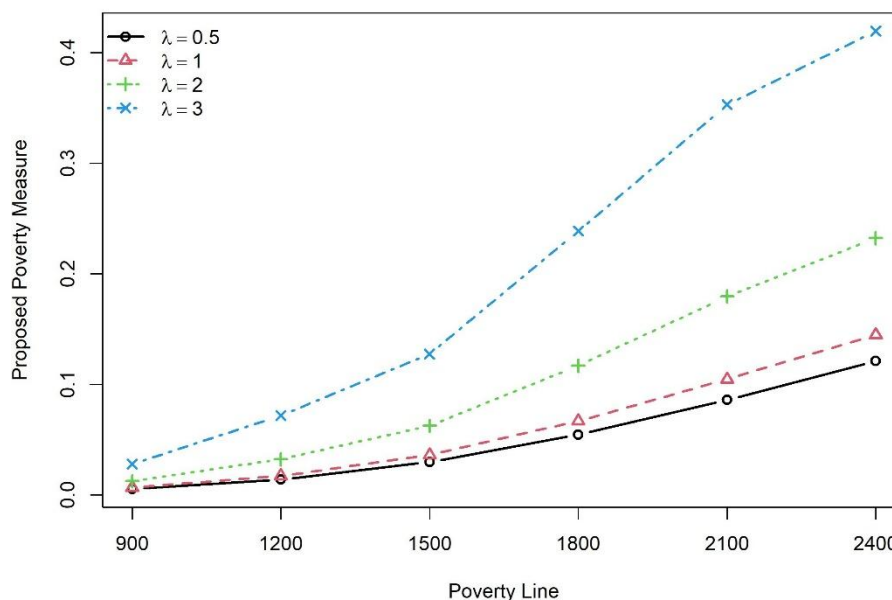
3.4 Sensitivity and Dominance Analysis

Figure 2 presents the values of the Digvijay Poverty Measure (P_D) for different relative poverty lines and values of the deprivation parameter λ . The results show that P_D increases steadily with the poverty line for all values of λ , indicating that higher poverty thresholds lead to higher measured poverty.

The measure is also sensitive to the choice of the deprivation parameter. For every poverty line, poverty estimates increase as λ increases. This indicates that larger values of λ assign greater weight to households experiencing larger consumption shortfalls and therefore place greater emphasis on severe deprivation. As expected, P_D with $\lambda=1$ coincides with Sen's poverty measure, confirming that Sen's measure is a special case of the proposed framework.

The dominance curves shown in Figure 3 remain well separated and do not intersect over the entire range of poverty lines. The ordering $P_D(3) > P_D(2) > P_D(1) > P_D(0.5)$ is preserved throughout the analysis. The absence of curve crossings indicates that the ranking of poverty estimates remains stable across alternative poverty thresholds. Moreover, the gap between the curves widens at higher poverty lines, suggesting that the influence of the deprivation parameter becomes stronger as poverty severity increases.

Overall, the results demonstrate that P_D provides a flexible way to incorporate different degrees of sensitivity to deprivation while maintaining a consistent ordering of poverty estimates.

Sensitivity Analysis of Proposed Poverty Measure**Figure 3- Sensitivity and Dominance Curves of the Digvijay Poverty Measure for Alternative Values of λ**

3.5 State-wise Poverty Estimates

Table 4 presents the state-wise poverty estimates (weighted) obtained using the common national poverty line of ₹1409.67. Considerable variation in poverty is observed across States and Union Territories, reflecting substantial differences in household consumption expenditure and living standards.

The mean MPCE ranges from ₹2122.91 in Chhattisgarh to ₹9079.34 in Chandigarh. In general, states with lower average consumption expenditure tend to record higher poverty levels, while states with higher MPCE exhibit relatively low poverty.

Based on the Headcount Ratio, Chhattisgarh (34.79%), Jharkhand (31.33%), and Uttar Pradesh (27.26%) emerge as the poorest states. In contrast, Puducherry, Kerala, Chandigarh, and Goa record the lowest poverty incidence, with less than one percent of the population living below the poverty line.

A similar pattern is observed for Sen's poverty measure and the Digvijay Poverty Measure (P_D). Chhattisgarh, Jharkhand, and Uttar Pradesh continue to record the highest poverty levels, whereas Kerala, Goa, Puducherry, and Chandigarh remain among the least poor regions. This indicates broad consistency between the proposed measure and conventional poverty measures in identifying high- and low-poverty regions.

The Digvijay Poverty Measure provides additional information on poverty severity through the deprivation parameter λ (lambda). As the value of λ increases, poverty estimates rise more rapidly in states with severe deprivation. For example, P_D for Chhattisgarh increases from 0.1396 at $\lambda=0.5$ to 0.4714 at $\lambda=3$, while the corresponding increase for Jharkhand is from 0.1157 to 0.5250. In comparison, states with low poverty continue to record very small values even at higher levels of λ .

Overall, the results suggest that the proposed measure not only identifies the incidence of poverty but also distinguishes states according to the severity of deprivation among poor households. The effect becomes more pronounced as the value of λ increases, leading to a clearer separation between moderately poor and severely poor states.

Table 4- State-wise Poverty Estimates under the Common National Poverty Line

State Name	Mean MPCE	HR	P_s	$P_D(0.5)$	$P_D(1)$	$P_D(2)$	$P_D(3)$
Chandigarh(U.T.)	9079.34	0.0024	0.0003	0.0003	0.0003	0.0005	0.0011
A and N Islands (U.T.)	5668.77	0.0045	0.0011	0.0009	0.0011	0.0016	0.0025
Puducherry (U.T.)	5553.48	0.0012	0.0008	0.0007	0.0008	0.0010	0.0014
Kerala	5500.91	0.0023	0.0004	0.0003	0.0004	0.0008	0.0018
Telangana	5316.35	0.0179	0.0111	0.0098	0.0111	0.0156	0.0231
Goa	5309.89	0.0025	0.0003	0.0002	0.0003	0.0006	0.0012
Haryana	5027.05	0.0213	0.0098	0.0080	0.0098	0.0172	0.0341
Lakshadweep (U.T.)	4844.27	0.0071	0.0009	0.0007	0.0009	0.0018	0.0042
Delhi	4757.55	0.0875	0.0312	0.0261	0.0312	0.0502	0.0917
Dadra & Nagar Haveli and Daman & Diu	4636.54	0.0165	0.0038	0.0031	0.0038	0.0067	0.0133
Nagaland	4632.38	0.0154	0.0071	0.0057	0.0071	0.0125	0.0243
Tamilnadu	4530.43	0.0262	0.0065	0.0052	0.0065	0.0127	0.0318
Punjab	4444.55	0.0165	0.0069	0.0057	0.0069	0.0116	0.0218
Karnataka	4375.91	0.0433	0.0157	0.0121	0.0157	0.0323	0.0776
Gujarat	4250	0.0469	0.0152	0.0124	0.0152	0.0261	0.0515
Andhra Pradesh	4104.96	0.0196	0.0100	0.0083	0.0100	0.0164	0.0294
Himachal Pradesh	4079.5	0.0151	0.0030	0.0024	0.0030	0.0063	0.0154
Maharashtra	4063.36	0.0666	0.0188	0.0149	0.0188	0.0373	0.0929
Tripura	3726.45	0.0203	0.0036	0.0028	0.0036	0.0074	0.0202
Sikkim	3593.09	0.0376	0.0095	0.0075	0.0095	0.0189	0.0451
West Bengal	3587.54	0.0283	0.0063	0.0048	0.0063	0.0142	0.0439
Arunachal Pradesh	3583.29	0.0626	0.0118	0.0095	0.0118	0.0215	0.0466
Rajasthan	3377.16	0.0646	0.0172	0.0137	0.0172	0.0337	0.0814
Uttarakhand	3361	0.0557	0.0139	0.0110	0.0139	0.0278	0.0688
Jammu & Kashmir	3281.51	0.0358	0.0077	0.0062	0.0077	0.0136	0.0279
Odisha	3161.18	0.0883	0.0209	0.0169	0.0209	0.0384	0.0855
Ladakh (U.T.)	3137.41	0.0029	0.0003	0.0003	0.0003	0.0005	0.0011
Manipur	3077.74	0.1032	0.0524	0.0432	0.0524	0.0843	0.1459
Mizoram	3015.26	0.1933	0.0730	0.0592	0.0730	0.1289	0.2619
Meghalaya	2967.05	0.0859	0.0160	0.0126	0.0160	0.0323	0.0801
Madhya Pradesh	2672.98	0.1482	0.0379	0.0301	0.0379	0.0747	0.1847
Assam	2651.25	0.1361	0.0349	0.0279	0.0349	0.0677	0.1651
Uttar Pradesh	2285.92	0.2726	0.0891	0.0727	0.0891	0.1559	0.3171
Jharkhand	2215.61	0.3133	0.1433	0.1157	0.1433	0.2567	0.5250

Bihar	2212.18	0.1635	0.0440	0.0355	0.0440	0.0805	0.1758
Chattisgarh	2122.91	0.3479	0.1673	0.1396	0.1673	0.2679	0.4714

IV. DISCUSSION

The findings of this study show that poverty levels in India vary considerably across regions and between rural and urban sectors. States with lower levels of consumption expenditure generally exhibit higher poverty, while states with higher consumption levels record relatively low poverty. The results obtained from the Headcount Ratio, FGT measures, and Sen's poverty measure broadly identify the same high- and low-poverty states, indicating consistency in the overall pattern of poverty across India.

The Digvijay Poverty Measure also identifies similar poverty patterns but provides additional information on the severity of deprivation. By introducing the deprivation parameter λ , the measure allows different levels of importance to be assigned to households experiencing larger consumption shortfalls below the poverty line. As a result, the distinction between moderately poor and severely poor regions becomes clearer as the value of λ increases.

The rural–urban comparison further highlights the usefulness of the proposed measure. Although consumption inequality is higher in urban areas, poverty remains substantially higher in rural India. The Digvijay Poverty Measure captures this difference more clearly at higher values of λ , indicating that severe deprivation is more concentrated in rural households.

The sensitivity and dominance analyses support the robustness of the proposed measure. The measure responds systematically to changes in the poverty line and maintains a stable ordering across alternative poverty thresholds. The non-intersecting dominance curves indicate that the results are not driven by the particular choice of poverty line.

Overall, the empirical findings suggest that the Digvijay Poverty Measure can complement existing poverty measures by providing additional information on poverty severity while retaining consistency with established approaches such as Sen's poverty measure.

V. CONCLUSION

This study applied the Digvijay Poverty Measure to the Household Consumption Expenditure Survey (HCES) 2023–24 data and compared its performance with the Headcount Ratio, FGT measures, and Sen's poverty measure. Poverty estimates were examined at the national, rural–urban, and state levels using a common relative poverty line.

The results show that poverty remains unevenly distributed across India. Rural areas experience higher poverty than urban areas, while substantial differences are observed across states and union territories. Chhattisgarh, Jharkhand, and Uttar Pradesh emerge as the poorest states under most poverty measures, whereas Kerala, Goa, Puducherry, and Chandigarh record the lowest poverty levels.

The proposed Digvijay Poverty Measure produces results that are consistent with conventional poverty measures while offering greater flexibility through the deprivation parameter λ . Higher values of λ place greater emphasis on severely deprived households and provide a clearer distinction between regions with moderate and severe poverty. The sensitivity and dominance analyses further confirm the stability of the measure across alternative poverty thresholds.

The study demonstrates that the Digvijay Poverty Measure can serve as a useful addition to the existing set of poverty measures. By incorporating different degrees of sensitivity to deprivation, it provides a more detailed understanding of poverty and may assist policymakers in identifying regions where severe deprivation requires greater attention.

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