CHAPTER - 5

INCOME DISTRIBUTION AND INEQUALITY IN MIZORAM
INCOME DISTRIBUTION AND INEQUALITY IN MIZORAM

This chapter is divided into three sections. Section A explains the income distributional scenario of Mizoram during 80's while section B is devoted to fitting of income frequency distribution. The last section, section C discusses calculation of income inequality using pre defined formulae in chapter 2.

SECTION A: INCOME DISTRIBUTIONAL SCENARIO

Scenario during early 80's

The organisation of National Sample Survey had conducted income survey in Mizoram for rural and urban areas in the year 1981 (Jan) and 1984 (April 1983 – March 1984) respectively. During 1981 the urban population comprised of 25.17% of the state population and the then urban towns are Aizawl, Lunglei, Kolasib, Champhai, Serchhip and Saiha¹. For the survey period the average income at current price of the then Aizawl, Lunglei and Saiha district are Rs 405.10p, Rs 280.50p and Rs 228.90p respectively whereas, the average income for the rural area of these districts was Rs 569.66p, Rs 360.68p and Rs 443.45p respectively. There are seven blocks having per capita income higher than the state average in Aizawl district while one each in Lunglei and

Chhimtuipui district\(^1\). The income share of the bottom 10% and top 10% for rural Mizoram during the period is 2.96% and 20.06% respectively. The percentage share of bottom 40% in 1981 was estimated to be 25% of total state production and hence, Mizoram may be categorised as low-income inequality during the early part of 1980's. The rural Gini coefficient is 10.11\(^2\), which is extremely low as compared to the corresponding figure of other states (Annexure No 4.C).

The reason why rural average income is higher than that of urban was most probably on account of monetary assistance received by several household through the implementation of the Integrated Rural Development Programme (IRDP) during the survey year. From this observation it is clear that there is no significant difference between rural and urban income distribution in a semi-primitive economy of the type found in the state as a whole. In the survey for rural areas as many as 3,12,526 persons from 50,037 families are covered, this survey covers 64.07% of the total population, which is sufficient to represent the whole state of Mizoram. Rural population and rural scenario of the state in respect of economic activities will; any way; dominate Mizoram. Therefore, the only available detail data of rural Mizoram will be used to

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\(^2\) 1981 figure suffers certain degree of distortion however can be, somehow, calculated as such this Gini coefficient is supposed to be underestimate.
represent Mizoram State for the year 1981 with a good degree of confidence. This is justified because the official data is collected for the purpose of assigning strategic needs of developmental work. There is, moreover, no other option but to use official data for the temporal study of income distribution in the state.

In another survey in 1984, it was found that the urban monthly per capita income of the then Aizawl district is Rs 405.10/-, Lunglei – Rs 280.50/- and the then Chhmituipui district – Rs 228.90p\(^1\). Most of the people are engaged in Agriculture & allied activities and as such the level of inequality was extremely low during that year. It is here appropriate to mention that by the year 1960-61, primary sector alone contributed around 76.9% of the state net domestic product and the figure is declining to 33.75% in 1983-84\(^2\), and to 21.12 in 2003-04\(^3\).

This income survey reveals that there is a tendency income distribution in the urban area that will result in widening the gap between the rich and the poor unless some appropriate economic measures are taken by the government. This study will investigate whether economic

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\(^2\) Ibid, p-168

planning did enough to re-slide economic pie more unevenly between the elite and economically weaker section of the people.

**SECTION B: FITTING OF INCOME FREQUENCY DISTRIBUTION**

**Income frequency distribution**

Many curves that have been frequently used for graduating income data at various places are briefly highlighted in chapter 2. These curves have been tested fitting the income data of Mizoram to see which model/curve is most suitable for graduating the income data. These curves have their own characteristics that facilitate them to possess their unique advantage to explain a particular condition of income distribution. The identification of the functional distributional form of income is of crucial importance for it gives an analytical tool for further developmental planning and policy prescriptions.

In this study, there are three types of random variables Viz, Village/Locality (69 samples), household income (256 samples) and monthly income per capita (256 samples). After fitting the various distributions, we found that some of them are not applicable to Mizoram data. Those distributions that are applicable are listed below and the summary results are displayed hereunder.
B.1. When 'village/Locality' is taken as random variable

When the 'mean income of the villages/localities' is taken as random variables with sample size of 69, there are three distributions that fit well Mizoram data and the fitted results are summarised as follows.

B.1.1. Lognormal Distribution:

Estimated: Location (\( \mu \)) = 7.625  Scale (\( \sigma \)) = 0.6248

Estimation of parameter(s): Maximum likelihood method. Log transformation is used on data.

<table>
<thead>
<tr>
<th>Limit</th>
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<th>Expected</th>
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Calculated \( \chi^2 = 4.06 \), Tabular \( \chi^2 \) at 5 df for 5% = 11.07
FIGURE No. 5.1
(Fitted graph of Lognormal distribution)

B.1.2. Wald/Inverse Guassian Distribution:

Estimated: Location ($\mu$) = 2533.3, Scale ($\lambda$) = 5262.4 Estimation of parameter(s): Maximum likelihood method.

<table>
<thead>
<tr>
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<th>Limit</th>
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Calculated $\chi^2 = 3.127$, Tabular $\chi^2$ at 3 for 5% = 7.815
**Figure No. 5.2**
(Fitted graph of Wald/Inverse Guassian Distribution)

**B.1.3. Exponential Distribution:**
Estimated: Location ($\theta$) = 585.050, Scale ($\lambda$) = 1948.289275. Estimation of parameter(s): Maximum likelihood method.

**Table No 5.3**
(Test of goodness of fit for Exponential distribution)

<table>
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<tr>
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Calculated $\chi^2 = 5.949$, Tabular $\chi^2$ at 3df for 5% = 7.815
B.2. When ‘family monthly income’ is taken as random variable.

When the family monthly income is taken as random variable, there are only 2 distributions that fit well Mizoram data and the fitted result is as under.

B.2.1. Lognormal Distribution

Estimated: Location ($\mu$) = 9.164, Scale ($\sigma$) = 1.0127

Estimation of parameter(s): Maximum likelihood method. Log transformation is used on data.
Table No 5.4
(Test of goodness of fit for lognormal distribution)

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Calculated $\chi^2 = 10.189$, Tabular $\chi^2$ at 8 df for 5% = 15.507

Figure No. 5.4
(Fitted graph of Lognormal Distribution)
B.2.2. Exponential Distribution

Estimated: Location ($\theta$) = 800  Scale ($\lambda$) = 14866.8

Estimation of parameter(s): Maximum likelihood method.

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Calculated $\chi^2 = 4.81$, Tabular $\chi^2$ at 3df for 5% = 7.815

Figure No. 5.5
(Showing the fitted graph of exponential Distribution)
B.3. *When ‘monthly income per capita’ is taken as random variable*

When the ‘monthly income per capita (total family income divided by total family members)’ is taken as random variable, only Lognormal distribution fits well Mizoram data and the fitted result is as under.

**B.3.1. Lognormal distribution**

Estimated: Location ($\mu$) = 7.421, Scale($\sigma$) = 1.1253.

Estimation of parameter(s): Maximum likelihood method.

Log transformation is used on data.

<table>
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</tr>
</tbody>
</table>

Calculated $\chi^2 = 5.59$, Tabular $\chi^2$ at 8 df for 5% = 15.507
For policy and estimation purposes the properties of these distributions have an advantage in that they can give predictable results.

To make clear this point, let us take a simple example. Suppose, for 'family income', the location ($\mu$) = 9.1647 and scale ($\sigma$) = 1.013, so that the statistic of the income unit can be calculated as:

1) $\text{Mean} = e^{\frac{\mu^2}{2} + \frac{\sigma^2}{2}} = e^{\frac{9.1647^2 + 1.013^2}{2}} = 15959.1$

   i.e. the estimated mean income is Rs 15,959.10p whereas the actual mean is Rs 15,666.82p

2) $\text{Median} = e^{\mu} = e^{0.1647} = Rs 9,553.85p.$

   i.e. The estimated median income is Rs 9,553.85p whereas the actual median is Rs 10,540.81p.
Following this technique one can estimate the number of persons whose income is in between certain intervals ‘a’ and ‘b’.

The fitted graphs of some distributions that do not suitable to Mizoram data are given in the annexure 5.B.

SECTION C: CALCULATION OF INEQUALITY

Various measures of inequality have been discussed in chapter 2. In this chapter, the actual calculation of these measures is done to facilities comparison and to explore the ground reality in respect of income inequality prevailing in the state. Measures are categorised into those that are -

1) Based on Lorenz curve.
2) Not based on Lorenz curve.

The suffix ‘fam’ denotes family and ‘Ind’ denotes individual which is equal to monthly income per capita

LORENZ CURVE

For the first time in Mizoram the Lorenz curve was drawn for the year 1981 and 2006 are presented in annexure 5.A. These curves indicate the degree of income inequality for the corresponding year. The percentage of population and their income share are represented in the horizontal and vertical axis respectively. Many of inequality measures are dependent on this Lorenz curve. The greater the distance between
Lorene curve and line of equality, the greater is the degree of inequality and vice versa.

C.1. INDICES BASED ON LORENZ CURVE

C.1.1. Gini Coefficient: One of the most common and widely used measures of inequality to analyse the size distribution of income is Gini Coefficient proposed by Gini in 1921 which is define as

$$G = \frac{\Delta}{2\mu},$$

where $$\Delta = \frac{1}{n(n-1)} \sum_{i=1}^{n} \sum_{j=1}^{n} |y_i - y_j|,$$

$y_j$ being the income of the $j^{th}$ unit, and $n$ the total number of units. Subsequently Gini proposed inequality measure that is $[1 - (\text{twice the area under Lorenz curve})]$. 

i.e. $$G = 1 - 2 \text{ [Area under Lorenz curve]}$$

Another very useful formula can be represented as under$^1$:

Let $p_i = \frac{p}{P}$, $y_i = \frac{x_i}{x}$, $z_i = \sum_{i=1}^{n} y_i$, $i = 1,2,3,...,n$.

Here $P$ is the total number of persons/households, $P_i$ the number of persons/households in the $i^{th}$ income class, $i = 1,2,3,...,n$. $y$ the total income and $y_i$ the income of the $i^{th}$ class. Therefore, $P_i$ is the

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population share of the $i^{th}$ income class, $y_i$; the corresponding income share and $z_i$, the cumulative share of income up to the $i^{th}$ income class.

Some times the figure is multiplied by a factor of 100 for easy remembrance. Using these, Gini coefficient is calculated separately for 1981 and 2006 as

$$G^{81} = 1 - \sum_{i=1}^{n} p_i (z_i + z_{i-1}), \quad z_0 = 0.$$  
$$= 1 - 8988.93$$  
$$= 0.101107 \text{ or } 10.11$$

Similarly,

$$G^{06} = 1 - 6873.068979$$  
$$= 0.312693102 \text{ or } 31.27$$

C.1.2. Relative Mean difference$^1$: Von Bortkiewicz proposed the relative mean difference as a measure of inequality in 1898 (his result was published in 1930). Pietra (1948) investigated the statistical property. The measure is defined as

$$RMD = \frac{1}{2\mu N} \sum_{i=1}^{n} |x_i - \bar{x}|$$  
$$= \frac{1}{2\mu N} \sum_{i=1}^{n} f_i |x_i - \bar{x}|$$

$$RMD_{ind}^{81} = \frac{1}{2 \times 513 \times 322382} \sum_{i=1}^{20} f_i |x_i - 513|$$  
$$= 0.151641$$

$^1$ Since this measure is classified under this category, it is here also placed under Lorenz curve's related measure (see Nanak C. Kakwani, op cit page 118)
\[ RMD_{\text{fam}}^{06} = \frac{1}{2 \times 15666.82 \times 256} \sum_{i=1}^{256} |x_i - 15666.82| \]
\[ = 0.3703 \]

Similarly,
\[ RMD_{\text{ind}}^{06} = \frac{1}{2 \times 2540.0285 \times 1579} \sum_{i=1}^{1579} |x_i - 2540.0285| \]
\[ = 0.35044 \]

**C.1.3. Bowley’s Index:** Bowley’s index of inequality measure is defined by the following formula:

\[ B = \frac{Q_3 - Q_1}{Q_3 + Q_1}, \]

Where \( Q_i = \frac{iN}{4} - c.f. \), \( i \) is the cumulative frequency preceding median class and \( f_{\text{ind}} \) is the frequency of median class. In our case study, the first and third quartile for the year 1981 are respectively \( Q_1^{\text{Ind}} = 307.07 \) and \( Q_3^{\text{Ind}} = 555.13 \), so that, the Bowley’s index is

\[ B^{\text{Ind}} = 0.2877. \]

Again, arrange families into ascending order of their income and locate the quartiles. The first and third quartiles for the year 2006 are \( Q_1^{\text{fam}} = 4191 \) and \( Q_3^{\text{fam}} = 18860 \) respectively. So that,
\[ B_{\text{fam}}^{0.0} = 0.6364 \]

Similarly, the corresponding figure are \( Q_{1}^{\text{ind}}^{0.0} = 830.246 \),

\[ Q_{1}^{\text{ind}} = 3103.6 \] respectively. So that \( B_{\text{ind}}^{0.0} = 0.5779 \)


\[ G = \frac{2 \text{Cov}(y, r_y)}{n \bar{y}} \]

Where \( 2 \text{Cov}(y, r_y) \) is the covariance between income and rank of all individuals/recipient according to income ranging \( r_y \) from the poorest (rank = 1) to the richest (rank = n) and \( \bar{y} \) is mean income. In our data, \( 2 \text{Cov}(y, r_y) = 62491.36 \), \( n \bar{y} = 174800.43 \), so that

\[ G = 0.3575012 \text{ or } 35.75 \]

C.1.5. Milanovic (1997) formula: Milanovic (1997) claims to have devised an even simpler formula using Coefficient of variation and correlation coefficient for calculating Gini coefficient as

\[ G = \frac{CV_y \gamma(y, r_y)}{\sqrt{3}}, \]
Where $CV_{y}$ is the coefficient of variation of income and $\gamma(y,r_{y})$, the correlation coefficient between income and rank of individuals by income. In our data $CV_{y} = 0.7994436$, $\gamma(y,r_{y}) = 0.7803079$ and $\sqrt{3} = 1.7320508$. So that $G = 0.3601581$ or 36.02

C.1.6. Elteto and Frigyes' inequality measure: In 1968 Elteto and Frigyes proposed a set of inequality measures that are defined as -

$$u = \frac{\mu}{\mu_{1}} \quad v = \frac{\mu_{2}}{\mu_{1}} \quad \text{and} \quad w = \frac{\mu_{2}}{\mu}$$

Where $\mu = E(x)$, $\mu_{1} = E(x|x < \mu)$ and $\mu_{2} = E(x|x \geq \mu)$

The range of these measures are from one to infinity, it has transformed them so that they are confined within the finite range of zero to unity as-

$$u' = 1 - \frac{1}{u} \quad v' = 1 - \frac{1}{v} \quad \text{and} \quad w' = 1 - \frac{1}{w}$$

Among 3,22,382 persons covered in 1981 survey, there are 1,62,247 and 1,60,135 persons whose mean income is less than and more than population mean income of Rs 513.00p respectively. So that $\mu = 513.00p$, $\mu_{1} = 358.43$ and $\mu_{2} = 669.618$.

Then, $u^{*}_{ind} = 1.43$, $v^{*}_{ind} = 1.87$ and $w^{*}_{ind} = 1.305$

Among the sample of 256 households there are 169 and 87 households whose income is less than and more than the household
mean income of Rs 15666.82p respectively. So that \( \mu = 15666.82 \), \( \mu_1 = 6878.69 \) and \( \mu_2 = 32737.99 \). Then,

\[
\begin{align*}
&u_{fam}^{06} = 2.278, \quad v_{fam}^{06} = 4.76 \quad \text{and} \quad w_{fam}^{06} = 2.09 \\
\end{align*}
\]

Among 1579 persons covered in this survey, there are 1040 and 539 persons whose mean income is less than and more than mean income of Rs 2540.03p respectively. So that \( \mu = 2540.03 \), \( \mu_1 = 1164.15 \) and \( \mu_2 = 5194.78 \),

Then,

\[
\begin{align*}
&u_{ind}^{06} = 2.182, \quad v_{ind}^{06} = 4.46 \quad \text{and} \quad w_{ind}^{06} = 2.045 \\
\end{align*}
\]

Accordingly, we obtain \( u' \), \( v' \) and \( w' \) from the above values.

**C.2. INDICES NOT BASED ON LORENZ CURVE**

**C.2.1. Range (R):** The value of range have been calculated for family income and individual income separately. Recall that

\[
\text{Range } R = \frac{1}{x} \left[ X_{\text{Max}} - X_{\text{Min}} \right]
\]

\[
\begin{align*}
R_{ind}^{06} &= \frac{1}{513} \left[ 1040.36 - 128.78 \right] \\
&= 1.777 \\
R_{fam}^{06} &= \frac{1}{15666.817} \left[ 149285 - 800 \right] \\
&= 9.4777
\end{align*}
\]
\[ R_{\text{ind}}^{06} = \frac{1}{2540.029} [41450.667 - 100] \]

\[ = 16.28 \]

The Range ignores the distribution inside the extremes; that it obviously violates the Pigou - Dalton condition.

**C.2.2. Standard deviation (σ):** The standard deviation of the income \( x \) can be written as-

\[ \sigma = \sqrt{\frac{1}{n} \sum (x_i - \bar{x})^2} \quad \text{or} \quad \frac{1}{N} \sum f_i (x_i - \bar{x})^2 \]

\[ \sigma_{\text{ind}}^{06} = \sqrt{48753.24155} \]

\[ = 220.801 \]

\[ \sigma_{\mu \text{m}}^{06} = \sqrt{341848703.6} \]

\[ = 18489.151 \]

i.e. Standard error = 1155.57

\[ \sigma_{\text{ind}}^{06} = \sqrt{11773379.84} \]

\[ = 3431.236 \]

i.e. Standard error = 21.327

**C.2.3. Variance of log – income:** Unlike the variance of income, the variance of the logarithm of income \( V(\log x) \) is a mean-independent measure of inequality.

\[ V(\log x) = \frac{1}{n} \sum (\log x_i - \overline{\log x})^2 \quad \text{or} \]

\[ = \frac{1}{N} \sum f (\log x_i - \overline{\log x})^2 \]
\[ V(\log x)_{\text{ind}}^{81} = \frac{1}{322382} [12075.43551] \]
\[ = 0.0374569 \]

\[ V(\log x)_{\text{fam}}^{06} = \frac{1}{256} (49.521) \]
\[ = 0.19344 \]

\[ V(\log x)_{\text{ind}}^{08} = 0.2342 \]

Sometimes the deviation of logarithms of income \( x \) is taken from the logarithm of arithmetic mean \( \log \mu \), rather than \( \log \bar{\mu} \).

i.e. \[ I'(\log x) = \frac{1}{n} \sum (\log x_i - \log \mu)^2, \]
\[ = \frac{1}{n} \sum [(\log x_i - \log \bar{\mu}) + (\log \bar{\mu} - \log \mu)]' \]
\[ = V(\log x) + (\log \bar{\mu} - \log \mu)^2 \]

\[ V'(\log x)_{\text{ind}}^{81} = 0.0374569 + (\log 513 - 2.63089)^2 \]
\[ = 0.11688 \]

\[ V'(\log x)_{\text{fam}}^{06} = 0.19344 + (\log 15666.82 - 3.98)^2 \]
\[ = 0.23957 \]

\[ I''(\log x)_{\text{ind}}^{06} = 0.2342 + (\log 2540.029 - 3.223)^2 \]
\[ = 0.2673 \]

If all incomes are multiplied by a positive scalar factor \( \lambda \), the variance of log income does not change at all. That is \[ V(\log x \lambda) = V(\log x). \]
x) which satisfy the property of population - size independence. However it does not satisfy the Pigou-Dalton condition for the entire range of incomes.

C.2.4. Standard deviation of logarithm: The standard deviation of logarithm as a measure of inequality is defined as the square root of variance of log-income defined above.

\[ L = \left[ \frac{1}{n} \sum_{i=1}^{n} \frac{1}{i} \sum_{j=1}^{x_i} \log x_i - \log x_j \right]^\frac{1}{2} , \]

By taking the square root of the Variance of log-income, we can easily obtain the standard deviation of log-income as -

\[ SDL_{ind}^{81} = 0.1935378 \]
\[ SDL_{fam}^{06} = 0.4895 \]
\[ SDL_{ind}^{06} = 0.4839 \]

C.2.5. The Co-efficient of Variation (C.V.): The co-efficient of variation (C.V.) as a measure of income dispersion can be represented as under.

\[ C.V. = \frac{\sigma}{\mu} , \]

\[ (CV)_{ind}^{81} = \frac{220.801}{513} = 0.430411 \]
\[ (CV)_{farm}^{06} = \dfrac{18489.151}{15666.82} = 1.18 \]
\[ (CV)_{ind}^{06} = \dfrac{3431.236}{2540.028} = 1.351 \]

This satisfies the Pigou – Dalton condition over the entire income scale because, by squaring the deviation from the mean, they ensure the crucial property of concavity.

**C.2.6. Theil’s Entropy Index:** The first Theil’s Entropy Index \( T \) based on notion of Entropy in information theory is defined as

\[ T = \frac{1}{n} \sum \frac{y_i}{\mu} \log \frac{y_i}{\mu} \]

where \( n\mu = \sum y_i = y \) is the total income.

Let \( \frac{y_i}{\mu} \) be the income share of the \( i^{th} \) person and the entropy of income share is defined as

\[ H(y) = \frac{1}{n} \sum \frac{y_i}{\mu} \left( \log \frac{y_i}{y} \right) \]

The upper limit of \( H(y) \) is \( \log n \), which is reached when all individuals earn equal income, and the minimum of \( H(y) \) is zero, which represents that one individual is receiving all the income. Thus the Entropy \( H(y) \) of an income distribution can be regarded as a measure of income inequality. Theil obtains a measure of income inequality by
subtracting $H(y)$ from its maximum value $\log n$. Thus, the inequality measure as proposed by Theil ($T$) is -

$$T = \log n - H(y)$$
$$= \log n - \sum \frac{y_i}{}\sum y_i \log \left( \frac{y}{y_i} \right)$$

$$T_{ind}^{81} = \log 20 - \frac{11846.109}{9375.82}$$
$$= 0.03756$$

$$T_{fam}^{06} = \log 256 - \frac{8842662.316}{4010705.068}$$
$$= 0.2035$$

Here household is taken as an income unit represented by the family mean income.

$$T_{ind}^{06} = \log 256 - \frac{1715928.48}{799735.72}$$
$$= 0.26262$$
Annexure 5.A
Lorenz curve for Mizoram 1981

Lorenz curve of Mizoram 2006

Cumulative share of people from lower income
Cumulative share of income earned
Annexure 5.B.
(Fitted graphs of some distributions that do not suitable to Mizoram)

1. Distribution: Logistic

2. Distribution: Gumbel

Fitted Distribution
3. Distribution: Normal

FITTED DISTRIBUTION

4. Distribution: Gamma

FITTED DISTRIBUTION
5. Distribution: Weibull

FITTED DISTRIBUTION

6. Distribution: Pareto

FITTED DISTRIBUTION
7. Distribution: Wald/Inverse Gaussian

8. Distribution: Exponential