

# **PART TWO**

## **CONCEPTS AND MEASUREMENTS OF INCOME INEQUALITY**

# CHAPTER OUTLINE



In this chapter we will study

## **CONCEPTS AND MEASUREMENTS OF INCOME INEQUALITY**

1. Definition of income inequality
2. Measuring income inequality

## Why is there a renewed interest in inequality?

*There is a renewed interest in inequality for a number of reasons.....*

- With **more than a billion people living on less than one dollar per day**, some evidence of increasing gaps in living conditions within and between countries and clear evidence of **substantial declines in life expectancy or other health outcomes in some parts of the world**, the related topics of inequality, poverty and well-being are core international issues.

recent empirical work re-examines the **link between inequality and growth**. If at all, it tends to find a negative relationship, especially when looking at the impact of asset distribution and growth. **They assert that the more equal the distribution of assets such as land, the higher growth rates tend to be.**

## Why is there a renewed interest in inequality?

*There is a renewed interest in inequality for a number of reasons.....*

### Why inequality?

- If a single person holds all of a given resource, inequality is at a maximum. If all persons hold the same percentage of a resource, inequality is at a minimum.
- Inequality studies explore the levels of resource disparity and their practical and political implications...
- Economic efficiency?
- Welfare maximisation?
- Social justice

# I. Definition of income inequality

Equality of what?

- Process
- Outcomes
- Opportunities

Equality between whom?

- Individuals
- Genders, ethnic groups, other groups
- Generations
- Geographical areas
- Nations

# I. Definition of income inequality

## Types of inequality:

- **Economic inequality (income inequality):** refers to disparities in the **distribution of economic assets and income**. The term typically refers to inequality among individuals and groups within a society, but can also refer to inequality among nations.
- Economic inequality has existed in a wide range of societies and historical periods; its nature, cause and importance are open to broad debate.
  - A country's economic structure or system (for example, capitalism or socialism), ongoing or past wars, and differences in individuals' abilities to create wealth are all involved in the creation of economic inequality.
- **Social Inequality:** the **unequal distribution of life chances** within the population of a society.
  - Social inequality has existed since the dawn of civilization. Social scientists in the 20th century have examined inequality in the main dimensions of life, including income, race, gender, and, more recently, quality of life.

# I. Definition of income inequality

## What is inequality?

- Inequality means different things to different people and is and some times **broader concept than poverty** in that it is defined over the whole distribution, not only the censored distribution of individuals or households below a certain poverty line.

### *Our primary interest is in economic inequality*

- In this context, inequality measures the disparity between a percentage of population and the percentage of resources (such as income) received by that population.
- Income inequality refers to the extent to which income is distributed in an unevenly manner among the population.
- The unequal distribution of household or individual income across the various participants in an economy.
- Income inequality is often presented as the percentage of income to a percentage of population.

# I. Definition of income inequality

- Equality is at the core of the human development approach which intrinsically pursues the value of social justice
- Income inequality though represents one (very important) component of economic inequality defined by Ray (1998, p.p 170) as:
  - “...the fundamental *disparity* that permits one individual certain *material* choices, while denying another individual those very same choices.”
- What Ray is really saying is that those factors that determine material choices are of importance here such household wealth, income
- Inequalities refer to the uneven distribution of income across the population or individuals within society
- The gap between the rich is inevitably consequence of growth and development
- The high inequality raises a moral question about fairness and social justice



## I. Definition of income inequality What Is Inequality?

- Economic inequality is the fundamental disparity that **permits** an individual certain material choices, while **denying** another individuals those very same choices
- Inequality is a broader concept than poverty in that it is defined over the entire population, and does not only focus on the poor
- Inequality has been an ongoing concern for economists and scholars worldwide.
- Inequality is a part of development economics

I. Definition of income inequality

Income inequality is the gap between rich and poor **i.e.** is the differences in the distribution of economic assets (wealth) and income within or between populations or individuals.

It is the state of an economy in which the shares of total income earned by the rich and poor are highly unequal

Economic inequality varies between societies, historical periods, economic structures and systems (for example, capitalism or socialism), ongoing and past wars, and between individuals' abilities to create wealth.

It can refer to cross sectional descriptions of the income or wealth at any particular period, and to the lifetime income and wealth over longer periods of time. There are various numerical indices for measuring economic inequality.

**INCOME INEQUALITY**

According to the United Nations Human Development Report, the ratio of the income earned by the richest 10% to that of the poorest 10% of the population was 15.9 in the United States in 2007; that ratio was 4.5 in Japan, 9.4 in Canada, 17.7 in Singapore, and 40.6 in Brazil.

Economic policy makers can face a tradeoff between promoting equity and economic growth.

As income shares become more equal, the incentive for individuals to accumulate skills, work hard, and take risks might become smaller, thus shrinking the size of the economy.

## 2. Measuring income inequality

### Why measure Inequality?

- Measuring changes in inequality helps determine the effectiveness of policies aimed at affecting inequality and generates the data necessary to use inequality as an explanatory variable in policy analysis.
- What inequalities are we interested in or concerned about – inequality of income, inequality of opportunity, inequality of wealth?

## 2. Measuring income inequality: Measuring of what?

Types of Asset income or....

- Shares
  - Houses
  - Bank deposits
  - Land
  - Building Society Accounts
  - Currency holdings
  - Buildings
  - Machinery and Equipment
  - Gold
  - Etc.
- Income represents a FLOW
  - Birr x per week, month, year, etc.
  - Income can be in the form of:
    - Wages
    - Rents
    - Dividends
    - Interest
    - Pensions
    - Benefit payments
    - Income from self employment
    - Inheritance

## 2. Measuring income inequality

- Just as for measuring poverty, **debates exist** on how to measure income inequality.
- Deciding on a standard measure is challenging because these measures are dependent on what society considers unequal.
- Choosing a standard inequality measure is really a choice between alternative definitions of inequality rather than a choice between alternative measures of a single theoretical construct.
- **Relative measures of income inequality compare the income of one individual group with the income of another group.**
  - These measures are most useful when analyzing the scope and distribution of income inequality.

## 2. Measuring income inequality

Some popular measures include:

- **Personal or size distribution of income**
  - Median Share of income
  - Range
  - The McLoone Index
  - Percentile, Quintiles and Deciles distributions
  - Lorenz Curve and the Gini Coefficient
  - Robin Hood Index
  - Atkinson Index
  - Theil's Entropy Measure
  - Coefficient of Variation
- **Functional distribution of income**

## 2. Measuring income inequality

### Personal or size distribution of income (PSDIM)

- Personal or size distribution of income deals with the individual persons or households and the total income they receive.

### **Functional or factor share distribution of income**

- Functional or factor share distribution of income uses the share of total national income that each of the factors of production receives.

- Example: The theory of functional income distribution represents the percentage that labor receives as a whole and compares with the percentages of total income distributed in the form of rent, interest and profit

# 2. Measuring income inequality: PSDI Measures

## Range

- The range is simply the difference between the highest and lowest observations (value): **The higher the range, the higher is the inequality**

	Number of employees	Salary
	2	\$1,000,000
	4	\$200,000
	6	\$100,000
	6	\$60,000
	8	\$45,000
	12	\$24,000

In this example, the Range  
 = \$1,000,000-\$24,000  
 ≡ 976,000

- Cons
- Ignores all but two of the observations
  - Does not weight observations
  - Affected by inflation
  - Skewed by outliers



## 2. Measuring income inequality: PSDI Measures

### Median Share of Income

•Median share of income refers to the proportion of income held by households whose incomes fall below the median household income. The measure is calculated as follows:

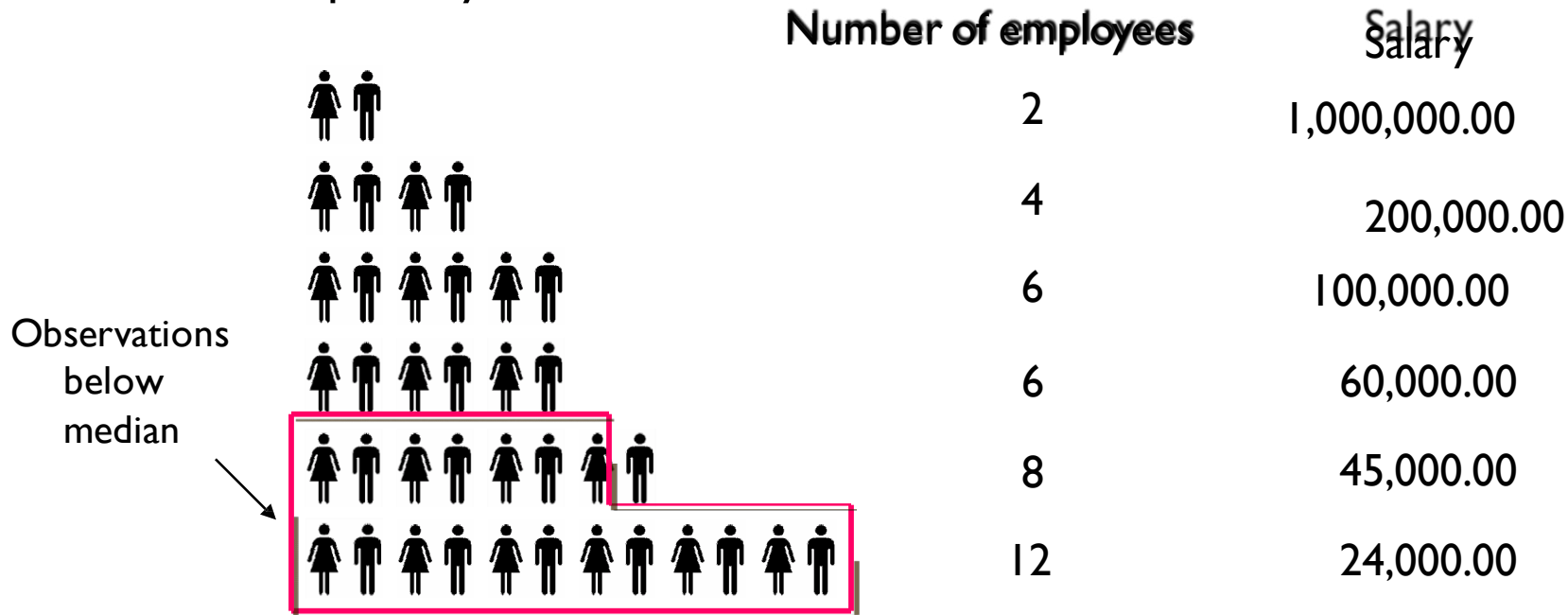
- 1.Determine median household income (e.g. \$20,000).
- 2.Add together the incomes of the bottom half of all households in area being studied (e.g. \$1,000,000).
- 3.Add together all household incomes in the area being studied (\$5,000,000)
4. Divide the total household income of **the bottom half** of households by the **total household income of all households** in that area ( $\$1,000,000/\$5,000,000$ ).

- Therefore the median share of income is 20%. A proportion of 50% would mean no inequality.
- This measure is simple to calculate and uses readily available data. However, it is not sensitive to varying proportions of the income distribution within the upper or lower 50% of the distribution.

# 2. Measuring income inequality: PSDI Measures

## The McLoone Index

- The McLoone Index divides the summation of all observations below the median, by the median multiplied by the number of observations below median



- In this example, the summation of observations below the median = 603,000, and the median = 45,000
  - Thus, the McLoone Index =  $603,000 / (45,000(19)) = .7053$
- The higher index, the higher is the inequality**

## 2. Measuring income inequality: PSDI Measures

### Quintiles and Deciles(Using percentage share of income)

•We divide the population into 5 groups (Quintiles) or 10 groups (deciles), and consider about what percentage share of income that each group receives. Ideally, each group has to get income or benefit equally, but it does not like this due to uneven distribution which leads to inequality.

Income Category	Percentage share of income
(Q1)- <b>Lowest Quintile</b> - <i>Lowest</i>	20%
(Q2)- <b>Second Quintile</b> - <i>Low-mid</i>	20%
(Q3)- <b>Third Quintile</b> - <i>Middle</i>	20%
(Q4)- <b>Fourth Quintile</b> - <i>Mid-upper</i>	20%
(Q5)- <b>Highest Quintile</b> - <i>Upper</i>	20%

Income Category	Percentage share of income
<b>Lowest deciles</b>	10%
<b>Second deciles</b>	10%
<b>Third deciles</b>	10%
<b>Fourth deciles</b>	10%
<b>Fifth deciles</b>	10%
<b>Sixth deciles</b>	10%
<b>Seven deciles</b>	10%
<b>Eight deciles</b>	10%
<b>Ninth deciles</b>	10%
<b>Highest deciles</b>	10%

## 2. Measuring income inequality: PSDI Measures

### Income quintiles / quartiles / deciles

- “Quantiles” are a set of 'cut points' that divide a sample of data into groups containing (as far as possible) equal numbers of observations.
- Main steps
  - Divide population into ‘groups’ ranked from ‘poorest’ to ‘richest’ based on expenditure (or income)
    - Divide into 4 groups (25% of the population each): **quartiles**
    - Divide into 5 groups (20% of the population each): **quintiles**
    - Divide into 10 groups (10% of the population each): **deciles**
  - Sum for each group (equal proportion of the population) the total consumption (or income)
  - Calculate the share of the consumption expenditure for each specific group (quintile, quartile or decile) to the total consumption expenditure or income
- Usual indicators
  - Last quintile/decile - richest fifth/tenth of the population
  - First quintile/decile - poorest fifth/tenth of the population

## 2. Measuring income inequality: PSDI Measures

Indicator of distribution. Example of quintiles

- Income distribution: Share of **Poorest** Quintile
- Total income of the poorest quintile (20%), as a share of total income of the population
- Income distribution: Share of **Richest** Quintile
  - Total income of the richest quintile, as a share of total income of the population.

$$C_{(x)} = \frac{\sum_{i=1}^m y_i}{\sum_{i=1}^N y_i}$$

Where **y<sub>i</sub>** is per capita income

- **N** is the total population
- **m** is the number of individuals in the lowest x %.

# 2. Measuring income inequality: PSDI Measures

## Income per capita by Quintile

Region X and Y: Distribution of income(28 Days) by quintile and areas

Region X 2004/2005	Rural	Urban	Total	Region Y (2007)
Q1 - poorest	9.8	8.9	9.3	7.2
Q2	13.9	12.9	13.3	11.9
Q3	17.3	16.5	16.8	16.3
Q4	22	22	21.9	22.3
Q5 - richest	37	39.6	38.8	42.3
Total	100	100	100	100
Ratio Q5:Q1	3.8	4.4	4.2	5.9
Tshs (millions)	11316	9433	20750	

In **Region X**, the richest 20% get on average nearly 40% of total income

The 20 percent richest get 42 percent of total income: This is **6 times more** than the poorest

In **Region Y** the poorest 20 percent spent 7.2 percent of total income

## 2. Measuring income inequality: PSDI Measures

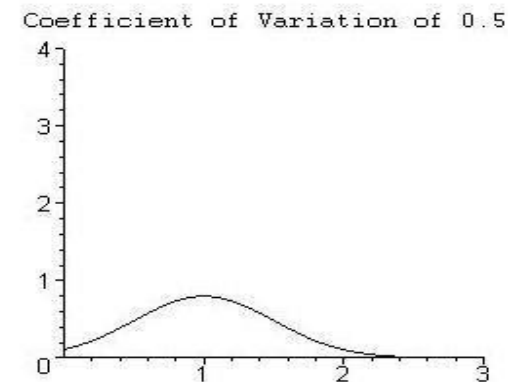
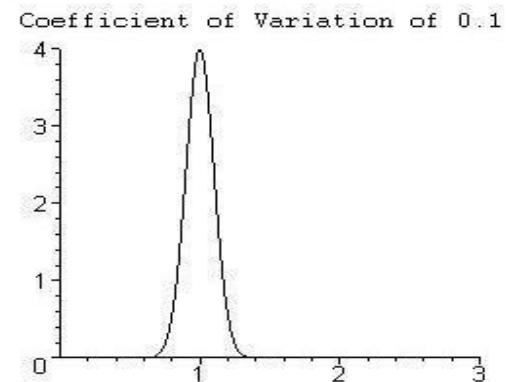
### Coefficient of Variation (CV)

- The coefficient of variation (CV) is a simple statistical method of representing the inequality of an income distribution.

**The higher index, the higher is the inequality**

To calculate the Coefficient of Variation:

- Divide the standard deviation of an income distribution by the mean of the same distribution. Coefficients of Variation can be graphed as follows



Both distributions above have the same mean, 1, but the standard deviation is much smaller in the distribution on the left, resulting in a lower coefficient of variation.

## 2. Measuring income inequality: PSDI Measures

- More equal income distributions will yield smaller CV values due to smaller standard deviations
  - For example, the graph on the left yields a smaller CV value because the standard deviation of the income distribution is smaller
- The coefficient of variation is simple to calculate but requires comprehensive individual data
  - Also, the mean and standard deviation used to calculate this measure are influenced by outliers such as high or low income values
  - Therefore, if income is not normally distributed, this measure would not be appropriate, No standard for an acceptable level of inequality, and it is not commonly used.



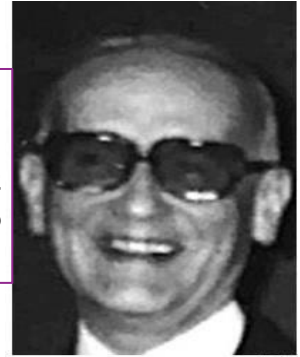
## 2. Measuring income inequality: PSDI Measures

### Lorenz Curve and Gini Coefficient

#### The Lorenz Curve

- Is a diagram to explain income inequality in a country
- The **Lorenz curve** is a graphical representation of the cumulative distribution function of the empirical probability distribution of wealth. It is often used to represent income distribution, **where it shows for the bottom x% of households, what percentage y% of the total income they have.**
- A Lorenz curve shows the degree of inequality that exists in the distributions of two variables, and is often used to illustrate the extent that income or wealth are distributed unequally in a particular society.
- Is based on two pieces of information, **income and population**
- Information is required on both and then formed into two variables that reflect **the cumulative value of income and the population**

**Max Otto Lorenz** (September 19, 1876 in Burlington, Iowa – July 1, 1959 in Sunnyvale, California) was an American economist who developed the Lorenz curve in 1905 to describe income inequalities.



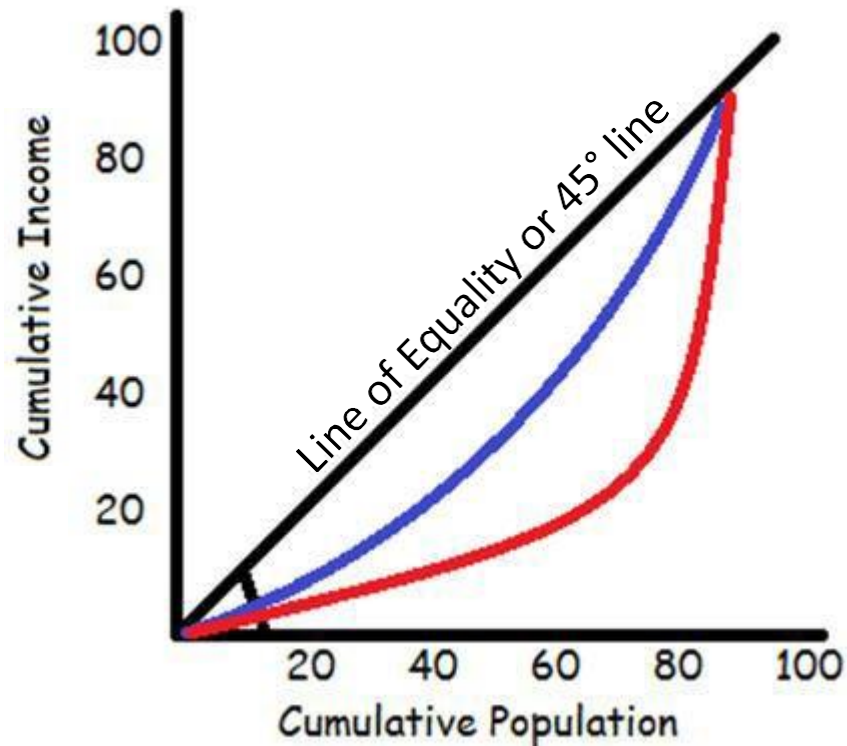
## 2. Measuring income inequality: PSDI Measures

*Diagrammatic way to depict the distribution of income in any society*

- On the horizontal axis we sort the cumulative population in the ascending order of income, with the lowest income first followed by the second lowest and so on. Hence the first 20% of the population will necessarily be the poorest 20% of the entire population
  - Horizontal axis depicts cumulative percentages of population arranged in increasing order of income;
  - Vertical axis depicts percentage of national income accruing to any fraction of population
- Slope at any point gives the contribution of the person at that point to the cumulative share of national income

## 2. Measuring income inequality: PSDI Measures

### The Lorenz Curve



- The horizontal axis gives the percentage of households.
- The vertical axis gives the percentage of nations income

- The black line or 45-degree line is called line of equal distribution or egalitarian line
- **Note that no nation has a Lorenz curve such as black line.** The degree of inequality typically prevails

Perfect equality: Lorenz curve is 45° line

Perfect inequality: Lorenz curve is backward L along horizontal line and right axis.

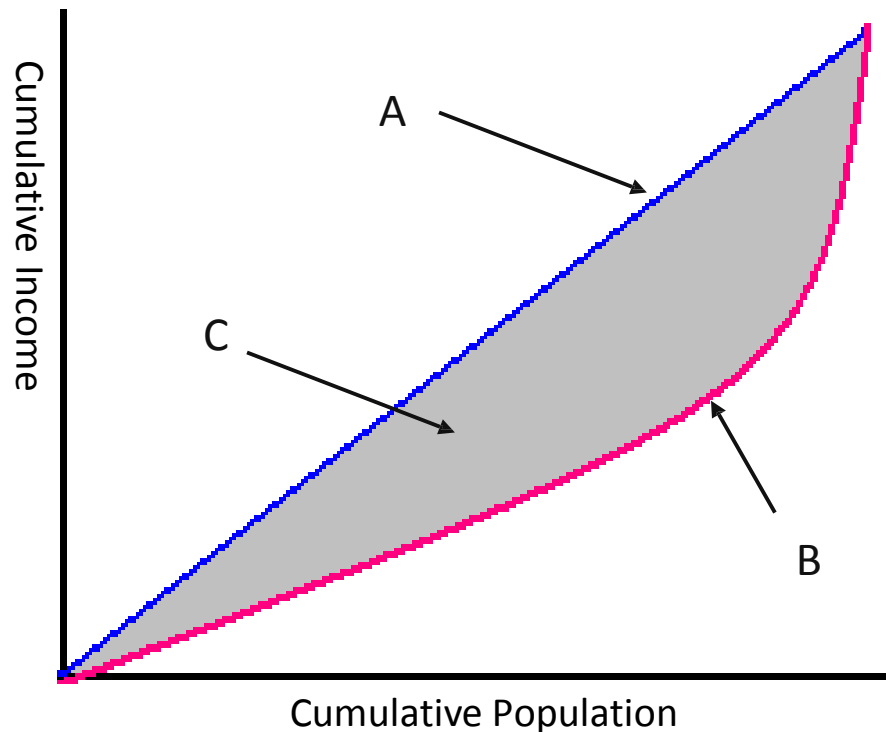
- More skewed the curve, greater the Inequality.
- The difference between the 45 degree line and the Lorenz curves depicts the level of inequality.
- Lorenz Curve is always bowed to the right of the line of equality.

## 2. Measuring income inequality: PSDI Measures

### The Lorenz Curve

An equality diagonal represents perfect equality: at every point, cumulative population equals cumulative income.

**The Lorenz curve measures the actual distribution of income**



- A – Equality Diagonal Population = Income
- B – Lorenz Curve
- C – Difference Between Equality and Reality

## 2. Measuring income inequality: PSDI Measures

### How to build Lorenz Curves

1. Arrange the data from lowest to highest
2. Calculate the total income
3. Divide into quintiles
4. Calculate the total income of each quintile and convert into %
5. Define the proportion of income owned by each quintile and the proportion on total population
6. Calculate the cumulative percentage of household income and population (Define the cumulative proportion of income and the cumulative proportion of population)
7. Define the line of equi-distributed income
8. Plot the cumulative proportion of income against the cumulative proportion of population

## 2. Measuring income inequality: PSDI Measures

Example: Assume the following monthly Budget flow to Amhara region zones, define the Lorenz curve to understand the inequality

---

Zone	Budget
Wag hemra	1500.00
Bahir Dar	30000.00
South Gondar	16000.00
North Wollo	2000.00
East Gojjam	20000.00
Oromia	8000.00
Awi	9000.00
North Shewa	10000.00
North Gondar	12000.00
West Gojjam	15000.00

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## 2. Measuring income inequality: PSDI Measures

Zone	Budget
Wag hemra	1500.00
North Wollo	2000.00
Oromia	8000.00
Awi	9000.00
North Shewa	10000.00
North Gondar	12000.00
West Gojjam	15000.00
South Gondar	16000.00
East Gojjam	20000.00
Bahir Dar	30000.00



1. Arrange the data from lowest to highest
2. Calculate the total income: \$123,500.00
3. **Divide into quintiles.**  $10/5 = 2$  earners in each quintile.
  - Wag and N/Wollo compose the lowest quintile or 20% of income earners;
  - Oromia and Awi compose the second quintile or cumulative of 40% of income earners;
  - N/Shewa and Gondar compose the third quintile, or a cumulative of 60% of income earners;
  - W/Gojam and S/Gondarcompose the fourth quintile, or a cumulative of 80% of income earners; and
  - E/Gojjam and Bahir Dar are the fifth quintile or a cumulative of 100% of income earners

## 2. Measuring income inequality: PSDI Measures

4. Calculate the total income and convert into % :

Quintle population	Income ( \$ )	Income %
20	3500	0.028
20	17,000	0.138
20	22,000	0.178
20	31,000	0.251
20	50,000	0.404
TOTAL	123,500	

5. Calculate the cumulative percentage of household income

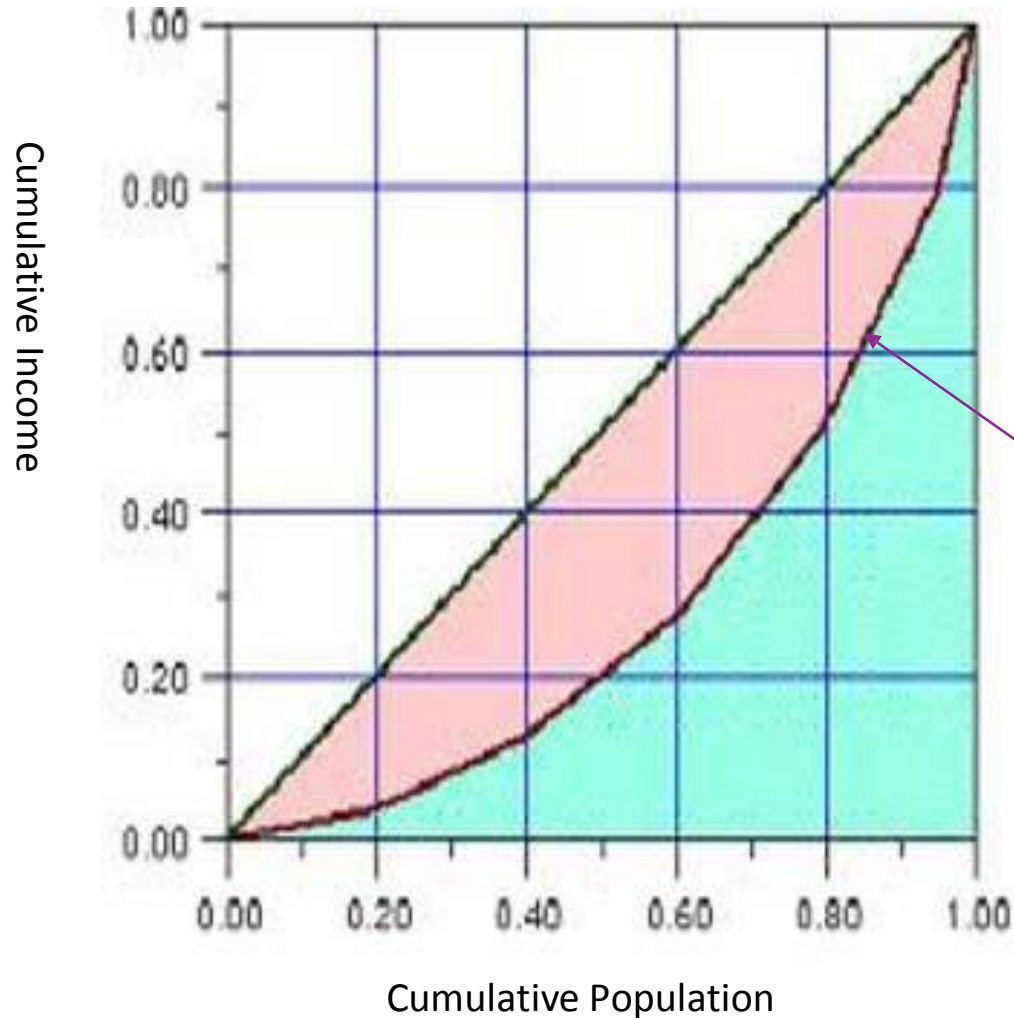
Population QUINTLE	Cuml'Ve Population	Income ( \$ )	% Income	Cumulative frequency
20	20	3500	0.03	0.03
20	40	17,000	0.14	0.17
20	60	22,000	0.18	0.35
20	80	31,000	0.25	0.6
20	100	50,000	0.04	1



40% proportion of the budget is earned by the top 20% of the zones (E/Gojjam and Bahir Dar )



# 2. Measuring income inequality: PSDI Measures

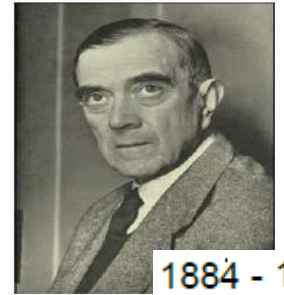


From the information in Lorenz Curve, we can say there is inequality among zones of the region

In this example, the Lorenz curve lies further below the line of equality. Now, the poorest 20% only earn 3% of the regional budget

## 2. Measuring income inequality: PSDI Measures

### Gini Coefficient



1884 - 1965

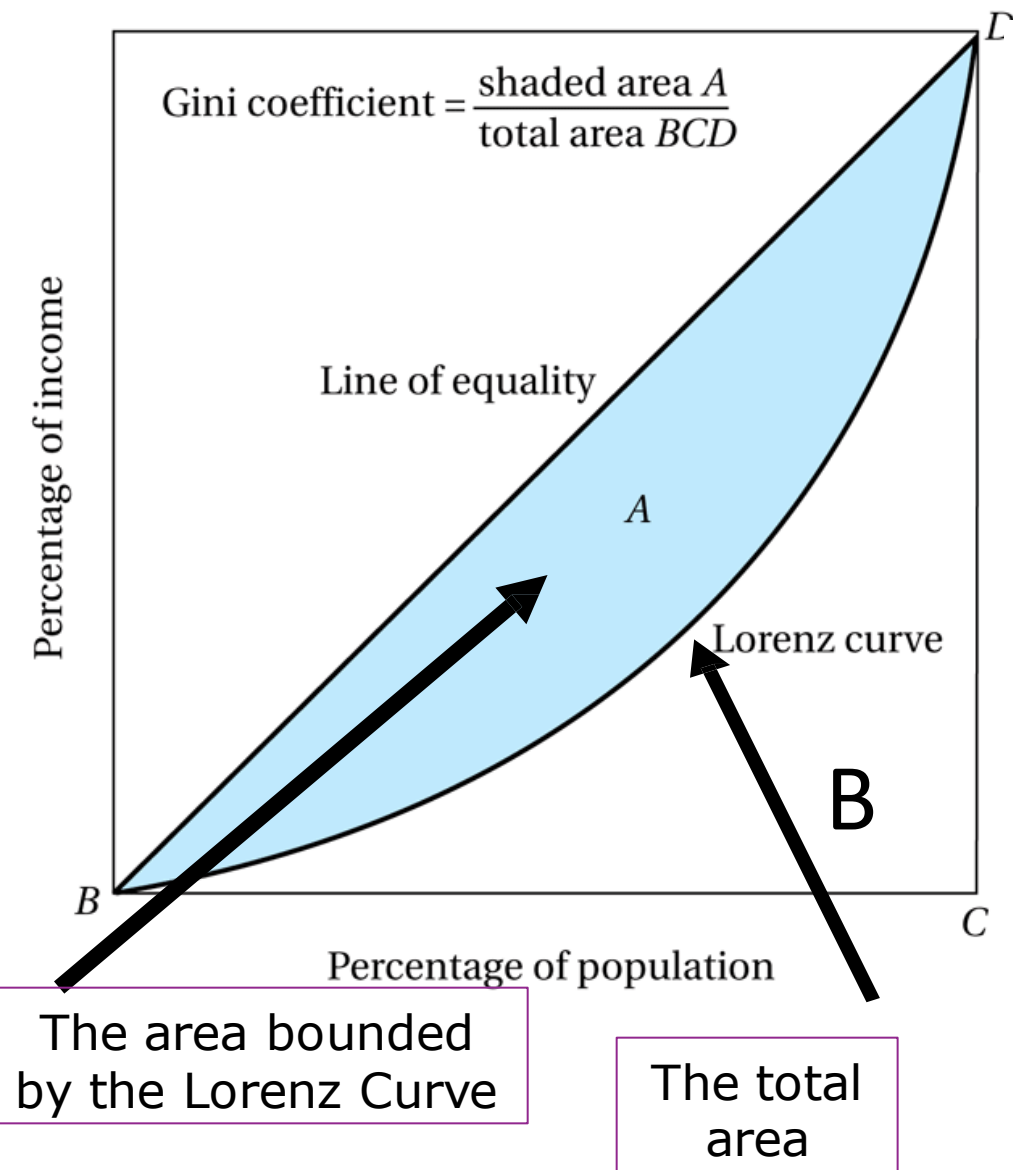
Corrado Gini

- A Gini coefficient is a summary numerical measure of how unequally one variable is related to another. The Gini coefficient is a number between 0 and 1, where perfect equality has a Gini coefficient of zero, and absolute inequality yields a Gini coefficient of 1.
- The Gini index measures the area between the Lorenz curve and the hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line.
- Is measured graphically by dividing the area between the perfect equality line and the Lorenz curve by the total area lying to the right of the equality line in a Lorenz curve diagram.

## 2. Measuring income inequality: PSDI Measures Gini Coefficient

- To understand the Gini Coefficient, one must first understand the Lorenz Curve, which orders all observations and then plots the cumulative percentage of the population against the cumulative percentage of the resource
- Mathematically, the Gini Coefficient is equal to twice the area enclosed **between the Lorenz curve and the equality diagonal.**
- When there is perfect equality, the Lorenz curve is the equality diagonal, and the value of the Gini Coefficient is zero.
- When one member of the population holds all of the resource, the value of the Gini Coefficient is one.

## 2. Measuring income inequality: PSDI Measures



- $G := \frac{A}{A + B} = G = \frac{\text{concentration area}}{\text{Maximum concentration area}}$

- If  $L(x) =$  Lorenz curve,

$$B = \int_0^1 L(x) dx$$

- Also,  $A + B = 1/2$ , so

$$G = 1 - 2B$$

- ✓ **A** is the area between the line of perfect equality and the Lorenz curve under study.

- ✓ **B** represents the area below the Lorenz curve but above the curve of complete inequality.

$0 \leq$  Gini coefficient  $\leq 1$ :

$G = 0$  for curve of perfect equality (since  $A = 0$ ).

$G = 1$  for complete inequality (since  $B = 0$ ).

## 2. Measuring income inequality: PSDI Measures

### Gini Coefficient -

•Another way to compute the Gini is directly from an algebraic formula. Given that the data is ordered from smallest to largest values of the variable of interest, the formula is:

$$G = \frac{2}{n^2 \bar{x}} \sum_{i=1}^n i(x_i - \bar{x})$$

Where;

○  $x_i$  is an observed value(say income- the individual's variable value),  $n$  is the number of values observed(say households) and  $i$  is the rank of values in ascending order(individual's rank order number),  $\bar{x}$  is the population average or mean

$$G = \frac{\sum_{i=1}^n (2i - n - 1)x_i}{n \sum_{i=1}^n x_i}$$

## 2. Measuring income inequality: PSDI Measures

### *Decision rule for inequality with Gini index value:*

- A rule of thumb to decide the level of inequality is Where the Gini index is
  - Between 0.200 and 0.299, the level of inequality is “**low inequality**”;
  - Between 0.300 and 0.399, “**medium inequality**”;
  - Between 0.400 and 0.499, “**high inequality**” and
  - Where the gini index is above 0.500, “**very high inequality**”.

## 2. Measuring income inequality: PSDI Measures

### Example:

Zone	Budget(x)	i	n	xbar	2i	2i-n-1	(2i-n-1)*xi
Wag hemra	1500.00	1	10	12350	2	-9	-13500
North Wollo	2000.00	2	10	12350	4	-7	-14000
Oromia	8000.00	3	10	12350	6	-5	-40000
Awi	9000.00	4	10	12350	8	-3	-27000
North Shewa	10000.00	5	10	12350	10	-1	-10000
North Gondar	12000.00	6	10	12350	12	1	12000
West Gojjam	15000.00	7	10	12350	14	3	45000
South Gondar	16000.00	8	10	12350	16	5	80000
East Gojjam	20000.00	9	10	12350	18	7	140000
Bahir Dar	30000.00	10	10	12350	20	9	270000
SUM	123500.00						442500.00

$$442500.00/10(123500.00) = 0.358$$

- The Gini Coefficient is 0.36
- In this case the Region faces medium inequality

## 2. Measuring income inequality: PSDI Measures

### Other Income Inequality Indices

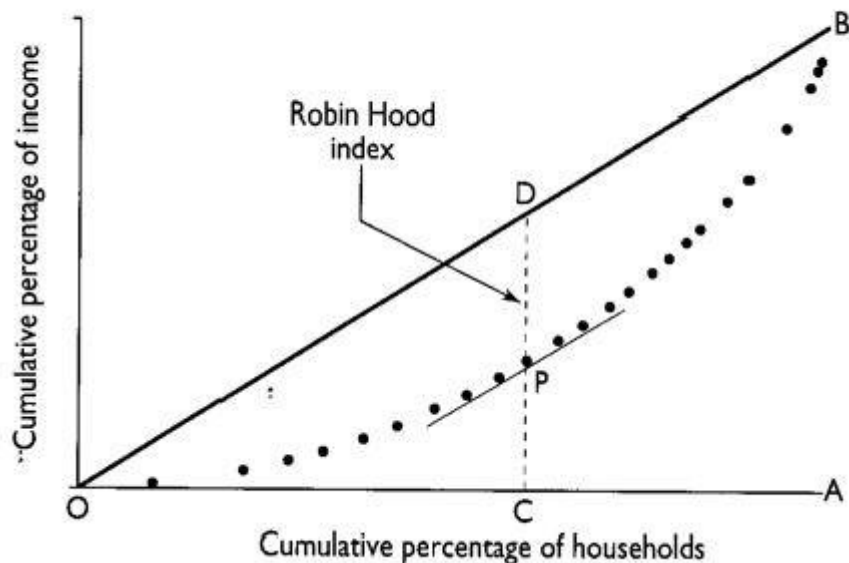
*Robin Hood Index, Atkinson Index, Theil's Entropy Measure,*

### Robin Hood Index

- The Robin Hood index is related to **the Lorenz curve and the Gini coefficient**. It measures the portion of total income that would need to be distributed in order for there to be perfect equality.
- This measure is equivalent to the maximum vertical distance between the Lorenz curve and the line of perfect equality (45° line) as shown in Figure
- The Robin Hood Index, represents the maximum vertical distance from the Lorenz curve to the 45°, it is called the Robin Hood index because **it can be interpreted as the proportion of income that has to be transferred from those above the mean to those below the mean in order to achieve an equal distribution**.
- The value of the index approximates **the share of total income that has to be transferred from households above the mean to those below the mean to achieve equality in the distribution of incomes**.



## 2. Measuring income inequality: PSDI Measures



- The Robin Hood Index is easy to interpret and fairly easy to calculate once the Lorenz Curve has been calculated. However, much like the Gini, it is not sensitive to income transfers between households on the same side of the mean income.
- As such, higher Robin Hood values indicate a more unequal society, wherein a larger share of income needs to be distributed to achieve equality.
- The Robin Hood index has been used effectively in several studies of the income inequality hypothesis. Unlike the Atkinson and GE indexes, the Robin Hood framework does not incorporate a sensitivity parameter.

## 2. Measuring income inequality: PSDI Measures

### Other Income Inequality Indices

#### Robin Hood Index How to calculate

- Sort the distribution from low to high
- Calculate the mean of the distribution
- Add all income (Y)
- Add the sub sample income of the poor and rich
- Take the difference between the **average and the income of the poor** and add it (X)
- $RI = X/Y$

# 2. Measuring income inequality: PSDI Measures

## Robin Hood Index How to calculate

Zone	Budget(x)	Mean	Bellow Avarage Zones	Mean- Poor's inc
Wag hemra	1500	12350	1500	10850
North Wollo	2000	12350	2000	10350
Oromia	8000	12350	8000	4350
Awi	9000	12350	9000	3350
North Shewa	10000	12350	10000	2350
North Gondar	12000	12350	12000	350
West Gojjam	15000	12350		
South Gondar	16000	12350		
East Gojjam	20000	12350		
Bahir Dar	30000	12350		
<b>SUM</b>	<b>123500</b>			<b>31600</b>
<b>SUM</b>	<b>12350</b>		RI=31600 / 123500 =0.26	

## 2. Measuring income inequality: PSDI Measures

### Atkinson's inequality measures

- Atkinson has proposed another class of inequality measures that are used from time to time
- This class also has a weighting parameter  $\varepsilon$  (which measures aversion to inequality) and some of its theoretical properties are similar to those of the extended Gini index
- The value of the Atkinson Index can vary between 0 and 1. Like the Gini Coefficient, the Atkinson index is most effectively used **in comparisons between regions**.
  - A **lower** Atkinson value represents an income distribution that is **more equal**. In addition, this measure incorporates a sensitivity parameter  $\varepsilon$  which can range from 0 to infinity.
  - As the sensitivity index approaches higher values, the Atkinson Index becomes more sensitive to changes at the lowest income groups.
  - As the sensitivity index approaches 0, the Atkinson Index becomes more sensitive to changes in the income position of the higher income groups in a distribution. It is common to see sensitivity values of 0.5, 1, 1.5 or 2.

## 2. Measuring income inequality

The Atkinson class is defined as follows

$$A_\epsilon = 1 - \left[ \frac{1}{N} \sum_{i=1}^N \left( \frac{y_i}{\bar{y}} \right)^{1-\epsilon} \right]^{1/(1-\epsilon)}, \quad \epsilon \neq 1$$

Where  $y_i$  is the proportion of total income earned by the  $i$ th group, and  $\epsilon$  is the sensitivity parameter

$$I = 1 - \frac{\prod_{i=1}^N (y_i^{(1/N)})}{\bar{y}}, \quad \epsilon = 1.$$

Where  $(I)$  represents the Atkinson Index and  $\bar{Y}$  is the mean income

## 2. Measuring income inequality

- The Atkinson index allows for varying sensitivity to inequalities in different parts of the income distribution
- Therefore, his index incorporates a sensitivity parameter ( $\epsilon$ ); which can range from **0** (meaning that the researcher is indifferent about the nature of the income distribution), **to infinity** (where the researcher is concerned only with the income position of the very lowest income group).
- An intuitive interpretation of this index is possible: Atkinson values can be used to calculate the proportion of total income that would be required to achieve an **equal level** of social welfare as at present if incomes were perfectly distributed.
  - For example, an Atkinson index value of 0.20 suggests that we could achieve the **same level of social welfare** with only  $1 - 0.20 = 80\%$  of income. The theoretical range of Atkinson values is 0 to 1, with 0 being a state of equal distribution.

## 2. Measuring income inequality

### *Theil's Entropy Measure*

- Entropy means 'disorder' – deviations from perfect income equality.
- This measure is based on an income contribution or share that each individual or group holds. It involves complex mathematical calculations.
  - When individual data is available, each individual has an identical population share ( $1/N$ ), so each individual's Theil's Entropy measure is determined by his or her proportional distance from the mean.
  - When individual data is not available, the Theil's Entropy measure can be adjusted for groups. The index has a potential range from zero to infinity with higher values indicating more unequal distribution of income.
- This measure is useful in that it allows the researcher to understand the contributions to inequality by **within group and between group components**. However, there are a number of caveats with Theil's Entropy measure.

## 2. Measuring income inequality

- The general formula is given by

$$GE(\alpha) = \frac{1}{\alpha(\alpha - 1)} \left[ \frac{1}{N} \sum_{i=1}^N \left( \frac{y_i}{\bar{y}} \right)^\alpha - 1 \right]$$

Where

- $\bar{Y}$  is the mean income per person (or expenditure per capita)
- GE generalized entropy (GE) inequality measures
- The values of GE measures vary between zero and infinity, with zero representing an equal distribution and higher values representing higher levels of inequality.
- The parameter  $\alpha$  in the GE class represents the weight given to distances between incomes at different parts of the income distribution, and can take any real value.
- For lower values of  $\alpha$ , GE is more sensitive to changes in the lower tail of the Distribution, and for higher values of  $\alpha$  GE is more sensitive to changes that affect the upper tail.



## 2. Measuring income inequality

- The most common values of  $\alpha$  used are 0, 1, and 2. GE(1) is Theil's T index, which may be written mathematically, with individual level data Theil's T statistic of income inequality is given by the basic form of the Thiel Index:

$$T = \frac{1}{n} \sum_i \left( \frac{y_i}{\bar{y}} \right) \ln \left( \frac{y_i}{\bar{y}} \right)$$

Where

- $n$  is the number of individuals in the population,  $y_i$  is the income of the person indexed by  $i$ , and  $\bar{Y}$  is the population's average income

The summation sign reinforces the idea that each person will contribute a Thiel element.

- $y_i/\bar{Y}$  is the proportion of individual's income to average income
- The natural logarithm of  $y_i/\bar{Y}$  determines whether the element will be positive ( $y_i/\bar{y} > 1$ ); negative ( $y_i/\bar{Y} < 1$ ); or zero ( $y_i/\bar{Y} = 1$ ).

## 2. Measuring income inequality

$$T = \frac{1}{n} \sum_i \left( \frac{y_i}{\bar{y}} \right) \ln \left( \frac{y_i}{\bar{y}} \right)$$

### Example:

Individual (1)	Income (2)	Average Income (3)	Ratio of income to average income (4)	Log (ratio of income to average income) (5)	(6)=(4) x (5)	Theil Index is sum of 6 divided by observations
$n$	$y_i$	$\bar{y}$	$\frac{y_i}{\bar{y}}$	$\ln \left( \frac{y_i}{\bar{y}} \right)$	$\left( \frac{y_i}{\bar{y}} \right) \ln \left( \frac{y_i}{\bar{y}} \right)$	
1	300		0.170	-1.769	-0.302	
2	500		0.284	-1.258	-0.358	
3	1000		0.568	-0.565	-0.321	
4	2000		1.136	0.128	0.145	
5	5000		2.841	1.044	2.966	
		1760			Sum of values =2.132	<b>0.426</b>

## 2. Measuring income inequality

- Often, individual data is not available. Theil's T Statistic has a flexible way to deal with such instances.
- If members of a population can be classified into mutually exclusive and completely exhaustive groups, then Theil's T Statistic for the population ( $T$ ) is made up of two components, the between group component ( $T'_g$ ) and the within group component ( $T^{wg}$ ).

Algebraically, we have:

$$T = T'_g + T^{wg}$$

- When aggregated data is available instead of individual data,  $T'_g$  can be used as a lower bound for Theil's T Statistic in the population
- The between group elements capture each group's contribution to overall inequality
- The sum of the between group elements is a reasonable lower bound for Theil's T statistic in the population

## 2. Measuring income inequality

The between group element of the Theil index has a familiar form:






$$T'_g = \sum_{i=1}^m \left\{ \left( \frac{p_i}{P} \right) * \left( \frac{y_i}{\mu} \right) * \log_{10} \left( \frac{y_i}{\mu} \right) \right\}$$

where  $i$  indexes the groups,  $p_i$  is the population of group  $i$ ,  $P$  is the total population,  $y_i$  is the average income in group  $i$ , and  $\mu$  is the average income across the entire population.

- Can decompose the Theil index into between group inequality and within group inequality.
- E.g. Look at income inequality within racial groups and then between racial groups.

# 2. Measuring income inequality

Example 2: The following example assumes that exact salary information is known for each individual

	Number of employees	Exact Salary
	2	\$100,000
	4	\$80,000
	6	\$60,000
	4	\$40,000
	2	\$20,000

For this data, Theil's T Statistic = 0.079078221

- Individuals in the top salary group contribute large positive elements. Individuals in the middle salary group contribute nothing to Theil's T Statistic because their salaries are equal to the population average. Individuals in the bottom salary group contribute large negative elements.

## 2. Measuring income inequality

### Theil's T statistic

#### Pros

- Can effectively use group data
- Allows the researcher to parse inequality into within group and between group components

#### Cons

- No intuitive motivating picture
- Cannot directly compare populations with different sizes or group structures
- Comparatively mathematically complex

**Summary of income inequality measures**

Measure	Complexity of Calculation	Benefits	Caveats	Recommendation
Calculations based on Percentile distributions	easy	<ul style="list-style-type: none"> <li>-data readily available</li> <li>-easy to interpret</li> <li>-allows for comparisons over time (including direction and magnitude)</li> <li>-used to calculate effectiveness of government transfers over time</li> </ul>		use
Lorenz Curve and Gini Coefficient	complex but aided by statistical software	<ul style="list-style-type: none"> <li>-a graphical representation of income inequality that can be compared over time and between geographic areas</li> <li>-simple to calculate</li> <li>-data readily available</li> <li>-can be calculated for individual and household level data</li> <li>-easily interpreted when compared to other Gini coefficients</li> </ul>	<ul style="list-style-type: none"> <li>-incapable of showing different kinds of inequality represented by various shapes of Lorenz curves</li> <li>-does not emphasize inequalities in the top or bottom of the spectrum (polarization)</li> <li>-shows the direction of income redistribution but does not indicate where the redistributions are occurring</li> <li>-ignores life cycle effects</li> <li>-does not allow for within or between income group comparisons</li> </ul>	use

Summary of income inequality measures				
Measure	Complexity of Calculation	Benefits	Caveats	Recommendation
Median share of Income	easy	-data readily available	-not sensitive to varying proportions of the income distribution within the upper or lower 50% of the distribution	use in combination with other measures
Robin Hood Index	easy if have Lorenz curve	-uses the same data needed to calculate the Lorenz curve -easy to interpret	-not sensitive to income transfers between households on the same side of the mean income	use together with the Gini coefficient
Atkinson Index	complex	-incorporates a sensitivity parameter directly into the equation.	-sensitivity parameter means that a subjective judgment has been made about inequality -not intuitive	do not use
Theil's Entropy Measure	complex	-shows the contributions to inequality by within group and between group components	-complex to calculate and interpret. -varies greatly when the distribution varies regardless of whether the change in distribution occurs at the top, middle or bottom -income redistributions will impact the calculation irrespective of whether the redistribution takes place between rich and poor or rich and middle -cannot directly compare populations with different sizes as calculation is dependent on number of individuals in the population or group	do not use
Coefficient of Variation	easy		-requires comprehensive individual data -not intuitive -cannot use if the income distribution is not normal	do not use



### 3. Characteristics of income inequality Causes of income inequality

#### •Economic Inequalities can occur for several reasons:

- Physical attributes – distribution of natural ability is not equal
- Personal Preferences – Relative valuation of leisure and work effort differs
- Social Process – Pressure to work or not to work varies across particular fields or disciplines
- Public Policy – tax, labor, education, and other policies affect the distribution of resources

# 3. Characteristics of income inequality

## Causes of Inequality

- Individual
  - Ownership of resources – housing, land, etc.
  - Qualifications
  - Motivation
  - Skills
  - Ability
  - Family size
- National
  - Factor endowments (land, labour, capital)
  - Size and quality of labour force
  - Climate
  - Stage of economic development
  - Economic Power – ability to be able to dictate terms with suppliers, buyers, etc.

### 3. Characteristics of income inequality

- Relation between economic growth and inequality.....
- Does growth affect the level of inequality?
- Does initial inequality affect growth?
  - Kuznets' Inverted- U Hypothesis.....
- Why is inequality bad?
- Inequality and poverty reduction.....
- How is poverty related to economic inequality?

More discussion in the coming chapter



**PART THREE**  
**INTRAHOUSEHOLD**  
**RESOURCE ALLOCATION**