Analytical tools beyond Gini index to study inequality: a case of City of Blitar, East Java, Indonesia

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Abstract. This paper demonstrates the use of some analytical tools beyond usual Gini index to study inequality in the City of Blitar (henceforth, Blitar), East Java, Indonesia. The Blitar’s mid-term development plan has set social and macroeconomics indicators as basis to evaluate how local development is carried out by the city government. Of the government’s primary concerns is how the city’s economic pie is distributed between its citizens. As in many other places or context, Gini index has long been a to-go indicator to gauge inequality at first glance. Gini is in fact a never obsolete since it has many desirable properties to be a good indicator for inequality. However, it is necessary to go deeper so the policy makers would better understand the inequality decomposition and dynamics. Attempts to understand inequality should also include an assessment whether the observed growth is pro-poor. Better equality and pro-poor growth make quality growth, which is a primary dimension of sustainable development goals. This paper offers rather comprehensive yet practical guidance for policy analysts or planning practitioners to study inequality in a more meaningful way.

Keywords: inequality, pro-poor growth, Gini, inequality indices.

1. Introduction

Based on Minister of Home Affairs Regulation Number 54 of 2010 about Implementation of Government Regulation Number 8 of 2008 with reference to Stages, Procedures for Organization, Control and Evaluation of Implementation of Regional Development Plans, in the preparation of regional development planning documents, regional economic analysis is required in order to assess to what extent the regional development realization can influence the economic performance and how far the economic indicators realization are in accordance with what is assumed in medium-term development planning. The analysis is also used as one of the main inputs in making regional financial analysis. Furthermore, the results of the analysis forms the basis for determining the formulation of priorities and development goals, including being one of the references in formulating development issues.

In order to determine government policies which are on target as described above, the preparation of the inequality analysis needs to be done as a reference study in the preparation of a quality development planning. In this regard, the inequality analysis was carried out to help the Regional Development Planning Board of Blitar City preparing the Gini Analysis of the City of Blitar in 2018. The preparation
2. Basic concept of inequality measures

According to Atkinson [1,2], inequality is a broader concept than the concept of poverty because its measurement is based on the entire population, not only for the part (subset) below a certain poverty line. Most indicators of inequality do not depend on the average distribution of welfare indicators which is used (e.g., per capita expenditure). The mean feature of independence is a desirable feature of the size of inequality. In addition to per capita expenditure, measurement of inequality can also use other indicators, for example: income, land, assets, tax payments, and many other economic demographic variables.

The simplest measure of inequality is to rank the population based on selected indicators (e.g., expense), from the poorest to the richest; and then the percentage of expense (or income) that corresponds to each group (quintile, quintile) or tithe (decile, decile) of the population. The poorest quintile usually accounts for 6-10 percent of all expenses, the top quintile is 35-50 percent. The World Bank (World Bank) standard in measuring inequality is by seeing the contribution of the poorest 40% in the distribution of expenditure as shown in Table 1 [3].

| Income Distribution | Inequality Level |
|---------------------|------------------|
| The 40% poorest group have < 12% expense of all expenses | High |
| The 40% poorest group have 12%–17% expense of all expenses | Average |
| The 40% poorest group have > 17% expense of all expenses | Low |

The popular measure of inequality is the Gini coefficient or Gini index, whose values range from 0 (perfect equality) to 1 (perfect inequality), but usually in the range of 0.3 to 0.5 for per capita expenditure indicators. The Gini coefficient comes from the Lorenz curve, which groups the population from the poorest to the richest, and shows the cumulative proportion of the population on the horizontal axis and the proportion of cumulative expense (or income) on the vertical axis. The Gini coefficient meets many indicators of good inequality indicators, including:

1. Mean independence. If the expense (income) of all members of the population is doubled, the Gini coefficient value will not change.
2. Population size independence. If the population size changes, but other variables remain (ceteris paribus), the Gini index value does not change.
3. Symmetry. If two people in the population exchange expenses (income), the Gini index value does not change.
4. Pigou-Dalton Transfer sensitivity. Based on these criteria, if there is a transfer from the rich group to the poor, the Gini coefficient value will decrease, meaning that there will be a decrease in inequality.

Table 2 below provides a benchmark level of inequality based on the Gini coefficient value.
Table 2. The inequality level based on Gini coefficient score

| Gini coefficient score | Inequality Level |
|------------------------|------------------|
| Gini < 0.4             | Low              |
| 0.4 < Gini < 0.5       | Average          |
| Gini > 0.5             | High             |

In addition, there are also various other measures of inequality. The most common measure of entropy for assessing inequality is Theil’s T and Theil’s L, both of which allow one to decompose inequalities that occur within regions (for example, urban and rural) and inequality caused by differences between regions (for example, village income inequality cities), as well as sources of changes in inequality over time. Usually, at least a third of inequality in a country caused by inequality in the group, and the rest is differences between groups. The size of Theil's inequality has a feature that the Gini coefficient does not have, named decomposability. The size of class inequality by Atkinson is also used sometimes. The decile dispersion ratio is also a measure of inequality which is easy and popular, but is a rough measure. The decile dispersion ratio is defined as the expense (or income) of the richest deciles divided by the poorest deciles, is a popular and easy method but is a very rough measure. For visualization of the inequality dynamics, Pen's Parade Charts can be useful in showing how distribution of expense (income) changes over time.

3. Methodology

The most widely used measure of inequality is the Gini coefficient. The Gini coefficient is derived from the Lorenz curve (see Figure 1), named the cumulative frequency curve that compares the distribution of certain variables (for example, expense) with a uniform distribution that represents equality. To construct the Gini coefficient, graph the cumulative percentage of households (from poor to rich) on the horizontal axis and the cumulative percentage of expense (or income) on the vertical axis. Diagonal lines represent perfect equality. The Gini coefficient is defined as the ratio of area A / (area A + area B), where A and B are the areas shown in the image. If A = 0, the Gini coefficient becomes 0, which means absolute equality, whereas if B = 0, the Gini coefficient becomes 1, which means absolute inequality [4]. In this example, the Gini coefficient is around 0.35. Some users, including the World Bank, multiply this number by 100, in this case it will be reported as 35.

In mathematical formulas [5], Gini coefficients can be calculated using the following formula:

$$ Gini = 1 - \sum_{i=1}^{N} \left( x_i - x_{i-1} \right) \left( y_i + y_{i-1} \right). $$

(1)

Where $x_i$ is a value in the x axis, and $y$ is a value in y axis.
These following is a mathematical formula to calculate the entropy inequality index.

Formula (2): General Entropy

\[ GE(\alpha) = \frac{1}{\alpha^2 - \alpha} \left\{ \frac{1}{N} \sum_{i=1}^{N} \left( \frac{y_i}{\bar{y}} \right)^{\alpha} - 1 \right\} \]

N= population size;
\( y_i = \) individual expense (income);
\( \alpha = \) weighting factor, given to the distance between expenses (income) between various different positions in the distribution.

Formula (3): GE(1) or Theil’s T index

\[ GE(1) = \frac{1}{N} \sum_{i=1}^{N} \frac{y_i}{y} \ln \left( \frac{y_i}{y} \right) \]

Formula (4): GE(0) or Theil’s L index or Mean-log deviation

\[ GE(0) = \frac{1}{N} \sum_{i=1}^{N} \ln \left( \frac{y}{y_i} \right) \]

The main data for the preparation of the Gini analysis is the micro data of the National Socio-Economic Survey (Susenas). Without this Susenas data, this Gini analysis work cannot be done. Susenas data is usually stored in SPSS sav and dBASE dbf formats. Susenas data consists of three groups of
files, namely: KORIND (individual), KORRT (household), and three blocks: 4.1, 4.2, and most importantly 4.3. The scope of data needed is Susenas data for the whole East Java. So, comparative analysis can be done, to find out the relative position of Blitar City to other selected cities/districts, both the whole city/regency in East Java or especially the districts/cities in the former Kediri residency. The data needs for this analysis to be done is throughout the 2010-2017 period or longer if it is available. So that you can do trend analysis and future projections. Analysis of the inequality dynamics can be done by making two graphs: namely Parade Graphs and Pro-poor Growth Charts [6].

4. Results
This chapter shows the calculation result and Gini analysis, and others inequality indicators. Especially the time series Gini data of Blitar City, the data used is the data given by the statistics bureau of Blitar City. Other than that, all calculation and output used the Susenas data based on the method which already been explained in the section 3 methodology. What is meant by per capita expenditure is the average per capita expenditure per month.

4.1. Gini and Entropy
Table 3 shows the Gini coefficient and GE (α) entropy index of Blitar City throughout the 2008 to 2017 period. Based on the categorization of inequality levels based on the magnitude of the Gini coefficient (see Table 2 in Section 2), the inequality level in Blitar City in 2008-2017 is still classified as low. There was a slight decrease in the Gini coefficient in 2017 compared to 2016. However, if we look at it in a longer period (2012-2017 or 2008-2017), there seems to be an increasing trend.

Table 3. Gini and GE(α) Blitar City, 2008-2017

| Year | Gini | GE(0) | GE(1) |
|------|------|-------|-------|
| 2008 | 0.32 | -     | -     |
| 2009 | 0.32 | -     | -     |
| 2010 | 0.33 | 0.13  | 0.14  |
| 2011 | 0.34 | 0.19  | 0.21  |
| 2012 | 0.38 | 0.33  | 0.54  |
| 2013 | 0.40 | -     | -     |
| 2014 | 0.35 | -     | -     |
| 2015 | 0.37 | 0.27  | 0.30  |
| 2016 | 0.41 | 0.29  | 0.34  |
| 2017 | 0.39 | 0.26  | 0.28  |

Note: “-”, the calculation can not be done because of the data limitations.

As explained in Section 2, the GE (α) entropy index is additively decomposable, while the Gini coefficient is not. Because it has additively decomposable features, the decomposition analysis of the entropy index can be used to understand deeper the character and process of visible inequality. The trend of increasing inequality seems to occur because there is an increase in inequality between expenditure groups (40% down, 40% medium, and 20% above), as indicated in Table 4.

Table 4 shows the total magnitude and decomposition of the GE entropy index (α), which consists of within groups inequality and between groups inequality. The ratio of inequality between groups to total inequality is also shown (numbers in dark blue). In the 2012-2017 period, the ratio of inequality between groups to total inequality increased. Contribution of inequality between expense groups to overall inequality is more dominant than the contribution of inequality in groups.
Table 4. Entropy Index Decomposition, GE(α)

| GE(α): total, within, between, share | 2012 | 2017 |
|-------------------------------------|------|------|
| GE(0) total                         | 0.33 | 0.26 |
| GE(0) within group                  | 0.07 | 0.04 |
| GE(0) between group, bw             | 0.26 | 0.21 |
| Share GE(0) bw to total             | 0.78 | 0.83 |
| GE(1) total                         | 0.54 | 0.28 |
| GE(1) within group                  | 0.26 | 0.06 |
| GE(1) between group, bw             | 0.28 | 0.22 |
| Share GE(1) bw to total             | 0.52 | 0.78 |

Figure 2 shows the trend of inequality of Blitar City in the period 2010-2017 based on the Gini index and GE entropy (α) visually. In a short period, for example from a year compared to one year before, the Gini index looks smoother (smooth) compared to the two types of GE entropy index (α). Nonetheless, the three seem to move in tandem, where: i) there is a trend of increasing inequality; ii) the level of inequality at the end of the period is greater than at the beginning of the period.

![Gini and two indicators of Blitar City inequality, 2010-2017](image)

**Figure 2.** Blitar City inequality trend, 2010-2017
Figure 3 shows the trend of inequality of Blitar City in the 2010-2017 period visually based on the Gini index compared to two comparison regions, named East Java and former Kediri Residency. Calculations for two fixed comparison areas include Blitar City data. During the period, the trend of inequality in Blitar City seemed more volatile compared to the trend of inequality in the two comparison regions. At the beginning of the period, the level of inequality in Blitar City was lower than the level of inequality between the two comparison regions. At the end of the period, the level of inequality in Blitar City was higher than the level of inequality of the former region. The Kediri Residency, although still lower than the level of East Java inequality as a whole.

4.2. Lorenz Curve

As explained in Section 2, the Lorenz curve is a cumulative frequency curve that compares the distribution of certain variables, in this case per capita expenditure per month, with a uniform distribution representing equality. In the Lorenz curve, the uniform distribution is represented by a 45 degree diagonal straight line. Mathematically, the actual magnitude of the Gini coefficient is derived from the Lorenz curve. In addition, the Lorenz curve also visualizes inequality, named how far the actual distribution of welfare indicators is used relative to the equivalent distribution of the indicator.

In this section is shown the Lorenz curve of Blitar City and former Kediri Residency as a comparison area for 2010-2017 period, not including 2013 and 2014, due to incomplete data for the district/city level in the two years. In line with Figure 3 above, from a group of Lorenz curves shown (Figure 4 a-f), the level of inequality of Blitar City is smaller than the level of inequality of the former Kediri residency only in 2010 (Figure 4 f)

The gray area in the Lorenz curve is an area of 95% confidence range. That is, if a measurement is made 100 times, 95 times that of 100 measurements, the actual Gini coefficient value will be located within that confidence level. Generally, the greater the variation in data distribution, the wider the range of trust or the greater the gray area shown in the figure.
4.3. The inequality standard of World Bank

In line with the trend of inequality in Table 3 and Figure 2, the trend of inequality in Blitar City according to World Bank standards also shows movement from the low category at the beginning of the period to the medium category (see Table 1 in Section 2) at the end of the period. The group expenditure ratio of 40% down to total expenditure in 2017 is 0.16 (16%). This ratio is close to the upper limit of 17% for the medium category, given that the World Bank categorizes moderate inequality if the poorest group of 40% of expenditure is 12% - 17% of total expenditure. The transition to the lower limit of the category...
of moderate inequality or even falls into the category of high inequality (the poorest group of 40% spending <12% of total expense) or returning to the low category (the poorest 40% of expense >17% of total expense) depends on many things, especially in the formulation and implementation of Blitar City Government policies to promote equity.

Table 5. The Three Group Share Expense on Total Spending

| Year | 40% Low | 40% Average | 20% High |
|------|---------|-------------|----------|
| 2017 | 0.16    | 0.38        | 0.46     |
| 2016 | 0.15    | 0.37        | 0.48     |
| 2015 | 0.15    | 0.36        | 0.48     |
| 2012 | 0.14    | 0.28        | 0.58     |
| 2011 | 0.20    | 0.36        | 0.44     |
| 2010 | 0.22    | 0.39        | 0.39     |

Table 6 shows the per capita expenditure limit for each expense group, namely: the poorest 40% (bottom), 40% middle (medium), and the richest 20% (above), in 2015-2017. Expenditure limits are calculated based on three statistics, namely the mean (average), minimum value, and maximum value. For ease of reading and interpretation, we can focus on just one statistic, which is the maximum value (blue). In 2017, those with a per capita expenditure of or less than Rp. 723,164 belong to the poorest 40% group. In 2016, for example, someone with a per capita expenditure of Rp. 700,000 already included in the group of 40% middle; however, with the same per capita expenditure, it will be included in the group of 40% poorer in 2017. This means that the level of expenditure per capita is needed or the standard of expenditure is higher (which of course requires an increase in income level) to keep from falling into lower expense group.

Table 6. Three Group Per Capita Expenditures (IDR)

| Year | Statistics | 40% Low | 40% Average | 20% High |
|------|------------|---------|-------------|----------|
| 2017 | Mean       | 484.945 | 1.072.143   | 2.693.513|
|      | Min        | 197.057 | 723.485     | 1.588.667|
|      | Max        | 723.164 | 1.583.622   | 12.000.000|
| 2016 | Mean       | 440.418 | 1.016.045   | 2.764.930|
|      | Min        | 253.828 | 633.580     | 1.431.498|
|      | Max        | 630.688 | 1.429.957   | 12.600.000|
| 2015 | Mean       | 461.925 | 1.021.015   | 2.639.310|
|      | Min        | 231.666 | 697.702     | 1.527.377|
|      | Max        | 694.127 | 1.514.036   | 20.200.000|

4.4. Inequality dynamics: pro-poor growth?
The trickle down effect thesis argues that growth will be distributed downward. But this thesis does not explain how the growth that occurs will trickle down. In other words, this thesis does not offer a complete explanation of how the drop down works or how existing growth will be distributed among various groups of people. The group here is percentile or quintile of the welfare indicator, for example per capita expenditure as used in preparing this Blitar City Gini analysis analysis report.
Quality growth has many dimensions. These dimensions include improvements in the quality of Human Resources (HR) and employment, environmental quality, and reduced inequality/improvement in equity, especially for the poorest groups. This report focuses on the dimensions of equity. One of the available analysis tools to check whether the growth that occurs is also enjoyed proportionally by the poorest groups is a diagram called the growth incidence curve or growth curve for the income group.

The Blitar City growth incidence curve between 2012 and 2017 is stated in Figure 6. Growth is calculated based on the real value of per capita expenditure in 2012 and 2017. This means that inflation in per capita expenditure in 2017 has been neutralized based on the 2012 base year, where the 2012 consumer price index (CPI) is expressed as 100, or commonly stated as follows, 2012 = 100.

From the data, the absolute negative growth actually only occurs in the first percentile (the poorest 1%) and at the 99th percentile (the richest 1%). The other percentiles still experience positive growth (>0%). However, if the standard values are used (mean: 50.5%) and the median value (median: 51%) growth of all percentiles, around 50% of the population experiences growth below that standard. The group that experienced growth far above the standard was the group between the 60-80 percentile and between the 90-100 percentile. In essence, the growth performance of the poorest 50% group is still below the 50% growth performance of the richest community.

The pattern of growth distribution as depicted in the growth incidence curve is in line with Figure 6 below or commonly referred to as the Parade diagram. The Parade as in Figure 4.5 also uses the real value for the 2012 base year. The level of expenditure per capita in all 2017 percentiles (in blue) is compared with the level of expenditure per capita in all of the 2012 percentiles (red). As expected and because there is indeed a positive absolute growth between the level of real per capita expenditure between 2012-2017 as illustrated in Figure 4.4 before, the level of expenditure per capita 2017 is always above the 2012 per capita expenditure level.

However, the gap between the two is increasing for the expense groups above the poorest 20% group. Gap enlargement is increasingly progressive for the upper middle class (above the poorest 40% group). The pattern of gap enlargement such as open scissors indicates a divergence process. In simple terms, divergence occurs when a group of wealthier individuals experiences a higher level of expense growth compared to the growth rate of the poor. The process of divergence will maintain or even increase inequality.

Figure 5. Growth incidence curve of Blitar City, 2012-2017
4.5. Inequality projection

Because the existing time series data range is not too long, the projections that can be done are only up to the next five years, namely 2018-2022 (see Table 7). The least squares method is used to produce estimates for all three models, namely: 1) linear model; 2) non-linear models with 10 log-based transformations, Log; 3) non-linear models with natural number-based log transformations, Ln. The three models produce almost the same estimates every year.

The projection results indicate the movement of the level of inequality moves from the low category to the medium category. This indication is in line with the trend of shifting categories of inequality based on World Bank standards as outlined in sub-section 4.3 above.

The estimation shown is the average value or point estimation. The range estimation upper and lower limits with a 95% confidence range are not displayed. That is, it could be that the actual Gini coefficient in the future is smaller (greater) than the point estimation value displayed in the table. More important than the upper and lower limits of range estimation is how we behave towards the projection results. This projection needs to be addressed with a positive attitude and interpreted as a sign of early warning.

The projection results in Table 7 should be used as a motivation to formulate and implement policies to encourage equity to be more effective, so that the level of inequality in Blitar City does not shift into the medium category.

| Year | Model 1: linier | Model 2: non-linier (Log 10) | Model 3: non-linier (Ln) |
|------|----------------|-------------------------------|-------------------------|
| 2018 | 0,41           | 0,41                          | 0,41                    |
| 2019 | 0,42           | 0,42                          | 0,42                    |
| 2020 | 0,43           | 0,44                          | 0,43                    |
| 2021 | 0,44           | 0,45                          | 0,44                    |
| 2022 | 0,45           | 0,46                          | 0,45                    |
5. Conclusion

Some conclusion which can be addressed are:

1. Various inequality indicators whether it is Gini or entropy index show that there is an increase in inequality trend.
2. Contribution of inequality between expense groups to overall inequality is more dominant than the contribution of inequality within groups.
3. Throughout the study period, the level of inequality in Blitar City is more varied compared to the level of inequality in East Java as a whole or the former region of Kediri Residency.
4. The inequality level in Blitar City facing an shifting risk from the low category to the average category.
5. Middle upper class groups experience higher rates of growth per capita expenditure compared to the poor.

These are the policy recommendations which need to be considered:

1. Carry out fiscal expansion, such as the Family Hope Program (PKH) at the national level, to increase the purchasing power of the poorest groups of society. Increasing purchasing power of the poor in turn will also increase the economic growth of Blitar City, because consumption is still the main growth engine of Blitar City.
2. In order for the program and activities in the first point to be more targeted, it is necessary to improve the database of the poorest groups of people. This database should not only feature by name, by address, but also by Figure. Improving and verifying this database must be an annual program.

6. References

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