Decomposing Regional Income Inequality using Two-Stage Nested Theil Decomposition Method

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Abstract

The objective of this paper is to present an inequality decomposition method, the two-stage nested Theil decomposition method, which is an extension of the ordinary one-stage Theil decomposition method. The method is analogous to a two-stage nested design in the analysis of variance (ANOVA). It considers the three-level hierarchical structure of a country: region-province-district, and decomposes the overall regional inequality, as measured by Theil indices based on district-level mean incomes, into three components: the between-region, between-province, and within-province inequality components. The within-province component is a weighted-average of within-province income inequalities for each province, while the between-province component is a weighted-average of between-province income inequalities within each region. The method uses districts as a basic regional unit to measure regional income inequality, rather than provinces, and thus can analyze the contribution of within-province inequalities as well as between-province and between-region inequalities to the overall regional income inequality in a coherent framework. This paper applies this two-stage nested Theil decomposition method to district-level income and population data in China and Indonesia and explores the factors of regional income inequality in China and Indonesia.

1. Introduction

As pointed out by Metwally and Jensen (1973), the measure of regional income inequality based on regional mean incomes relative to the national mean income fails to explain either the dispersion of individual incomes nationally or the dispersion of incomes within regions. It is quite possible for the measure to decrease over time (i.e., a convergence in regional mean incomes), while the dispersion of actual incomes could show an opposite trend. Despite this technical problem, however, there have been a number of studies that measure regional income inequality based on regional mean incomes, using such inequality indices as the weighted coefficient of variation (Williamson, 1965), Theil entropy indices (Theil, 1967) and the variance of log-income.[1] This is attributable mainly to the paucity of data on individual incomes within each region and the availability of data on regional mean incomes.

This paper presents an inequality decomposition method, the two-stage nested Theil decomposition method, which is an extension of the ordinary one-stage Theil decomposition method.[2] The method is analogous to a two-stage nested design in the analysis of variance (ANOVA), [3] and considers the three-level hierarchical structure of a country: region-province-district as shown in Figure 1, and decomposes the overall regional inequality, as measured by a Theil index based on district-level mean incomes, into three components: the between-region, between-province, and within-province inequality

[1] For example, Akita (1988), Akita and Lukman (1995), Akita, Yue, and Kawamura (1999), Chen and Fleisher (1996), Daniere (1996), Das and Barua (1996), Esmara (1975), Gilbert and Goodman (1976), Green (1969), Jensen (1969), Mathur (1983), Mutlu (1991), Tabuchi (1988), Tsui (1991, 1993, 1996), Uppal and Budiono (1986), Wei and Ma (1996), Zheng (1997).

[2] For the one-stage decomposition of Theil indices, see, for example, Anand (1983).

components. It should be noted that the new method relies on per capita GDP to measure regional income inequality; thus it does not solve the intrinsic problem mentioned above. However, it uses districts as a basic regional unit to measure regional income inequality, rather than provinces, which most of the previous studies use, and thus can analyze the contribution of within-province inequalities as well as between-province and between-region inequalities to the overall regional income inequality in a coherent framework.

In this paper, I chose China and Indonesia as a case study, since in these two countries, district-level GDP and population data are available in some years, and their within-province inequalities seem to have been more prominent than between-province inequalities.

The paper is organized as follows. Next section presents the two-stage nested Theil decomposition method, while section 3 discusses the data used in the inequality decomposition analysis. Section 4 then applies the two-stage nested Theil decomposition method to district-level GDP and population data in China and Indonesia and explores the factors of regional income inequality. Finally, section 4 provides the summary of the findings and some policy implications.

2. Decomposition of Theil Inequality Indices: Two-Stage Nested Theil Decomposition Method

Theil inequality decomposition method is based on two Theil inequality indices (T and L). Theil indices are additively decomposable and satisfy several desirable properties as a measure of regional income inequality, i.e., mean independence, population-size independence, and the Pigou-Dalton principle of transfers (Bourguignon, 1979; Shorrocks,

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[3] For a two-stage nested design in ANOVA, see, for example, Montgomery (1984).

1980). An inequality index is said to be additively decomposable if total inequality can be written as the sum of between-group and within-group inequalities. Mean independence implies that the index remains unchanged if every region's income is changed by the same proportion, while population-size independence means that the index remains unchanged if the number of people in each region is changed by the same proportion, i.e., the index depends only on the relative population frequencies at each region, not the absolute population frequencies. Finally, the Pigou-Dalton principle of transfers implies that any income transfer from a richer to a poorer region that does not reverse their relative ranks in income reduces the value of the index.

This section first presents the ordinary one-stage Theil inequality decomposition method and then develops the two-stage nested Theil decomposition method as an extension of the one-stage Theil decomposition method. There are numerous studies that used the one-stage Theil decomposition method to analyze the factors of income inequality. But most studies applied the method to analyze inter-personal or inter-household income inequality.[4]

2.1. One-Stage Theil Decomposition Method

Consider the following hierarchical structure of a country: region-province. Using province as a basic regional unit, the overall regional income inequality can be measured by the following Theil index (Theil index T).

$$T_p = \sum_i \sum_j \left(\frac{Y_{ij}}{Y} \right) \log \left(\frac{Y_{ij} / Y}{N_{ij} / N} \right) \qquad (1)$$

[4] See, for example, Akita and Lukman (1999), Akita, Lukman, and Yamada (1999), Ching (1991), Estudillo (1997), Glewwe (1986), Ikemoto (1985), Jenkins (1995), Mookherjee and Shorrocks (1982), Tsakloglou (1993), and Tsui (1993).

where Y_{ij} is the income of province j in region i,

Y is the total income of all provinces $\left(= \sum_i \sum_j Y_{ij} \right)$,

N_{ij} is the population of province j in region i, and

N is the total population of all provinces $\left(= \sum_i \sum_j N_{ij} \right)$.

If we define T_{pi} as follows to measure between-province income inequality for region i,

$$T_{pi} = \sum_j \left(\frac{Y_{ij}}{Y_i} \right) \log \left(\frac{Y_{ij} / Y_i}{N_{ij} / N_i} \right) \qquad (2)$$

then Theil index T in equation (1) can be decomposed into

$$\begin{aligned} T_p &= \sum_i \left(\frac{Y_i}{Y} \right) T_{pi} + \sum_i \left(\frac{Y_i}{Y} \right) \log \left(\frac{Y_i / Y}{N_i / N} \right) \\ &= \sum_i \left(\frac{Y_i}{Y} \right) T_{pi} + T_{BR} \\ &= T_{WR} + T_{BR} \end{aligned} \qquad (3)$$

where Y_i is the total income of region i $\left(= \sum_j Y_{ij} \right)$,

N_i is the total population of region i $\left(= \sum_j N_{ij} \right)$, and

$T_{BR} = \sum_i \left(\frac{Y_i}{Y} \right) \log \left(\frac{Y_i / Y}{N_i / N} \right)$ measures income inequality between regions.

Equation (3) is the ordinary one-stage Theil inequality decomposition, in which the

overall income inequality T_p is the sum of the within-region component (T_{WR}) and the between-region component (T_{BR}), where the within-region component is a weighted average of between-province income inequalities for each region (T_{pi}).

The Theil index T_p as defined by equation (1) employs income shares as weights. Therefore, it is sensitive to changes in richer provinces. Another Theil index, Theil index L, which is defined as follows, uses population shares as weights, and thus sensitive to changes in poorer provinces.

$$L_p = \sum_i \sum_j \left(\frac{N_{ij}}{N} \right) \log \left(\frac{N_{ij}/N}{Y_{ij}/Y} \right) \tag{4}$$

Theil index L in equation (4) can also be decomposed into two components.

$$\begin{aligned} L_p &= \sum_i \left(\frac{N_i}{N} \right) L_{pi} + L_{BR} \\ &= L_{WR} + L_{BR} . \end{aligned}$$

2.2. Two-Stage Nested Theil Decomposition Method

Next, we consider the following hierarchical structure of a country: region-province-district. In this case, using districts as a basic regional unit, the overall regional income inequality can be measured by the following Theil index (Theil index T).

$$T_d = \sum_i \sum_j \sum_k \left(\frac{y_{ijk}}{Y} \right) \log \left(\frac{y_{ijk}/Y}{n_{ijk}/N} \right), \tag{5}$$

where y_{ijk} is the income of district k in province j in region i,

Y is the total income of all districts $\left(= \sum_i \sum_j \sum_k y_{ijk} \right)$,

n_{ijk} is the total population of district k in province j in region i, and

N is the total population of all districts $\left(= \sum_i \sum_j \sum_k n_{ijk} \right)$.

If we define T_{di} as follows to measure between-district income inequality for region i,

$$T_{di} = \sum_j \sum_k \left(\frac{y_{ijk}}{Y_i} \right) \log \left(\frac{y_{ijk} / Y_i}{n_{ijk} / N_i} \right), \tag{6}$$

then T_d in equation (5) will be decomposed into

$$\begin{aligned} T_d &= \sum_i \left(\frac{Y_i}{Y} \right) T_{di} + \sum_i \left(\frac{Y_i}{Y} \right) \log \left(\frac{Y_i / Y}{N_i / N} \right) \\ &= \sum_i \left(\frac{Y_i}{Y} \right) T_{di} + T_{BR} \end{aligned} \tag{7}$$

where Y_i is the total income of region i $\left(= \sum_j \sum_k y_{ijk} \right)$,

N_i is the total population of region i $\left(= \sum_j \sum_k n_{ijk} \right)$, and

$T_{BR} = \sum_i \left(\frac{Y_i}{Y} \right) \log \left(\frac{Y_i / Y}{N_i / N} \right)$ measures income inequality between regions.

Therefore, the overall regional income inequality T_d is the sum of the within-region component and the between-region component.

Next, if we define T_{ij} as follows to measure within-province income inequality for province j in region i,

$$T_{ij} = \sum_k \left(\frac{y_{ijk}}{Y_{ij}} \right) \log \left(\frac{y_{ijk} / Y_{ij}}{n_{ijk} / N_{ij}} \right)$$

then T_{di} in equation (6) can be further decomposed into

$$T_{di} = \sum_j \left(\frac{Y_{ij}}{Y_i} \right) T_{ij} + \sum_j \left(\frac{Y_{ij}}{Y_i} \right) \log \left(\frac{Y_{ij} / Y_i}{N_{ij} / N_i} \right) \qquad (8)$$

$$= \sum_j \left(\frac{Y_{ij}}{Y_i} \right) T_{ij} + T_{pi}$$

where Y_{ij} is the total income of province j in region i $\left(= \sum_k y_{ijk} \right)$,

N_{ij} is the total population of province j in region i $\left(= \sum_k n_{ijk} \right)$, and

$T_{pi} = \sum_j \left(\frac{Y_{ij}}{Y_i} \right) \log \left(\frac{Y_{ij} / Y_i}{N_{ij} / N_i} \right)$ measures income inequality between provinces in region i (same as equation (2)).

By substituting T_{di} in equation (8) into equation (7), we obtain

$$T_d = \sum_i \left(\frac{Y_i}{Y} \right) \left[\sum_j \left(\frac{Y_{ij}}{Y_i} \right) T_{ij} + T_{pi} \right] + T_{BR}$$

$$= \sum_i \sum_j \left(\frac{Y_{ij}}{Y} \right) T_{ij} + \sum_i \left(\frac{Y_i}{Y} \right) T_{pi} + T_{BR}$$

$$= T_{WP} + T_{BP} + T_{BR} \qquad (9)$$

Equation (9) is the two-stage Theil inequality decomposition equation, in which the overall regional income inequality is decomposed into the within-province component (T_{WP}), the between-province component (T_{BP}), and the between-region component (T_{BR}). The within-province component is a weighted average of within-province income inequalities (T_{ij}), while the between-province component is a weighted average of between-province income inequalities (T_{pi}). It should be noted that T_{BP} in equation (9) is

the same as T_{WR} in equation (3).

In the region-province-district framework, Theil index L is defined as:

$$L_d = \sum_i \sum_j \sum_k \left(\frac{n_{ijk}}{N} \right) \log \left(\frac{n_{ijk}/N}{y_{ijk}/Y} \right) \qquad (10)$$

Theil index L in equation (10) can also be decomposed into three components.

$$L_d = \sum_i \sum_j \left(\frac{N_{ij}}{N} \right) L_{ij} + \sum_i \left(\frac{N_i}{N} \right) L_{di} + L_{BR}$$

$$= L_{WP} + L_{BP} + L_{BR}$$

3. The Data

This section describes the data used in a one-stage decomposition analysis and a two-stage nested decomposition analysis in China and Indonesia.

3.1. China

A one-stage decomposition analysis for China uses provincial GDP and population data from *the China Statistical Yearbook* (State Statistical Bureau, various issues), whereas a two-stage nested decomposition analysis relies on district-level GDP and population data from various *Provincial Statistical Yearbooks* (Provincial Statistical Bureaus, various issues). The study period for the one-stage analysis is 1990-1997, but the two-stage analysis is conducted only for 1997 due to data limitation. It should be noted that regional income inequalities are measured by current price GDP data; thus care should be taken in analyzing the changes in regional income inequality over time.

China is divided into four regions: Western Region, Central Region, Eastern Region, and Northeastern Region. Western Region includes Sichuan, Guizhou, Yunnan, Shaanxi,

Gansu, Ningxia, Tibet, Qinghai, and Xinjian. Central Region includes Jiangxi, Shanxi, Anhui, Henan, Hunan, and Hubei. Eastern Region includes Fujian, Guangdong, Guangxi, Hainan, Zhejian, Jiangsu, Shanghai, Shandon, Hebei, Beijing, and Tianjin. Finally, Northeastern Region includes Heilongjiang, Jilin, Liaoning, and Neimonggu (Inner Mongolia).

In the Theil inequality decomposition analyses (both one-stage and two-stage analyses), Shanghai is merged to Jiangsu, Beijing and Tianjin are merged to Hebei, and Hainan is merged to Guangdong. Furthermore, in the two-stage nested Theil decomposition analysis, Gansu, Ningxia, and Tibet in Western Region are excluded due to the lack of district-level data on GDP.

3.2. Indonesia

A one-stage decomposition analysis for Indonesia uses provincial GDP and population data from the *Gross Regional Domestic Product of Provinces in Indonesia* (Central Bureau of Statistics, various issues), whereas a two-stage nested decomposition analysis employs district-level GDP and population data from the *Gross Regional Domestic Product of Regencies/Municipalities in Indonesia* (Central Bureau of Statistics, 1998). Provincial and district-level GDP figures are all at constant 1993 prices. The study period for the one-stage analysis is 1993-1997, but the two-stage analysis is conducted only for 1996.

In this study, Indonesia is divided into five regions: Sumatra, Java-Bali, Kalimantan, Sulawesi, and Others. Sumatra includes DI Aceh, North Sumatra, West Sumatra, Riau, Jambi, South Sumatra, Bengkulu, and Lampung. Java-Bali includes DKI Jakarta, West Java, Central Java, DI Yogyakarta, East Java, and Bali. Kalimantan includes West, Central, South, and East Kalimantans. Sulawesi includes North, Central, South, and Southeast Sulawesis. Finally, Others are West and East Nusatenggaras, East Timor, Maluku, and Irian Jaya.

Inequality figures obtained based on provincial income and population data are comparable with the sum of the between-province and between-region inequality components in the two-stage nested Theil decomposition analysis (compare equation (3) with equation (9) in the previous section).

4. Results: Decomposing Regional Income Inequality in China and Indonesia

This section applies the two-stage nested Theil decomposition method to district-level GDP and population data in China and Indonesia. However, as a prelude to the two-stage nested Theil decomposition analysis, it first presents the results of a one-stage Theil decomposition analysis based on province-level GDP and population data.

4.1. One-Stage Theil Inequality Decomposition Analysis

(a) China

Table 1 presents the result of the one-stage Theil decomposition analysis by Theil index T for China. It is apparent that the overall regional inequality as measured by provincial per capita GDP increased significantly from 0.057 in 1990 to 0.088 in 1994. But, after 1994, it became stable at around 0.085.

Decomposition of the overall regional inequality into the between-region and within-region components reveals that a significant increase in the overall regional income inequality between 1990 and 1994 is due wholly to a rise in the between-region component (from 0.035 to 0.064), since the within-region component was quite stable between 1990 and 1994 at 0.022-0.025. Thus, the percentage contribution of the between-region component increased from 61 percent in 1990 to 73 percent in 1994. In other words, income disparity

between four regions became more and more prominent in the overall regional inequality in provincial per capita GDP.

Between 1990 and 1997, Eastern Region had the largest per capita GDP, which was followed by Northeastern Region, Central Region, and Western Region. A large increase in the between-region inequality component between 1990 and 1994 was due to a relative decrease in the per capita GDP of Western, Central, and Northeastern Regions. It should be noted also that while Central Region recorded a rise in per capita GDP relative to Eastern Region after 1994, Northeastern Region experienced a further decrease in per capita GDP, signifying the so-called 'Northeast Phenomenon', which refers to the sluggish economic condition of northeastern provinces due to their high dependence on inefficient state-owned heavy industries.

Though the within-region component was found to be relatively stable between 1990 and 1997, each within-region inequality showed a distinct movement over the period. The within-region inequality of Eastern Region revealed a slight decreasing trend, indicating that economic activities gradually spread into the whole Eastern provinces as the regional economy develops under the reform and open-door policies, though the within-region inequality was still the highest in 1997 at 0.034.

Contrary to Eastern Region, the within-region inequality of Western Region exhibited an increasing trend. In 1990, it was only 0.014, but it gradually increased and became the second largest next to Eastern Region at 0.027 in 1997. On the other hand, the within-region inequality of Central Region was very stable and at a very low level (0.005-0.010), indicating that Central Region has managed a balanced regional economic growth even under the reform and open-door policies. Finally, the within-region inequality of Northeastern Region fluctuated at around 0.023-0.039. Until 1994 (with the exception of

1993), Northeastern Region had the second largest within-region inequality, but in 1995 Western Region replaced Northeastern Region.

(b) Indonesia

Tables 2 and 3 presents the result of the one-stage Theil decomposition analysis for Indonesia, with and without oil and gas sectors, respectively. Including oil and gas sectors, the overall regional inequality decreased from 0.181 in 1993 to 0.172 in 1997, while excluding oil and gas sectors, it increased slightly from 0.144 in 1993 to 0.149 in 1997. This reflects a declining importance of oil and gas sectors in regional economic development in Indonesia. The share of oil and gas sectors in total national GDP decreased from 10 percent in 1993 to 8 percent in 1997; oil and gas producing provinces of Aceh, Riau, and East Kalimantan showed either declining or slightly increasing per capita GDP at 1993 constant prices over the period (-1 to 2 percent), while Indonesia as a whole achieved a per capita GDP growth of more than 5 percent.

According to the one-stage decomposition analysis, the within-region component, as measured by the Theil index T, contributed more than 80 percent to the overall regional inequality, whether including or excluding oil and gas sectors. This contrasts significantly with China's value of 27 percent (see Table 1). When excluding oil and gas sectors, Indonesia's between-region inequality was 0.017 in 1997, much smaller than China's counterpart (0.062), whereas its within-region inequality component amounted to 0.132 in 1997, which was six times as large as China's within-region component (0.023). Table 3 shows also that Indonesia's relatively large within-region component is owing mainly to a very large within-region inequality registered by Java-Bali region (0.172), which is, in turn, due to Jakarta's very large per capita GDP (about 7 million Rupiah in 1997 at 1993 constant prices) relative to the other provinces in Java-Bali region (around 1.5-2.5 million Rupiah).

Java-Bali's within-region inequality, in fact, accounted for 75 percent of the overall regional inequality in provincial GDP.

When excluding oil and gas sectors, Kalimantan showed a downward trend in within-region inequality during 1993-1997 (from 0.085 to 0.069), while the other regions exhibited an upward trend. A much slower growth in per capita GDP by East Kalimantan, the richest province in Kalimantan, than the other Kalimantan provinces seems to have contributed to this downward trend. Contrary to Kalimantan, Sumatra increased its within-region inequality significantly over the period (from 0.024 to 0.032). This seems to be attributable to a much higher per capita GDP growth by North Sumatra, the richest province in Sumatra when excluding oil and gas, than the other Sumatra provinces. Finally, while Sulawesi's within-region inequality exhibited a slight increasing trend, it remained at a very low level (0.005 in 1997), indicating Sulawesi's balanced regional development based on the agricultural sector, which accounts for more than 30 percent of total GDP in Sulawesi.

4.2. Two-Stage Nested Theil Inequality Decomposition Analysis

(a) China

Table 4 presents the result of the two-stage nested decomposition analysis for China in 1997. Since the two-stage decomposition analysis uses district-level data from various *Provincial Statistical Yearbooks*, provincial per capita GDP figures in Table 4 are different from provincial per capita GDP figures from the *Chinese Statistical Yearbook*, which are used in the one-stage decomposition analysis. In general, provincial per capita GDP figures based on district-level data are larger than those from the *Chinese Statistical Yearbook*. It should be reminded that the two-stage Theil decomposition analysis excludes the three poor provinces of Tibet, Gansu, and Ningxia in Western Region due to the lack of district-level

GDP data. Thus, the two-stage Theil decomposition analysis provides a smaller between-province inequality for Western Region than the one-stage decomposition analysis.[5]

According to the two-stage decomposition analysis, the overall regional income inequality was 0.238 as measured by the Theil index T and 0.216 by the Theil index L. Decomposition of the overall regional inequality into the within-province, between-province, and between-region components by the Theil index T shows, however, that 64 percent of the overall inequality was due to the within-province component (a weighted average of within-province inequalities for each province). The between-province and between-region components accounted for, respectively, 11 and 25 percent of the overall inequality.

Between-Region Inequality

It is said that the reform and open-door policies favoring coastal eastern provinces have facilitated income disparity between coastal and inland areas. According to Table 4, there is, in fact, a large disparity in per capita GDP between four regions. Especially, the per capita GDP of Eastern Region was 2.4 times as much as that of Western Region (9,338 yuan against 3,919 yuan). However, the two-stage decomposition analysis shows that the within-region component (i.e., the sum of the within-province and between-province components) was much more significant than the between-region component, accounting for about 75 percent (= 64 + 11) of the overall regional inequality.

Between-Province Inequalities

Among four regions, Eastern Region had the largest between-province inequality in

[5] The within-region component in the one-stage Theil decompostion analysis is comparable with the between-province component in the two-stage decomposition analysis.

per capita GDP (0.030 by Theil T), accounting for 7 percent of the overall regional inequality, and it was followed by Northeastern Region (0.026), Western Region (0.024), and Central Region (0.019). If we compare the two-stage decomposition result (Table 4) with the one-stage decomposition result (Table 1), Central Region had a much larger between-province inequality in the two-stage decomposition analysis (0.019 vs. 0.006). This seems to be due to a much larger per capita GDP registered by Hubei in the two-stage decomposition analysis.

Within-Province Inequalities

Among Western provinces, Qinghai had the largest within-province inequality (0.327) as measured by the Theil index T, which was followed by Yunnan (0.324), Xinjiang (0.267), and Sichuan (0.160). It is interesting to note that in Western Region, large inequality provinces were not necessarily large per capita GDP provinces.

Provinces in Central Region were much more equitable than provinces in Western Region. According to the Theil index T, Shanxi had the largest within-province inequality in Central Region (0.093), but the figure is smaller than the smallest within-province inequality in Western Region, which was recorded by Shaanxi (0.113). This suggests that Central Region has so far achieved a very balanced regional development, not only across provinces but also within provinces.

There is a large variation in within-province inequalities in Eastern Region. Guangdong registered the largest within-province inequality at 0.399 as measured by the Theil index T, accounting for 18 percent of the overall regional inequality, and it was followed by Jiangsu (0.215), accounting for 12 percent, Shandong (0.133), and Fujian (0.105). Guangdong, in fact, had the largest within-province inequality in China. On the other hand, the smallest within-province inequality was recorded by Zhejiang at 0.057,

among the smallest in China. These observations suggest that each province in Eastern Region has had a distinct pattern of provincial economic development under the reform and open-door policies. At the district level in Guangdong, the largest per capita GDP was 103,200 yuan, which was more than 40 times as much as the smallest in the province (2,500 yuan). In Jiangsu, the ratio between the largest (i.e., Shanghai) and the smallest per capita GDP was 8.7 (25,700 against 3,000 yuan). On the other hand, in Zhejiang, the ratio between the largest and the smallest was 3.7 (17,000 against 4,600 yuan). It should be noted that together with the region's between-province inequality, Eastern Region contributed to about a half of the overall regional inequality.

Among provinces in Northeastern Region, Heilongjinag had the highest within-province inequality at 0.148 as measured by the Theil index T, which was followed by Liaoning (0.136), Neimonggu (0.092), and Jilin (0.039). However, according to the Theil index L, Liaoning was the largest inequality province, and Heilongjiang followed next. This comes from the fact that larger per capita GDP districts tended to have larger GDP shares in Heilongjiang *vis-a-vis* Liaoning.

(b) Indonesia

Tables 5 and 6 presents the results of the two-stage nested decomposition analysis for Indonesia in 1996, with or without oil and gas sectors, respectively. Since the two-stage decomposition analysis uses district-level data from the *Gross Regional Domestic Product of Regencies/Municipalities in Indonesia*, provincial GDP figures in Tables 5 and 6 are different from provincial GDP figures from the *Gross Regional Domestic Product of Provinces in Indonesia* used in the one-stage decomposition analysis; thus, estimates of between-region and between-province inequalities in Tables 5 and 6 are different from their counterparts in Tables 2 and 3.

Since oil and gas sectors' direct contribution to regional welfare is very small as most of benefits derived from oil and gas sectors go to the central government, in this section I will focus on an analysis of the result based on per capita GDP excluding oil and gas sectors. Unless noted otherwise, I will explain the result based on the Theil index T. The conclusion will not be changed very much if the Theil index L is used.

The overall regional inequality as measured by the Theil index T in per capita GDP with and without oil and gas sectors was 0.345 and 0.281, respectively. When excluding oil and gas sectors, the within-province component accounted for 48.4 percent of the overall regional inequality in district-level per capita GDP, whereas the between-province and between-region inequality components, respectively, contributed to 44.2 and 7.4 percent of the overall regional inequality.

Between-Region Inequality

Reducing income disparities between rich western and poor eastern regions has been one of the main policy issues in Indonesia. It is true that even if oil and gas sectors are excluded, the highest per capita GDP, registered by Kalimantan, was 2.6 times as large as the lowest by Others, which include Nusatenggara provinces, Maluku, and Irian Jaya (2.6 against 1.0 million Rupiah).[6] According to Table 6, however, the between-region inequality was only 0.021, accounting for merely 7.4 percent of the overall regional inequality. Java-Bali region registered the second largest per capita GDP at 2.1 million Rupiah, but this is due mostly to the existence of Jakarta, the richest province.

[6] Per capita GDP figures are all at constant 1993 prices, hereafter.

Between-Province Inequalities

Among five regions, Java-Bali had the largest between-province inequality (0.169 by Theil T), accounting for 40 percent of the overall regional inequality, and it was followed by Kalimantan (0.070), Others (0.049), Sumatra (0.028), and Sulawesi (0.006). Java-Bali's very large between-province inequality is owing to Jakarta's primacy in per capita GDP. Jakarta's per capita GDP (7.1 million Rupiah) was more than 5 times as large as the smallest given by Central Java (1.3 million Rupiah).

Within-Province Inequalities

Within Sumatra, Riau had the largest within-province inequality at 0.274 as measured by the Theil index T, which was followed by West Sumatra (0.087), and Lampung (0.06). The main reason why Riau had a very high inequality is the existence of Batam island, which is located just 20 km southeast of Singapore and has received special treatment from the central government as an export-oriented industrial zone. Batam's per capita GDP of 11 million Rupiah far exceeded other districts' per capita GDP excluding oil and gas in Riau. Except Riau, however, Sumatra provinces had relatively low within-province inequalities (0.014-0.087).

Among Java-Bali provinces, East Java had the largest within-province inequality at 0.358, accounting for 20.6 percent of the overall regional inequality in district per capita GDP. East Java's very high inequality is due to the existence of a few very rich districts: urban Kediri, urban Surabaya, and Gresik. Though its population size is not large, urban Kediri's per capita GDP was 20 million Rupiah, which was larger than Central Jakarta's per capita GDP (16 million Rupiah) and in fact, the largest per capita GDP in Indonesia. Surabaya and Gresik had per capita GDP of 5.4 and 3.6 million Rupiah, respectively.

Within Java-Bali, the second largest within-province inequality was registered by Central Java (0.186), in which Kudus and urban Semarang had relatively large per capita GDP (5.1 and 3.9 million Rupiah, respectively). West Java had the third largest inequality at 0.101, but it was much smaller than Central Java and East Java. This comes from the fact that unlike Central Java and East Java, which include, respectively, the primary cities of Semarang and Surabaya, West Java districts are very uniformly developed and does not include any dominant cities. In West Java, urban Tangerang had the largest per capita GDP of 4.8 million Rupiah, and urban Bandung followed this at 4 million Rupiah. In other districts, per capita GDP ranges from 1.0 to 3.5 million Rupiah. It should be noted that West Java does not include the adjacent dominant city of Jakarta.

Among Kalimantan provinces, West Kalimantan registered the highest within-province inequality at 0.105, where urban Pontianak had the largest per capita GDP of 4 million Rupiah. It is interesting to observe that while East Kalimantan had a very large per capita GDP (4.4 million Rupiah excluding oil and gas sectors), its within-province inequality is one of the smallest in Indonesia when oil and gas sectors are excluded.

Within Sulawesi, South Sulawesi had the highest within-province inequality at 0.072 due to the existence of Ujung Pandang, whose per capita GDP was 2.3 million Rupiah. Sulawesi, however, had a very equitable distribution of income not only across provinces but also within provinces. Finally, within Others, Irian Jaya had the largest within-province inequality at 0.106, where Jaya Pura had the largest per capita GDP (2.7 million Rupiah).

In order to see how the distribution of GDP within each province compares to the distribution of household expenditure within each province, Figure 2 plots the relationship between within-province inequalities in per capita GDP estimated by this study (on the vertical axis) and within-province inequalities in household expenditure estimated by Akita

and Szeto (2000) based on the 1996 National Socio-Economic Survey (on the horizontal axis). No significant relationship exists between them, as the simple correlation coefficient is only 0.21. In general, inequalities based on per capita GDP are much smaller than inequalities based on household expenditures, indicating that large inequalities still exist between households within each district.

5. Conclusion

The paper presented an inequality decomposition method, the two-stage nested Theil inequality decomposition method, as an extension of the ordinary one-stage Theil inequality decomposition method. The method uses districts as a basic regional unit, rather than provinces, to measure regional inequality in per capita GDP; thus, it can analyze within-province inequalities as well as between-region and between-province inequalities in a coherent framework. Though the method cannot solve the intrinsic problem that the measure of regional inequality based on per capita GDP fails to explain the dispersion of incomes within basic regional units, it provides a better picture of regional inequalities within a country, especially in such large, developing countries as China and Indonesia.

With the unequal distribution of natural resources and transportation facilities, some regional income disparities are inevitable from the efficiency point of view. China and Indonesia are still at a relatively early stage of economic development, and thus income-enhancing economic activities tended to have concentrated in a few districts in each province to enjoy agglomeration economies. The result of this study shows, in fact, that a very large regional income inequality still exists among the districts of China and Indonesia.

Applying the two-stage nested decomposition method to district-level GDP and population data reveals that in China, the within-province component accounted for 64 percent of the overall regional inequality, while in Indonesia, it accounted for about a half of

the overall regional inequality; that is, within-province inequalities are much more significant than between-region and between-province inequalities, at least in these two big countries. These observations suggest that policy makers should look not only at between-region or between-province inequalities, but also within-province inequalities to formulate better policies to reduce regional income inequality.

Table 1

One-Stage Inequality Decomposition by Theil Index T for China 1990 - 1997

Regions	1990	1991	1992	1993	1994	1995	1996	1997
Western Region	0.014	0.017	0.019	0.022	0.026	0.027	0.025	0.027
Central Region	0.008	0.010	0.008	0.008	0.006	0.005	0.005	0.006
Eastern Region	0.037	0.036	0.040	0.037	0.034	0.032	0.032	0.034
Northeastern Region	0.024	0.025	0.027	0.039	0.033	0.026	0.023	0.024
Within-Region	0.022	0.023	0.025	0.025	0.024	0.023	0.022	0.023
(% Contribution to Total)	(38.6)	(35.9)	(33.3)	(29.8)	(27.3)	(26.7)	(26.5)	(27.1)
Between-Region	0.035	0.041	0.050	0.059	0.064	0.063	0.061	0.062
(% Contribution to Total)	(61.4)	(64.1)	(66.7)	(70.2)	(72.7)	(73.3)	(73.5)	(72.9)
Total	0.057	0.064	0.075	0.084	0.088	0.086	0.083	0.085

Table 2

One-Stage Inequality Decomposition by Theil T for Indonesia Including Oil and Gas 1993 - 1997

Regions	1993	1994	1995	1996	1997
Sumatra	0.138	0.127	0.118	0.107	0.106
Java-Bali	0.157	0.159	0.161	0.161	0.162
Kalimantan	0.278	0.276	0.253	0.239	0.225
Sulawesi	0.002	0.003	0.003	0.004	0.005
Others	0.175	0.170	0.195	0.204	0.199
Within-Region	0.158	0.156	0.154	0.152	0.151
(% Contribution to Total)	(87.3)	(87.2)	(87.5)	(87.9)	(87.8)
Between-Region	0.023	0.023	0.022	0.021	0.021
(% Contribution to Total)	(12.7)	(12.8)	(12.5)	(12.1)	(12.2)
Total	0.181	0.179	0.176	0.173	0.172

Table 3

One-Stage Inequality Decomposition by Theil T for Indonesia Excluding Oil and Gas 1993 - 1997

Regions	1993	1994	1995	1996	1997
Sumatra	0.024	0.026	0.028	0.027	0.032
Java-Bali	0.169	0.169	0.170	0.171	0.172
Kalimantan	0.085	0.076	0.077	0.073	0.069
Sulawesi	0.002	0.003	0.003	0.004	0.005
Others	0.161	0.153	0.183	0.194	0.188
Within-Region	0.129	0.128	0.131	0.131	0.132
(% Contribution to Total)	(89.6)	(88.9)	(89.7)	(89.1)	(88.6)
Between-Region	0.015	0.016	0.015	0.016	0.017
(% Contribution to Total)	(10.4)	(11.1)	(10.3)	(10.9)	(11.4)
Total	0.144	0.144	0.146	0.147	0.149

Table 4

Two-Stage Nested Inequality Decomposition for China in 1997

Regions Provinces [a]	Theil T	Contrib. to Total[b]	Theil L	Contrib. to Total[b]	GDP Share	Population Share	Per Capita GDP (in yuan)
Western Region (80)	0.024	1.1%	0.026	2.3%	11.1%	19.0%	3,919
1 Sichuan (10)	0.160	2.9%	0.142	4.8%	4.4%	7.2%	4,084
2 Guizhou (8)	0.124	0.6%	0.107	1.6%	1.1%	3.1%	2,325
3 Yunnan (16)	0.324	3.0%	0.278	4.4%	2.2%	3.4%	4,236
4 Shaanxi (20)	0.113	0.8%	0.112	1.6%	1.8%	3.0%	3,916
5 Qinghai (9)	0.327	0.3%	0.255	0.5%	0.2%	0.4%	3,609
6 Xinjiang (17)	0.267	1.7%	0.236	2.0%	1.5%	1.8%	5,516
Central Region (87)	0.019	1.8%	0.017	2.5%	22.3%	30.4%	4,926
1 Jiangxi (11)	0.090	0.8%	0.078	1.3%	2.0%	3.6%	3,783
2 Shanxi (11)	0.093	0.8%	0.087	1.1%	1.9%	2.7%	4,807
3 Anhui (16)	0.048	0.8%	0.045	1.1%	3.8%	5.3%	4,744
4 Henan (18)	0.072	1.6%	0.068	2.6%	5.4%	8.1%	4,476
5 Hunan (14)	0.056	0.9%	0.054	1.4%	3.9%	5.6%	4,627
6 Hubei (17)	0.092	2.1%	0.093	2.2%	5.3%	5.1%	7,035
Eastern Region (101)	0.030	7.0%	0.033	6.2%	55.2%	39.7%	9,338
1 Fujian (9)	0.105	1.8%	0.095	1.2%	4.1%	2.8%	9,686
2 Guangdong (22)	0.399	18.0%	0.321	10.0%	10.7%	6.7%	10,673
3 Guangxi (15)	0.076	0.9%	0.074	1.4%	2.8%	4.0%	4,661
4 Zhejiang (11)	0.057	1.6%	0.063	1.1%	6.7%	3.8%	11,660
5 Jiangsu (14)	0.215	11.5%	0.230	7.6%	12.7%	7.2%	11,906
6 Shandong (17)	0.133	4.9%	0.139	4.9%	8.8%	7.7%	7,753
7 Hebei (13)	0.098	3.9%	0.098	3.4%	9.5%	7.5%	8,470
Northeastern Region (48)	0.026	1.3%	0.027	1.4%	11.4%	11.0%	7,010
1 Heilongjiang (13)	0.148	2.1%	0.115	1.7%	3.4%	3.2%	7,177
2 Jilin (9)	0.039	0.3%	0.040	0.4%	1.9%	2.3%	5,755
3 Liaoning (14)	0.136	2.7%	0.153	2.5%	4.7%	3.5%	8,959
4 Neimonggu (12)	0.092	0.5%	0.090	0.8%	1.4%	2.0%	4,697
Within-Province	0.153	64.3%	0.128	59.6%			
Between-Province	0.026	11.1%	0.027	12.3%			
Between-Region	0.059	24.5%	0.061	28.1%			
Total (316)	0.238	100.0%	0.216	100.0%	100.0%	100.0%	6,715

(Note) (a) Number in the parentheses are the number of districts.

(b) Contribution to the overall regional inequality (in %).

Table 5
Two-Stage Nested Inequality Decomposition for Indonesia in 1996 Including Oil and Gas

Regions Provinces [a]	Theil T	Contrib. to Total[b]	Theil L	Contrib. to Total[b]	GDP Share	Population Share	Per Capita GDP[c] (in 1000 Rp)
Sumatra (73)	0.110	6.8%	0.102	7.7%	21.4%	21.1%	2,097.6
1 DI Aceh (10)	0.310	2.5%	0.293	2.1%	2.8%	2.0%	2,909.3
2 North Sumatra (17)	0.036	0.6%	0.037	0.8%	5.8%	5.7%	2,092.6
3 West Sumatra (14)	0.087	0.5%	0.081	0.7%	1.9%	2.2%	1,743.2
4 Riau (7)	0.346	4.9%	0.415	3.1%	4.9%	2.1%	4,937.5
5 Jambi (6)	0.038	0.1%	0.038	0.2%	0.8%	1.2%	1,293.0
6 South Sumatra (10)	0.052	0.5%	0.052	0.7%	3.2%	3.7%	1,756.1
7 Bengkulu (4)	0.014	0.0%	0.015	0.0%	0.4%	0.7%	1,226.6
8 Lampung (5)	0.060	0.3%	0.052	0.7%	1.7%	3.4%	1,021.2
Java-Bali (116)	0.159	28.3%	0.119	25.7%	61.3%	60.2%	2,108.2
1 DKI Jakarta (5)	0.089	4.2%	0.077	1.3%	16.1%	4.7%	7,062.9
2 West Java (25)	0.104	5.3%	0.098	7.1%	17.7%	20.2%	1,807.0
3 Central Java (35)	0.214	6.2%	0.181	9.8%	10.0%	15.1%	1,369.2
4 D I Yogyakarta (5)	0.064	0.2%	0.057	0.3%	1.3%	1.5%	1,753.8
5 East Java (37)	0.358	15.1%	0.266	16.4%	14.6%	17.2%	1,752.5
6 Bali (9)	0.097	0.5%	0.087	0.5%	1.8%	1.5%	2,466.7
Kalimantan (29)	0.251	6.7%	0.226	4.4%	9.2%	5.5%	3,483.9
1 West Kalimantan (7)	0.105	0.5%	0.099	0.7%	1.7%	1.9%	1,851.4
2 Central Kalimantan (6)	0.038	0.1%	0.038	0.1%	1.0%	0.9%	2,378.1
3 South Kalimantan (10)	0.053	0.2%	0.054	0.3%	1.5%	1.5%	2,020.4
4 East Kalimantan (6)	0.155	2.3%	0.172	0.8%	5.1%	1.2%	8,542.4
Sulawesi (38)	0.006	0.1%	0.006	0.2%	4.2%	7.1%	1,219.3
1 North Sulawesi (7)	0.038	0.1%	0.036	0.2%	0.9%	1.4%	1,410.9
2 Central Sulawesi (4)	0.001	0.0%	0.001	0.0%	0.5%	1.0%	1,108.0
3 South Sulawesi (23)	0.072	0.5%	0.067	0.9%	2.3%	3.9%	1,238.8
4 Southeast Sulawesi (4)	0.011	0.0%	0.010	0.0%	0.4%	0.8%	949.9
Others (47)	0.202	2.3%	0.177	4.0%	4.0%	6.2%	1,324.1
1 West Nusatenggara (7)	0.023	0.1%	0.023	0.2%	0.8%	1.9%	861.8
2 East Nusatenggara (12)	0.063	0.1%	0.059	0.4%	0.7%	1.8%	738.7
3 East Timor (13)	0.077	0.0%	0.073	0.1%	0.2%	0.4%	766.5
4 Maluku (5)	0.053	0.1%	0.047	0.2%	0.7%	1.1%	1,386.7
5 Irian Jaya (10)	0.941	4.6%	0.688	2.5%	1.7%	1.0%	3,397.8
Within-Province	0.171	49.4%	0.139	49.9%			
Between-Province	0.152	44.1%	0.117	42.0%			
Between-Region	0.022	6.5%	0.023	8.2%			
Total (303)	0.345	100.0%	0.278	100.0%	100.0%	100.0%	2,069.2

(Note) (a) Number in the parentheses are the number of districts (i.e., the number of Kabupatens and Kotamadyas).

(b) Contribution to the overall regional inequality (in %).

(c) Per capita GDP figures are at constant 1993 prices.

Table 6
Two-Stage Nested Inequality Decomposition for Indonesia in 1996 Excluding Oil and Gas

Regions Provinces [a]	Theil T	Contrib. to Total[b]	Theil L	Contrib. to Total[b]	GDP Share	Population Share	Per Capita GDP[c] (in 1000 Rp)
Sumatra (73)	0.028	1.8%	0.029	2.7%	18.3%	21.1%	1,626.9
1 DI Aceh (10)	0.019	0.1%	0.019	0.2%	1.7%	2.0%	1,575.1
2 North Sumatra (17)	0.037	0.8%	0.037	0.9%	6.3%	5.7%	2,053.6
3 West Sumatra (14)	0.087	0.6%	0.081	0.8%	2.1%	2.2%	1,743.2
4 Riau (7)	0.274	2.1%	0.177	1.6%	2.2%	2.1%	1,990.7
5 Jambi (6)	0.037	0.1%	0.037	0.2%	0.8%	1.2%	1,253.6
6 South Sumatra (10)	0.034	0.4%	0.034	0.6%	3.0%	3.7%	1,494.7
7 Bengkulu (4)	0.014	0.0%	0.015	0.1%	0.5%	0.7%	1,226.6
8 Lampung (5)	0.060	0.4%	0.052	0.8%	1.9%	3.4%	1,021.2
Java-Bali (116)	0.169	39.9%	0.126	33.4%	66.2%	60.2%	2,063.0
1 DKI Jakarta (5)	0.089	5.6%	0.077	1.6%	17.8%	4.7%	7,062.9
2 West Java (25)	0.101	6.7%	0.092	8.2%	18.6%	20.2%	1,724.6
3 Central Java (35)	0.186	7.0%	0.155	10.3%	10.5%	15.1%	1,300.9
4 D I Yogyakarta (5)	0.064	0.3%	0.057	0.4%	1.4%	1.5%	1,753.8
5 East Java (37)	0.358	20.6%	0.266	20.2%	16.1%	17.2%	1,751.3
6 Bali (9)	0.097	0.7%	0.087	0.6%	1.9%	1.5%	2,466.7
Kalimantan (29)	0.070	1.9%	0.064	1.6%	7.4%	5.5%	2,553.2
1 West Kalimantan (7)	0.105	0.7%	0.099	0.8%	1.9%	1.9%	1,851.4
2 Central Kalimantan (6)	0.038	0.2%	0.038	0.1%	1.1%	0.9%	2,378.1
3 South Kalimantan (10)	0.054	0.3%	0.055	0.4%	1.6%	1.5%	2,011.3
4 East Kalimantan (6)	0.026	0.3%	0.027	0.2%	2.9%	1.2%	4,413.0
Sulawesi (38)	0.006	0.1%	0.006	0.2%	4.6%	7.1%	1,219.3
1 North Sulawesi (7)	0.038	0.1%	0.036	0.2%	1.0%	1.4%	1,410.9
2 Central Sulawesi (4)	0.001	0.0%	0.001	0.0%	0.6%	1.0%	1,108.0
3 South Sulawesi (23)	0.072	0.7%	0.067	1.2%	2.6%	3.9%	1,238.8
4 Southeast Sulawesi (4)	0.011	0.0%	0.010	0.0%	0.4%	0.8%	949.9
Others (47)	0.049	0.6%	0.048	1.3%	3.4%	6.2%	1,026.5
1 West Nusatenggara (7)	0.023	0.1%	0.023	0.2%	0.9%	1.9%	861.8
2 East Nusatenggara (12)	0.063	0.2%	0.059	0.5%	0.7%	1.8%	738.7
3 East Timor (13)	0.077	0.1%	0.073	0.1%	0.2%	0.4%	766.5
4 Maluku (5)	0.055	0.2%	0.048	0.2%	0.8%	1.1%	1,379.7
5 Irian Jaya (10)	0.106	0.3%	0.125	0.6%	0.9%	1.0%	1,583.3
Within-Province	0.136	48.4%	0.115	50.8%			
Between-Province	0.124	44.2%	0.089	39.2%			
Between-Region	0.021	7.4%	0.023	10.1%			
Total (303)	0.281	100.0%	0.227	100.0%	100.0%	100.0%	1,873.4

(Note) (a) Number in the parentheses are the number of districts (i.e., the number of Kabupatens and Kotamadyas).
(b) Contribution to the overall regional inequality (in %).
(c) Per capita GDP figures are at constant 1993 prices.

Figure 1
Three-Level Hierarchical Structure
Region-Province-District

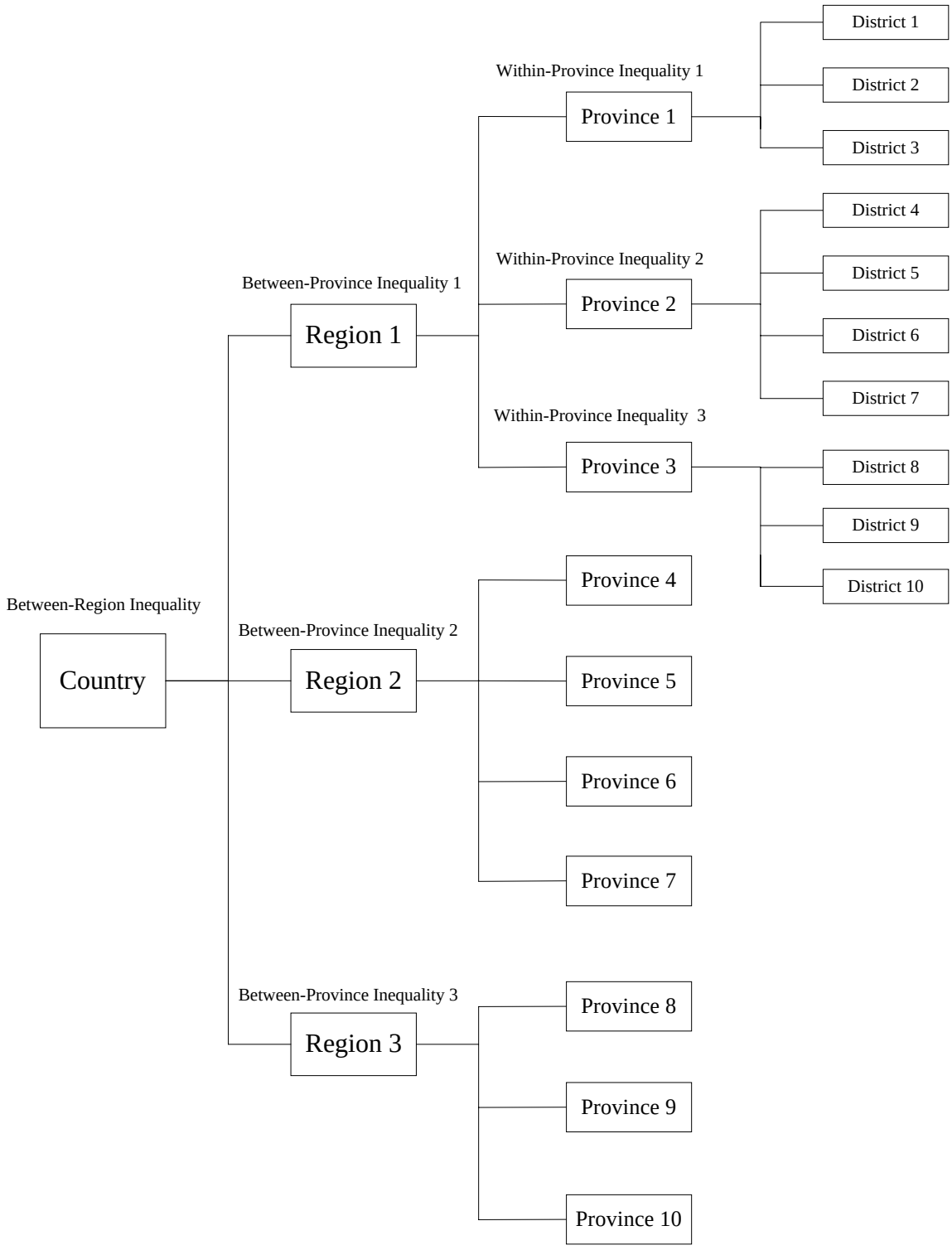
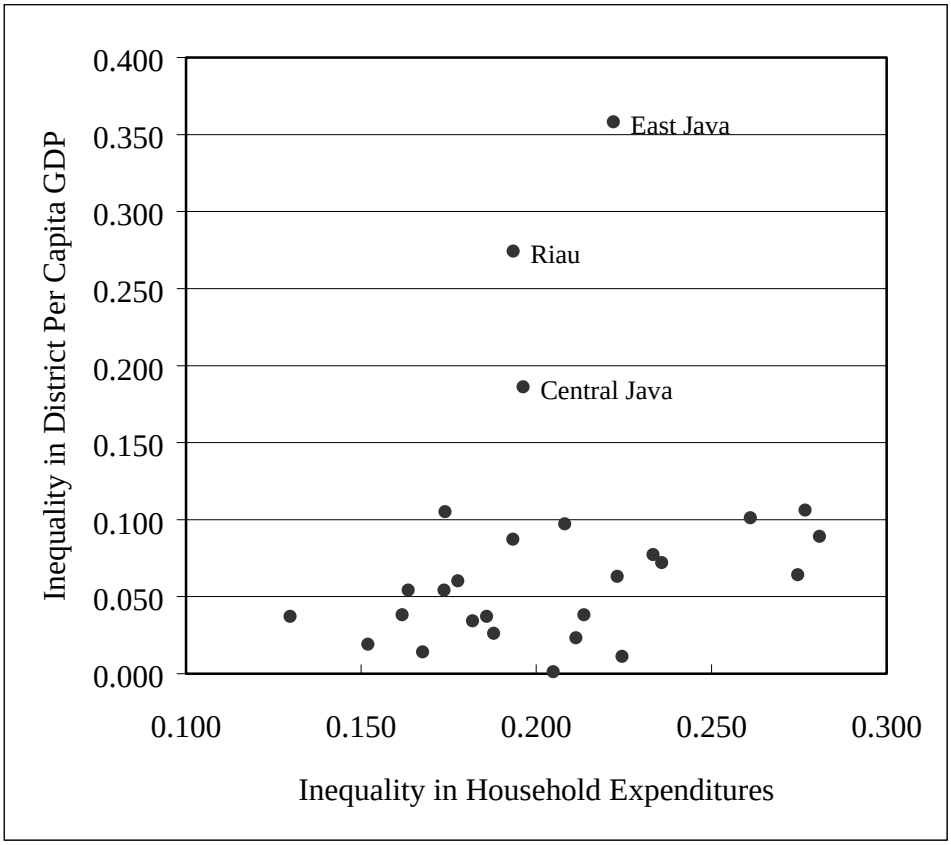


Figure 2

Inequalities in Per Capita GDP and Household Expenditure within Each Province



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