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The mode-based decomposition into the growth and distribution effects for segments of poor

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Abstract

This study proposes the mode-based decomposition approach to better examine the change of the wealth of more impoverished populations into growth and distribution effects. Given Gibrat's law, the decomposition first approximates the income distribution to the lognormal distribution from the household sample surveys applying the maximum likelihood estimation. Then, it performs the residual-free and the time-reversion consistent decomposition into growth and distribution effects for the segments of poor. The case study focuses the post *Doi Moi*, 1993-2014, where historical reduction of poverty happened. The results indicate that the distribution effect adversely affects the bottom 10 and 20 percent of the population, unlike the growth effect that mostly induced the decrease of poor. Inducing growth that targets the mean or per capita income increase are good for the poor on average. Still, it could fail to capture the sensitive change of the lower segments, which is particularly vulnerable to shocks and fluctuations of business cycle.

Keywords: Growth and distribution effects of the lower income segments, Mode-based decomposition method, Gibrat's law, Lognormal distribution, Shapley value decomposition, Structural change, Patterns of development, Historic reduction of poor, Shocks and vulnerability, Business cycles, Socialist institutions and their transitions

JEL classification: C18, D31, O11, P41

1. Introduction

Policymakers have argued a recurring issue of the development arena if the main focus of poverty reduction policies should prioritize pro economic growth in a country or pro (re)distribution to the poor amid maintaining political stability. International communities may see poverty as an old issue under control with the success of millennium development goal 1.a—halving extreme poverty from the 1990 level—which was accomplished in 2010. However, it would be plausible that the reversal of all the progress and achievements due to the ongoing coronavirus pandemic has brought poverty and equity issues to come front again. Kanbur (2000) has argued that the views on the trade off between economic growth and disparity have shifted from pro growth (Rosenstein-Rodan, 1943; Lewis, 1954; Kuznets, 1955) to a more balanced view, stressing both importance and inter dependence. Given the limited fiscal space and insufficient social expenditures most countries have faced, the finance authorities and development communities, have favoured pro growth (or pro poor growth) macroeconomic policies to reduce poverty and the welfare for the lower income segments. Empirical evidence has also endorsed the rationale of pro growth policies as they have turned out to be pro poor on average based on cross country exercises (e.g., de Janvry and Sadoulet, 2000; Dollar and Kraay, 2002; Dollar et al., 2016). Simultaneously, the growth elasticity of poverty has been negligible in some cases cross and within country spatial heterogeneity behind, indicating growth does not necessarily reach to poor and understanding the causes of that heterogeneity is critical for designing welfare for the poor. Also, it is weighty to note that the distribution elasticity of poverty has been less discussed than the growth. A part of this reason would be that policymakers and economist regard the

distribution elasticity of poverty (e.g., explicitly through social spending) as much smaller than that of the growth. Reinforcing a national redistribution system as a tangible example through a series of capacity building (e.g., tax administrations and social security) is in fact costly and time consuming to realize.

Past studies explore the heterogeneity of the growth or distribution elasticity of poverty in the 1980-the 90s (e.g., Datt and Ravallion, 1992; Grootaert, 1995; Sahn and Stifel, 2000)[1]. These studies helped provide country level diagnostics in monitoring poverty reduction progress in conjunction with growth and distribution. However, some methodological challenges remain, that is, the welfare dynamics is not accurately separable into either growth component or distribution component as it adds a residual term in its functional form. In similar timing to these studies, the residual-free decomposition appears by considering the welfare dynamics sequentially (Kakwani and Subbarao, 1990; Kakwani, 1993; and Jain Tendulkar, 1990): the first two studies assume that growth takes place first, then distribution follows, and the latter study assumes the reverse. After that, it incorporates the Shapley solution in cooperative games that allow all the possible sequences and then calculates the marginal contribution of each component, which satisfy the time-reversion consistency (Kolenikov and Shorrocks, 2005; and Shorrocks, 2013).[2]

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1 The studies are restricted to countries and region as such Côte d'Ivoire, India, and Indonesia.

2 The first draft of Shorrocks (2013) is in 1999. Its empirical investigation based on Russian data by Kolenikov and Shorrocks (2005) was published earlier than the original work.

In this strand of literature, our study decomposes it explicitly into growth and distribution effects, that is the residual-free decomposition as the welfare dynamics of lower segments is separable into each effect, and incorporates Shapley solution that satisfies time reversion consistency.[3] Besides, our study newly decomposes it based on the mode of income distribution rather than the mean to capture the sensitive income change of the poor that situates under the average. In statistical distribution, the mode is the value that appears most frequently in a set of data (mass population in a distribution)—suppose $\boldsymbol{X}$ is a vector of a discrete random variable, the mode is the value x that probability mass function holds the maximum value. Given the Gibrat's law that indicates income distribution follows the right skewed lognormal distribution (Gibrat, 1931), the inequality relationship, $mode < median < mean$, holds in equation 1 where μ is equal to mean and σ is standard deviation (SD). In lognormal distribution, the mode is smaller than the mean and it is regarded the shape fits to the lower income segments of the distribution.

$$\exp(\mu - \sigma^2) < \exp(\mu) < \exp\left(\mu + \frac{\sigma^2}{2}\right) \quad \text{where}$$

$$mode: \exp(\mu - \sigma^2), \qquad median: \exp(\mu), \qquad mean: \exp\left(\mu + \frac{\sigma^2}{2}\right) \tag{1}$$

3 Our study does not need to deal with the sub period additivity in its application. More specifically, an additivity principle decomposes the contribution of a particular component to poverty changes between t_0 and t_2 that cannot be expressed simply as a sum of contributions between t_0 and t_1 and between t_1 and t_2.

The conventional poverty decomposition into the growth and distribution components is based on the mean. However, the commonly used summary statistics, mean, do not necessarily represent the level of living standards of the poorer mass population situated around the mode of distribution (Yamada, 2017, 2021). To deal with this issue, this study extends its decomposition framework to apply the mode of income distribution to capture the welfare dynamics of the poor better. The mode-based decomposition approach first approximates the income distribution from the household sample surveys to the lognormal distribution and applies the maximum likelihood (ML) estimation. Then, it decomposes welfare dynamics into growth and distribution effects featuring the residual-free and the time-reversion consistent poverty decomposition.

This study relies on the mode-based decomposition based on longer years of surveys, 1993-2014, and empirically adds new evidence further by employing the post *Doi Moi* as a world success story, where monumental poverty reduction has taken place with the reduction of the headcount ratio from 63.8 percent in 1993 to 2.4 percent in 2012 at 1.25 international dollars a day (2005 PPP). Past studies have engaged in decomposition analyses into the growth and distribution effects conventionally. Still, their focus is mainly on the methodological aspect and do not take a successful part in poverty reduction to extract lessons. *Doi Moi* reforms have initiated in 1986, a post Vietnam War ended thirteen years after the Paris Accords in 1973, aimed at liberalization and integration into the international economy (the transition from the central planning system to the market led), with effects spanning between 1986 and the 1990s. During this period, the country has exhibited bold growth rates with low inequality except post financial crisis: the late 1990s (post Asian Financial Crisis) and the late 2000s (post Global Financial

Crisis). The questions are the following: how much does economic growth contribute to poverty reduction relative to the distribution effect? (ii) are there any heterogeneities in the growth and distribution effects across different income levels of the population and areas? and (iii) are there any specific chronological characteristics in the growth and distribution effects of welfare dynamics? To answer these, this study applies the proposed mode-based decomposition method to the bottom 40 percent of the population across areas over two decades of household sample surveys, 1993 to 2014. The main empirical results indicate the distribution effect adversely affect the bottom 10 and 20 percent of the population, notably in the post financial crisis periods, unlike the growth effect that mostly induce the income increase. Inducing growth policies targeting the mean or per capita increase of income is generally good for the poor on average (e.g., de Janvry and Sadoulet, 2000; Dollar and Kraay, 2002; Dollar et al., 2016), but it could fail to capture the sensitive welfare change of the lower segments, which is particularly vulnerable to shocks and fluctuations to business cycles.

This study contributes to the literature in several ways. First, it proposes a residual-free and time-reversion consistent mode-based decomposition approach to closely observe the dynamics of living standards of the poor. This mode-based decomposition approach is conceptually easy to understand and implementable empirically. Second, this study applies the mode-based decomposition in every 10th percentile of the bottom 40 percent of the population to thoroughly assess the growth and distribution effects to closely observe the sensitive welfare dynamics of lower income. Third, this study decomposes it into growth and distribution and compares elasticity of each effect to welfare dynamics by incorporating spatial heterogeneity by

area within a country. Fourth, this study employs about two decades of surveys of post *Doi Moi*, VLSS/VHLSS, from 1993 through 2014 to examine the chronological change of the growth and distribution effects over the long run.

The structure of this article is as follows. Section 2 describes the development of growth, distribution and welfare dynamics in post *Doi Moi* as a successful country case study in reduction of poor. Section 3 describes the methodology and dataset. Section 4 describes the analytical results of the mode-based poverty decomposition. Section 5 concludes.

2. Post *Doi Moi* as case study applying the decomposition

Post *Doi Moi* observes the monumental achievements in reducing absolute poverty and promoting higher and more stable economic growth over the decades. *Doi Moi* reforms initiated in 1986 aims at liberalization and integration into the international economy, with effects spanning between 1986 and the 1990s. Since the initiation, the basis for economic development has been strengthened, then the benefit of economic development leads to social development. The real GDP growth rate increased from 5 percent on average in constant prices with 2010 base year in the 1980s to 7.4 in the 1990s, and 6.6 on average in the 2000s, according to the World Development Indicators. Although the real GDP growth rate has decelerated to 5.9 percent on average in the first half of the 2010s, it still maintains bold growth relative to the averages in East Asia and the Pacific (4.4 percent), Lower middle income economies[4] (4.9 percent) and the

4 Lower middle income economies are those with a GNI per capita between $1,026 and $4,035, defined by the World Bank.

world (2.8 percent). Economic reforms applied between the 1980s and 1990s, particularly in macroeconomic stabilization, are the trade liberalization, introduction of positive real interest rates, and initial property rights reform in agrarian economy. Those, notably macroeconomic arena has been regarded as a contributor to the rapid economic growth of the 1990s (Dollar, 2002). Subsequent reforms induce significant steps for facilitating foreign investments and streamlining productions in economic sectors [5]. Also, it has strengthened the external partnerships that foster economic integration to the world[6]. Poverty in the country is 2.4 percent of the headcount ratio at 1.25 international dollars a day (2005 PPP) in 2012, a monumental improvement from 63.8 percent in 1993[7] (Table 1). Similarly, the severity measurement of impoverishment, the poverty index, the gap index, and the squared gap index, indicates significant improvement. Inequality, as measured by the Gini index, is at the lowest level in the world. Besides, the Gini index has been fairly stable on the average of 36.5 with a SD of 1.3

5 The reforms include a series of modernization in institutions: the de–collectivization of agriculture in 1988, the 1992 Law on Enterprises, the creation of tradable land use rights under the 1993 Land Law, the 1996 Foreign Investment Law, and the liberalization of the trade regime.

6 The integration efforts include the restarting of official development assistance (ODA) from Japan in 1992; diplomatic normalization with the USA in 1995; and accession to World Trade Organization (WTO) in 2007.

7 These data are adapted from the World Bank's PovcalNet, based on Purchasing Power Parity (PPP) exchange rates for household expenditure from the 2005 International Comparison Program, with data from more than 1,000 household surveys across 128 developing and 21 high income countries. For reference purpose, Table 1 shows the result of the poverty and inequality index based on 1.90 international dollars a day threshold with 2011 PPP exchange rates with data from more than one thousand household surveys across 138 countries in six regions, and 21 other high income countries.

from 1992 to 2012, applying 1.25 international dollars a day as the poverty threshold with 2005 PPP dollars (Table 1).

Table 1: Depth of poor, a country level from 1993 to 2012

survey year	1.25 for the line of poverty			gini index	1.90 for the line of poverty			gini index
	head count ratio	gap ratio	squared gap ratio		head count ratio	gap ratio	squared gap ratio	
2012	0.02	0.001	0.002	35.6	0.03	0.06	0.002	38.7
2010	0.04	0.008	0.003	39.3	0.05	0.01	0.003	42.7
2008	0.17	0.04	0.01	35.6	0.16	0.04	0.01	38.2
2006	0.21	0.05	0.02	35.8	0.22	0.06	0.02	37.4
2004	0.31	0.08	0.03	36.8	0.27	0.07	0.03	37.2
2002	0.40	0.11	0.04	37.6	0.39	0.1	0.04	37.3
1998	0.49	0.15	0.06	35.5	0.35	0.09	0.03	35.4
1992/93	0.64	0.24	0.11	35.7	0.49	0.15	0.06	35.7

Source: Author based on PovcalNet
Note: The computation based on PovcalNet, the World Bank. The poverty line indicates the international dollars a day.

3. Method and data

3.1. Method

3.1.1. Estimation of income distribution applying ML estimation

To estimate the income distribution, the analysis applies ML estimation, supposing lognormal distribution.[8] ML estimation allows parametric estimation of the parameters of a statistical model, given lognormal distribution, with the mean and SD or variance calculated by some restricted samples. Suppose there are random samples $X_1, X_2, X_3, \ldots, X_n$ where probability distribution depends on the parameter θ. The name of maximum likelihood is derived from the idea that a reasonable estimate of the unspecified θ would be the θ maximizing the likelihood

8 In the applied analysis of income distribution, kernel density estimation is also commonly used as a statistical method that non parametrically estimates the probability density function of a random variable. For simplicity and precise calculation of the growth and distribution effects of welfare dynamics (please see the calculations described in Figures 1 and 2 in Section 3.1.2), we employ parametric ML estimation instead of kernel density estimation.

of the obtained sample data. Given point estimate of θ is $x_1, x_2, x_3, \dots, x_n$, the probability density function of each X_i is $f(x_i;\ \theta)$. Random samples of probability density function $X_1, X_2, X_3, \dots, X_n$ can be expressed as equation 2.

$$\begin{aligned} L(\theta) &= P(X_1 = x_1, X_2 = x_2, X_3 = x_3, \dots, X_n = x_n) \\ &= f(x_1;\ \theta) \cdot f(x_2;\ \theta) \cdot f(x_3;\ \theta) \cdot \dots f(x_n;\ \theta) \\ &= \prod_{i=1}^{n} f(x_i;\ \theta) \end{aligned} \quad (2)$$

Although our data relies on country representative household surveys, even more coarse grouped data is applicable in the ML.

Gibrat's law is a foundation describing that income distribution follows a lognormal distribution (Gibrat, 1931)[9]. After that, it is argued expenditure is approximately the same as income (Friedman, 1957) and expenditure has a better fitting to lognormal distribution than income (Battistin and Blundell, 2009). Based on these, we estimate the expenditure distribution relying on lognormal distribution in this article. Suppose x is a lognormal distributed random variable, and μ and σ are unknown mean and SD, respectively. The functional forms of lognormal distribution, its mean and SD are in equations 3-5.

$$F(x) = \frac{1}{\sqrt{2\pi}\sigma x} \exp\left[-\frac{(\ln x - \mu)^2}{2\sigma^2}\right], \quad x \in (0, +\infty), \quad (3)$$

$$Mean = \exp\left(\mu + \frac{\sigma^2}{2}\right) \quad (4)$$

$$SD = 2^{2\mu+\sigma^2}[\exp(\sigma^2 - 1)] \quad (5)$$

9 Pareto's Law fits the tail (very high income) of the income distribution (Pareto, 1897).

The estimated distributions are exhibited in Appendix Figures 1-3. The process of the lognormal approximation creates approximation errors and estimates of growth among the poorest x % of the population could be biased if income or expenditure is measured with error (Glewwe and Dang, 2011). In our case, although negligible, the variance of fitness of the approximation is relatively large in the urban areas and 2014. This is likely as the divide between haves and have not is enlarged in urban area and recent years.

3.1.2. The mode-based decomposition into growth and distribution effects

The idea about the growth and distribution decompositions of income or expenditure change can be decomposed into the growth and distribution components, which is expressed as a function of growth in mean income or expenditure and change in distribution (equation 6).[10]

$$mean\ income \text{ or } expenditure = \mathrm{f}(\mathrm{g}, \mathrm{d}) \quad \text{where}$$
$$g: growth,\ d: distribution \tag{6}$$

In equation 6, Datt and Ravallion (1992), Grootaert (1995), Sahn and Stifel (2000) add a residual term, but theoretically speaking, mean income change (e.g., average income change of the poor) can be precisely decomposed into either growth component or distribution component. In this regard, the residual-free decomposition is deemed to be appropriate for empirical exercises (Kakwani and Subbarao, 1990; Kakwani, 1993; and Jain and Tendulkar,1990).

10 See Figures 1 and 2 depict the idea of growth and distribution decompositions of mode income or expenditure, unlike the convention based on mean.

Suppose a residual-free function of poverty that is explained by poverty line (z), mode income or expenditure (μ') instead of mean, and the SD (σ) given by

$$\theta = \theta(z, \mu', \sigma) \tag{7}$$

Change in poverty between period i and j is represented as

$$\Delta\,\theta_{ij} = \theta\left(z, u'_j, \sigma\right) - \theta(z, u'_i, \sigma) \tag{8}$$

where μ'_j are adjusted for price changes between two periods, and the poverty line does not change. Suppose the growth effect between year i and j by g_{ij}, and distribution effect by d_{ij}, then the change in poverty between the period is described in equation 9.

$$\Delta\,\theta_{ij} = g_{ij} + d_{ij} \tag{9}$$

Now, in equation 9, note that the function form satisfies the following axioms.

$$\text{If } g_{ij} = 0, \text{then } \Delta\,\theta_{ij} = d_{ij} \text{ and if } d_{ij} = 0, \text{then } \Delta\,\theta_{ij} = g_{ij}$$

$$\therefore g_{ij} = d_{ij} = \Delta\,\theta_{ij} = 0, \text{then } \Delta\,\theta_{ij} = \theta\left(z, u'_j, \sigma_j\right) - \theta(z, u'_i, \sigma_i) = 0$$

(Axiom 1)

$$\text{If } g_{ij} = d_{ij} = 0, \text{then } \Delta\,\theta_{ij} = 0$$

$$\therefore g_{ij} = d_{ij} = \Delta\,\theta_{ij} = 0, \text{then } \Delta\,\theta_{ij} = \theta\left(z, u'_j, \sigma_j\right) - \theta(z, u'_i, \sigma_i) = 0$$

(Axiom 2)

$$\text{If } g_{ij} \leq 0 \text{ and } d_{ij} \leq 0, \text{then } \Delta\,\theta_{ij} \leq 0, \text{and if } g_{ij} \geq 0 \text{ and } d_{ij} \geq 0, \text{then } \Delta\,\theta_{ij} \geq 0$$

(Axiom 3)

$$g_{ij} = -g_{ji} \text{ and } d_{ij} = -d_{ji} \tag{Axiom 4}$$

Given the above axioms, the total change of poverty is decomposed into (i) the growth effect without distributional change (g_{ij}) and (ii) the distribution effect without growth change (d_{ij}), which is denoted in equations 10 and 11.

$$g_{ij} = \frac{1}{2}\{\theta[z, \mu'_j, \sigma_i] - \theta[z, \mu'_i, \sigma_i]\} - \frac{1}{2}\{\theta[z, \mu'_i, \sigma_j] - \theta[z, \mu'_j, \sigma_j]\} \quad (10)$$

$$d_{ij} = \frac{1}{2}\{\theta[z, \mu'_i, \sigma_j] - \theta[z, \mu'_i, \sigma_i]\} - \frac{1}{2}\{\theta[z, \mu'_j, \sigma_i] - \theta[z, \mu'_j, \sigma_j]\} \quad (11)$$

That is, the growth effect expresses the poverty change (Δp) without distributional change and the distribution effect without growth change in equation 12.

$$\Delta p_{ij} = g_{ij} + d_{ij} = \Delta \theta_{ij} \quad (12)$$

Following the equations from 6 to 12, Figures 1 and 2 exhibit the visualized mode-based decomposition into growth and distribution effects. The vertical axis denotes the population share, and the horizontal axis denotes the living standards proxied by income or expenditure. The analysis calculates the growth effect and the distribution effect depending on which distribution move first, either the initial distribution to the initial distribution' (prime) (Figure 1) or the new distribution to the new distribution' (Figure 2).

In Figure 1, Panel A shows the initial distribution (in 2008), the new distribution (in 2010), and the initial distribution'. Along with the shift from the initial distribution to the new distribution, the area below the poverty line decreases. This decrease can be decomposed into the growth and distribution effects by setting up the initial distribution' denoted by the dotted line, which has the same mode of the new distribution and the same shape/distribution of the

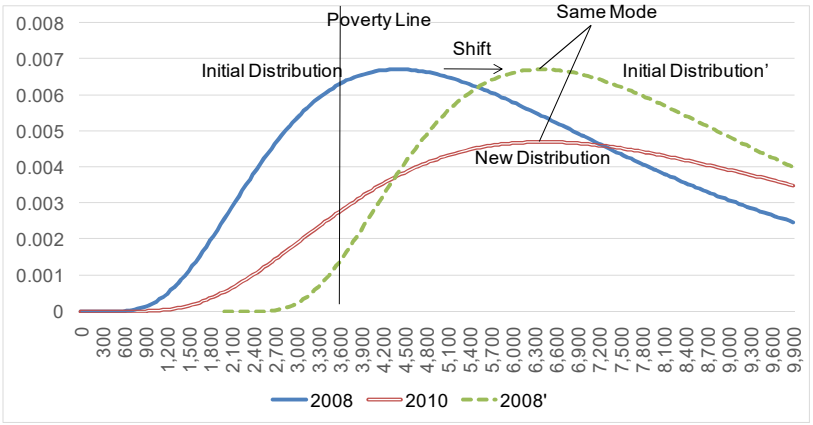
initial distribution. Panel B calculates the growth effect (GE) by shifting the initial distribution to the initial distribution'. With this growth effect shift, the area below the poverty line is decomposed into the area poverty is reduced by the growth effect and the area poor population remain. Panel C exhibits the calculation of the distribution effect (DE) by shifting the initial distribution' to the new distribution. In this case, the poverty area increases along with the shift of distribution effect.

In Figure 2, Panel A exhibits the initial distribution, the new distribution, and the new distribution'. Contrary to Figure 1, Figure 2 first shift the new distribution to the new distribution'. The new distribution' has the same mode as the initial distribution and the same shape/distribution of the new distribution. With this shift the area of poverty, encompassed by the new distribution, the new distribution', the initial distribution, and the poverty line, is divided by the growth effect (GE, Panel B) and the distribution effect (DE, Panel C).

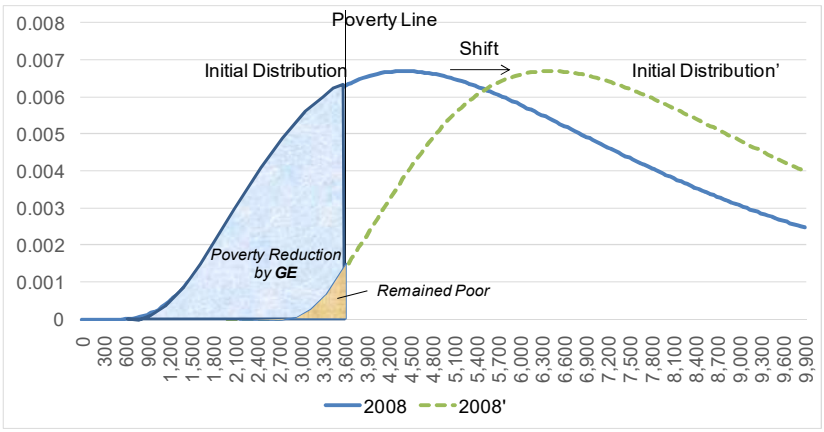
Based on the ideas described in equations from 6 to 12 and graphics in Figures 1 and 2, the mode-based decomposition applies the lines every 10th percentile of the bottom 40 percent of expenditure instead of a single poverty line to see the sensitive movement of welfare dynamics in poorer groups (Section 4).

Figure 1: The mode-based decomposition into growth and distribution effects: The shift of initial distribution to the initial distribution'

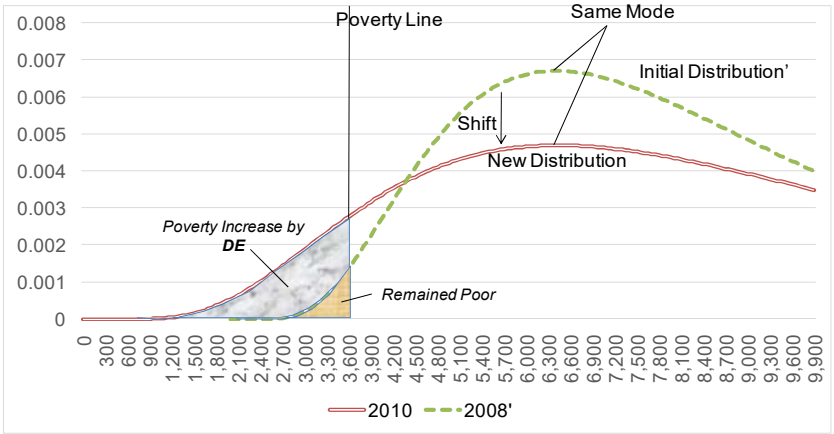
Panel A: The initial distribution (in 2008), the new distribution (in 2010), and the initial distribution'



Panel B: Calculation of the growth effect by shifting the initial distribution to the initial distribution'



Panel C: Calculation of the distribution effect by shifting initial distribution' to the new distribution

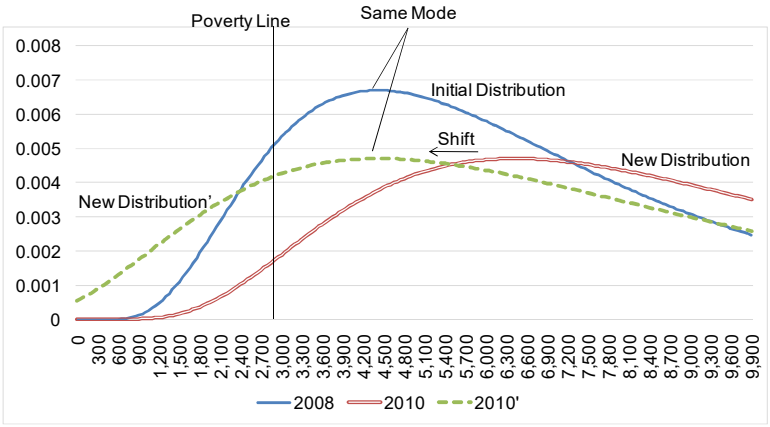


Source: Author

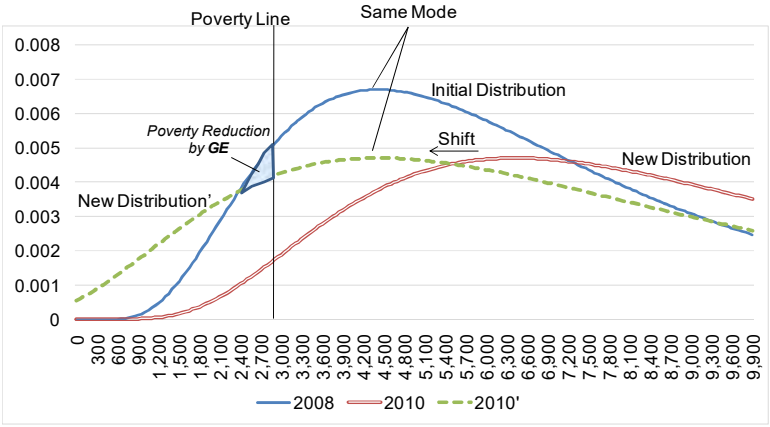
Note: The vertical axis denotes the share of the population, and the horizontal axis denotes the income or expenditure. GE denotes the growth effect and DE denotes the distribution effect, respectively.

Figure 2: The mode-based decomposition into growth and distribution effects: The shift of new distribution to the new distribution'

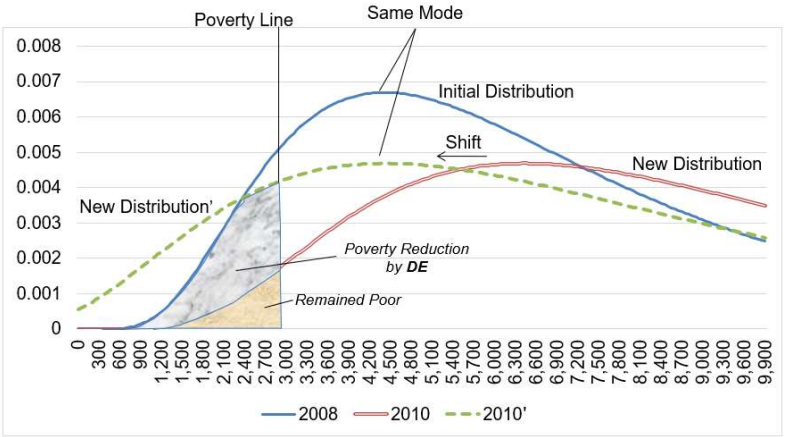
Panel A: The new distribution (in 2010), the initial distribution (in 2008), and the new distribution'



Panel B: Calculation of the growth effect by shifting the new distribution to the new distribution'



Panel C: Calculation of the distribution effect



Source: Author

Note: The vertical axis denotes the share, and the horizontal axis denotes the income or expenditure. GE denotes the growth effect and DE denotes the distribution effect, respectively.

3.2. Data

This study employs real per capita expenditure from the country representative surveys, VLSS and VHLSS, for about two decades as a measurement of living standards. Those surveys are nationally representative household surveys based on stratified random sampling launched by the statistical authority[11]. The sample size is summarized in Table 2.

Table 2: Sample size by area and year

	1993	1998	2002	2004	2006	2008	2010	2012	2014
Urban	960	1,730	6,909	2,250	2,307	2,352	2,649	2,703	2,781
Rural	3,839	4,269	22,621	6,939	6,882	6,837	6,750	6,696	6,618
Overall	4,799	5,999	29,530	9,189	9,189	9,189	9,399	9,399	9,399

Source: Author based on the household surveys, VLSS 1993 and 1998; and VHLSS 2002, 2004, 2006, 2008, 2010, 2012 and 2014

Nominal expenditure is adjusted by month and region, and then converted to real value by the time series deflator with the base year in 2005. Expenditure is a better proxy of welfare than income, especially in emerging and developing economies, because (i) income is largely from self-employment; (ii) fluctuations of income are larger than expenditure (Paxson 1993), and (iii) households are often able to recall expenditure accurately unlike income that is likely to be understated (Donaldson 1992; Blundell and Preston, 1998). Hence, the analysis relies on expenditure as a proxy of the welfare of each household.

11 The surveys aim to evaluate the living standards of the country with the technical surveillance from the World Bank.

4. Results

4.1. Estimation of the distribution in expenditure

As described in the methodological section, lognormal distribution approximates the samples of real per capita expenditure from VLSS/VHLSS to estimate population distribution by area in respective survey year (Appendix Figures 1-3). As time goes by, the mode value increases, except for 2008 when the global financial crisis occurred. Interestingly, the mode in each distribution is closest to the 30th percentile from 1993 to 2014 throughout (Table 3). Even when we extract data from urban and rural, the unique characteristics is the same.[12] Henceforth, we apply the mode-based decomposition to the population's 10th, 20th, 30th and 40th percentiles by area throughout the years to see the sensitive welfare dynamics of lower segments.

[12] We found that roughly the poorest 10 percent of the Cote d'Ivoire survey 1985/86 happens to be the mode of distribution where Kakwani (1993) analysed.

Table 3: The real per capita expenditure of the mode and every 10th percentile of the bottom 40 percent by area from 1993 to 2012

		1993	1998	2002	2004	2006	2008	2010	2012
Overall	Mode of the initial distribution	1,500	2,200	2,300	2,550	2,950	2,950	4,200	4,850
	10th percentile	1,050	1,450	1,500	1,650	1,950	1,950	2,800	3,200
	20th percentile	1,250	1,850	1,950	2,150	2,550	2,500	3,650	4,150
	30th percentile	1,450	2,200	2,300	2,600	3,050	3,000	4,400	5,050
	40th percentile	1,650	2,550	2,700	3,050	3,600	3,500	5,200	5,900
Urban	Mode of the initial distribution	2,250	3,700	3,900	4,400	5,100	4,400	6,400	7,400
	10th percentile	1,500	2,450	2,600	2,900	3,350	2,900	4,250	4,950
	20th percentile	1,950	3,150	3,350	3,800	4,300	3,750	5,450	6,250
	30th percentile	2,350	3,800	4,100	4,600	5,200	4,500	6,550	7,400
	40th percentile	2,750	4,450	4,850	5,450	6,100	5,300	7,650	8,550
Rural	Mode of the initial distribution	1,450	2,100	2,200	2,400	2,800	2,700	3,850	4,450
	10th percentile	950	1,400	1,500	1,600	1,850	1,800	2,550	3,000
	20th percentile	1,200	1,700	1,850	2,000	2,350	2,300	3,250	3,800
	30th percentile	1,350	2,000	2,150	2,400	2,750	2,700	3,900	4,500
	40th percentile	1,550	2,250	2,400	2,750	3,200	3,100	4,600	5,250

Source: Author based on VLSS 1993 and 1998, and VHLSS 2002, 2004, 2006, 2008, 2010, and 2012
Note: The unit of expenditure is VND 1,000. The frequency is calculated every VND 50,000 interval, so that the summary statistics in this table start from the tenth digit.

4.2. The performance of the two decompositions based on mode, either the shift from initial to the new distribution or reverse

This section examines the average performance difference between the two types of decompositions based on mode, either the shift from initial to the new or reverse (Figures 1 and 2 in Section 3.1.2). Figure 3 shows the average growth and distribution effects of poverty change by comparing (i) the shift of the initial distribution to the initial distribution' in Figure 1 (the normal order decomposition) to (ii) the shift of the new distribution to the new distribution' in Figure 2 (the reverse order decomposition). The positive values denote the contribution to poverty reduction, and the negative values denote the contribution to poverty growth.

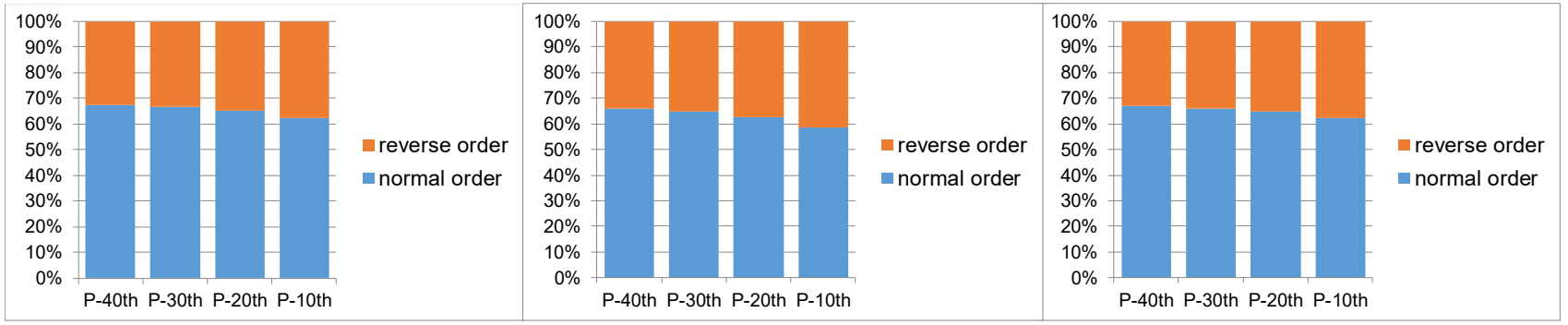
Panel α shows the average contribution to the poverty change during the period 1993-2014 in the growth effect between (i) the normal order and (ii) the reverse order decomposition. The average magnitude of the growth effect during 1993-2014, the normal order decomposition is 1.5-2.3 times larger than the reverse to reduce poverty. The growth effect is most significant at the 40th percentile in the normal order decomposition, and the effect gradually shrinks in the smaller percentiles. By convention welfare dynamics of income per capita or mean (the 50th percentile) were the indices for the reflection of wealth of nation and that is deemed to be good for poor. However, it is the story of average of poor, not capturing the welfare dynamics of further lower segments. This indicates the advantage of mode (the 30th percentile closest) for precise examination of welfare dynamics of poor. These characteristics are the same across areas—the whole country, urban and rural.

Panel β shows the average contribution to the poverty change in the distribution effect during the period of 1993-2012 between (i) the normal order and (ii) the reverse order decomposition. The distribution effect from 1993 to 2014 in the normal order decomposition is negative, but the effect is positive in the reverse order decomposition. Strikingly the distribution effect is always negative in the 10th-20th percentiles, increase of poor, and the 30th percentile in urban. The negative distribution effect is the direst in the 10th percentile in rural—the largest increase of poor appears in the rural bottom. At least to the bottom 10th-20th percentiles the distribution effect is adverse constantly, the need in the mode-based examination to closely observe the welfare dynamics of the bottom.

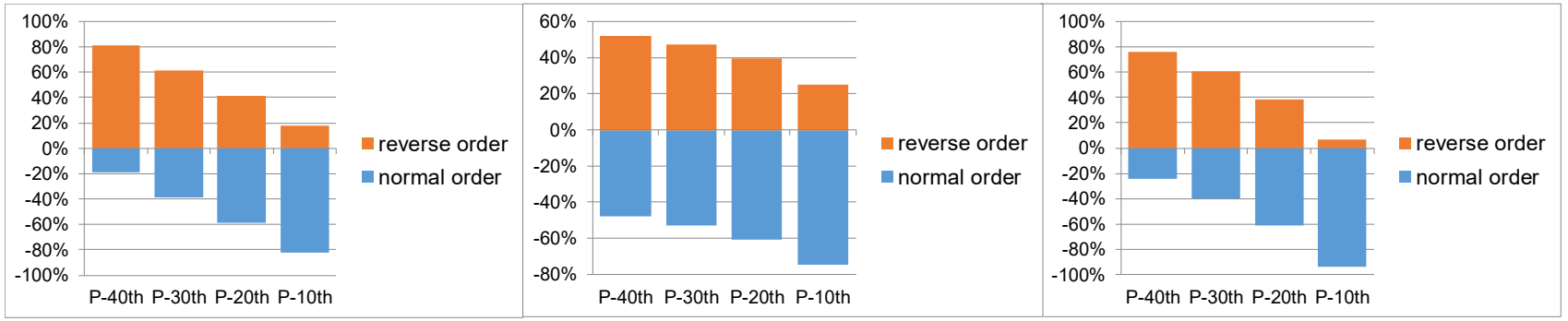
Figure 3: Performance difference between the two types of the mode-based decompositions, the average of 1993-2014

Panel A: Whole country Panel B: Urban Panel C: Rural

Panel α: Average contribution to poverty change in the growth effect between (i) the shift of initial distribution to the initial distribution' (the normal order) and (ii) the shift of new distribution to the new distribution' (the reverse order)



Panel β: Average contribution to poverty change in the distribution effect between (i) the shift of initial distribution to the initial distribution' (the normal order) and (ii) the shift of new distribution to the new distribution' (the reverse order)



Source: Author based on VLSS 1993 and 1998, and VHLSS 2002, 2004, 2006, 2008, 2010, 2012 and 2014

Note: The positive values denote the contribution to the poverty reduction and the negative values denote the contribution to poverty growth. 'normal' denotes (i) the shift of initial distribution to the initial distribution' and 'reverse' denotes (ii) the shift of new distribution to the new distribution'. P-10th-40th indicates every 10th percentile of expenditure in the lower segments. The bars follow a 100 percent stacked column in absolute value.

4.3. Main analysis: The growth and distribution effects of welfare dynamics

4.3.1. Growth and distribution effects of lower income segments relying on the mode by area and depth of poor

This section examines the growth effect and distribution effect of poverty change relying on the mode-based decomposition approach discussed in Section 4.2. Figure 4 shows the average contribution to poverty change in the growth and distribution effects based on the mode-based poverty decomposition by area and the deciles of the bottom 40 percent of the population, 1993–2014. The positive values denote the contribution to poverty reduction, and the negative values denote the contribution to the increase in poverty. Tables 4 and 5 show the disaggregated results of the growth and distribution effects by year to thoroughly investigate the chronological change of the growth and distribution effects of the mode-based poverty decomposition.

Figure 4 indicates that the growth effect performs the significant role in the reduction of poor for every percentile of the bottom 40 percent of the population. The role of the distribution effect is far small relative to the growth effect, at most from 5-20%, and constantly negative in the bottom 10 and 20 percent of the population across the areas, increasing poverty about 5-15%. The bottom 30 percent of the urban area population is negatively affected by the distribution effect though negligible in total during the period 1993-2014, which is deemed to be the spill over from the global financial crisis in 2008[13]. These results strikingly exhibit the

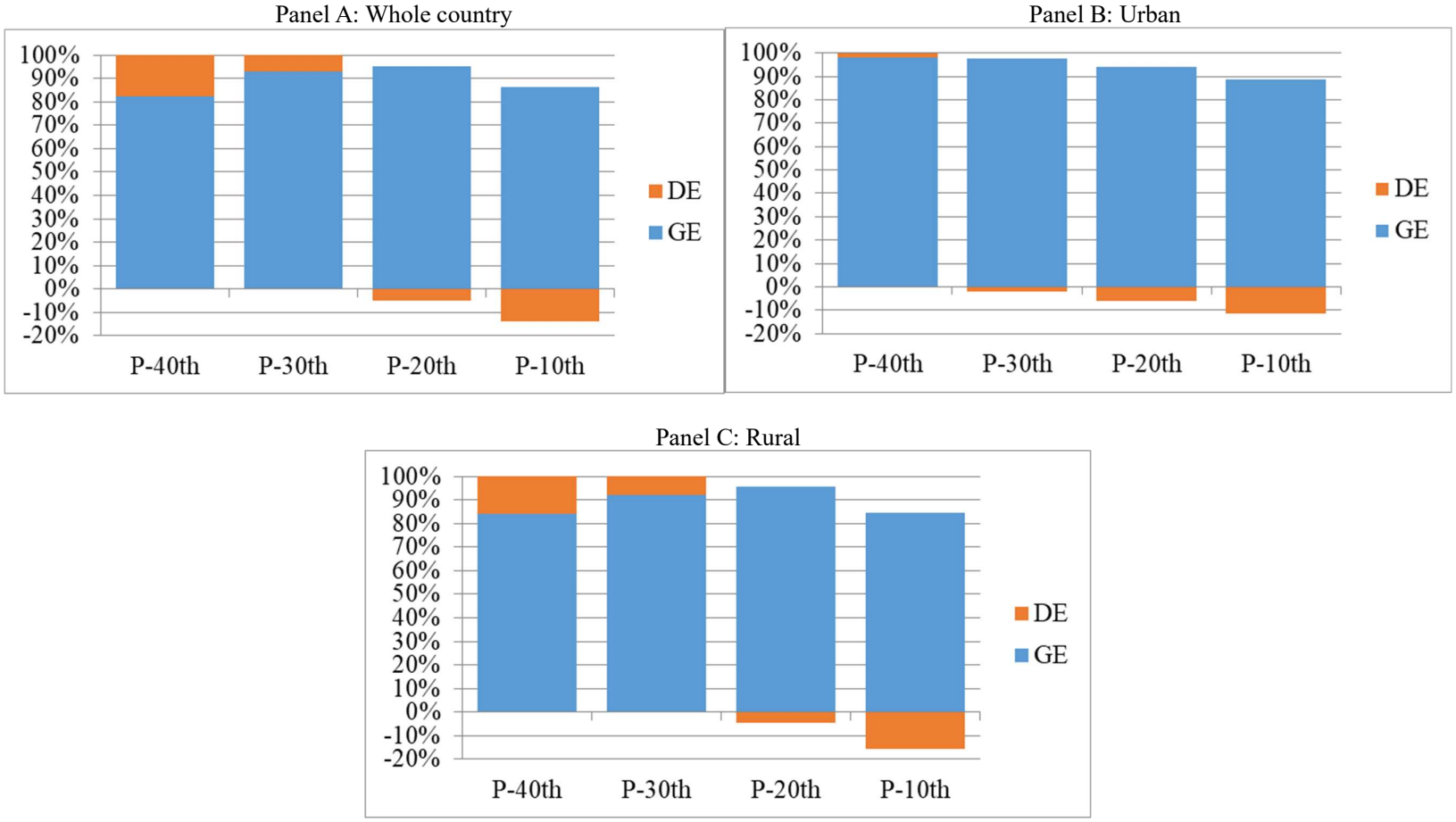
[13] It denotes the bankruptcy of Lehman Brothers in September 2008 although the side effect emerges in a few years ago, the period 2004-2006. See the chronological fluctuations of the urban growth and distribution effects of the 30th percentile, relative to rural and whole country (Tables 4 and 5).

income growth of the mode (mass population in distribution) is occupying the benefit for reducing the poor, while the distributional effect adversely emerges at least to the 10th and 20th percentile of the population.

The disaggregated results (Table 4 and 5) in respective period ij between 1993 and 2014 exhibit the heterogenous effects from the growth and distribution although the growth is still dominant factor in reducing poor. The distribution effect was negligible in the initial period 1993-98, the share contributing to welfare dynamics at most around 10%. It negatively influenced the bottom 10th percentile of the population notably in rural area. Since then, the structure of the economy has been transformed, the growth of the mode is fairly good for the bottom 10th and 20th percentile of the population but adversely effective for the distribution. Market structure has been strengthened through the initiation of *Doi Moi*, 1986, the country level headcount poverty rate gradually reduces from 49 to 21% during the period 1998-2006 keeping the disparity at the world lowest level around 35 of Gini index. Having hold that the disaggregated statistics exhibit sensitive welfare dynamics every percentile of the bottom 10th-40th percentile across area chronologically. Disaggregation of the mode-based growth and distribution examination for the welfare dynamics is crucial at least to the bottom 10th-20th percentile as the results are contrasting to the country level aggregate. Further, the period 2006–2008 is exceptional (Table 5), the growth effect is zero in the whole country, and it leads to the increase of poverty in urban and rural areas. In urban, the distribution effect is also strange relative to past decade affecting severely to the bottom 30th-40th percentiles but surprisingly it improves the welfare of the bottom 10th percentile and indicates the negligible increase of poor

in the bottom 20th. Further, in rural, it increases the poverty evenly across the percentiles of the bottom 40th. The abnormality in the period 2006-2008 likely comes from the global financial crisis stemmed from the bankruptcy of the Lehman Brothers in September 2008. The heterogeneity is restricted to 2006-2008 and the trend post 2008 gets back to the steady states exhibited between 1998-2006.

Figure 4: Average contribution to poverty changes in the growth and distribution effects between 1993 and 2014



Source: Author based on VLSS 1993 and 1998, and VHLSS 2002, 2004, 2006, 2008, 2010, 2012 and 2014

Note: The positive values denote the contribution to the poverty reduction and the negative values denote the contribution to the increase in poverty. GE denotes the growth effect and DE denotes the distribution effect of the mode-based poverty change. P-10th-40th indicates the percentile of expenditure. The bars follow a 100 percent stacked column in absolute value.

Table 4: Contribution to poverty change in the growth and distribution effects between 1993 and 2006

		1993-1998		1998-2002		2002-2004		2004-2006	
		GE	DE	GE	DE	GE	DE	GE	DE
Overall	10th Percentile	107%	-7%	132%	-32%	139%	-39%	129%	-29%
	20th Percentile	102%	2%	110%	-10%	96%	4%	104%	-4%
	30th Percentile	95%	5%	93%	7%	75%	25%	88%	12%
	40th Percentile	88%	12%	82%	18%	60%	40%	75%	25%
Urban	10th Percentile	103%	-3%	121%	-21%	130%	-30%	126%	-26%
	20th Percentile	101%	-1%	81%	19%	106%	-6%	114%	-14%
	30th Percentile	98%	2%	60%	40%	88%	12%	105%	-5%
	40th Percentile	93%	7%	48%	52%	76%	24%	93%	7%
Rural	10th Percentile	110%	-10%	125%	-25%	127%	-27%	126%	-26%
	20th Percentile	105%	-5%	91%	9%	92%	8%	105%	-5%
	30th Percentile	102%	-2%	70%	30%	71%	29%	88%	12%
	40th Percentile	95%	5%	60%	40%	60%	40%	76%	24%

Source: Author based on VLSS1993 and 1998, and VHLSS 2002, 2004 and 2006.

Note: The positive values denote the contribution to the poverty reduction and the negative values denote the contribution to the increase in poverty. GE denotes the growth effect and DE denotes the distribution effect of the mode-based poverty change. P-10^{th}-40^{th} indicates the percentile of expenditure. The bars follow a 100 percent stacked column in absolute value. The share of the growth and the distribution effects follow a plus or minus 100 percent stacked column.

Table 5: Contribution to poverty change in the growth and distribution effects between 2006 and 2014

		2006-2008		2008-2010		2010-2012		2012-2014	
		GE	DE	GE	DE	GE	DE	GE	DE
Overall	10th Percentile	0%	-100%	115%	-15%	128%	-28%	128%	-28%
	20th Percentile	0%	-100%	104%	-4%	109%	-9%	109%	-9%
	30th Percentile	0%	-100%	94%	6%	94%	6%	94%	6%
	40th Percentile	0%	-100%	83%	17%	84%	16%	82%	18%
Urban	10th Percentile	-119%	19%	113%	-13%	125%	-25%	121%	-21%
	20th Percentile	-97%	-3%	108%	-8%	116%	-16%	108%	-8%
	30th Percentile	-64%	-36%	99%	1%	113%	-13%	94%	6%
	40th Percentile	-43%	-57%	89%	11%	109%	-9%	82%	18%
Rural	10th Percentile	-49%	-51%	116%	-16%	125%	-25%	121%	-21%
	20th Percentile	-51%	-49%	106%	-6%	112%	-12%	106%	-6%
	30th Percentile	-51%	-49%	97%	3%	98%	2%	93%	7%
	40th Percentile	-51%	-49%	93%	7%	88%	12%	80%	20%

Source: Author based on VHLSS 2008, 2010, 2012 and 2014.

Note: The positive values denote the contribution to the poverty reduction and the negative values denote the contribution to the increase in poverty. GE denotes the growth effect and DE denotes the distribution effect of the mode-based poverty change. P-10^{th}-40^{th} indicates the percentile of expenditure. The bars follow a 100 percent stacked column in absolute value. The share of the growth and the distribution effects follow a plus or minus 100 percent stacked column.

4.3.2. Transition of the mode and inequality indices by area from 1993-2014

This section examines the transition of real mode expenditure and welfare disparity, exhibiting the real terms of live that is reflective to the contribution of the growth and distribution effects in the previous discussion.

The mode expenditure steadily increases across the period, twice from 1993-2004 and 1.7 times from 2004-2014 in urban, and 1.7 times from 1993-2004 and 1.9 times from 2004-2014 in rural (Table 6). The contribution to the total expenditure is 33% relative to rural 67% in urban area given that the mass population of rural citizens in 1993 but as the structural transformation along with the urban expansion of the economy the urban contribution increases rapidly to 40.4% in 2004 and 41.7% in 2014.

Within and between urban and rural inequality are computed from Theil T index (Shorrocks, 1980). Within inequality contributes to the total at 78.1% relative to the between at 21.9% in 1993. The contribution of the within decreases to 74% relative to the between at 26% in 2004 but it increases to 85.4% relative to the between at 14.6% in 2014. This exhibits the between inequality of urban and rural area increases from 1993-2004 indicating the expansion of urban economy and relative rural stagnation. Also, it indicates that the urban-rural between inequality shrinks from 2004-2014 contrary to the increase of the within inequality, suggesting the tremendous growth in rural rich as well as the consequence of the enlarged divide of the haves and have not in both within urban and rural, respectively.

Table 6: Transition of the mode and inequality indices by area across the year from 1993-2014

	1993		2004		2014	
mode expenditure	mode	contribution	mode	contribution	mode	contribution
urban	2250	0.330	4400	0.404	7400	0.417
rural	1450	0.670	2400	0.596	4450	0.583
	value	contribution	value	contribution	value	contribution
within inequality						
urban-rural	0.165	0.781	0.175	0.740	0.195	0.854
	value	contribution	value	contribution	value	contribution
between inequality						
urban-rural	0.046	0.219	0.061	0.260	0.033	0.156

Source: Author based on VLSS 1993, VHLSS 2004 and 2014
Note: Within and between inequalities are computed from Theil T inequality index. The mode of 2014 is the mode of initial distribution in 2012.

5. Conclusion

International communities may see poverty as an old issue under control with the historical progress of poverty reduction records over the achievement of the millennium development goal 1, halving the poverty from the 1990 level, in 2010. However, the ongoing coronavirus pandemic crisis has brought poverty and equity issues to come front again. Amid this momentum, it is crucial to design poverty reduction strategies by carefully investigating how pro growth policies and pro (re)distribution policies affect lower income segments systematically in total population distribution.

To do so, this study examines how the growth and distribution effects are effective against the welfare dynamics of lower segments based on the mode of income distribution rather than the mean of the population. The convention relies on the mean but it largely under the influence of the tail of the population in income distribution—the very high income groups in the restricted populations. Such commonly employed summary statistics do not necessarily represent the sensitive welfare dynamics of the poorer mass population situated around the mode of distribution given the inequality relationship, $mode < median < mean$, based on the Gibrat's law (Gibrat, 1931). The mode-based decomposition approach first approximates the income distribution to lognormal distribution applying ML estimation and household sample surveys. Then, it calculates the growth and distribution components of poverty change that satisfy the residual-free and the time-reversion consistency in the course of decomposition exercises.

Empirical results applying the post *Doi Moi* where monumental reduction of poverty occurred after the initiation of structural transformation in 1986. The contribution from the growth effect is the dominant factor in reducing poverty, and the contribution by the distribution effect is rather small and even negative for the bottom 10th and 20th percentile of the population resulted in the increase of poor. These trends are prevalent across years from 1993-2014 and areas, urban and rural, except the economic slump triggered in September 2008 bankruptcy of Lehman Brothers (resulted in the increase of poor notably in urban through the backward growth). Contrary, the distribution effect positively affects the bottom 10th and 20th percentile of the population during the dire global financial crisis. The economy cycled back to the steady states in coming years, the contribution of growth and distribution effects in respective percentile of the bottom 40th resumes alike the period 1998-2006. The income disparity is the world lowest level in Gini index at around 35 except the post financial turmoil particularly noted as the collapse of Lehman Brothers, where the Gini inches up to around 39 although it is still fairly low relative to other countries. The urban-rural divide widens in the period 1993-2004 but it shrinks afterward with the period 2004-2014. However, it is contrasting that within areal disparity, urban and rural respectively, shrinks in the period 1993-2004 and it widens 2004-2014, an indication of the expansion of the division of the haves and have not.

Further empirical applications relying on the mode-based decomposition are able to examine the sensitive welfare dynamics of the lower income segments like the application of this study in the bottom 40th percentile. The convention mannerly in vogue considering the per capita income of the population could be a simple and straightforward for better move of the

unified attempt for both policy and academics. However, beyond the average, it shall be more sensible with the mode-based approach that examines the growth and distribution effects of the lower segments, encompassing the complications of heterogenous agents across time and space. Elucidating the complications is crucial in understanding the detailed welfare dynamics needed to better design poverty reduction.

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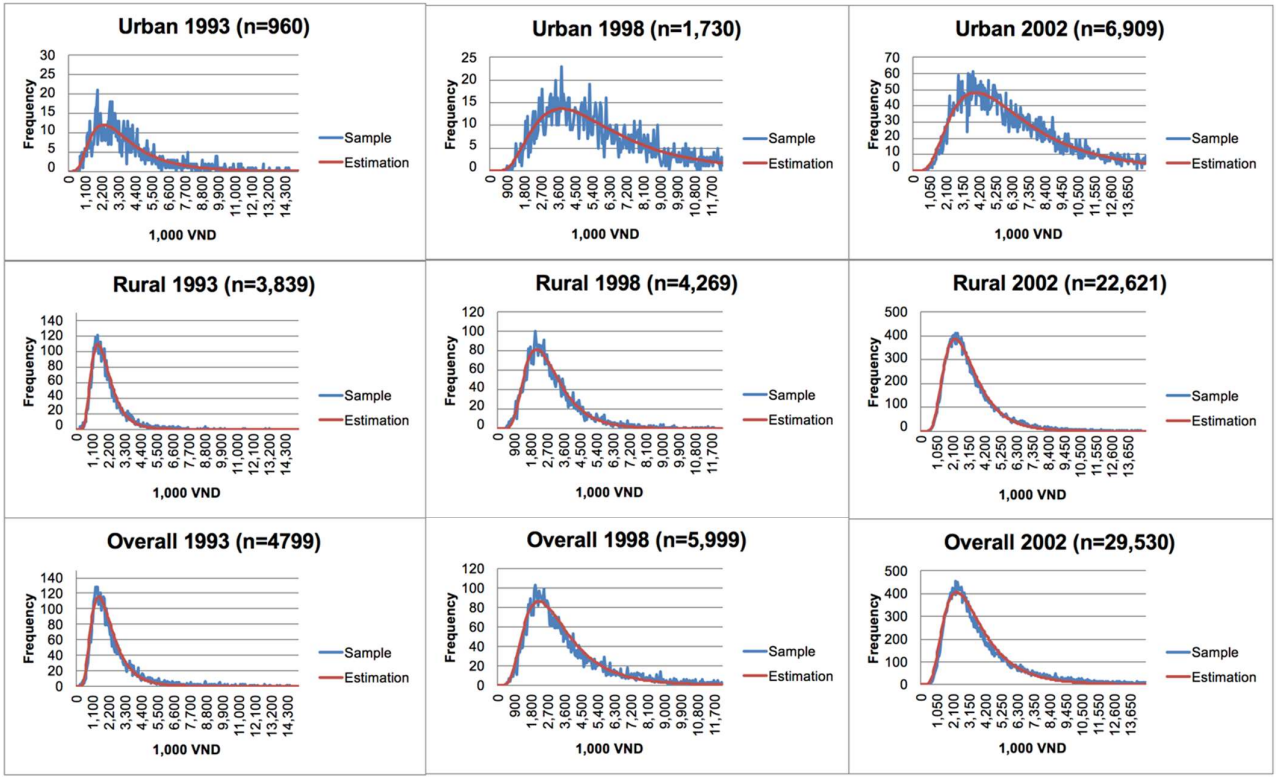
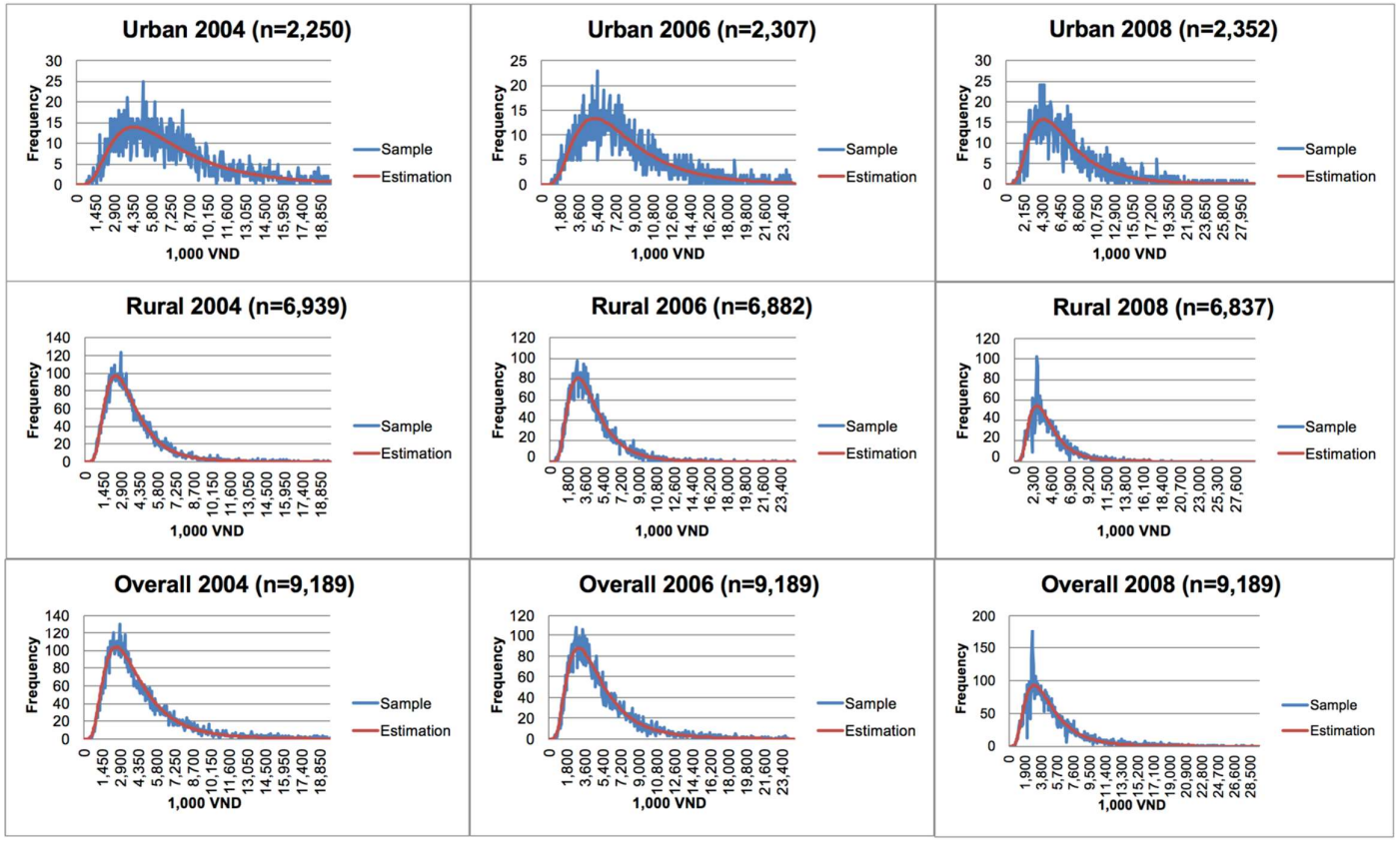
Appendix Figure 1: ML approximation of the expenditure data to lognormal distribution by area, 1993–2002



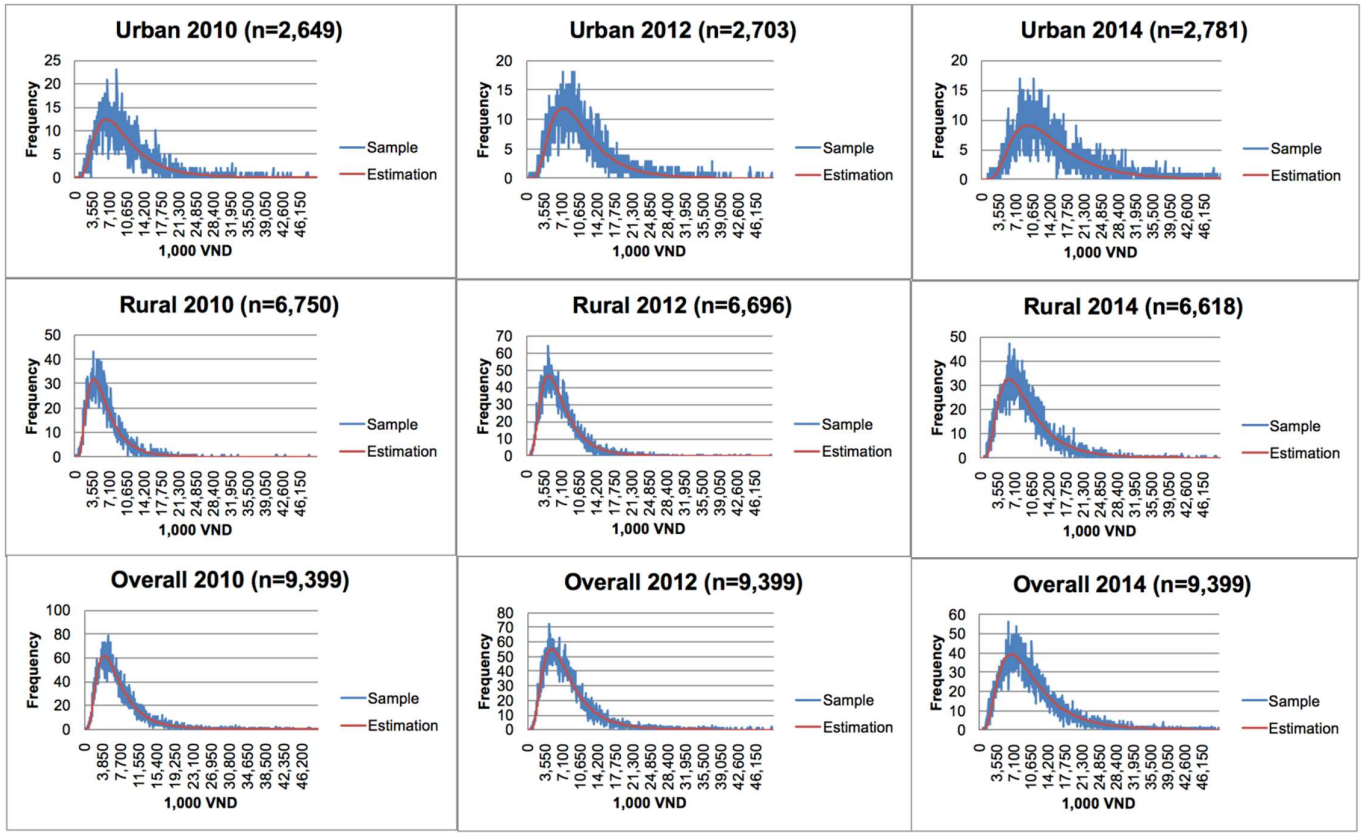
Source: Author based on VLSS 1993 and 1998, and VHLSS 2002

Appendix Figure 2: ML approximation of the expenditure data to lognormal distribution by area, 2004–2008



Source: Author based on VHLSS 2004, 2006, and 2008

Appendix Figure 3: ML approximation of the expenditure data to lognormal distribution by area, 2010–2014



Source: Author based on VHLSS 2010, 2012, and 2014