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DECOMPOSING POVERTY CHANGE: DECIPHERING CHANGE IN TOTAL POPULATION AND BEYOND

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In the understanding of decomposing poverty change, the growth effect of mean income is replaced with the growth effect of total income and the impact of change in total population. These two, along with changes in inequality, form the three broader effects that can be computed in multiple ways depending upon the base period and the sequence of calculation. Changing the base does not alter the broader effects while specific attributions within each effect get interchanged. For a given base, there will be six possible sequences and we take an average of these to compute the three broad effects. Finally, poverty change on account of the three broad effects comprising growth of total income, change in inequality, and change in total population are shown as part of the within-group effect while change in population shares, which is different from change in total population, is a between-group effect. We provide empirical illustrations with data from India.

JEL Codes: C18, D63, I32

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1. INTRODUCTION

A question that we seek to explore in the current exercise is to understand the impact of change in total population in the decomposition of poverty change. We will do this by using the Foster, Greer, and Thorbecke (1984; hereafter FGT) poverty measure, which is additively decomposable by sub-groups of population.

In the literature on decomposing poverty change into growth and inequality effects (e.g., Jain and Tendulkar, 1990; Kakwani and Subbarao, 1990; Datt and Ravallion, 1992; Tsui, 1996; Kakwani, 2000), the impact of change in total population is concealed by the implicit assumption that the growth effect can be captured by looking at the growth rate of mean income. Huppi and Ravallion (1991) explore decomposition of poverty change within sectors of employment and

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changes in population shares between these sectors. This decomposition of within-group and between-group effects of poverty change has been given a formal shape by Son (2003). In particular, the decompositions based on growth and inequality form part of the within-group effect while changes on account of shifts in population shares form part of the between-group effect.

As mentioned earlier, we explore the role of change in total population on the decomposition of poverty change. This is in line with the larger thinking that the impact of economic growth on poverty reduction is likely to be reduced because of an increase in total population. Incorporating this also demands that growth effect, unlike the conventional usage of mean income, has to be based on changes in total income. Thus, we will have three effects: growth on account of total income, inequality, and change in total population. These three can be computed in multiple possibilities depending on the sequence that each is computed and the base year. Taking an average of all the possibilities, as an extension of Kakwani (2000), gives us three broad effects that are mutually exclusive. These are discussed in Section 3. To facilitate this and the subsequent discussions, notations are given in Section 2.

The three broad effects can be decomposed by sub-groups, as indicated in Section 4, an advantage of using the FGT measure. However, this will hold for any other poverty measure that is additively decomposable across sub-groups of population. In this section, the decomposition by Son (2003) is introduced and our three broad effects can be considered as part of the within-group effect while retaining the independent relevance of change in population shares as a between-group effect. We illustrate the methodological improvements with National Sample Survey (NSS) household data on consumption expenditure from India for 2004–05 and 2009–10 in Section 5. Concluding remarks are in Section 6.

2. Notations

There are two time periods, $t = 1, 2$ (or $\tau = 1, 2$; $t \neq \tau$), and in each period there are $i_t = 1_t, \ldots, n_t$ individuals who are non-decreasingly ranked by their income, x_{i_t}, where a_{i_t} is income share, m_t is average income, and X_t is total income.

In both periods, z is the poverty line and a person is poor if $x_{i_t} < z$. An individual's population share is b_{i_t}. The additively decomposable class of poverty measures by FGT can be represented in a general form as

$$P_{\alpha_t} = \sum\nolimits_{i_t=1}^{n_t} b_{i_t}\left(\frac{z - x_{i_t}}{z}\right)^{\alpha}; \alpha \geq 0. \tag{1}$$

In equation (1), $\alpha = 0$, 1, 2, denotes head count ratio (incidence), poverty gap (depth), and squared poverty gap (severity), respectively. The Lorenz ratio or Gini coefficient is denoted as L_t.

Each individual's income can be multiplied by a constant factor, $\lambda_v = \left(\frac{m_\tau}{m_t}\right), \left(\frac{X_\tau}{X_t}\right), \left(\frac{n_t}{n_\tau}\right); v = m, X, n$ denotes a distribution identified with the other period's mean income, total income, and total population, respectively. Thus,

(2) $$P_{\alpha_t|\gamma_\tau} = \sum_{i_t=1}^{n_t} b_{i_t} \left(\frac{z - \lambda_v x_{i_t}}{z} \right)^{\alpha}; \alpha \geq 0, \gamma_\tau = m_\tau, X_\tau, n_\tau.$$

There are $k = 1, \ldots, K$ groups, and group-specific income share, population share, mean income, total population, total income, poverty measure, Lorenz ratio, and a constant factor indicating change in individual income are denoted by $a_{i_{kt}}$, $b_{i_{kt}}$, m_{kt}, n_{kt}, X_{kt}, $P_{\alpha_{kt}}$, L_{kt}, and λ_{kv}, respectively. For illustration purpose, as also in our empirical exercise, we take two groups: rural, r, and urban, u. Poverty change is $\Delta P_\alpha = P_{\alpha_2} - P_{\alpha_1}$, while ΔP_{α_j}, ΔP_{α_k}, and $\Delta P_{\alpha_{jk}}$ refer to poverty change for specific effect ($j = X$, L, n denote growth, inequality, and population, respectively), group-specific effect, and both together, respectively. If there are N specific effects they can be computed in multiple ways and each method of computation is denoted by $s = 1, \ldots, S$.

3. Growth, Inequality, and Population Decompositions

3.1. *Analysis with Mean Income*

The literature on decomposition of poverty change has largely calculated growth and inequality effects where growth is based on changes in mean income. From equations (1) and (2), and following Heshmati (2004), one can compute growth and inequality decompositions in various ways. The one proposed by Kakwani and Subbarao (1990) is:

(3) $$\Delta P_\alpha = \left(P_{\alpha_1|m_2} - P_{\alpha_1}\right) + \left(P_{\alpha_2} - P_{\alpha_1|m_2}\right).$$

An alternative formulation suggested by Jain and Tendulkar (1990) is:

(4) $$\Delta P_\alpha = \left(P_{\alpha_2} - P_{\alpha_2|m_1}\right) + \left(P_{\alpha_2|m_1} - P_{\alpha_1}\right).$$

Kakwani (2000) suggested a simple averaging of both the growth and inequality components from equations (3) and (4), which is:

(5) $$\Delta P_\alpha = (1/2)\left\{\left(P_{\alpha_1|m_2} - P_{\alpha_1}\right) + \left(P_{\alpha_2} - P_{\alpha_2|m_1}\right)\right\} + (1/2)\left\{\left(P_{\alpha_2} - P_{\alpha_1|m_2}\right) + \left(P_{\alpha_2|m_1} - P_{\alpha_1}\right)\right\}.$$

3.2. *Bringing in Total Income*

Equations (3), (4), and (5) compute the growth effect of poverty change through an analysis of mean income. However, this would be different if the analysis were done through total income. In such an eventuality, equation (5) can be rewritten as:

(6) $$\Delta P_\alpha = (1/2)\left\{\left(P_{\alpha_1|X_2} - P_{\alpha_1}\right) + \left(P_{\alpha_2} - P_{\alpha_2|X_1}\right)\right\} + (1/2)\left\{\left(P_{\alpha_2} - P_{\alpha_1|X_2}\right) + \left(P_{\alpha_2|X_1} - P_{\alpha_1}\right)\right\}.$$

In equation (6), the growth components can be further decomposed into a mean income effect and an additional effect from total income after accounting for the mean income effect. Thus,

(7) $$\left(P_{\alpha_1|X_2} - P_{\alpha_1}\right) = \left(P_{\alpha_1|m_2} - P_{\alpha_1}\right) + \left(P_{\alpha_1|X_2} - P_{\alpha_1|m_2}\right), \text{ and}$$

(8) $$\left(P_{\alpha_2} - P_{\alpha_2|X_1}\right) = \left(P_{\alpha_2} - P_{\alpha_2|m_1}\right) + \left(P_{\alpha_2|m_1} - P_{\alpha_2|X_1}\right).$$

The growth effect on account of mean income is what Kakwani (2000) and others have already indicated. This could be considered as a sub-component of the larger growth effect. The mean income growth effect will be equal to the larger growth effect if there is no change in total population in the two periods. We elaborate this in Proposition 1. The proof of this and the subsequent propositions are given in Appendix 1.

Proposition 1. *If the two periods have the same total population, the growth effect on poverty change computed through an analysis of mean income will be the same as that computed through an analysis of total income. In other words, if* $n_t = n_\tau$ *then* $P_{\alpha_t|m_\tau} = P_{\alpha_t|X_\tau}$.

However, if $n_t \neq n_\tau$, one cannot conclusively state that $P_{\alpha_t|m_\tau}$ and $P_{\alpha_t|X_\tau}$ are likely to be different, as there is a possibility that they are similar: for instance, if total population and total income change in the same proportion, $\frac{n_\tau}{n_t} = \frac{X_\tau}{X_t}$; or, if a change in total population goes hand-in-hand with a change in inequality such that the combined effect leaves us with the same level of poverty.

Now, getting back to equation (6) by incorporating equations (7) and (8) gives:

(9) $$\Delta P_\alpha = (1/2)\left\{\left(P_{\alpha_1|m_2} - P_{\alpha_1}\right) + \left(P_{\alpha_2} - P_{\alpha_2|m_1}\right)\right\} + (1/2)\left\{\left(P_{\alpha_1|X_2} - P_{\alpha_1|m_2}\right) + \left(P_{\alpha_2|m_1} - P_{\alpha_2|X_1}\right)\right\} + (1/2)\left\{\left(P_{\alpha_2} - P_{\alpha_1|X_2}\right) + \left(P_{\alpha_2|X_1} - P_{\alpha_1}\right)\right\}.$$

The three components of equation (9) are growth effect on account of mean income, growth effect on account of total income after accounting for mean income, and inequality effect.

3.3. *Changes in Total Population*

What seems to be the inequality effect in equation (9) is actually a combination of inequality effect and an effect of change in total population. They are:

(10) $$\left(P_{\alpha_2} - P_{\alpha_1|X_2}\right) = \left(P_{\alpha_2|n_1} - P_{\alpha_1|X_2}\right) + \left(P_{\alpha_2} - P_{\alpha_2|n_1}\right), \text{ and}$$

$$(11) \qquad \left(P_{\alpha_2|X_1} - P_{\alpha_1}\right) = \left(P_{\alpha_2|X_1} - P_{\alpha_1|n_2}\right) + \left(P_{\alpha_1|n_2} - P_{\alpha_1}\right).$$

It is tautological that there will be no impact of change in total population if we have the same total population in both periods. Nevertheless, we elaborate this in Proposition 2.

Proposition 2. *If total population remains constant, the estimation of poverty by taking the total population of the other period should not change. In other words, if* $n_t = n_\tau$ *then* $P_{\alpha_t} = P_{\alpha_t|n_\tau}$.

Incorporating equations (10) and (11) in equation (9) gives:

$$(12) \qquad \begin{aligned} \Delta P_\alpha &= (1/2)\left\{\left(P_{\alpha_1|m_2} - P_{\alpha_1}\right) + \left(P_{\alpha_2} - P_{\alpha_2|m_1}\right)\right\} + (1/2)\left\{\left(P_{\alpha_1|X_2} - P_{\alpha_1|m_2}\right) + \left(P_{\alpha_2|m_1} - P_{\alpha_2|X_1}\right)\right\} \\ &+ (1/2)\left\{\left(P_{\alpha_2|n_1} - P_{\alpha_1|X_2}\right) + \left(P_{\alpha_2|X_1} - P_{\alpha_1|n_2}\right)\right\} + (1/2)\left\{\left(P_{\alpha_2} - P_{\alpha_2|n_1}\right) + \left(P_{\alpha_1|n_2} - P_{\alpha_1}\right)\right\}. \end{aligned}$$

In equation (12) there are four broad components: growth effect on account of mean income, growth effect on account of total income after accounting for mean income, inequality effect, and change in total population effect. If there is no change in total population between the two periods then, following Propositions 1 and 2, what we have are growth effect on account of mean income and inequality effect. Thus, if there will be no change in total population, the results from equation (12) will be the same as those from equations (9), (6), and (5).

Associated with the underlying relationship between mean income, total income, and population, an alternative interpretation of the growth effect on account of total income in equation (12) is that it could also denote an inverse population change effect, $-\Delta P_{\bullet|n}$, because $\left(P_{\alpha_1|X_2} - P_{\alpha_1|m_2}\right) = \left(P_{\alpha_1|X_2,n_1} - P_{\alpha_1|X_2,n_2}\right)$ and $\left(P_{\alpha_2|m_1} - P_{\alpha_2|X_1}\right) = \left(P_{\alpha_2|X_1,n_1} - P_{\alpha_2|X_1,n_2}\right)$. However, the purpose of the current exercise leading to equation (12) is to show that growth effect on account of total income is different from growth effect on account of mean income. Having done that, our next step is to show that if there are multiple effects, their possible computations in decomposing would also be multiple.

3.4. *Multiple Possibilities*

The possible ways of decomposing will depend on the sequence in which each effect is calculated, and the use of the base period. In our subsequent analysis, we will compute the decomposition of poverty change to three effects: growth of total income, inequality, and total population. We do this for two reasons. First, on account of the underlying relationship mentioned earlier, mean income is derived out of total income and total population, and hence we propose to compute the latter two effects.

Second, if there are N effects, there will be $N!$ ways of computing the decomposition. In fact, a recent paper by Shorrocks (2013) on a general approach to decomposition as a representation of the Shapley value also indicates something similar. Thus, the use of three effects will imply that there will be six possible ways of computing them; these will help us illustrate the extension of Kakwani (2000), which is an important aspect of the current exercise. The six ways of computing, with the first period as base, are given in equations (13) through (18).

Growth-inequality-population:

$$\Delta P_\alpha = \left(P_{\alpha_1|X_2} - P_{\alpha_1}\right) + \left(P_{\alpha_2|n_1} - P_{\alpha_1|X_2}\right) + \left(P_{\alpha_2} - P_{\alpha_2|n_1}\right), \tag{13}$$

Growth-population-inequality:

$$\Delta P_\alpha = \left(P_{\alpha_1|X_2} - P_{\alpha_1}\right) + \left(P_{\alpha_2|L_1} - P_{\alpha_1|X_2}\right) + \left(P_{\alpha_2} - P_{\alpha_2|L_1}\right), \tag{14}$$

Inequality-growth-population:

$$\Delta P_\alpha = \left(P_{\alpha_1|L_2} - P_{\alpha_1}\right) + \left(P_{\alpha_2|n_1} - P_{\alpha_1|L_2}\right) + \left(P_{\alpha_2} - P_{\alpha_2|n_1}\right), \tag{15}$$

Inequality-population-growth:

$$\Delta P_\alpha = \left(P_{\alpha_1|L_2} - P_{\alpha_1}\right) + \left(P_{\alpha_2|X_1} - P_{\alpha_1|L_2}\right) + \left(P_{\alpha_2} - P_{\alpha_2|X_1}\right), \tag{16}$$

Population-growth-inequality:

$$\Delta P_\alpha = \left(P_{\alpha_1|n_2} - P_{\alpha_1}\right) + \left(P_{\alpha_2|L_1} - P_{\alpha_1|n_2}\right) + \left(P_{\alpha_2} - P_{\alpha_2|L_1}\right), \text{ and} \tag{17}$$

Population-inequality-growth:

$$\Delta P_\alpha = \left(P_{\alpha_1|n_2} - P_{\alpha_1}\right) + \left(P_{\alpha_2|X_1} - P_{\alpha_1|n_2}\right) + \left(P_{\alpha_2} - P_{\alpha_2|X_1}\right). \tag{18}$$

The six possible decompositions have three components each. We explain them by using equation (13) for illustration. The first component $\left(P_{\alpha_1|X_2} - P_{\alpha_1}\right)$ is on account of growth. In the notations, total income changes while population and inequality are fixed for the first period. The middle component $\left(P_{\alpha_2|n_1} - P_{\alpha_1|X_2}\right)$ is on account of inequality. Here the notations indicate that population is fixed for the first period and total income is fixed for the second period while inequality changes. This is so because the inequality effect is computed after the growth effect has been computed. Thus, this inequality effect is conditional on growth. The third component $\left(P_{\alpha_2} - P_{\alpha_2|n_1}\right)$ is on account of population. The notations have population changing while total income and inequality are fixed for the second period. With the first period as base, it is conditional on growth and inequality effects. However, if the base changes, the sequence of the three components will get reversed and one could interpret that the population effect is straightforward, inequality effect is conditional on population, and growth effect is conditional on population and inequality.

TABLE 1

Decomposing Poverty Change by Combining All Possibilities with First Period as Base

Effect	Specific Attributions	Weight	Components with P_{α_1} Base
Growth (total income/MPCE)	Growth alone	One-third	$P_{\alpha_1\|X_2} - P_{\alpha_1}$
	Growth given inequality	One-sixth	$P_{\alpha_2\|n_1} - P_{\alpha_1\|L_2}$
	Growth given population	One-sixth	$P_{\alpha_2\|L_1} - P_{\alpha_1\|n_2}$
	Growth given inequality and population	One-third	$P_{\alpha_2} - P_{\alpha_2\|X_1}$
Inequality	Inequality alone	One-third	$P_{\alpha_1\|L_2} - P_{\alpha_1}$
	Inequality given population	One-sixth	$P_{\alpha_2\|X_1} - P_{\alpha_1\|n_2}$
	Inequality given growth	One-sixth	$P_{\alpha_2\|n_1} - P_{\alpha_1\|X_2}$
	Inequality given population and growth	One-third	$P_{\alpha_2} - P_{\alpha_2\|L_1}$
Population (total)	Population alone	One-third	$P_{\alpha_1\|n_2} - P_{\alpha_1}$
	Population given growth	One-sixth	$P_{\alpha_2\|L_1} - P_{\alpha_1\|X_2}$
	Population given inequality	One-sixth	$P_{\alpha_2\|X_1} - P_{\alpha_1\|L_2}$
	Population given growth and inequality	One-third	$P_{\alpha_2} - P_{\alpha_2\|n_1}$

Note: If we change the base the broader effects will remain the same, but the interpretation of the specific attributions will change.

Source: Author's calculations.

Each of the three broad effects will have a component in each of the six equations, (13) through (18). Thus, for each broad effect, the contribution to change in poverty can be computed by averaging the contribution from all the six possibilities:

$$\Delta P_{\alpha_j} = \frac{1}{S}\sum_s \Delta P_{\alpha_{js}};\ j = X, L, n;\ s = 1, \dots, S. \tag{19}$$

A careful observation of the six components for each broad effect shows that when the component is at the beginning or at the end of the sequence, it is repeated twice, whereas when it is in the middle it is unique. The interpretation of the components for each broad effect with the first period as base is presented in Table 1. This, along with equation (19), takes us to Proposition 3.

Proposition 3. *Poverty change can be decomposed into growth of total income, inequality, and change in total population effects that are independent and mutually exclusive. In other words,*

$$\Delta P_{\alpha} = \sum_j \Delta P_{\alpha_j};\ j = X, L, n. \tag{20}$$

For calculations using equations (3) through (6) one can compute any one of the effects and the remainder will be the other effect. This means that one can work with the growth effect and keep away from the messy world of controlling inequality and computing its effect directly. With three or more effects, it is possible to resort to the remainder approach only after computing $N - 1$ effects. One can use it for all six possibilities or at the aggregate level. Keeping this aside, we now take up a discussion on controlling inequality.

3.5. *Controlling for Inequality*

In their computation of growth (mean income) and inequality effects, Datt and Ravallion (1992) control for inequality parametrically. We take a fig leaf, but instead control for inequality by maintaining income shares and population shares for one period while using the total income or total population for the other period. This gives us two propositions.

Proposition 4. *The measure of poverty for one period where inequality is the same as that of the other period will be equal to a measure of poverty for the other period where the mean income is the same as that from the earlier period. In other words,* $P_{\alpha_t|L_\tau} = P_{\alpha_\tau|m_t}$.

The result in Proposition 4 can also be written as $P_{\alpha_t|L_\tau} = P_{\alpha_\tau|m_t} = P_{\alpha_\tau|X_t,n_t}$. Similarly, $P_{\alpha_t|X_\tau} = P_{\alpha_\tau|L_t,n_t}$ and $P_{\alpha_t|n_\tau} = P_{\alpha_\tau|L_t,X_t}$. These mean that a measure of poverty for one period where we control for only one of the three effects (growth of total income, inequality, and change in total population) from the other period will be equal to a measure of poverty for the other period that controls for the other two effects from the earlier period.

Proposition 5. *If mean income and inequality remain the same, then any change in total income will have to be matched by a proportionate change in total population and vice versa and there will be no change in estimates of poverty. In other words, if* $m_t = m_\tau$ *and* $L_t = L_\tau$ *then* $\frac{X_t}{X_\tau} = \frac{n_t}{n_\tau}$ *and* $P_{\alpha_t} = P_{\alpha_\tau}$.

4. Sub-Group Decompositions

Each component of Table 1 has two parts (the minuend and the subtrahend) and each part is independently decomposable by sub-groups. In Proposition 6, we indicate that they can also be decomposable by sub-groups together.

Proposition 6. *The growth, inequality, and change in total population effects on poverty change given in equation (20) or other similar formulations are additively decomposable by sub-groups of population.*

This, along with Proposition 3, indicates that

$$\Delta P_\alpha = \sum_{k=1}^{K} \Delta P_{\alpha_k} = \sum_j \sum_{k=1}^{K} \Delta P_{\alpha_{jk}}; \; j = X, L, n. \tag{21}$$

On sub-group decompositions, it is worthwhile to bring in the contribution of Son (2003), who decomposes poverty change to within-group and between-group effects,

$$(22)\quad \Delta P_\alpha = \left(P_{\alpha_2} - P_{\alpha_1}\right) = \left(\sum\nolimits_{k=1}^{K} b_{k2} P_{\alpha_{k2}}\right) - \left(\sum\nolimits_{k=1}^{K} b_{k1} P_{\alpha_{k1}}\right)$$
$$= \left(\left(\sum\nolimits_{k=1}^{K} b_{k2} \Delta P_{\alpha_k}\right) + \left(\sum\nolimits_{k=1}^{K} b_{k1} \Delta P_{\alpha_k}\right) + \left(\sum\nolimits_{k=1}^{K} P_{\alpha_{k2}} \Delta b_k\right) + \left(\sum\nolimits_{k=1}^{K} P_{\alpha_{k1}} \Delta b_k\right)\right) \Big/ 2$$
$$= \left(\left(\sum\nolimits_{k=1}^{K} \left(\frac{b_{k1} + b_{k2}}{2}\right) \Delta P_{\alpha_k}\right) + \left(\sum\nolimits_{k=1}^{K} \left(\frac{P_{\alpha_{k1}} + P_{\alpha_{k2}}}{2}\right) \Delta b_k\right)\right).$$

This decomposition of Son (2003) can be superimposed on our formulation suggested in equation (21) or any other formulations. This gives us proposition 7.

Proposition 7. *The within-group effect can be decomposed into growth, inequality, and change in total population components; it is independent of the between-group effect on account of change in population shares, and all these within- and between-group components are decomposable by sub-groups and are mutually exclusive. In other words,*

$$(23)\quad \Delta P_\alpha = \left(\left(\sum\nolimits_{j} \sum\nolimits_{k=1}^{K} \left(\frac{b_{k_1} + b_{k_2}}{2}\right) \Delta P_{\alpha_{jk}}\right) + \left(\sum\nolimits_{k=1}^{K} \left(\frac{P_{\alpha_{k1}} + P_{\alpha_{k2}}}{2}\right) \Delta b_k\right)\right);\ j = X, L, n.$$

This means that our decomposition of poverty change indicated in equation (20) could be further decomposed to within-group and between-group effects of Son (2003). The within-group effect will have three components representing growth of total income, inequality, and change in total population, while the between-group effect represents the impact of change in population shares and all the components are mutually exclusive.

There are two population-related components: one is on account of change in total population, as a sub-component of the within-group effect; and the other is on account of changes in population shares between groups. In the former case, an increase in total population, with total income and inequality remaining constant, will lead to an increase in poverty for that group and this is feasible for all groups. The latter is a between-group effect of change in population shares. In this, if the status quo is not maintained, then at least one group has to have a positive impact and at least one group has to have a negative impact. Thus, if there are two groups, like rural and urban, it will be positive for one and negative for the other.

The above arguments have been made for FGT, but they can be extended to any poverty measure that can be decomposable by sub-groups. Now, we provide some empirical illustrations.

5. Empirical Illustrations

Our empirical illustrations use household level National Sample Survey (NSS) data from India for 2004–05 and 2009–10. These are consumption surveys and we use monthly per capita consumption expenditure (MPCE) as an outcome indicator to represent an individual's well-being, which should be considered as a measure of income in our earlier formulations. Poverty lines are absolute and are based on a reference commodity basket of urban India for 2004–05 that has been computed and provided by the Planning Commission (2011, 2012) and is sector (rural/urban) and state specific. Populations used are estimates based on interpolations from the 2001 and 2011 censuses of India and are sub-group consistent while being sector and state specific.

In our calculation, appropriate adjustments were made to average MPCE for the unit household using the reference commodity basket as a basis so that the estimated values are real and comparable. The data for each year are arranged in an ascending order based on the value of comparable average MPCE. Based on the sample design, each household is assigned a multiplier that can be used to arrive at population estimates. For each household, a product of this household-specific multiplier with the household's family size will give the survey specific population that the sample household represents. We adjust this with sub-group consistent population estimates that we interpolated from censuses to arrive at the overall population that each sample observation represents. Taking a product of the comparable average MPCE with the overall population that the observation represents gives us the overall MPCE that the observation represents. In addition, we compute the overall MPCE share and overall population share for each observation separately for both the years. A sum of overall MPCE and overall population across all observations gives us total MPCE and total population.

Our subsequent computations controlled three things—total MPCE, total population, and inequality (depends on share of overall MPCE, and share of overall population, for each observation together)—by using the same for the other period; note that a change in total MPCE will also change overall MPCE, while a change in total population will change overall population and through it the overall MPCE. The controls that we used in our calculations were always sector and state specific. With two sectors (rural and urban) and 35 states/union territories, we have $k = 70$ groups at the all India level and 35 groups for each sector.

Inequality was controlled by using the other period's share of MPCE, $a_{i_{k\tau}}$, and population, $b_{i_{k\tau}}$, which means using the dataset for the other period along with the group specific total MPCE, X_{kt}, and total population, n_{kt}, for the current period, implying that a change in inequality can be explained by a change in mean MPCE of the other period (recall Proposition 4). A change in mean MPCE, total MPCE, and total population will lead to a change in total MPCE and through that to a change in overall MPCE by a constant factor λ_{kv} which is $\frac{m_{k\tau}}{m_{kt}}$, $\frac{X_{k\tau}}{X_{kt}}$, and $\frac{n_{kt}}{n_{k\tau}}$, respectively, and this computation was also carried out in our data. This gives us three additional variables of average MPCE; we computed incidences of poverty for these in both years and have used the same in our subsequent discussion on decomposition of changes in poverty.

The basic particulars of the data, which includes poverty incidence, total MPCE, and total population for rural, urban, and all India, are given in Appendix 2. With more than a billion people, the impact of an increase in population on decomposition of poverty change is important.

In Table 2 we show impact of growth, inequality, and change in total population on change in the incidence of poverty for India by rural and urban sectors

TABLE 2

Growth, Inequality, and Change in Total Population Effects on Change in Incidence of Poverty for India by Rural and Urban Sector, 2004–05 and 2009–10: A First Step

Sector	Components	Method 1	Method 2	Method 3
Rural	Growth effect of mean MPCE, given inequality	−7.64	−7.63	−7.64
	Additional growth effect, given inequality	−5.49	−6.15	−5.82
	Inequality effect, given total MPCE	−0.79	−0.50	−0.65
	Total population effect, given MPCE and inequality	5.75	6.11	5.93
	Total rural effect	−8.17	−8.17	−8.17
Urban	Growth effect of mean MPCE, given inequality	−6.38	−6.53	−6.46
	Additional growth effect, given inequality	−6.90	−8.98	−7.94
	Inequality effect, given total MPCE	1.64	1.82	1.73
	Total population effect, given MPCE and inequality	6.95	9.00	7.98
	Total urban effect	−4.69	−4.69	−4.69
Combined	Growth effect of mean MPCE, given inequality	−7.27	−8.80	−8.04
	Additional growth effect, given inequality	−5.90	−1.88	−3.89
	Inequality effect, given total MPCE	−0.09	−3.42	−1.75
	Total population effect, given MPCE and inequality	5.89	6.72	6.31
	Total effect (rural + urban)	−7.37	−7.37	−7.37

Note: Methods 1–3 are extensions of equations (3), (4), and (5), respectively. Total may not add up to the sub-components because of rounding off.

Source: Author's calculations.

based on equation (12). As expected, growth leads to a reduction in poverty while an increase in total population contributes to an increase in poverty. The inequality effect reduces poverty in rural areas but leads to an increase in urban areas. However, as discussed in the formulation, this method of decomposing more than two effects gives an incomplete picture.

By taking three broad effects—growth (total MPCE), inequality, and total population—we show in Table 3 the decomposition indicated in equation (20) by taking the first period (2004–05) as the base year. The observations from Table 2 get substantiated in Table 3. Growth has been having a poverty reducing effect, increase in total population has had a poverty enhancing effect, while inequality has led to a reduction of poverty in rural areas and an increase of poverty in urban areas.

The results of incorporating Son (2003) into our specification of equation (23) are given in Table 4. It reiterates some of our earlier observations and gives some additional insights. Growth effect reduces poverty and it is relatively more in rural areas. Inequality reduces poverty in rural areas but increases poverty in urban areas. Increase in total population leads to an increase in poverty that is relatively more in rural areas. Changes in population shares between rural and urban areas have reduced poverty in rural areas and increased it in urban areas; the combined effect suggests a decline in poverty, indicating that migration from rural to urban areas might have helped in reducing poverty.

6. Concluding Remarks

Conventionally the decompositions of poverty change had focused on two effects: growth and inequality. This growth effect relied on changes in mean

TABLE 3

Growth, Inequality and Change in Absolute Population Effects on Change in Incidence of Poverty for India by Rural and Urban Sector, 2004–05 and 2009–10: Combining Multiple Possibilities

Effect	Specific Attributions	Rural	Urban	Combined
Growth (total income)	Growth alone	–4.38	–4.43	–4.39
	Growth given inequality	–2.23	–2.25	–2.45
	Growth given population	–2.29	–2.56	–2.33
	Growth given inequality and population	–4.59	–5.17	–3.56
	Total growth effect	–13.49	–14.41	–12.73
Inequality	Inequality alone	–0.18	0.61	0.47
	Inequality given population	–0.08	0.30	–0.57
	Inequality given growth	–0.13	0.27	–0.01
	Inequality given population and growth	–0.18	0.56	–0.03
	Total inequality effect	–0.57	1.76	–0.14
Population (total)	Population alone	2.04	3.00	2.24
	Population given growth	0.91	1.15	0.98
	Population given inequality	1.02	1.50	0.31
	Population given growth and inequality	1.92	2.32	1.96
	Total population effect	5.89	7.96	5.50
Total	Total effect	–8.17	–4.69	–7.37

Note: The weights used for each specific attribution are as indicated in Table 1 with first period as base. Total may not add up to the sub-components because of rounding off.
Source: Author's calculations.

TABLE 4

Growth, Inequality and Change in Total Population Effects on Change in Incidence of Poverty for India by Rural and Urban Sector, 2004–05 and 2009–10: Within- and Between-Group Effects

Effect	Specific Attributions	Rural	Urban	Combined
Within group	Growth (total MPCE)	–9.45	–4.32	–13.77
	Inequality	–0.40	0.53	0.13
	Population change (total)	4.13	2.39	6.51
	Total within group	–5.72	–1.41	–7.13
Between group	Population change (share)	–0.63	0.39	–0.25
Total	Total effect	–6.35	–1.02	–7.37

Note: Total effect may not add up to the sub-components because of rounding off.
Source: Author's calculations.

income. We suggest that a reliance on mean income combines the changes in total income and total population, and hence, as a first step, build a case for separating these out.

Going beyond this first step we realized that there are multiple possibilities of separating out different effects. It depends on the base year (that is, whether to contrast with the poverty estimates of the first period or the second period), and the sequence to follow in calculating different effects. Given the three effects, we observed that there are six possible ways of decomposing poverty change into growth, inequality, and total population effects for a given base. Averaging these gives us three broad effects. A change in base alters the specific attribution/ interpretation, but the broader effects remain the same. Thus, we suggest that we choose a single base and delineate all components for a broader understanding of decomposing poverty change.

Finally, the three broader effects (as also its sub-components) can be considered as part of the within-group effect that is independent of the between-group effect of change in population shares. This also allows for additive decomposability over components and across groups.

We provide empirical illustrations with Indian data for 2004–05 and 2009–10. It shows a reduction in poverty (more so in rural areas) due to growth in total income. Inequality has led to a reduction in poverty in rural areas and an increase in urban areas. Increase in total population has led to an increase in poverty that is relatively higher for rural areas. Changes in population shares suggest that migration from rural to urban areas is likely to have contributed to reductions in poverty.

To sum up, our paper has methodological improvements that on the one hand draws from Kakwani (2000) and then incorporates these with that of Son (2003). These are illustrated with recent data from India. An important contribution of this exercise from a policy perspective is that if an increase in population can come in the way of poverty reduction, this should be part of the discussion on decomposition of poverty change.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Appendix 1: Proof of Propositions
Appendix 2: Basic Particulars of Data