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Poverty Accounting by Factor Components

With an Empirical Illustration Using Chinese Data

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Abstract

The purpose of this paper is to develop two poverty decomposition frameworks and to illustrate their applicability. A given level of poverty is broadly decomposed into an overall inequality component and an overall endowment component in terms of income or consumption determinants or input factors. These components are further decomposed into finer components associated with individual inputs. Also, a change in poverty is decomposed into components attributable to the growth and redistributions of factor inputs. An empirical illustration using Chinese data highlights the importance of factor redistributions in determining poverty levels and poverty changes in rural China.

Keywords: poverty decomposition, factor components, inequality, Shapley value, China

JEL classification: I32, D33, C43

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1 Introduction

Culminating in the Millennium Declaration, poverty reduction has been the most important and overarching goal of development for a decade or so. Despite controversies over the roles of growth versus redistribution (Dollar and Kraay 2002), one cannot refute the use of redistribution[1] as a powerful weapon in the fight against poverty when the size of the economic pie is given. On the other hand, growth is bound to benefit the poor if it does not induce more inequality. At any particular point of time, the size of the pie or resource base is predetermined. Under this static circumstance, redistribution is the only option for reducing poverty. Over time, however, growth may occur, leading to the expansion in the size of the resource base or the pie. Under this dynamic circumstance, the nature of growth has intrinsic bearings on the poverty profile. An equitable growth process or a fair distribution of extra resources or welfare generated by growth is needed to ensure that poverty does not to rise over time. To reduce poverty requires progressive redistribution of the initial and/or expanded pie or resources.

Thus, the central issue is not so much about the question '*if* growth or redistribution helps reduce poverty?', but it is of greater significance and urgency is to address '*what* or which factor growth and redistribution for poverty reduction?' Since economic outputs are produced by factor inputs and output distributions are essentially driven by factor distributions, it would be particularly interesting and indeed important to ascertain by how much poverty increases or decreases when these fundamental determinants of outputs are redistributed and/or their quantities alter. This can produce valuable insights into which factor growth and/or redistribution is more important in affecting poverty or its changes.

Clearly, what is needed is a prescriptive rather than a descriptive approach to poverty decomposition. While valuable, the descriptive approach prevailing in the literature focuses largely on the symptoms of poverty such as measuring overall poverty and decomposing it by sector, location or population subgroups. The prescriptive decomposition, as proposed in this paper, directly identifies and quantifies the causes or sources of poverty. To comprehend the prescriptive approach better requires a change of perception on growth-vs-redistribution effects from being output-based to being input-based. From the output-based perspective, the concepts of 'growth' and 'redistribution' are in terms of outputs of economic activities, such as GDP, income and consumption. In contrast, from the input-based perspective, growth and redistribution are in terms of factor inputs or determinants of economic outputs. Under the conventional output-based perspective, research findings and policy recommendations are confined to either 'more output growth' or 'progressive output redistribution'. This perception seems somehow restrictive, rendering the findings too general or too broad to policymakers who, in all likelihood, would ask: what growth and redistribution—capital, education, infrastructure or other factor inputs?

The answer to these vital and pragmatic questions appeals to poverty decomposition by factor components—attributing poverty and poverty changes to fundamental determinants of economic activities. Two such decompositions are developed in this

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[1] In this paper, redistribution is not only referred to transfer or reallocation of outputs from, but also reallocation of inputs into, economic activities.

paper, respectively corresponding to the static and dynamic cases discussed earlier. In the static case, accounting for the *level* of poverty (or simply level accounting/decomposition) can help to reveal the compositions of a given poverty, which provides information on the consequences of factor redistributions on poverty. In the dynamic case, accounting for the *change* in poverty (or simply difference accounting/decomposition) can help to discover the sources of increased or decreased poverty, which yields information on the impacts of growths and distributions of various fundamental determinants on poverty dynamics. Both forms of accounting offer useful ingredients for the formulation and execution of development policies and strategies. In fact, they are complementary to each other, given that the current level of poverty may affect subsequent growth and that policymakers are confronted with both the level of and the changes in poverty. As long as redistribution remains a policy option, the level decomposition is relevant. It is interesting to note the parallel literature on inequality accounting where attention has been mostly focused on the level issue.

Poverty decomposition by factor components appears to be absent in the current literature. A related contribution is that by Datt and Ravallion (1992), who have popularized the growth-vs-redistribution decomposition of poverty change. This important contribution falls within the output-based perception; the critical link of poverty with its fundamental determinants was not considered. As mentioned earlier, insofar as income or expenditure (or any other output variable of human wellbeing)[2] is a function of more fundamental variables, it is possible and useful to establish such a link, which will enable identification of the growth and redistribution effects of these individual factors on poverty.

This paper is written with two major objectives in mind. First, we develop two poverty accounting frameworks. The level decomposition is presented in section 2, while changes of poverty or the dynamic decomposition are considered in section 3. Next, we illustrate the applicability of these decomposition techniques in section 4, where we decompose poverty levels and the change in poverty in rural China. Section 5 concludes the paper.

2 Accounting for the level of poverty[3]

It has been rigorously established that for a given poverty line z, the level of poverty $P(Y; z)$, measured in terms of income or expenditure Y, is totally determined by the distribution of Y. The distribution of Y can be characterized by its mean and its Lorenz curve. Assuming, for ease of exposition, there are two or two groups of fundamental variables used for producing Y, say X_i and X_j, so that $Y = f(X_i, X_j)$, then the poverty level $P(Y; z)$ can be equivalently expressed as $P(X_i, X_j; z)$.

2 Income or expenditure will be used as the target variable in this paper, but use of other measures of human wellbeing does not change the thrust of the paper.

3 In a different context, the level of poverty can be decomposed into chronic and transitory components. See Thorbecke (2004). Poverty can also be decomposed by sectors or population subgroups. Both decompositions are essentially descriptive in nature rather than prescriptive.

When all factors are distributed evenly among all N agents or recipients (i.e., $X_i = \mu_i$ and $X_j = \mu_j$), Y is identical for everyone and inequality in Y disappears. As a consequence, all recipients receive $\mu_Y = f(\mu_i, \mu_j)$ where μ denotes mean or expected values appropriately indexed. The corresponding poverty $P(\mu_Y; z)$,[4] if any remain at all, is then entirely attributable to the shortage of resource endowments. Consequently, we can define $P_E(Y; z) = P(\mu_Y; z)$ as the endowment component of poverty, any reduction of which cannot be achieved by redistribution but only by increasing resources. Since $P_E(Y; z)$ represents poverty with completely even distributions of all resources and $P(Y; z)$ represents poverty with existing (most likely uneven) distributions of the same resources, the difference $P(Y; z) - P_E(Y; z)$ naturally represents contributions due to resource redistributions. Therefore, we can define $P(Y; z) - P_E(Y; z) \equiv P_R(Y; z)$ as the redistribution or inequality component of poverty. Such a definition is consistent with the 'before-and-after' principle of Cancian and Reed (1998). It is also used by Shorrocks (1980, 1982, 1984) for developing the classic frameworks of inequality decomposition by factor components or population subgroups. $P_R(Y; z)$ measures how much poverty could be reduced if all factors were evenly distributed. In other words, it measures that part of poverty caused by unequal distribution of resources.

Following the above discussions, the observed poverty level can be expressed as:

$$P(Y; z) = P_E(Y; z) + P_R(Y; z) \tag{1}$$

When the redistributions of Xs are sufficient for eliminating poverty, $P_E(Y; z) = P(\mu_Y; z) = 0$ and $P(Y; z) = P_R(Y; z)$. This corroborates with the scenario that there are sufficient resources; but poverty exists merely due to the distributional problem.

Equation (1) might be useful, but not very interesting. In particular, when the headcount ratio is used, $P_E(Y; z) = P(\mu_Y; z)$ can only take two values: 0 if $\mu_Y > z$ or 100 per cent otherwise. It is more challenging and useful to further decompose $P_R(Y; z)$ and $P_E(Y; z)$ into finer components associated with individual determinants of Y. That is to work out:

$$P_R(Y; z) = P_R(X_i) + P_R(X_j) \tag{2}$$

$$P_E(Y; z) = P_E(X_i) + P_E(X_j) \tag{3}$$

where subscript R indexes a redistribution component and E an endowment component.[5]

By definition, $P_R(X_i)$ represents poverty that is caused by unequal distribution of X_i. To obtain its value, the so-called before-after principle can be used. This principle is widely used in different contexts by other researchers, in addition to Shorrocks (1980, 1982, 1984) and Cancian and Reed (1998). Here, it involves constructing counterfactuals with and without the equal distribution of X_i and then measuring the corresponding poverty

4 μ_Y is a scalar but will be treated as a vector whenever necessary and appropriate. Such an abuse of notation does not seem to cause confusion.

5 To simplify notations but also maintain consistency, z will be dropped hereafter from expressions where input variables rather than Y are used as arguments of a poverty measure.

levels. The difference between these two levels is defined as the marginal contribution of X_i to the redistribution component of poverty, denoted by $MC_R(X_i)$:

$$MC_R(X_i) = P(X_i, X_j) - P(\mu_i, X_j) \tag{4}$$

Similarly,

$$MC_R(X_j) = P(X_i, X_j) - P(X_i, \mu_j) \tag{5}$$

These marginal contributions are termed first-round effects because the before-after principle can also be used to obtain:

$$MC_R(X_i) = P(X_i, \mu_j) - P(\mu_i, \mu_j) \tag{6}$$

$$MC_R(X_j) = \mathrm{P}(\mu_i, X_j) - \mathrm{P}(\mu_i, \mu_j) \tag{7}$$

Faced with multiple estimates of the same marginal contribution, an average can be obtained and defined as the contribution of factor X to the distributional component of poverty:

$$P_R(X_i) = 0.5\{[P(X_i, X_j) - \mathrm{P}(\mu_i, X_j)] + [P(X_i, \mu_j) - P(\mu_i, \mu_j)]\} \tag{8}$$

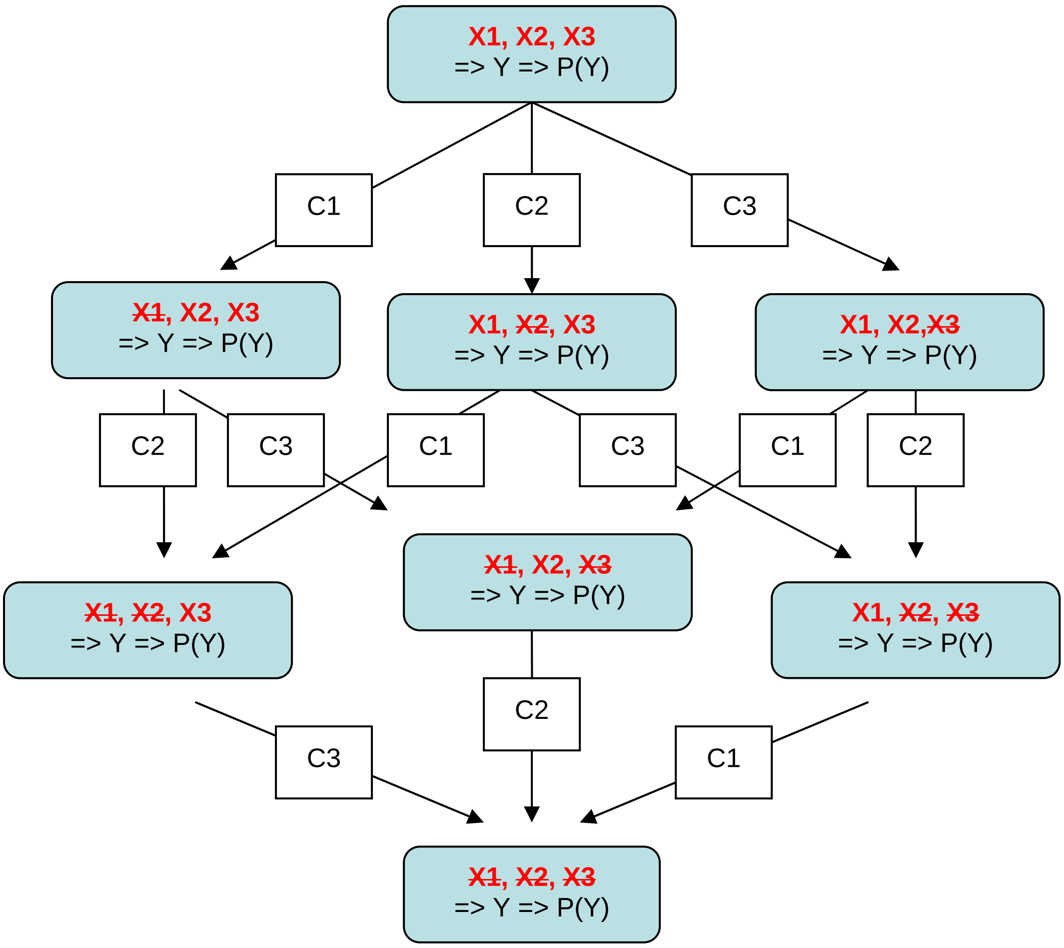
$$P_R(X_j) = 0.5\{[P(X_i, X_j) - \mathrm{P}(X_i, \mu_j)] + [P(\mu_i, X_j) - \mathrm{P}(\mu_i, \mu_j)]\} \tag{9}$$

Is the above an arbitrary or ad hoc procedure? Not so, according to the Shapley value founded on the cooperative game theory (Shapley 1953, Moulin 1988, Shorrocks 1999, Sastre and Trannoy 2002). The Shapley value also ensures the validity of (2) and (3) when the poverty components are obtained according to (4) - (9).

Figure 1 illustrates the Shapley procedure when there are three input variables $X1$-$X3$. In the Figure, crossed Xs denote mean values of Xs, $P(Y)$ represents poverty levels for a given poverty line when Y are obtained by substituting Xs or crossed Xs into the underlying function $Y = f(X1\text{-}X3)$. The symbols $C1$-$C3$ represent marginal contributions of Xs, calculated as the difference in poverty between the relevant two boxes. The same procedure is used in decomposing the overall endowment component and also for constructing the framework of poverty-difference accounting in section 3. Readers are referred to Shorrocks (1999) for technical details including various proofs.

The key feature of the Shapley procedure lies in the replacement of arguments in the relevant function, for example replacing Xs by their mean values. In the first round (corresponding to the first layer of Figure 1), one argument is replaced at a time. In the second round (second layer of Figure 1), two arguments are replaced at a time. This continues until the K-th round where all arguments are replaced at once. At each round, all possible combinations of replacement must be exhausted and estimates for the same marginal contribution are averaged to obtain an expected contribution. The expected contributions from different rounds are then averaged again to produce the final contribution.

Figure 1
Shapley decomposition of poverty



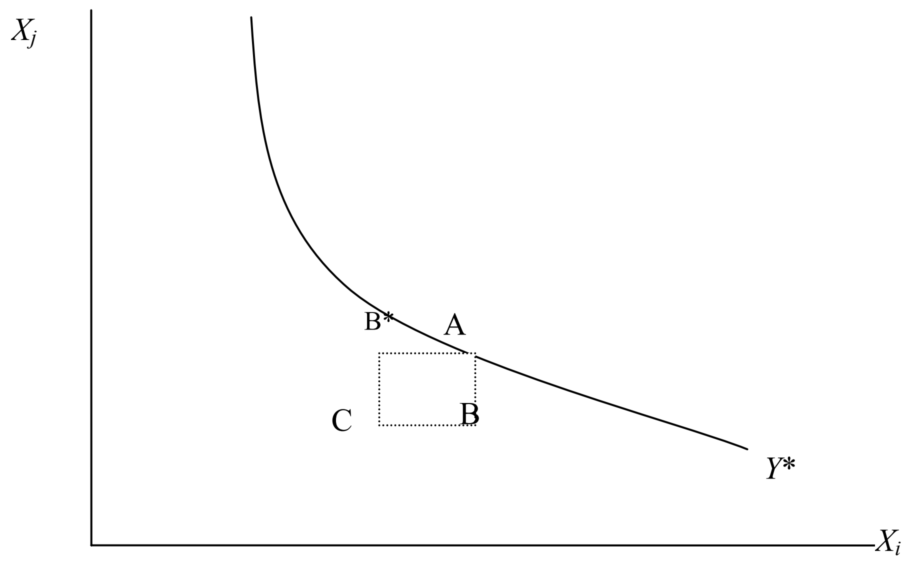
It is possible that the redistribution of one factor, say *X*, is sufficient to wipe out poverty. In this case, two scenarios must be considered. In the first scenario, all factor redistributions except that of *X* contribute nothing to poverty reduction. In this case, the Shapley procedure assigns 100 per cent contributions to *X*, zero to other factors, say $\underline{X}$. In the second scenario where redistributions of $\underline{X}$ contribute *q* per cent to poverty reduction, it is conceivable that policymakers may choose to redistribute these factors. Consequently, the marginal contribution of factor *X* equals to 100 minus *q*. Thus, the averaged percentage contribution of factor *X* is 0.5(100 + 100 – *q*) = 100 – 0.5 *q*.

We now turn to the decomposition of the endowment component. Recall that when redistributions are sufficient for poverty elimination, this component is zero. In this case, its decomposition is not needed. Only when redistributions of all factors fail to eliminate poverty, such decompositions are useful in the sense that they will provide information on the relative importance of additional resources for poverty eradication. Referring to Figure 2, after accounting for the redistribution component, every agent is now operating at the same point in the production space, say C, where average *X*s are used to produce μ_Y. Using Y^* to denote the indifference curve or isoquant given by $Y^* = f(X_i, X_j) = z$, the distance from C to the line Y^* indicates poverty severity after redistributing Xs. This distance signifies the shortfall of resources Xs needed for reaching the poverty line.

To eliminate poverty, point C must be moved onto or beyond Y^*. Since any point beyond Y^* is the same as those on Y^* as far as poverty elimination is concerned and the ultimate objective is poverty elimination with limited and costly resources, the optimal action is to simply move to a point on Y^*, say A. Consequently, the difference in poverty between points C and A can be defined as the endowment component of poverty. It must be kept in mind that no inequality is to be re-introduced when constructing the framework for decomposing the endowment component. That is, every agent must be assumed to possess the same amount of resources

Once point A is located, decomposing the endowment component can proceed as follows. From A to B, no change occurs to X_i, thus the difference in poverty between A and B is due to shortfall in X_j. We can define this difference as the marginal contribution of X_j to the endowment component. The same marginal contribution can be obtained for the movement from C to B*. Similarly, X_j remains unchanged from C to B, thus the difference in poverty between B and C can be defined as the marginal contribution of X_i, so is the difference in poverty between A and B*. Based on the Shapley value, averages can be computed and defined as the final estimates of factor contributions to the overall endowment component. Since for any X it is always valid to write $X^* = \mu_X + \Delta X$, where X^* denote inputs at point A. The Shapley procedure described earlier can be applied here by replacing X^*s by the mean values of Xs or μ_X (point C in Figure 2).

Figure 2
Decomposing the endowment component of poverty



How to identify A or X^* then? By theory of production, the optimal strategy is to move along the expansion paths of the income generation function $Y = f(X_i, X_j)$. Once the function is estimated, it is straightforward to solve for X^* or ΔX. This, in general, requires information on factor prices of Xs, which may not be available in many cases, especially when human capital variables are involved. Fortunately, the popular Cobb-Douglas, CES and homogenous translog functions, commonly used in production modelling, are homothetic. Under homotheticity, all expansion paths coincide and can be represented graphically as a straight line from the origin of the production space, implying proportionate usage of factor inputs. In this case, $X^* = r\,\mu_X$ for all Xs and $Y^* = f\,(r\,\mu_X) = z$, which can be solved for the only unknown scalar r. In the human capital literature, the semilog form or Mincerian function is most popular. This function is not homothetic. Under this circumstance, decomposing the total endowment effect into factor components does not seem possible unless factor prices for experience and education are known. In this case, one may rely on homotheticity as a reasonable assumption or approximation. It is noted that to be unable to break down the overall endowment component does not affect the usefulness of other decomposition results.

Measurement of these endowment effects is informative not only because it allows ranking of various resources for poverty elimination. More importantly, it can shed light on the likely time horizon for poverty reduction. For example, if education is found to dominate the endowment component, a short-run solution may not be hoped for. On the other hand, if physical capital is dominating, aid and borrowings may suffice for significant reduction in poverty.

3 Accounting for poverty difference[6]

Accounting for poverty changes typically follows Datt and Ravallion (1992) which is similar to Jain and Tendulkar (1990) and Kakwani and Subbarao (1990). Apart from the perception issue discussed in the introduction section of this paper, the Datt-Ravallion framework comes with a residual term which may obscure main findings from numerical analyses. Kolenikov and Shorrocks (2005) introduce the Shapley value approach, leading to the disappearance of the residual term. The latter, however, still maintains the output-based perception.

Let ΔP denote a poverty change and assuming both Y and z are measured in real terms (changes in the poverty line can also be accommodated), a change in poverty from time 0 to time T can be written as:

$$\Delta P = P(Y_T; z) - P\,(Y_0; z) \tag{10}$$

By definition, the growth component is the change in poverty due to a change in the mean of Y while holding its distribution (characterized by the Lorenz curve) constant. Meanwhile, the inequality or redistribution component is the change in poverty due to a change in the distribution of Y while holding its mean constant. Using Y(L, μ) to

6 A parallel literature on decomposing inequality changes exists, see, for example, Mookherjee and Shorrocks (1982), Wan (1997, 2001), and Fields and Yoo (2000).

represent a hypothetical distribution with Lorenz curve L and mean μ, and denoting the corresponding poverty by $P(L, \mu)$, ΔP can be expressed as:

$$P(Y_T; z) - P(Y_0; z) = P(Y_T; z) - P(L, \mu) + P(L, \mu) - P(Y_0; z) \quad (11)$$

Two ways exist for the construction of the hypothetical distribution $Y(L, \mu)$. Using the base period as the reference point, we can replace $P(L, \mu)$ by $P(L_0, \mu_T)$ which represents the poverty level when Y possesses the same distribution as Y_0 but has the same mean as Y_t or μ_T. Consequently, equation (11) becomes:

$$\begin{aligned} P(Y_T; z) - P(Y_0; z) &= [P(Y_T; z) - P(L_0, \mu_T)] + [P(L_0; \mu_T) - P(Y_0; z)] \quad (12) \\ &= [\text{inequality component}] + [\text{growth component}] \end{aligned}$$

If the terminal period is used as the reference point, we can replace $P(L, \mu)$ by $P(L_T; \mu_0)$ in (11) to produce:

$$\begin{aligned} P(Y_T; z) - P(Y_0; z) &= [P(Y_T; z) - P(L_T; \mu_0)] + [P(L_T; \mu_0) - P(Y_0; z)] \quad (13) \\ &= [\text{growth component}] + [\text{inequality component}] \end{aligned}$$

where $P(L_T; \mu_0)$ is defined analogously as $P(L_0, \mu_T)$. Adding up (12) and (13) and rearranging yield

$$\begin{aligned} \Delta P = &\ 0.5\{[P(Y_T; z) - P(L_0, \mu_T)] + [P(L_T; \mu_0) - P(Y_0; z)]\} \\ &+ 0.5\{[P(L_0; \mu_T) - P(Y_0; z)] + [P(Y_T; z) - P(L_T; \mu_0)]\} \quad (14) \end{aligned}$$

The above is equivalent to using both periods as the reference point and taking average. This is acceptable since using either period as the reference point is equally arbitrary or equally justified. In fact, equation (14) is identical to what Shorrocks (1999) derived using Shapley value. Thus, we can decompose poverty difference into a growth component G and an inequality component I without any residuals or parametric estimations:

$$G = 0.5\{[P(L_0; \mu_T) - P(Y_0; z)] + [P(Y_T; z) - P(L_T; \mu_0)]\} \quad (15)$$

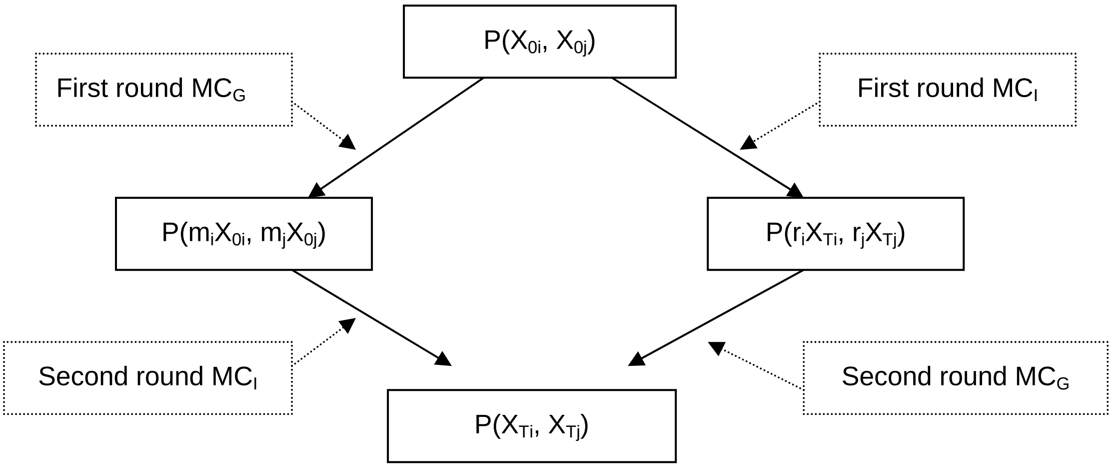
$$I = 0.5\{[P(Y_T; z) - P(L_0, \mu_T)] + [P(L_T; \mu_0) - P(Y_0; z)]\} \quad (16)$$

How to obtain the hypothetical distributions $P(L_T; \mu_0)$ and $P(L_0; \mu_T)$? To leave the dispersion of a variable or Lorenz curve intact but with a new mean, one can simply scale the variable. That is, we can simply obtain $Y(L_T, \mu_0) = Y_T\, \mu_0/\mu_T$ and $Y(L_0; \mu_T) = Y_0\, \mu_T/\mu_0$.

The above decomposition, while useful, does not provide sufficiently insightful details. It is more interesting to break down the overall growth and inequality components into those associated with individual factors. This is fairly straightforward for given $Y_t = f(X_{ti}, X_{tj})$ ($t = 0, T$) and changes in Xs. Let $r_i = \mu_{0i}/\mu_{ti}$ and $m_i = \mu_{ti}/\mu_{0i}$; both are scalars for scaling the X_i variable (the relevant notations corresponding to X_j can be defined in the same way). Then, a two-stage decomposition procedure can be established. In the first stage, the change from $P(Y_0; z) = P(L_0, u_0) = P(X_{0i}, X_{0j})$ to $P(Y_T; z) = P(L_T, \mu_T) = P(X_{Ti},$

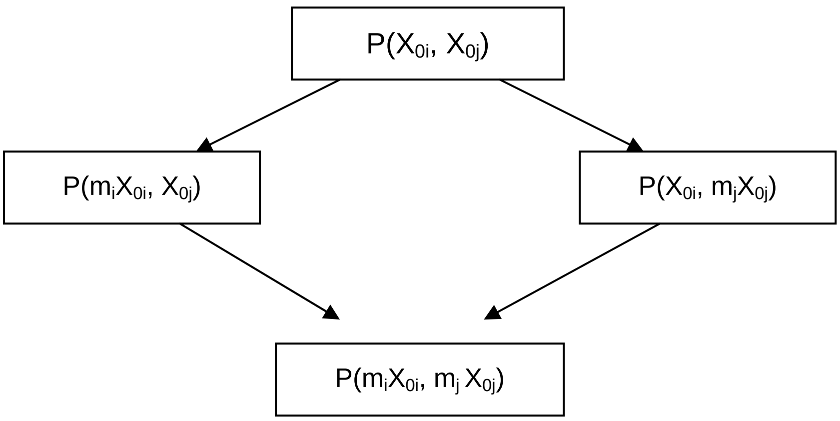
X_{Tj}) can be decomposed into the inequality and growth components I and G using (15) and (16). The equivalence between (15)–(16) and those derivable using the Shapley value is demonstrated by Figure 3, where MC_I and MC_G denote marginal contributions to the overall inequality or growth components, respectively.

Figure 3
Decomposing poverty changes



In the second stage, each of the marginal contributions can be attributed to individual *X*s by the Shapley value. For example, the first round marginal contribution to poverty due to growth, corresponding to the path from $P(X_{0i},X_{0j})$ to $P(m_iX_{0i}, m_jX_{0j})$, can be decomposed, as shown in Figure 4.

Figure 4
Decomposing a marginal contribution



The marginal contributions attributable to X_i and X_j are then given by:

$$MC_G(X_i) = 0.5\{[P(X_{0i},X_{0j}) - P(m_iX_{0i},X_{0j})] + [P(X_{0i},m_j X_{0j}) - P(m_iX_{0i}, m_j X_{0j})]\}$$

$$MC_G(X_j) = 0.5\{[P(X_{0i},X_{0j}) - P(X_{0i},m_j X_{0j})] + [P(m_iX_{0i},X_{0j}) - P(m_iX_{0i}, m_j X_{0j})]\}$$

Other marginal contributions shown in Figure 3 can be decomposed in a similar way. As usual, averages must be computed within each level and then across levels. Once again, the Shapley value will ensure $G = G_i + G_j$ and $I = I_i + I_j$ where I and G denote the inequality and growth effects attributable to the factors indicated by the relevant subscripts. Note that this decomposition procedure yields components of $P(X_{0i},X_{0j}) - P(X_{Ti}, X_{Tj})$, which are positive as long as poverty decreases over time.

4 An empirical illustration: the case of rural China

Until recently, poverty had been basically a rural phenomenon in China. Success in poverty eradication since late 1980s is being hailed as an outstanding achievement of the Chinese government. However, despite continued efforts, reduction in poverty has slowed down considerably in the new millennium. And urban poverty has emerged after significant reforms in the labour market and urban sector. Nevertheless, a large majority of China’s poor still live in the countryside. Unlike urban residents, rural population do not have access to social welfare due to absence of social safety net (Chen and Wang 2001).

The purpose of this section is to illustrate the applicability of the proposed frameworks, not providing a full empirical study. This is largely due to lack of appropriate data. Although 1995-2002 annual data for some 700 rural households are available, they come with different sample sizes for different years except for the years 2000 and 2001. Therefore, we only consider poverty in, and its change over, these two years. The needed data and income generating function are taken from Wan and Zhou (2005). While not claiming to be representative of China, the sample data do cover a variety of geo-economic conditions and are more representative than studies relying on data from a single province. For details on data source and model specification, see Wan and Zhou (2005).

The income generating function estimated by Wan and Zhou (2005) can be written as:

Ln Y = 7.084 + 0.096 Capital + 0.019 Land + 0.599 Labour + 0.1365 Education – 0.011 Education_squared + 0.1318 Training + 0.145 Age – 0.0255 Age_squared + 0.022 Wage_earner - 0.3164 Grain + Business-type dummy variable terms + Location dummy variable terms,

where:

Y	=	per capita real income,
Capital	=	per capita capital stock,
Land	=	per capita arable land area,
Labour	=	number of labourers divided by household size,
Wage_earner	=	proportion of wage earners in household labourforce,
Education	=	schooling years of household head,

Training	=	proportion of household members who received vocational training,
Age	=	age of household head,
Grain	=	ratio of grain sown area to total sown area.

The inclusion of the grain variable was intended to capture the effects of farming pattern. It is known that grain-cropping in China is often enforced administratively owing to low or negative returns (Wan 2004). Consequently, two identical households may receive different incomes simply because one grows grain and the other grows vegetables or other cash crops. The business-type dummies are included to control for different categories of business activities that a household engages in; China's ministry of agriculture classifies households into 10 different categories. In what follows, we group education, training and age to form a new term, namely human capital. Similarly, the grain, wage-earner and business-type dummies are combined to form what is termed Structure, indicating farming structure.

The location dummies (one for each village) are expected to take into consideration geographic conditions, including weather, market access, infrastructure and local culture. These village dummies, taken together, will be referred to as location in the following discussions. It is important to note that when a dataset contains matching observations, the location variable remains the same over time, thus its impact on poverty changes must be nil. When observations do not match as in this paper, the location variable captures the impact of location on poverty.

Before proceeding to poverty decomposition, two issues must be dealt with. First, poverty measure(s) must be chosen. In this paper, the FGT family of poverty measures will be used (Foster, Greer and Thorbecke 1984). It is important to point out that the proposed frameworks place no restrictions on the choice of poverty measures; any measure can be used. However, since a useful feature of the devised methodology lies in its capability to disentangle the redistribution effects, the transfer axiom becomes particularly relevant. It is thus recommended not to use measures insensitive to transfers such as the headcount ratio. When redistribution is insufficient to eliminate poverty, the headcount ratio always yields a value of 1 for the overall endowment component and always 1/K for each of the K production factors. The poverty gap ratio satisfies the weak transfer axiom but not the strong version; it is not sensitive to transfers among the poor. The squared poverty gap ratio satisfies both. Thus, we do not place much significance on the results under the headcount or poverty gap ratio. Second, a poverty line must be determined. Following conventional practice, the absolute rather than relative poverty line is used. Recognizing possible sensitivity of analytical results to poverty lines, three poverty lines are used: the official poverty line set by the Chinese government (RMB 625 in 2000), one and two US dollars a day (PPP-adjusted) poverty lines set by the World Bank (equivalent to RMB 929.03 and 1858.05 in 2000). There is little change in the price level in rural China between 2000 and 2001.

Table 1 presents the level-decomposition results, showing contributions to poverty due to existing inequality in the relevant factors. A positive (negative) value indicates decrease (increase) in poverty when the corresponding factor is equalized. It can be seen that the total redistribution components are all equal to the actual poverty levels. This finding is significant and surprising, significant in the sense that it is true in both 2000 and 2001, and no matter what poverty line or what poverty measure is used. And it is surprising because all endowment effects are nil, implying that China possesses sufficient resources to eliminate rural poverty under complete redistribution of income-generating factors. Complete redistribution is, of course, not possible for some factors such as location or as far as policy feasibility is concerned.

Another major finding from Table 1 is that land inequality is a poverty-reducing factor in every case, though its effect is small. Thus, redistribution of land will lead to increases in rural poverty in China. This is consistent with the observation that poor households are usually engaged in, or more engaged in, farming. In other words, the poor possess more land resource in China. This finding also corroborates well with the large positive contribution of the structure variable to poverty. The structure variable reflects allocation of household resources to different activities such as non-farming, cash crop, grain and so on. The large and positive contribution of the structure variable reflects gaps in returns among different economic activities. In fact, structure represents the second largest contributor to poverty in rural China, next to location or geography.

Not surprisingly, location factors contribute a dominant share to poverty in rural China. Depending on the year, the poverty line and poverty measure, this share varies between

Table 1
Effects of Factor Inequality on Poverty Level

	2000			2001		
Poverty line	RMB 625	US$1	US$2	RMB 625	US$1	US$2
			Headcount ratio (%)			
Capital	0.26	0.00	1.48	0.30	0.01	1.25
Land	-0.65	-0.06	-0.42	-0.59	-0.05	-0.42
Labour	-0.04	-0.06	2.38	0.19	-0.05	1.96
Structure	3.58	0.11	13.69	3.40	0.08	13.20
Human Capital	1.49	0.08	5.04	1.35	0.06	5.00
Location	6.98	12.97	14.46	6.56	12.99	15.25
Sum	11.60	13.04	36.64	11.21	13.04	36.25
Poverty level	11.60	13.04	36.64	11.21	13.04	36.25
			Poverty gap index (x100)			
Capital	0.08	0.09	0.32	0.08	0.09	0.30
Land	-0.20	-0.23	-0.15	-0.19	-0.22	-0.14
Labour	0.15	0.07	0.34	0.21	0.12	0.31
Structure	0.88	1.00	2.49	0.83	0.95	2.42
Human Capital	0.47	0.55	1.21	0.46	0.55	1.18
Location	1.11	4.39	9.62	1.05	4.30	9.55
Sum	2.49	5.88	13.84	2.44	5.79	13.61
Poverty level	2.49	5.88	13.84	2.44	5.79	13.61
			Squared poverty gap index (x1000)			
Capital	0.27	0.65	1.31	0.25	0.62	1.23
Land	-0.66	-1.61	-1.64	-0.62	-1.51	-1.55
Labour	0.70	0.96	1.33	0.82	1.30	1.60
Structure	2.15	6.84	11.43	2.06	6.48	10.96
Human Capital	1.44	3.85	6.26	1.40	3.81	6.16
Location	2.42	16.71	61.55	2.31	16.17	60.79
Sum	6.32	27.40	80.23	6.21	26.87	79.20
Poverty level	6.32	27.40	80.23	6.21	26.87	79.20

37.2 per cent (in 2001 under the Chinese government official poverty line and using the squared poverty gap index) and 99.6 per cent (in 2001 under US$1 a day and using the headcount ratio). This part of poverty cannot be eliminated in the short run despite that infrastructure investment may help poorly-located farmers to increase income in the long run.

Among all the factors considered, uneven distribution of human capital ranks third in most cases as a positive contributor to poverty. Its absolute contributions are small, possibly because inequality in human capital is low, thanks to the public education system in rural China. Moreover, unlike in the urban areas, human capital does not seem to play a major role in income generation in rural China, as dictated by the current state of technology prevailing in rural economic activities. Nevertheless, educational inequality is likely to increase and the premium for better education is likely to rise in rural China, as industrialization proceeds. Therefore, the small contribution of the human capital variable must be interpreted with caution as far as future policy design is concerned.

The level-decomposition results are consistent for 2000 and 2001 and across different poverty measures or poverty lines, with the only exception of labour contributions under the headcount ratio. These contributions change signs across different poverty lines, even for the same year. This is because the headcount ratio violates the transfer axiom so that inequality effects cannot be captured appropriately.

Table 2 shows components of the poverty change from year 2000 to year 2001. A positive value in the table means poverty-enhancing effect, and vice versa. It is noted that over this period average capital, structure and labour inputs rose while other inputs decreased. These explain all the growth effects being positive or negative. As reported in Wan and Zhou (2005), overall inequality declined from 2000 to 2001, which explains why the sums of the inequality effects are all negative in Table 2. Note that the overall changes in poverty match those reported in Table 1, showing constant or decreasing poverty from 2000 to 2001 in every case. For example, the poverty gap index shows a total change of -0.023 under two dollars a day. On the other hand, the contributions from all factors sum to -0.39 per cent when the headcount ratio is used with China's official poverty line.

A number of interesting findings can be discerned from Table 2. First, growth in labour and human capital plus improvement in farming structure help to reduce poverty. Second, declines in physical capital and land inputs lead to increases in poverty. Third, worsening location[7] dominates the growth effects (more than offsetting growth effects of all other factors combined). This renders the overall growth effects a positive value, making growth poverty-increasing. Fourth, factor inequalities improved so overall inequality effects are negative or poverty-reducing. In fact, the sum of inequality-induced effects (poverty reducing) overweighs the sum of growth-related effects (poverty increasing) in every case, giving rise to small reductions in total poverty. It is important to point out that all these four findings are robust to different poverty measures and different poverty lines.

While all growth effects are consistent in terms of signs across poverty measures and poverty lines, this is not the case with respect to inequality-effects. This, again, is related to the differing properties of alternative poverty measures. Also, different poverty lines imply different poor population under consideration. Unless all factor endowments are

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7 This means that the 2001 sample contains more farmers from location-disadvantaged villages.

perfectly correlated with total income, which is unlikely, the inequality effects may well differ in sign under different poverty lines.

Under US$1 a day and the headcount ratio, no change is observed in the poverty level between 2000 and 2001. However, this zero-sum result is due to a poverty-increasing growth effect of 0.46 and a poverty-reducing inequality effect of -0.46. Without improving factor distributions, poverty would have been increased by 0.46 per cent. Such a finding clearly demonstrates the importance of redistribution in combating poverty. In fact, factor redistribution was more powerful than factor growth in poverty eradication as the sums of inequality effects outweigh the growth counterparts in all cases of Table 2.

Table 2
Growth and Inequality Effects on Poverty Change from 2000 to 2001, by Factors

	Poverty line = RMB 625			Poverty line = US$1			Poverty line = US$2		
	Growth (1)	Inequality (2)	Total (1) + (2)	Growth (3)	Inequality (4)	Total (3) + (4)	Growth (5)	Inequality (6)	Total (5) + (6)
	Headcount ratio (%)								
Capital	0.002	0.013	0.015	0.001	0.001	0.002	0.003	0.022	0.025
Land	0.038	-0.301	-0.263	0.012	-0.103	-0.091	0.026	0.075	0.101
Labour	-0.036	0.196	0.160	-0.001	0.096	0.095	-0.124	0.123	-0.001
Structure	-0.278	0.297	0.018	-0.023	0.364	0.341	-1.193	0.775	-0.418
Human capital	-0.022	0.203	0.181	-0.001	0.199	0.198	-0.066	0.168	0.102
Location	3.751	-4.254	-0.503	0.468	-1.013	-0.544	1.419	-1.619	-0.200
Sum	3.455	-3.846	-0.391	0.456	-0.456	0.000	0.065	-0.456	-0.391
	Poverty gap index (%)								
Capital	0.001	0.002	0.002	0.001	0.002	0.003	0.002	0.007	0.009
Land	0.017	0.056	0.073	0.016	-0.012	0.004	0.017	-0.049	-0.033
Labour	-0.014	-0.074	-0.088	-0.014	-0.002	-0.016	-0.046	0.117	0.071
Structure	-0.150	-0.193	-0.343	-0.140	0.001	-0.139	-0.392	0.240	-0.152
Human capital	-0.006	-0.099	-0.105	-0.006	0.026	0.019	-0.023	0.124	0.101
Location	2.681	-2.276	0.405	2.287	-2.244	0.043	1.938	-2.166	-0.228
Sum	2.528	-2.583	-0.055	2.143	-2.228	-0.085	1.496	-1.727	-0.232
	Squared poverty gap index (%)								
Capital	0.000	0.001	0.001	0.001	0.002	0.002	0.001	0.003	0.004
Land	0.008	0.057	0.064	0.013	0.031	0.044	0.014	-0.024	-0.009
Labour	-0.006	-0.056	-0.062	-0.011	-0.039	-0.050	-0.022	0.060	0.038
Structure	-0.071	-0.128	-0.199	-0.115	-0.106	-0.221	-0.213	0.075	-0.138
Human capital	-0.003	-0.070	-0.073	-0.005	-0.040	-0.045	-0.010	0.081	0.071
Location	1.275	-1.017	0.259	1.972	-1.756	0.216	1.972	-2.041	-0.069
Sum	1.203	-1.214	-0.011	1.854	-1.908	-0.053	1.741	-1.845	-0.104

5 Conclusion

Given the overwhelming importance of the poverty-growth-inequality triangle (Bourguignon 2004), policymakers must face the vital and pragmatic question: what output, or more fundamentally, what factor growth or redistribution for poverty eradication—physical capital, human capital or other inputs? Simply saying ‘promoting growth' or 'reducing inequality' is far from being sufficient. Towards answering these questions, this paper develops a procedure for attributing total poverty at a given point of time to components associated with income-generating factors or resources. Another procedure is proposed to attribute a change in poverty to the growth and redistribution effects of individual income-generating factors. These procedures are applied to a set of data from rural China, demonstrating the usefulness of the proposed frameworks. Empirical evidence, though limited, forcefully highlights the importance of redistribution more than that of growth as a policy instrument in setting poverty-reduction strategies.

Theoretically speaking, redistribution can be complete in the sense that total endowment of resource is evenly allocated among agents. It can also be partial in the sense that some endowments are to be taken from the rich and be transferred for allocation among the poor. In this case, factor inequalities still exist after redistribution, although reduced. There is essentially an infinite number of ways to implement partial redistribution. Clearly, partial or incomplete redistribution is more feasible in reality. Nevertheless, complete redistribution is often assumed in the inequality literature when constructing counterfactuals. For example, in the classic example of inequality decomposition by population subgroups, the methodology is founded on the assumption of complete redistribution of total income within different groups. Another example is the popular Oaxaca-Blinder procedure, which assumes equal returns and complete redistribution of endowments within individual groups.

Though rare, redistribution may lead to worsening poverty, such as land redistribution in rural China. Needless to say, factor redistribution can be difficult to implement in reality. Unlike growth, there is always a limit to the extent of redistribution. As far as policy instruments are concerned, however, redistributing factor inputs seems easier than redistributing outputs (such as income). Factor redistribution makes more sense in promoting sustainable growth as it gives the poor the means for income generation. Simply providing income support usually ends up with no future growth potential unless the support is invested not consumed.

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