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Robust Multiperiod Poverty Comparisons

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Robust Multiperiod Poverty Comparisons

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Abstract

We propose a methodology for comparing poverty over multiple periods across time and space without arbitrarily aggregating income over various years or relying on arbitrarily specified poverty lines. Following Duclos *et al.* (2006a), we use the multivariate stochastic dominance methodology to create dominance surfaces for different time spans. We elaborate the method for the bi-dimensional case, using income observed over two periods, one at the beginning and one at the end of a time span, as dimensions. We also embed in this framework a new concept of chronic and transient poverty. We illustrate our approach by performing poverty comparisons using data for Indonesia and Peru.

Key words: Chronic Poverty, Multiperiod Poverty, Poverty Dominance, Poverty Dynamics, Transient Poverty.

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1 Introduction

Today it is widely accepted that poverty is a dynamic phenomenon. However, that raises the question how poverty can be measured over multiple periods. Cross-section poverty measures can well inform about the extent of poverty at a given point in time, but have almost nothing to say about the extent to which people escape from or fall into poverty. Recognizing this, Kanbur and Grootaert (1995) suggested relatively early to focus on household's changes in poverty status.[1] Other authors developed concepts to aggregate incomes over multiple periods using an evaluation function capturing explicitly the risk aversion of households (see e.g. Cruces, 2005). While such an approach has the advantage of accounting for the negative effects of income variability on the household's well-being it needs however arbitrary assumptions about how exactly 'risk-adjusted mean income' should be computed. Likewise, considering the various proposed methodologies of measuring and conceptualizing chronic and transient poverty, one can state that the importance and consequently the policy implications will also depend on how both forms of poverty are measured, i.e. how incomes are aggregated over time and how the poverty line is set (see e.g. Hulme and McKay, 2005; Jalan and Ravallion 1998; Duclos, Araar and Giles, 2006).

To circumvent part of these problems, we suggest a new approach of multiperiod poverty measurement, which is based on stochastic dominance tests and thus able to establish poverty orderings which are valid for a wide range of aggregation rules and poverty lines. Our approach is inspired by the literature on multi-dimensional poverty orderings (Duclos *et al.*, 2006a).[2] Within this framework we also embed a new concept of chronic and transient poverty, which again need neither a cross-period aggregation rule nor the determination of a specific poverty line. Our methodology can be applied to comparisons over time and space. This is illustrated using longitudinal data for Indonesia and Peru.

The remainder of our paper is organized as follows. In Section 2 we present our methodology. In Section 3 we provide an illustration using data from Indonesia and Peru. In Section 4 we discuss the results and conclude.

2 Methodology

2.1 Stochastic dominance in a one-period welfare measure

Tests of stochastic dominance are today widely used to establish poverty orderings $\mathbf{P}(\mathbf{Z})$ which are robust for a broad class of poverty measures,

[1] Surprisingly, the recent literature on pro-poor growth has largely by-passed the issue of poverty dynamics (see on this issue Grimm (2006)).

[2] See also Duclos, Sahn and Younger (2006b) and the seminal papers by Bourguignon and Chakravarty (2002, 2003).

$P(F;z)$, and a large range of poverty lines, $z \in Z$. If the welfare measure is denoted y_t and $F(y_t)$ its cumulative distribution function, then stochastic dominance states that

$$F(y_1)\mathbf{P}(\mathbf{Z})F(y_2) \text{ if and only if } P(F(y_1);z) \leq P(F(y_2);z) \; \forall \; z \in Z$$

$$\text{and } P(F(y_1);z) < P(F(y_2);z) \text{ for some } z \in Z, \tag{1}$$

where $F(y_1)\mathbf{P}(\mathbf{Z})F(y_2)$ means that $F(y_1)$ has unambiguously less poverty than $F(y_2)$ with respect to the poverty index P and the range Z.

This result holds for all poverty measures within the Foster-Greer-Thorbecke family, P_α (Foster, Greer and Thorbecke, 1984) with $\alpha \geq 0$ (Foster and Shorrocks, 1988a, b).[3]

The concept of poverty dominance is very useful because it allows to circumvent the problem of choosing one particular poverty measure and one specific poverty line. In what follows we extend that concept to two-period welfare measures and then embed a concept of chronic and relative poverty.

2.2 Stochastic dominance in a two-period welfare measure

Assuming that the dynamics of poverty are important, we do not define poverty over a one-period welfare measure y_t, but over a two-period welfare measure (y_1, y_2). Furthermore, we impose, that well-being is differentiable with respect to the welfare measure in $t = 1$ and $t = 2$ and that income in both periods contributes positively to individual well-being, but we impose nothing regarding the precise value of the contribution of each year to individual well-being.

Obviously, as for period by period poverty comparisons it is desirable that poverty comparisons over multiple time spans, T_j like $T_A = [t = 1a; t = 2a]$ vs. $T_B = [t = 1b; t = 2b]$, are robust to a large set of poverty lines $z \in Z$. This can be ensured by simply transferring the concept of stochastic dominance for univariate welfare distributions to the case of bivariate welfare distributions.

Furthermore, poverty orderings in the bivariate case should be robust to a broad range of aggregation procedures of the observed welfare measures in the two periods constituting a time span. Thus, the weight attributed to each single period should not matter, e.g. wether we discount income in the second period of the time span to the present value of the first period of this time span or whether we worry more about the income in the second period relative to the first period. In the bivariate case the stochastic dominance

[3]The Foster-Greer-Thorbecke poverty measure has the formula $P_\alpha = 1/N \sum_{i=1}^{z} (\frac{z-y_i}{z})^\alpha$, where N is the total number of individuals $i = 1, \ldots, N$. The parameter $\alpha > 0$ is a poverty aversion parameter: $\alpha = 0$ yields the poverty headcount index, $\alpha = 1$ the poverty gap index, and $\alpha = 2$ poverty severity index (Foster, Greer and Thorbecke, 1984).

methodology guarantees robustness to all these aggregation procedures as long as there is no overlap of the time spans under consideration, i.e. the second period of the first time span corresponds not simultaneously to the first period of the second time span. In contrast if such an overlap exists, an equal weight has to be attributed to each period and in consequence the poverty line has also to stay constant in real terms over time.[4]

Considering the robustness to a broad range of poverty lines (but constant over time), we say that

$$F(y_{1a}, y_{2a})\mathbf{P}(\mathbf{Z})F(y_{1b}, y_{2b})$$

$$\text{if and only if } P(F(y_{1a}, y_{2a}; z) \leq P(F(y_{1b}, y_{2b}); z) \; \forall \; z \in Z$$

$$\text{and } P(F(y_{a1}, y_{a2}); z) < P(F(y_{b1}, y_{b2}); z) \text{ for some } z \in Z, \qquad (2)$$

where $F(y_{1a}, y_{2a})\mathbf{P}(\mathbf{Z})F(y_{1b}, y_{2b})$ means that $F(y_{1a}, y_{2a})$ has unambiguously less poverty than $F(y_{1b}, y_{2b})$ with respect to the poverty index P and the range Z, i.e. multiperiod poverty is less over time span T_A than over time span T_B.

Note, that $F(y_1, y_2)$ refers now to a bivariate distribution and, hence, the test of stochastic dominance does not imply to compare two curves but two surfaces, where each surface is characterized by its two dimensions—the welfare measure in the first and second period—and the cumulative density at each point of that surface.

The way we wrote the dominance criteria above, implicitly assumes that we test for the whole range $z \in Z$, but that z is constant over time. Again, this simplification is necessary as long as there is an overlap of both time spans, i.e. $y_{2a} = y_{1b}$. Put differently, we then attribute the same weight to each period. Thus, we only test dominance between both surfaces across an expansion path of z, where $y_1 < z \wedge y_2 < z$.

However, in the most general case our concept allows to choose $z_1 \neq z_2$ s.t. $z_{1a} = z_{1b}$ and $z_{2a} = z_{2b}$, i.e. to give a different weight to the first and second period within each time span and that is the case we consider in what follows. Such weights could reflect risk aversion or a preference for the present as mentioned above. In this case the test domain for dominance expands to a rectangle, where $y_1 < z_1 \wedge y_2 < z_2$.

Considering for robustness to poverty lines as well as to aggregation procedures, we say that

$$F(y_{1a}, y_{2a})\mathbf{P}(\mathbf{Z})F(y_{1b}, y_{2b})$$

$$\text{if and only if } P(F(y_{1a}, y_{2a}); z_1, z_2) \leq P(F(y_{1b}, y_{2b}); z_1, z_2) \; \forall \; z_1, z_2 \in Z$$

$$\text{and } P(F(y_{1a}, y_{2a}); z_1, z_2) < P(F(y_{1b}, y_{2b}); z_1, z_2) \text{ for some } z_1, z_2 \in Z, \quad (3)$$

[4]Note, that comparisons of multiperiod poverty over *space* are obviously always robust to aggregation procedures.

where $F(y_{1a}, y_{2a})\mathbf{P}(\mathbf{Z})F(y_{1b}, y_{2b})$ means that multiperiod poverty is less over time span T_A than over time span T_B with respect to the poverty index P, the range Z *and* any aggregation procedure of incomes observed in the two periods constituting a time span.

Our concept is similar to the concept of multi-dimensional poverty comparisons suggested by Duclos *et al.* (2006a), where the dimensions refer not to different periods but to different dimensions of human well-being, such as income, education and health. Although, Duclos *et al.* (2006a) make stronger assumptions regarding the aggregation procedure of the various dimensions by assuming that they enter the poverty measure in a multiplicative way, which implies that the marginal poverty benefit of an increase in one dimension decreases with the value of the other dimension. Put differently, the more someone has in one dimension, the less is overall poverty deemed to be reduced if well-being in the other dimension increases.

2.3 A concept of chronic and transient poverty based on stochastic dominance

The Chronic Poverty Research Center defined chronic poverty as 'poverty experienced by individuals and households for extended periods of time or throughout their entire lives' and transitory poverty as 'poverty experienced as the result of a temporary fall in income although over a longer period the household resources are on average sufficient to keep the household above the poverty line' (Chronic Poverty Research Center, 2004; Hulme and Shepard, 2003).

Operationalizing such concepts obviously needs some arbitrary aggregation of year-specific incomes and the assumption of one specific and again arbitrary poverty line. Jalan and Ravallion (1998), for instance, suggest to compute intertemporal poverty as the average of poverty evaluations over time for a household and chronic poverty as the poverty evaluation at the average income over time for a household. Transient poverty is then defined as the difference between both. The contributions of all households to each form of poverty are aggregated into populations means using the squared poverty gap.

This approach is interesting in many respects and very appealing given its property of additive decomposability. However, it is sensitive to the chosen poverty line and implies averaging income over subsequent periods. To circumvent the problem of making any arbitrary assumptions, we suggest to link our concept of stochastic dominance in the bi-dimensional case into the concept of chronic and transient poverty. Hence, we define chronic and transient poverty as follows.

1. **Chronic poverty:** An individual is defined as being chronically poor, if her income over a time span T_j is below the poverty line z in both

periods constituting that time span.[5]

2. **Transient poverty:** An individual is defined as being transient poor, if her income is below the poverty line z *either* in period one or in period two of time span T_j and above the poverty line in the other period.[6]

It is important to note that our definition of transient poverty makes no specific assumption on the required income level in the period where income is above the poverty line. That means somebody is considered as transient poor over the time span T whenever her income was one period below and one period above the poverty line regardless of how far it was above the poverty line. Hence this definition is closely related to the concept of income mobility and is different to the above cited definition of transient poverty by Jalan and Ravallion (1998) which is based on estimated mean income.

Figure 1 illustrates our concept of chronic and transient poverty. Checking for chronic poverty dominance requires to test for dominance for an intersection poverty frontier. The relevant domain for the test is a rectangle built by all pairs (y_1, y_2) for which: $y_1 < z_1 \wedge y_2 < z_2$. Thus, to establish a robust chronic poverty comparison on this domain for the time spans A and B, one must check that time span A's (B's) dominance surface is above time span B's (A's) dominance surface at every point in this rectangle (if z is equal across periods, $z_1 = z_2$, the test domain obviously reduces to the bisector of that rectangle and the robustness reduces to the range of poverty lines). Mathematically[7],

$$F(y_{1a}, y_{2a})\mathbf{P^C}(\mathbf{Z})F(y_{1b}, y_{2b})$$

if and only if

$$\int_0^{z_1}\int_0^{z_2} p(y_{1a}, y_{2a})dF(y_{1a})dF(y_{2a})dy_{1a}dy_{2a},$$

$$\leq \int_0^{z_1}\int_0^{z_2} p(y_{1b}, y_{2b})dF(y_{1b})dF(y_{2b})dy_{1b}dy_{2b},\ \forall\ z_1, z_2 \in Z$$

and

$$\int_0^{z_1}\int_0^{z_2} p(y_{1a}, y_{2a})dF(y_{1a})dF(y_{2a})dy_{1a}dy_{2a},$$

[5]This is conceptually the same as the intersection poverty defined by Duclos *et al.* (2006a).

[6]This is different to the concept of union poverty defined by Duclos *et al.* (2006a), because transient poverty does not include chronic poverty, while union poverty includes intersection poverty.

[7]Equation 4 is mathematically the same as equation 3. However, writing equation 3 in integrals allows to illustrate the link of our concept of multiperiod poverty to the concept of chronic poverty and finally to relate it to the concept of transient poverty (equation 5).

$$< \int_0^{z_1} \int_0^{z_2} p(y_{1b}, y_{2b}) dF(y_{1b}) dF(y_{2b}) dy_{1b} dy_{2b}, \text{ for some } z_1, z_2 \in Z, \quad (4)$$

where $F(y_{1a}, y_{2a})\mathbf{P^C}(\mathbf{Z})F(y_{1b}, y_{2b})$ means that $F(y_{1a}, y_{2a})$ has unambiguously less chronic poverty than $F(y_{1b}, y_{2b})$ with respect to the poverty index P (and marginal contributions p) and the range Z, i.e. multiperiod chronic poverty is less over time span T_A than over time span T_B.

Once dominance is established, one can be sure, that the chronic poverty ordering is not only robust at that precise intersection poverty frontier defined by z, but also for any other poverty frontier which lies in this rectangle. Hence, it is neither necessary to determine a precise poverty line nor to define a specific aggregation rule of incomes within a time span T.

To test over a transient poverty frontier, the test domain would consist of all pairs (y_1, y_2), where $y_1 < z_1 \wedge y_2 > z_2$ and $y_1 > z_2 \wedge y_2 < z_2$. These test points fulfill the requirement of our definition of transient poverty for the two-period case. Someone is transient poor if she crosses the poverty line within a time span T. Our dominance criteria defined in Section 2.2 requires that the dominance surface is higher for time span A than time span B (or for time span B than time span A) over all points, where $y_1 < z_1 \wedge y_2 > z_2$ and $y_1 > z_2 \wedge y_2 < z_2$, simultaneously.[8][9] Mathematically,

$$F(y_{1a}, y_{2a})\mathbf{P^T}(\mathbf{Z})F(y_{1b}, y_{2b})$$

if and only if

$$\int_0^{z_1} \int_{z_2}^{+\infty} p(y_{1a}, y_{2a}) dF(y_{1a}) dF(y_{2a}) dy_{1a} dy_{2a},$$

$$\leq \int_0^{z_1} \int_{z_2}^{+\infty} p(y_{1b}, y_{2b}) dF(y_{1b}) dF(y_{2b}) dy_{1b} dy_{2b}$$

$$\text{and } \int_{z_1}^{+\infty} \int_0^{z_2} p(y_{1a}, y_{2a}) dF(y_{1a}) dF(y_{2a}) dy_{1a} dy_{2a},$$

$$\leq \int_{z_1}^{+\infty} \int_0^{z_2} p(y_{1b}, y_{2b}) dF(y_{1b}) dF(y_{2b}) dy_{1b} dy_{2b}, \ \forall \ z_1, z_2 \in Z$$

and

$$\int_0^{z_1} \int_{z_2}^{+\infty} p(y_{1a}, y_{2a}) dF(y_{1a}) dF(y_{2a}) dy_{1a} dy_{2a},$$

$$< \int_0^{z_1} \int_{z_2}^{+\infty} p(y_{1b}, y_{2b}) dF(y_{1b}) dF(y_{2b}) dy_{1b} dy_{2b}$$

[8] This is relevant, because it prevents transient poverty dominance just because of strong growth in the used welfare measure within one of the time spans. Put differently, transient poverty dominance can only be established if there are relatively more people in a country overleaping as well as falling below all relevant poverty lines.

[9] If z is equal across periods, $z_1 = z_2$, the robustness reduces to the range of poverty lines.

$$\text{or} \int_{z_1}^{+\infty} \int_{0}^{z_2} p(y_{1a}, y_{2a}) dF(y_{1a}) dF(y_{2a}) dy_{1a} dy_{2a},$$

$$< \int_{z_1}^{+\infty} \int_{0}^{z_2} p(y_{1b}, y_{2b}) dF(y_{1b}) dF(y_{2b}) dy_{1b} dy_{2b}, \text{ for some } z_1, z_2 \in Z, \quad (5)$$

where $F(y_{1a}, y_{2a})\mathbf{P^T}(\mathbf{Z})F(y_{1b}, y_{2b})$ means that $F(y_{1a}, y_{2a})$ has unambiguously less transient poverty than $F(y_{1b}, y_{2b})$ with respect to the poverty index P (and marginal contributions p) and the range Z, i.e. multiperiod transient poverty is less over time span T_A than over time span T_B.

To be explicit, dominance in transient poverty of A over B means that in A relatively less individuals crossed the poverty line in either one direction, regardless how many individuals stayed over both periods below or above the poverty line. Hence, our concept of transient poverty should always be seen in connection with our concept of chronic poverty, taken alone it would only make make a judgement about mobility into and out of poverty.

2.4 Estimation and inference

To establish dominance empirically, it is sufficient, as shown by Duclos *et al.* (2006a), to calculate the differences of $\hat{F}(y_{1a}, y_{2a})$ and $\hat{F}(y_{1b}, y_{2b})$ at a grid of test points and test for statistical significance of these differences based on student's t-tests.

2.5 Bounds to multidimensional dominance

When applying the methodology presented above, one needs to define a maximum poverty set $\lambda^*(z_1, z_2 \in Z)$. Obviously, defining that frontier is always arbitrary. We follow again Duclos *et al.* (2006a) and estimate that frontier directly from our sample as the maximum λ^+ for which multiperiod poverty dominance holds. Then we can locate within λ^+ all of the possible poverty frontiers (chronic and transient) for which there is necessarily more poverty in time span A than in time span B. We then can judge case by case whether these critical sets and frontiers are sufficiently wide to justify a conclusion of poverty dominance.

3 Illustration

3.1 Data

To illustrate the methodology presented above, we use longitudinal data for Indonesia and Peru.

For Indonesia, we use all three existing waves of the Indonesian Family Life Survey conducted by RAND, UCLA and the University of Indonesia's Demographic Institute in 1993 (IFLS1), 1997 (IFLS2) and 2000 (IFLS3).

The IFLS is representative of 83% of the Indonesian population living in 13 of the nation's current 26 provinces. The IFLS is judged as having a very high quality, among other things, because individuals who moved are tracked to their new location and, where possible, interviewed there. Hence, this procedure ensured that the re-contact rate in the IFLS3 was 95.3% of IFLS1 households (for details see Strauss, Beegle, Sikoki *et al.* (2004)). Using the three waves, we built two panels, one from 1993 to 1997 (6,723 households; 31,324 individuals) and one from 1997 to 2000 (7,187 households; 32,314 individuals).[10] We use real household expenditure per capita as the welfare measure. Expenditure is expressed in 1993 prices and adjusted by regional price deflators to the Jakarta price level.

For Peru we use the first (ENAHO1, 1997) and third wave (ENAHO3, 1999) of the Peruvian Encuesta Nacional de Hogares conducted by the Instituto Nacional de Estadística e Informática. The ENAHO is representative for the three rural and four urban areas of Peru. The 'panel-households' are only a sub-sample of all households interviewed. In total 3,027 households (14,948 individuals) have been followed over the first three waves. De Vreyer, Mesplé-Somps and Herrera (2002) have shown that there is no significant attrition bias. Attrition could be a problem if the fourth wave (2000) were used, because of a substantial drop out of many panel households. We use again real household expenditure per capita as the income measure. Expenditure is expressed in 1997 prices and adjusted by regional price deflators to the Lima price level.

Data on Purchasing Power Parity over GDP is retrieved from the Penn World Table 6.1 (see Heston *et al.* (2002)). In PWT 6.1 the base year is 1996. For our illustration, we estimate the PPPs for the years 1993 and 1997 by applying the relative rates of inflation between the country under consideration (Peru, Indonesia) and the base country (United States) to the PPP of 1996.

3.2 Robust multiperiod poverty comparisons for Indonesia

Using the three waves of the Indonesian Family Life survey, we apply the methodology introduced and elaborated above in order to perform multiperiod poverty comparisons and to illustrate our concepts of chronic and transient poverty. The time spans we consider are 1993 to 1997 and 1997 to 2000. We create a two-dimensional poverty index for each time span. Household expenditures observed in 1993 and 1997 constitute the poverty index for the first time span and those observed in 1997 and 2000 the second. A person is referred to be chronically poor, if she is below the poverty line in both years, i.e. in both periods of a time span. Transient poverty is

[10] The number of households is higher in the second period, because it includes so called 'split-off' households, i.e. individuals covered by the IFLS1, but who left their initial household and formed their own new household.

experienced, if a person is below the poverty line in either one year, while she is above the line in the other year.

As we have already mentioned, if there is an overlap of time span A and time span B, poverty lines have to be equal across periods. Consequently, different weights and thus different aggregation procedures cannot be accounted for. In this special case, that we refer to in our illustration, multiperiod poverty comparisons over time in Indonesia are robust to a broad range of poverty lines.

According to equation 3, poverty comparisons can be made by testing for significant differences between the dominance surface for 1993/1997 and the dominance surface for 1997/2000. Rather than testing at all points, we choose a 20×20 grid of test points spread evenly over the entire domain of the surfaces.[11] Depending on the poverty measure, the relevant test domain changes. This is illustrated in Figure 2, which shows the dominance surface of the time span 1993-1997. The x and y axes measure household expenditure per capita per day at the beginning (1993) and the end (1997) of the period. Expenditures are expressed in 1993 US$ PPP equivalents. The z axis measures the cumulative share of people who are below the points defined in the (x, y) domain.

Since people have to be below the poverty line in both dimensions to be chronically poor, the lower middle part of the surface is the domain of interest when checking for chronic poverty dominance. The test points for transient poverty can only be seen in connection with the test points for chronic poverty. According to our definition of transient poverty, people are transient poor if they cross the poverty line within the time span in either direction. Thus, testing for transient poverty requires to check the test points that are the direct neighbors of the test points for chronic poverty.

The difference of both dominance surfaces ([1993-1997] - [1997-2000]) is visualized in Figure 3. The hump at the upper right part of the figure can be explained by the drastic increase in income from 1993 to 1997, i.e., there were relatively more people experiencing an increase in income from 1993 to 1997, than people experiencing an increase in income from 1997 to 2000. The figure clearly indicates that the surface of the period 1993-1997 lies above the 1997-2000 surface over almost the entire domain. Following Duclos *et al.* (2006a), we calculate the t-statistics of the differences of the surfaces. Table 1 shows the 20×20 matrix of test points. On the vertical (horizontal) axis is the income at the beginning (end) of the time spans. 1 indicates a significant positive difference, i.e. 1997-2000 dominates 1993-1997. 0 means that no conclusions can be made, while (-1) indicates a significant negative difference, i.e. 1993-1997 dominates 1997-2000.

The test domain for chronic poverty is at the upper left corner of Table 1. If z is equal across periods, as in our special case, the test domain for

[11] Theoretically, it would be appropriate to test at all points over the entire domain.

chronic poverty reduces to the bisector of that rectangle. For example, the 1 (marked by brackets) in the second row and second column of Table 1 shows, that the share of individuals who had less than $\exp(0.18) \approx 1.2$ \$ per day in both periods significantly declined between the first and second time span, i.e. between 1993/1997 and 1997/2000. The wider the chosen critical frontiers, the further expands the test domain from the upper left origin.

Dominance in transient poverty can be checked by examining the test points that are direct neighbors of the test points for chronic poverty, simultaneously. If z is equal across periods the test domain for transient poverty reduces to the upper and lower analogy of the bisector. To illustrate this, consider the 1 in the second row and the third column of Table 1. This 1 (marked by a star) indicates, that the share of people, who jumped over the poverty line of $\exp(.18) \approx 1.2$\$ from 1993 to 1997 was significantly higher than the share of people jumping over the same poverty line between 1997 and 2000. On the other hand, the 1 (marked by a star) in the second column and the third row indicates that the share of people, who fell below the poverty line of $\exp(.18) \approx 1.2$\$ from 1993 to 1997 was also significantly higher than the share of people falling below the same poverty line between 1997 and 2000. Thus, according to our definition, dominance in transient poverty can be established at this poverty line. Once again, the wider the chosen critical frontiers, the further expands the test domain from the upper left origin.

As can be seen from Table 1, any conclusion about dominance in chronic and transient poverty of the time span 1997-2000 over the time span 1993-1997 relies on the selection of the maximum poverty frontiers.

Chronic poverty is significantly higher between 1993 and 1997 over all possible set of poverty lines up to the poverty line $\exp(2.16) \approx 8.7$\$. Accordingly, the maximum poverty set λ^+ for which multiperiod chronic poverty dominance holds is $\lambda(2.16)$. Since this is above the 8\$ PPP poverty line, the frontier should be wide enough to conclude that chronic poverty declined significantly during the nineties. The crucial point is that this chronic poverty ordering is not only robust at that precise intersection poverty frontier defined by $z = 2.16$, but also for any other smaller poverty frontier which lies on this bisector.

Dominance in transient poverty is established over all possible sets of poverty lines up to the poverty line $\exp(1.62) \approx 5.1$\$. Since this is above the 5\$ PPP poverty line, the frontier should also be wide enough to conclude that transient poverty declined significantly during the nineties. As stated in section 2.3, any conclusions about dominance in transient poverty should always be seen in connection to our concept of chronic poverty.

In a second step, we examine chronic and transient poverty dominance for urban and rural Indonesia. Table 2 indicates, that there is neither chronic nor transient poverty dominance of 1997-2000 in urban Indonesia. In contrast, Table 3 implies dominance for both poverty measures in rural Indone-

sia. The maximum poverty sets for chronic poverty $\lambda(2.52)$ as well as for transient poverty $\lambda(2.34)$ are both far above any reasonable poverty line. This result suggests that the decline in both poverty measures in Indonesia was largely driven by a significant reduction in poverty in rural Indonesia.

3.3 Robust multiperiod relative poverty comparisons for Indonesia

The concept of multiperiod *relative* poverty comparisons is closely related to the introduced method of absolute poverty comparisons in section 3.2. Absolute poverty measures bear on *income* mobility; they consider absolute poverty frontiers, for example the 1$ PPP poverty line, and keep track of people who either stay below or cross this fixed frontier. Relative poverty measures rather take into account *social* mobility; while still keeping track of people who either stay below or cross the poverty line, this frontier becomes endogenous, for example, expressed as a ratio of the median income. This concept is similar to Bossert, D'Ambrosio's, and Peragine (2006) concept of 'social exclusion'.

To illustrate the idea of relative poverty, consider a household who experiences a significant increase in income from 1993 to 1997, thus moves out of poverty from an absolute perspective. However, if income of almost all of the households in the region was boosted in the same way, this household might still be poor from a relative perspective, i.e the poverty gap to the median did not decline. Accordingly, people are referred to be relatively chronic poor, if their income as a ratio of the median income stays below a given proportion for consecutive year.

To test for differences in relative poverty between the two time spans in Indonesia, we standardize the households expenditures by a relative poverty line $\tilde{z}$: $\tilde{y} = y/\tilde{z}$. We choose $\tilde{z} = 50\%$ of median income.[12] Accordingly, a relative income of 1, for example, means that the individual's income is exactly half of the income of the median. The differences in relative poverty are presented in Figure 4. The x and y axes measure the relative household expenditures per capita, $\tilde{y}$, at the beginning and the end of the time span. The figure does not show any systematic pattern. This is supported by Table 4, that shows the 20×20 matrix of test points. Here the 0 in the third line and third row for example means that the share of people who had less than 50% ($\exp 0.00 = 1$) of the median income did not significantly change between the time spans 1993/1997 and 1997/2000. Hence, given the many 0's in the roster clearly show that no conclusions about changes in either relative chronic or relative transient poverty can be drawn.

Analyses for rural and urban Indonesia separately yield the same result; in both relative poverty measures, chronic and transient, dominance for

[12] Notice, that it does not matter which relative poverty line is chosen.

1997/2000 over 1993/1997 cannot be established.

3.4 Robust multiperiod poverty comparisons for Indonesia and Peru

The concept of multiperiod poverty comparisons using stochastic dominance tests, can also be applied to cross country comparisons. Absolute poverty comparisons using US$ PPP equivalents as denominations of national currencies, are applicable to countries having a comparable level of household expenditures per capita. Standardizing expenditures in the way proposed in Section 3.3, allows to perform relative poverty comparisons that are applicable for all kind of developing and even industrialized countries.

To illustrate the idea of international chronic and transient poverty comparisons, we now add to our Indonesian data set the above described panel data of Peru. For Peru we create a two-period poverty index covering the years 1997 and 1999. This index will be compared with the 1997/2000 index of Indonesia.

For absolute poverty comparisons, we convert expenditures of both countries and both years into US$ PPP equivalents using prices of 1997. The 20×20 grid of test points of the differences in dominance surfaces ('Peru minus Indonesia') is presented in Table 5. Poverty dominance of Peru over Indonesia is realized over the entire domain of test points, implying that absolute chronic as well as absolute transient poverty is higher in Indonesia than in Peru.

To test whether Peru also dominates Indonesia when relative poverty is considered, we divide expenditures of Peru and Indonesia by $\tilde{z} = 50\%$ of the respective median income. Table 6 shows the matrix of test points of differences of the two-period poverty surfaces ('Peru minus Indonesia'). In contrast to the comparison of absolute poverty, relative poverty in Peru seems to be higher. Even though dominance cannot be established over the entire domain, the maximum poverty sets for relative chronic as well as relative transient poverty are wide enough to conclude on dominance in both measures. The proportion of individuals having less than 50% of the median income is higher in Peru.

4 Discussion

In this paper, we present a concept allowing to undertake multiperiod poverty comparisons over time and space without arbitrarily aggregating income over various years. Inspired by the multidimensional stochastic dominance methodology, elaborated by Duclos *et al.* (2006a), we create two-period income surfaces for different time spans. These surfaces are then ordered using dominance tests. By defining alternative test domains, we also developed indices for chronic and transient poverty. Once dominance can be

established, the poverty ordering is robust to the aggregation procedure and over a broad range of poverty lines within the maximum poverty set.

Furthermore, we extended our framework to the measurement of *relative* chronic and *relative* transient poverty. In contrast to absolute poverty measures that bear on income mobility, relative poverty measures rather take into account social mobility. By following a relative approach, the absolute level of household income gets irrelevant, while rather the ratio of income to the median income becomes the measure of interest. Given the political relevance of social mobility and inequality, we think these measures constitute an interesting contribution to the existing literature on chronic poverty.

To illustrate our methodology, we compared chronic and transient poverty over two time spans in Indonesia. Absolute comparisons indicate that chronic poverty has significantly declined from 1993-1997 to 1997-2000. The same is true, although for a narrower set of poverty lines, for transient poverty. Both the decline in chronic and in transient poverty was largely driven by a substantial poverty decline in rural Indonesia.

Finally, we applied our methodology to cross country comparisons, using Peruvian and Indonesian household data. Regarding absolute poverty frontiers poverty measures suggest dominance of Peru over Indonesia. The opposite is true, when looking at relative poverty lines. This is an interesting result.

However, the suggested approach and the ideas developed in this paper also have their shortcomings. The most important one is certainly that all results are based on a sample of expenditures declared by households and that these declarations are generally affected by measurement error. Apparent outliers have been withdrawn from the sample using the Mahalanobis distance measure (see Grimm, 2006).[13] However, it is very likely that the remaining declarations are still affected by measurement error and pose problem when looking at the joint distribution of expenditures in $t = 1$ and $t = 2$. In fact many empirical studies show that measurement error is such that the extent of β-convergence over time is overestimated (see e.g. Bound, Brown and Mathiowetz (2001); Breen and Moisio (2004); Hulme and McKay (2005); Grimm (2006)). For our case, that would imply that chronic poverty might be underestimated and transient poverty overestimated. In absence of information on 'true income' or any instruments, there is not much that can be done against but it should be kept in mind when interpreting our results.

Finally, we assumed throughout the paper that our multiperiod poverty index is defined over two period-specific incomes. Obviously, it would be interesting to extend the methodology to three or more observations for each

[13] Discarding observations if they exceed a certain threshold in terms of the Mahalanobis distance allows to eliminate not only outliers in terms of income levels but also in terms of income changes over time. Using this method, we eliminated roughly 5.0% of all households in each sample.

time span. While it would still be possible to test for dominance in one surface of the other, the definition of chronic and transient poverty would be less obvious. To be consistent with the concept suggested above, one may think of defining an individual as chronically poor if her income was below the poverty line in all periods, but defining, in contrast, an individual as transient poor as soon as in one period her income was above the poverty line. Such a judgement if of course debatable. In addition one would have to think about how the surfaces should exactly be constructed; either with the maximum overlap as in our case (e.g. $T_A[y_1, y_2, \ldots, y_{n-1}]$ vs. $T_B[y_2, y_3, \ldots, y_n]$) or without any overlap ((e.g. $T_A[y_1, y_2, \ldots, y_{n/2}]$ vs. $T_B[y_{n/2+1}, y_{n/2+2}, \ldots, y_n]$). According to this decision, the robustness of poverty comparisons differs.

References

Breen, R. and P. Moisio (2004), Poverty dynamics corrected for measurement error. *Journal of Economic Inequality*, 2 (3): 171 - 191.

Bound J., C. Brown, and N. Mathiowetz (2001), Measurement error in survey data. In J.J. Heckman and E. Learner (eds.), *Handbook of Econometrics* Vol. 5 (pp. 3705-3843), Amsterdam: Elsevier Science.

Bourguignon F. and S.R. Chakravarty (2002), Multidimensional poverty orderings. Delta Working Paper 2002-22, Delta, Paris.

Bourguignon F. and S.R. Chakravarty (2003), The measurement of multidimensional poverty. *Journal of Economic Inequality*, 1: 25-49.

Bossert W., C. D'Ambrosio and V. Peragine (2006), Deprivation and Social Exclusion. *Economica*, forthcoming.

Cruces G. (2005), Income Fluctuations, Poverty and Well-Being Over Time: Theory and Application to Argentina. Discussion Paper No. DARP 76, London School of Economics.

Chronic Poverty Research Center (2004), *The Chronic Poverty Report 2004-05*. Institute for Development Policy and Management, University of Manchester.

De Vreyer P., S. Mesplé-Somps and J. Herrera (2002), Consumption growth and spatial poverty traps: an analysis of the effects of social services and community infrastructures on living standards in rural Peru. DIAL Working Paper DT/2002/17, DIAL, Paris.

Duclos J.-Y., A. Araar and J. Giles (2006), Chronic and Transient Poverty: Measurement and Estimation, with Evidence from China. IZA Discussion Paper No. 2078, IZA, Bonn.

Duclos J.-Y., D. Sahn and S.D. Younger (2006a), Robust Multidimensional Poverty Comparisons. *Economic Journal*, 116 (514): 943-968.

Duclos J.-Y., D. Sahn and S.D. Younger (2006b), Robust Multidimensional Spatial Poverty Comparisons in Ghana, Madagascar, and Uganda. *World Bank Economic Review*, 20 (1): 91-113.

Foster J.E., J. Greer and E. Thorbecke (1984), A Class of Decomposable Poverty Measures. *Econometrica*, 52: 761-776.

Foster J.E. and A.F. Shorrocks (1988a), Poverty Orderings. *Econometrica*, 56: 173-177.

Foster J.E. and A.F. Shorrocks (1988b), Poverty Orderings and Welfare Dominance. *Social Choice and Welfare*, 5: 179-189.

Grimm M. (2006), Removing the anonymity axiom in assessing pro-poor growth. *Journal of Economic Inequality*, forthcoming.

Grootaert C. and R. Kanbur (1995), The Lucky Few amidst Economic Decline: Distributional Change in Côte d'Ivoire as seen through Panel Datasets, 1985-1988. *Journal of Development Studies*, 31 (4): 603-619.

Heston, A., R. Summers and B. Aten (2002), Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP).

Hulme D. and A. McKay (2005), Identifying and Measuring Chronic Poverty: Beyond Monetary Measures. Mimeo, Institute for Development Policy and Management, University of Manchester.

Hulme D. and A. Shepard (2003), Conceptualizing Chronic Poverty. *World Development*, 31 (3): 403-424.

Jalan J. and M. Ravallion (1998), Transient Poverty in Postreform Rural China. *Journal of Comparative Economics*, 26: 338-357.

Strauss J., K. Beegle, B. Sikoki, A. Dwiyanto, Y. Herwati and F. Witoelar (2004), The Third Wave of the Indonesia Family Life Survey (IFLS3): Overview and Field Report. WR-144/1-NIA/NCHID, RAND Corporation.

Tables and Figures

Figure 1: Chronic and transient poverty indices

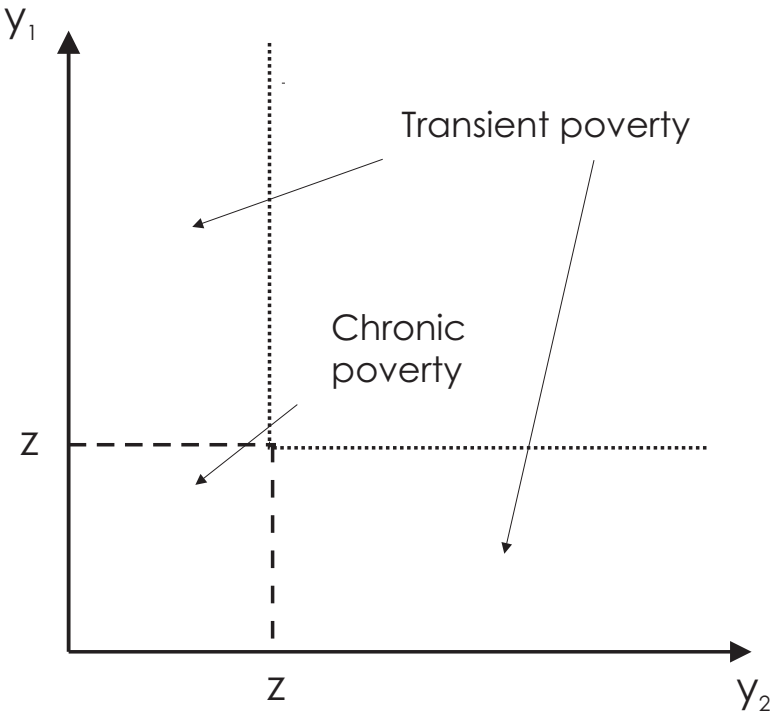

Figure 2: Absolute poverty in Indonesia: Dominance surface of the period 1993-1997

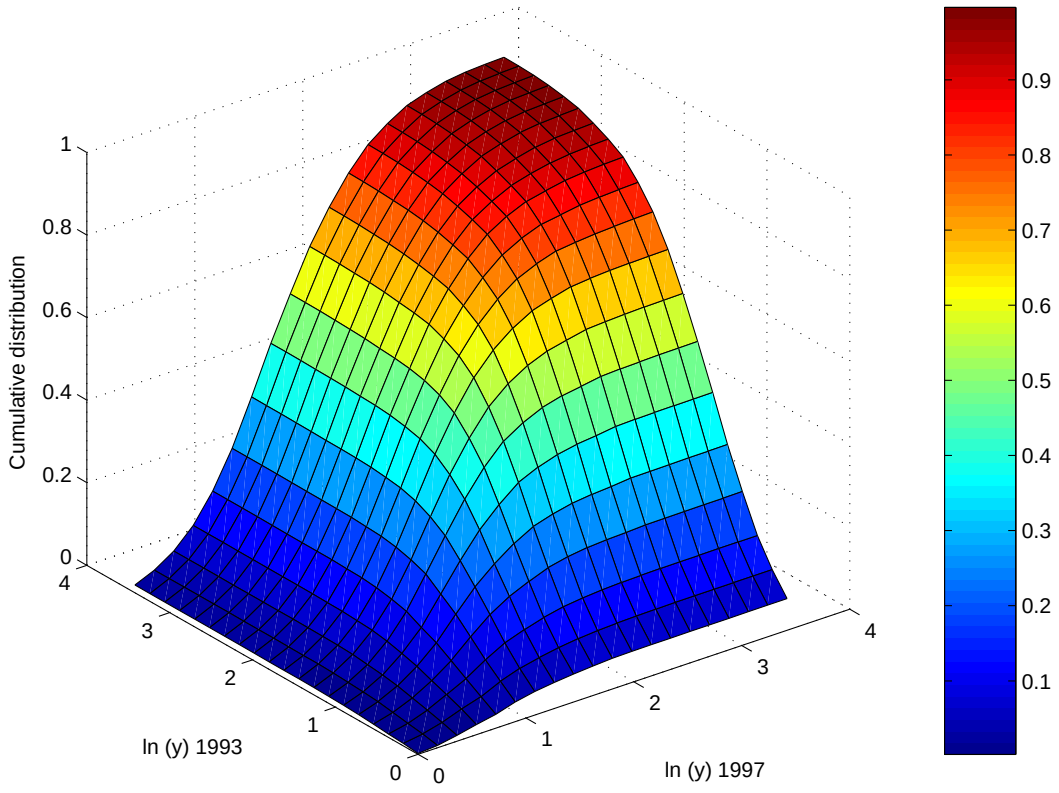

Figure 3: Absolute poverty in Indonesia: Differences in dominance surfaces ([1993-1997]-[1997-2000])

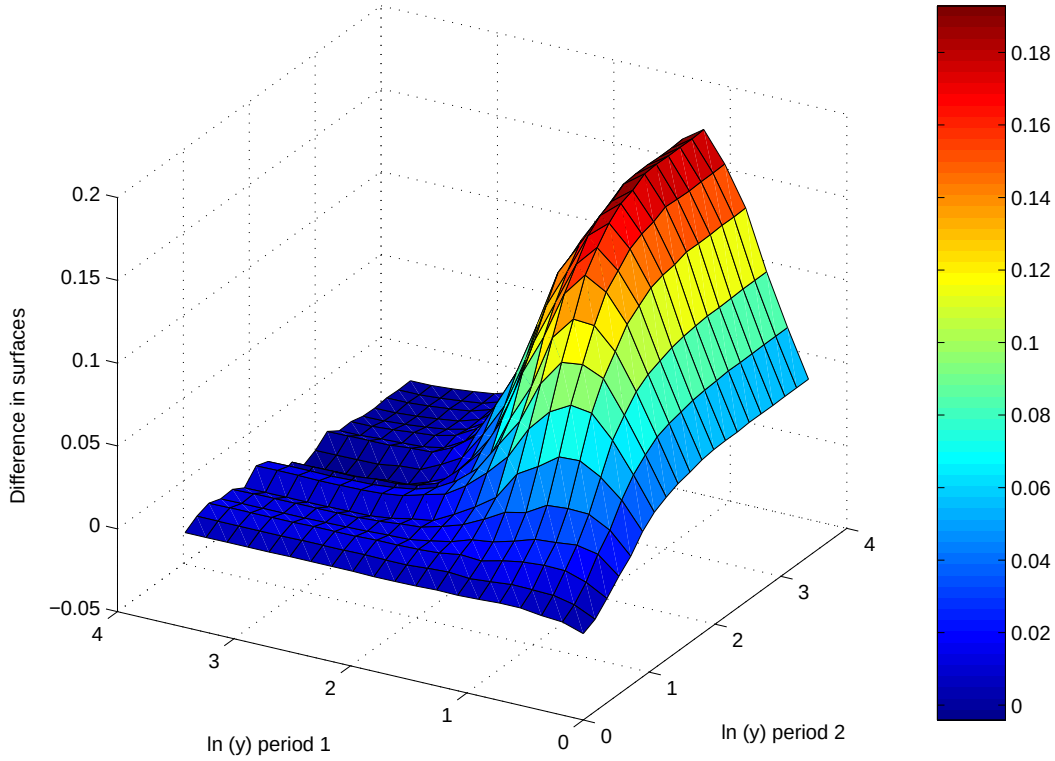

Figure 4: Relative poverty in Indonesia: Differences in dominance surfaces ([1993-1997]-[1997-2000])

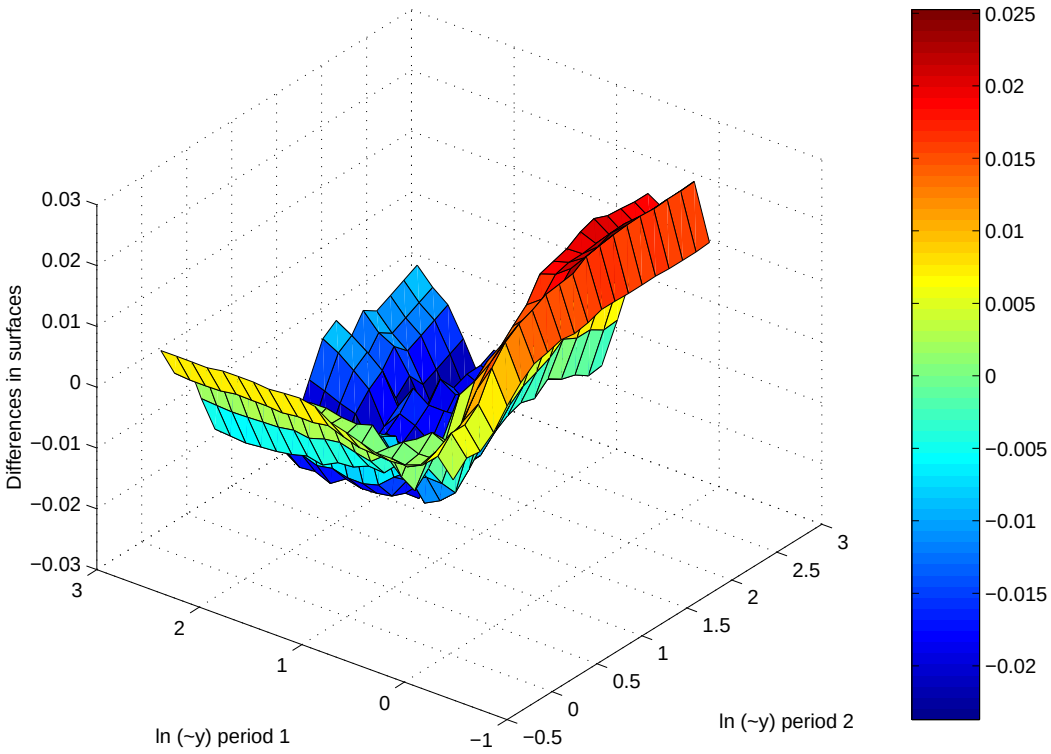

Table 1
Absolute poverty in Indonesia: Differences in dominance surfaces between 1993/1997 and 1997/2000

$\ln(y)$ period 1	$\ln(y)$ period 2																			
	0.00	0.18	0.36	0.54	0.72	0.90	1.08	1.26	1.44	1.62	1.80	1.98	2.16	2.34	2.52	2.70	2.88	3.06	3.24	3.42
0.00	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.18	1	(1)	1*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.36	1	1*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.54	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.72	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.90	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.08	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.26	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.44	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.62	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.80	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
1.98	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
2.16	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
2.34	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
2.52	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
2.70	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.88	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.06	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.24	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.42	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

1 indicates that the 1993/1997 surface was significantly above 1997/2000 surface, -1 indicates the opposite, 0 indicates no significant difference.

Table 2
Absolute poverty in urban Indonesia: Differences in dominance surfaces between 1993/1997 and 1997/2000

$\ln(y)$ period 1	$\ln(y)$ period 2																			
	0.00	0.18	0.36	0.54	0.72	0.90	1.08	1.26	1.44	1.62	1.80	1.98	2.16	2.34	2.52	2.70	2.88	3.06	3.24	3.42
0.00	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.18	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.36	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.54	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.72	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.90	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.08	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.26	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
1.44	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
1.62	0	-1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
1.80	0	-1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
1.98	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
2.16	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
2.34	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
2.52	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.70	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.88	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.06	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.24	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.42	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

1 indicates that the 1993/1997 surface was significantly above 1997/2000 surface, -1 indicates the opposite, 0 indicates no significant difference.

Table 3
Absolute poverty in rural Indonesia: Differences in dominance surfaces between 1993/1997 and 1997/2000

$\ln(y)$ period 1	$\ln(y)$ period 2																			
	0.00	0.18	0.36	0.54	0.72	0.90	1.08	1.26	1.44	1.62	1.80	1.98	2.16	2.34	2.52	2.70	2.88	3.06	3.24	3.42
0.00	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.36	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.54	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.72	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.90	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.08	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.26	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.44	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.62	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.80	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.98	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2.16	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1
2.34	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	1	1
2.52	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	0	1	1	1	1
2.70	1	1	1	1	1	0	1	1	0	0	0	1	1	1	0	0	0	0	0	0
2.88	1	1	1	1	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0
3.06	1	1	1	1	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0
3.24	1	1	1	1	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0
3.42	1	1	1	1	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0

1 indicates that the 1993/1997 surface was significantly above 1997/2000 surface, -1 indicates the opposite, 0 indicates no significant difference.

Table 4
Relative poverty in Indonesia: Differences in dominance surfaces between 1993/1997 and 1997/2000

$\ln(\tilde{y})$ period 1	$\ln(\tilde{y})$ period 2																			
	-0.30	-0.15	0.00	0.15	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.65	1.80	1.95	2.10	2.25	2.40	2.55
-0.30	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
-0.15	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
0.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1
1.65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1
1.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1
1.95	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1
2.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1
2.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1
2.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1
2.55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	-1	-1	-1	-1

1 indicates that the 1993/1997 surface was significantly above 1997/2000 surface, -1 indicates the opposite, 0 indicates no significant difference.

Table 5
Absolute poverty in Peru and Indonesia: Differences in dominance surfaces

$\ln(y)$ period 1	$\ln(y)$ period 2																			
	0,50	0,65	0,80	0,95	1,10	1,25	1,40	1,55	1,70	1,85	2,00	2,15	2,30	2,45	2,60	2,75	2,90	3,05	3,20	3,35
0,50	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0,65	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0,80	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0,95	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1,10	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1,25	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1,40	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1,55	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1,70	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1,85	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2,00	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2,15	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2,30	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2,45	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2,60	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2,75	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2,90	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
3,05	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
3,20	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
3,35	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

1 indicates that the Peru surface was significantly above the Indonesia surface, -1 indicates the opposite, 0 indicates no significant difference.

Table 6
Relative poverty in Peru and Indonesia: Differences in dominance surfaces

$\ln(\tilde{y})$ period 1	$\ln(\tilde{y})$ period 2																			
	-0.30	-0.15	0.00	0.15	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.65	1.80	1.95	2.10	2.25	2.40	2.55
-0.30	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
-0.15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.00	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.30	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.45	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.60	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.75	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.90	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.05	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.35	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.50	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.65	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
1.80	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
1.95	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1
2.10	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1
2.25	1	1	1	1	1	1	1	0	0	0	1	0	1	1	1	1	1	1	1	1
2.40	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1
2.55	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1

1 indicates that the Peru surface was significantly above the Indonesia surface, -1 indicates the opposite, 0 indicates no significant difference.