Statistical Tests of Changes in U.S. Poverty, 1975 to 1990

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ABSTRACT: Traditional measures of poverty, such as the Headcount Ratio, are seriously flawed, theoretically. And application of such measures without accounting for statistical variability compounds the potential errors. We apply two traditional and five newly developed distribution-sensitive poverty measures along with methods of statistical inference to examine poverty changes in the U.S. from 1975 to 1990. We also let the poverty line vary over a range rather than apply a single, arbitrary poverty line. The traditional poverty measures and distribution-sensitive measures present different patterns in the timing and duration of fluctuations in the poverty level. The numerical comparisons successfully rank order less than half the year-to-year and period changes in poverty. For the distribution-sensitive measures, the statistical procedures successfully rank orders nearly all year-to-year and period comparisons. The combined use of distribution-sensitive measures, multiple poverty lines, and statistical inference yields much more robust conclusions about poverty than do traditional poverty statistics.

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I. INTRODUCTION

Since President Lyndon Johnson declared the war on poverty three decades ago, scholars have devoted many volumes to analyzing characteristics of poverty, evaluating effectiveness of anti-poverty policies, and measuring changes in poverty. Unfortunately, most poverty studies have focused primarily on the incidence of poverty rather than on both the incidence of poverty and the income distribution within the poor population. Although A. K. Sen's (1976) seminal work on measurement of poverty demonstrated the importance of constructing and using a distribution-sensitive poverty measure in evaluating poverty, the U.S. Federal Government still uses the proportion of poor as virtually the only indicator of poverty. With few exceptions, such as Bishop, Formby, and Smith (1993), most recent scholastic works on poverty issues (*e.g.*, Sawhill 1988, Hanratty and Blank 1992) are also concerned exclusively with the incidence of poverty and use a single, arbitrary poverty line. In this study, we demonstrate that a more comprehensive look at poverty, using distribution-sensitive measures and multiple poverty lines, yields a somewhat different picture of poverty changes over time compared to what official U.S. statistics portray.

Practically, the comparison of poverty changes can be decomposed into three parts: (1) setting a poverty line--an income threshold below which a person is defined as poor. This step is also called the identification of the poor and is very important in poverty study; (2) choosing a method to aggregate individual poverty into overall poverty. Different methods of aggregating may lead to different conclusions about poverty changes. Therefore an appropriate method is essential for poverty study; and (3) statistical inference -- since conclusions about poverty changes are drawn from a random sample of the population, it is important to know whether the estimated poverty statistics represent the true population parameters. In the last two decades, following the path finding work of Sen (1976), many scholars have worked on the first two

issues and proposed alternative methods. Recently Kakwani (1992), Jantti (1992), and Zheng (1993a) have developed statistical testing procedures for a general class of poverty indices.

We use this framework to examine U.S. poverty changes from 1975 to 1990. This study differs from existing poverty measurement studies of the U.S. in three respects. First, instead of using a single, arguable poverty line, we introduce a *poverty critical range* in which any income level could be a poverty line. This lessens the disagreement over the appropriate poverty line because one can define the range broadly enough to accommodate different views of setting the poverty line. Second, in addition to using the official poverty measures (the headcount ratio and the poverty gap ratio), we apply distribution-sensitive, decomposable measures to observe poverty changes in the U.S. Since the use of any single measure may be misleading, we use multiple poverty measures to examine poverty changes. Third, we apply the recently developed methods of statistical inference to test hypotheses about poverty changes. Therefore, our results are much more robust compared with those of other studies.

The next section reviews new developments in the study of poverty measurement and methods of statistical inference. Section III introduces and defines the concept of strong and weak poverty dominance. This concept is related to partial poverty ordering, which gives uniform rankings of poverty levels for all poverty lines in the poverty critical range. Section IV is a statistical analysis of changes in U.S. poverty from 1975 to 1990. Section V draws policy implications from the analysis.

II. POVERTY LINE, POVERTY MEASURE AND STATISTICAL INFERENCE

Poverty, according to Watts (1968), is a situation where income, representing command over resources, falls below a certain level. By this definition, a poverty index is a function of income only and the critical task consists of establishing an appropriate income level and choosing the way to measure poverty.

Poverty Line

The setting of a poverty line has been a topic of debate since the concept was first established. Early researchers such as Bowly were well aware of the arbitrariness of setting an official poverty line (Atkinson, 1987). In a cross-examination, Bowly was even questioned regarding what constituted a minimum basket of goods; whether a plate bearing a few scraps of bacon, fish and bread was sufficient breakfast for a man who had to carry heavy bags all day. The choosing of a poverty line is arbitrary and often is the target of critics.

Several researchers have attempted to define a poverty line. The proposed poverty lines vary from a certain fixed level of purchasing power to a decile-definition of poverty. However, there still is no dominating method of setting a poverty line. In their survey article, Hagenaars and Praag (1984) concluded that most poverty line settings fall somewhere between a pure absolute poverty line and a pure relative poverty line. A pure absolute poverty line is the minimum amount of income necessary for survival; a pure relative poverty line is the income level corresponding to a certain decile of the population. In order to avoid the arbitrary setting of a single poverty line, we follow the suggestion of Hagenaars and Praag and allow the poverty line to vary over an income range.

Poverty Measure

The study of poverty measures has attracted much more attention from scholars in recent years than has poverty line-setting research. As argued by Sen (1976), the selection of an appropriate poverty measure is at least as important as the choice of a poverty line. The traditionally used poverty measures are the headcount ratio (H) and the poverty gap ratio (I). The former represents the fraction of the people whose incomes fall below the poverty line. The U.S. Federal Government and the United Nations use this measure. The poverty gap ratio is the aggregate short-fall of the incomes of the poor, divided by the total amount of incomes if they were all just at the poverty line. The U.S. Social Security Administration uses this measure. Watts (1968) and Sen (1976, 1979) characterized these two measures as "very crude," for being

insensitive to distributional changes.

In his seminal paper, Sen (1976) proposed three basic axioms which a poverty measure should satisfy: (1) the Focus Axiom: only the poor are relevant for the measurement of the poverty level; (2) the Monotonicity Axiom: other things being equal, a decrement in a poor person's income should raise the poverty level; (3) the Weak Transfer Axiom: other things being equal, a transfer of income from a poor person to another poor person with higher income should raise the poverty level. H satisfies only the Focus Axiom, while I satisfies both the Focus and the Monotonicity Axiom. Sen developed a brand-new "distribution-sensitive" poverty measure that satisfies all three axioms.

Following Sen's pioneering work, many scholars have adopted an axiomatic approach and attempted to formulate alternatives to the Sen measure. Researchers have proposed more than one dozen additional axioms.[1] One such axiom which is appealing from both a theoretical and a practical perspective is Foster and Shorrocks' Subgroup Consistency Axiom--other things being the same, overall poverty increases as a result of the increase in a subgroup's poverty level (Foster and Shorrocks, 1991). Foster and Shorrocks went further to demonstrate that the combination of this axiom with some other very reasonable axioms implies that the satisfied poverty index will be a monotonic transformation of some decomposable poverty index--the aggregated poverty index is a weighted average of subgroup poverty. Since a poverty index is unique up to a monotonic transformation, Foster and Shorrocks' result also justifies the use of decomposable poverty measures. As pointed out by Foster and Shorrocks, the Sen measure does not satisfy the Subgroup Consistency Axiom and is not decomposable.

Generally, a decomposable poverty measure can be written as

$$P(z,h)=\int_0^z h(z,x)dF(x) \tag{1}$$

where x is the income variable, z is the poverty line, and $h_x^I \le 0$ and $h_z^I > 0$. Of all existent poverty measures, there are three measures that satisfy the Decomposability Axiom and are

[1] For a detailed survey of the properties of each axiom and the interactions among axioms, see Zheng (1993a).

distribution-sensitive:[2]

The Foster et al. measure: Foster, Greer and Thorbecke (1984) proposed a class of poverty measures that are of the form

$$F_\alpha(z) = \int_0^z \left(\frac{z-x}{z}\right)^\alpha dF(x), \ (\alpha \geq 2). \tag{2}$$

Note that the headcount ratio and the poverty gap ratio belong to this class when α takes on values of 0 and 1 respectively.

The Watts measure: Watts (1968) proposed a poverty measure that is defined as[3]

$$W(z) = \int_0^z (\ln z - \ln x) dF(x). \tag{3}$$

The Clark et al. measure: Clark, Hemming and Ulph (1981) proposed a poverty measure that is defined as [4]

$$C_\beta(z) = \frac{1}{\beta}\int_0^z \left(1 - \left(\frac{x_i}{z}\right)^\beta\right) dF(x), \tag{4}$$

where $0 < \beta < 1$. Since all these measures satisfy the reasonable axioms for a poverty index and the use of any single measure may sometimes generate a misleading conclusion, we use all three measures in this paper to analyze changes in the U.S. poverty level.[5] We also compare the results from these measures with those obtained by applying two traditional measures: the headcount ratio and the normalized poverty gap ratio.

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[2] There are about twenty poverty measures in the literature; for a discussion of their properties, see Zheng (1993a).

[3] The Watts measure was the first distribution-sensitive poverty index. However, this index has been largely ignored in the literature, even when scholars were searching for a distribution-sensitive and decomposable measure. Zheng (1993b) shows that the Watts measure satisfies all reasonable properties for a good poverty measure and, under a reasonable system of axioms, is the only measure if a poverty measure is perceived as the absolute amount of the social welfare loss due to poverty .

[4] The measure proposed by Chakravarty (1983) is the same as the Clark et al. measure with positive parameter.

[5] These measures differ with respect to some less critical properties and with respect to characteristics such as degree of poverty aversion. The choice among these measures is beyond the axiomatic approach.

Methods of Statistical Inference

Recently, Kakwani (1992), Jantti (1992), and Zheng (1993a) developed the large sampling properties for a class of generalized decomposable measures.[6] For ease of reference, we restate their basic results. The version adopted here is from Zheng (1993a). Suppose the income profile $x_1, x_2, \ldots, x_n$ is randomly drawn from a population having a continuous distribution function, $F(x)$. The poor are denoted as Ω_z, *i.e.*, all the people in this set have incomes less than or equal to z.[7] The sampled poverty index is $\hat{P}$.

Theorem 1 *If $F(x)$ is continuous with finite variance, then the statistic $\hat{P}_j(z,h)$ has a limiting normal distribution in that $n^{\frac{1}{2}}(\hat{P}(z,h) - P(z,h))$ is asymptotically normally distributed with mean zero and variance*

$$\sigma(z,h) = E([h(z,x)]^2 I(\Omega_z)) - (P(z,h))^2, \tag{5}$$

where $E(\cdot)$ is an expectation operator and $I(\Omega_z)$ is the indicator function of x that equals 1 when the income recipient is a poor person, zero otherwise.

With this property, we can establish statistical procedures to test various hypotheses about poverty orderings. Suppose we want to test the equivalence of the poverty level between distributions A and B. The samples of sizes n_A and n_B are randomly and independently drawn from these two populations. Given a poverty line z, let $\hat{P}_A(z,h)$ and $\hat{P}_B(z,h)$ be sampled poverty indices (overall or subgroup). Then under the null hypothesis H_0: $P_A(z,h) = P_B(z,h)$, the appropriate standard normal test statistic is

[6] Kakwani developed a testing procedure of a decomposable overall poverty index for a fixed poverty line. Independently, Chow (1991) developed a statistical test for generalized necessary conditions for stochastic dominance, which is similar to Kakwani's approach. Jantti extended Kakwani's procedure to the case of multiple poverty lines. Adopting the approach used in Chow (1991), Zheng established a general statistical testing approach for a class of decomposable poverty indices with multiple poverty lines using the *Student Maximum Modulus* test. His approach also features testing of subgroup contribution statistics.

[7] We adopt what Donaldson and Weymark (1986) called "the strong definition of the poor". The results are unaffected if we use the weak definition of the poor--the people on the poverty line are excluded from the poor group.

(6) $$s = (\hat{P}_A(z,h) - \hat{P}_B(z,h)) / [(\hat{\sigma}_A / n_A) + (\hat{\sigma}_B / n_B)]^{\frac{1}{2}}$$

where $\hat{\sigma}_A$ and $\hat{\sigma}_B$ are the corresponding estimated variances.

III. PARTIAL POVERTY ORDERING, POVERTY DOMINANCE, AND STATISTICAL TESTING PROCEDURES

As noted by Foster and Shorrocks (1988b), any conclusion about changes in the poverty level is arbitrary if a single poverty line is used. To reduce the arbitrariness in poverty comparisons, researchers have proposed the idea of *partial poverty ordering*--comparisons of poverty levels of different income distributions are carried out over a range of income cut-offs. Following Hagenaars and Praag's (1984) suggestion, we define the appropriate income range for a poverty line to be Z with the lower bound being the minimum amount of income necessary for survival and the upper bound being the income level corresponding to a certain decile of the population. Normally, Z lies within the income range, *i.e.*, $Z \in (0, \infty)$. Consequently, when z varies over Z, $P(z,h)$ becomes a curve that we define as a *Poverty Value Curve*, and partial poverty ordering becomes the ranking of different poverty value curves. If the poverty value curve of income distribution B lies above that of A, then A has a lower poverty level than B. Because every income level within the poverty critical range can be perceived as a poverty line, this dominance relationship can be further distinguished as strong dominance and weak dominance as follows:

Definition 1. (Weak Poverty Dominance) For two income distributions A and B, A weakly poverty dominates B if and only if

(7) $$P_A(z,h) \leq P_B(z,h)$$

for all $z \in Z$ and the strict inequality holds for at least one z.

Definition 2. (Strong Poverty Dominance) For two income distributions A and B, A strongly poverty dominates B if and only if

$$P_A(z,h) < P_B(z,h) \tag{8}$$

for all $z \in Z$.

Weak Poverty Dominance requires that (1) the poverty value curve of A nowhere lies above that of B over the poverty critical range Z; (2) for at least one point within Z, A has a lower poverty level than that of B. Strong Poverty Dominance requires the poverty value curve of A to lie strictly below that of B at every point in Z.

After specifying the poverty critical range Z, all we have to do is check whether condition (7) or (8) is satisfied. In practice, one can accomplish this task as follows: (a) divide the poverty critical range Z into K intervals, $z_0 < z_1 < \ldots < z_{K-1} < z_K$, with z_0 being the lower bound of the range and z_K being the upper bound; corresponding to these K intervals, there are $K+1$ poverty lines; (b) apply a given poverty measure $P(z,h)$ to these poverty lines to obtain $K+1$ poverty indices; (c) compare these indices for two income distributions. To consider sampling variability, we employ a joint hypothesis variation of Equation (6), the Student Maximum Modulus (*SMM*) test, for comparisons of multiple poverty lines.[8] Weak Poverty Dominance results if there is no positive significant difference and at least one (but not all) negative significant difference. Strong Poverty Dominance results if at every poverty line the difference is significantly negative. The curves cross if the difference for at least one poverty line is positive and significant while at least one other comparison is negative and significant. The poverty levels of two income distributions are equal if none of the differences are statistically significant.

All the above procedures apply equally well to each decomposable poverty measure. In

[8] This test has been successfully applied in ranking income distributions, *e.g.*, Beach and Richmond (1985), Bishop, Formby and Thistle (1989, 1992), Bishop, Formby, and Smith (1993). For a good description of the test, see Miller (1981) and Stoline and Ury (1979).

order to compare the poverty orderings by different measures, we compare the results obtained by applying statistical procedures to the orderings of each poverty measure. If all the measures give the same orderings over the poverty critical range, then we have more confidence to claim that such results depend less on either the setting of the poverty line or the selection of different poverty measures.

IV. TESTS OF THE CHANGES IN U.S. POVERTY LEVEL: 1975-1990

Data Source, Poverty Measures and the Poverty Critical Range

The microdata for this study are from the March tapes of the Current Population Survey for the years 1975-1990. The income measure is Census money income, which the Federal Government uses to calculate poverty statistics. The income recipient unit is "needs-adjusted per capita" where "needs" are determined using the well-known Orshansky equivalence scales normalized to one for an individual.[9]

The poverty lines in the U.S. were officially defined by the Council of Economic Advisors in 1964. The line was set at $1,500 for an individual and $3,000 for a family of four in 1964. Since 1964, these lines have been adjusted for changes in the Consumer Price Index (CPI) each year. Many people have expressed doubt regarding the precision of the official poverty line. Some suggest that the official poverty line should be 50 percent higher, while others hold the opposite opinion. The uncertainty about an appropriate poverty line suggests the use of a range of income rather than a single poverty line. Following Hagenaars and Praag's suggestion, we choose the poverty critical range to be the income interval between 50 percent and 175 percent of the official poverty line, which corresponds roughly to the 30 percent decile of population. For 1975, the corresponding poverty critical range is [$1,309, $4,581.5]; for 1990, it is [$3,060.5, $10,711.75]. These intervals are further divided into five equal sub-intervals, *i.e.*,

[9] For a good discussion of this adjustment procedure, see Cowell (1984).

50%, 75%, 100%, 125%, 150% and 175% of the official poverty line.

This study applies seven poverty measures to the data: the headcount ratio (H), the normalized poverty gap ratio (HI), two Foster et al. measures, three Clark et al. measures and the Watts measure (W). For the Foster et al. measures, we use $\alpha = 2$ and $\alpha = 3$ (denoted as F_2 and F_3); for the Clark et al. measures, we use two β values, 0.25 and 0.55 (denoted as C_1 and C_2) to check the sensitivity of the poverty changes.

Changes in the U.S. Poverty Level

In Figure 1, four measures (H, HI, F_3, and W) describe similar trends for the U.S. as a whole at the official poverty line. Overall poverty decreased initially, then increased sharply during the recession of the early 1980s, and decreased thereafter. All four measures show 1982 and 1983 as the peak poverty level years and 1978 among the years with the lowest poverty levels. However, these measures do not always agree on the poverty rankings of year-to-year comparisons. For example, H and HI reveal a sharp increase in the poverty level from 1979 to 1980, while the distribution-sensitive measures show only a mild increase. H and HI show a decrease in the poverty level from 1986 to 1987 when both government and the news media claimed progress in combating poverty; the two distribution-sensitive measures do not agree with this assessment. The comparison of 1975 with 1990 offers clear evidence of the differences among these measures: the headcount ratio shows 1990 to have a lower poverty level than 1975, while all other measures indicate the reverse.

The results for varying the poverty line are in Tables 1 and 2 and Figure 2. For illustrative purposes, Table 1 focuses on the Watts poverty measure, along with the appropriate test statistics. The symbol in the second column from the right indicates the result of numerical comparison of the year in question with the previous year. The comparisons indicate that 5 of 15 year-to-year changes are crossings. Using statistical procedures and comparing SMM test statistics with the critical value, which is 2.378 at the ten percent level, none of the year-to-year crossings is statistically significant. The symbol in the last column of Table 1 indicates the

result of statistical comparison between the year in question and the previous year.

The success of statistical comparisons enables an analysis of the trend in the changes of the poverty level.[10] We break the 16 year period into four distinct subperiods. The comparisons over these subperiods and for 1975-1990 are at the bottom of Table 1.[11] The first subperiod (1975-1978) is characterized by no significant year-to-year changes in the poverty level (denoted by the symbol "≈" in the last column of Table 1), because the absolute values of all SMM test statistics are less than 2.378. However, the comparison of the initial year (1975) with the end year (1978) reveals that 1978 weakly poverty dominates 1975, i.e. 1978 has a significantly lower level of poverty then 1975 at some poverty lines but is not significantly different at other poverty lines. The second period (1978-1982) consists of four year-to-year comparisons revealing statistically significant increases in poverty levels. As can be seen from Table 1, the years 1979 and 1980 are each weakly poverty dominated by the prior year (denoted by "↑") and the years 1980 and 1981 each strongly poverty dominate the subsequent year (denoted by "⇧"). For the subgroup as a whole, the initial year (1978) strongly dominates the end year (1982). The poverty level reaches a peak in 1982 and 1983, then starts to decline.[12] The rest of the period (1982-1990) is marked by a significant drop in the poverty level. According to the year-to-year changes in poverty levels, this period can be divided into two subperiods, *i.e.*, 1982-1985 and 1985-1990. The third subperiod (1982-1985) encompasses a significant decrease in the poverty level, *i.e.*, the year 1985 strongly poverty dominates the year 1982 (denoted by "⇩"). The year 1984 weakly poverty dominates the year 1983 (denoted by "↓"), and the other two year-to-year comparisons (1982/83 and 1984/85) show no significant changes. In the last subperiod (1985-1990), there are no significant year-to-year changes from 1985 to 1989. In 1990, there is a significant decrease in the poverty level at the lowest poverty line, resulting in weak poverty dominance of 1990 over 1989. 1990 weakly poverty dominates 1985. For the entire period,

[10] Partial ordering in a statistical sense is assumed in the rest of this paper unless stated otherwise.
[11] The number in each cell represents the difference between poverty indices of the initial year and end year of each subperiod.
[12] The comparison between 1982 and 1983 indicates a statistical equivalence.

1975-1990, the poverty level increases significantly at all poverty lines. The large *SMM* statistics suggest that society experienced a higher poverty level in 1990 than in 1975, by any poverty line in the range.

Figure 2 depicts the poverty value curves of four poverty measures (H, HI, F_3, and W) and for five years (1975, 1978, 1982, 1985 and 1990)--the initial and end years of four subperiods and the aggregate period. While the headcount ratio indicates a lower poverty level in 1990 than in 1975 at the official poverty line, it shows that the poverty value curve of 1975 crosses with that of 1990 at about 90 percent of the official poverty line. If the poverty line is 90 percent of the official poverty line, approximately 12 percent of people lived in poverty in both 1975 and 1990. At any poverty line below 90 percent of the official poverty line, there were relatively fewer people living in poverty in 1975 than in 1990. At any poverty line above 90 percent of the official poverty line, there were relatively more people living in poverty in 1975 than in 1990. When poverty is measured by the poverty gap ratio, the two poverty value curves of 1975 and 1990 cross at about 145 percent of the official poverty line. Therefore, these two measures do not provide us with an unambiguous conclusion regarding the poverty changes between 1975 and 1990 unless one is willing to accept other criteria or narrow the poverty critical range.

When using a distribution-sensitive measure, a clear picture emerges. Both F_3 and W (and all three other distribution-sensitive measures) show that 1975 statistically strongly poverty dominates 1990. This puts the poverty ordering in no doubt: at any poverty line between 50 percent and 175 percent of the official poverty line, 1990 had a higher poverty level than 1975. The conflict between the headcount ratio and the distribution-sensitive measures can be easily explained as follows: in 1975 relatively more people fell below the poverty line than in 1990 while relatively more people were concentrated at the bottom of the income distribution in 1990 than in 1975. This explanation corresponds to the general perception that there has been an increase in the amount of hard-core poverty since the 1970s.

Figure 2 also provides pairwise comparisons among different years. The headcount ratio

shows that the poverty value curve of 1975 also crosses with that of 1985. Both the Foster et al. and the Watts measures give a complete ranking among the five years. The poverty value curves of these five years are in the following order from the highest to the lowest: 1982, 1985, 1990, 1975, and 1978.

Table 2 summarizes the results of numerical and statistical comparisons for all seven poverty measures. By simple numerical comparisons, all seven poverty measures are able to rank only 6 of 20 comparisons (15 year-to-year, plus four subperiods and one aggregate period). The "distribution-sensitive" poverty measures (F_2, F_3, W, C_1 and C_2) uniformly rank only 12 of 20. There are several years that the headcount ratio indicates a crossing while other measures (including the poverty gap ratio) give uniform ranks (1976/77, 1978/79, 1982/83, 1987/88, and 1985/90). There are also some cases where the headcount ratio indicates dominance while all distribution-sensitive measures indicate a crossing (1979/80 and 1986/87). For 1988/89, the results for the headcount ratio are opposite in direction as compared to some other measures. Therefore the traditional poverty measures and the distribution-sensitive measures do not always give the same results.

The results of the statistical comparisons are encouraging. All seven poverty measures agree on the direction of change in 13 of the 20 comparisons, including all four subperiods. The distribution-sensitive poverty measures agree on the direction of change in 19 of 20 comparisons.[13] For some comparisons in which one or more measures indicate a numerical crossing, the changes in the poverty indices are not statistically significant at the ten percent level (1977/78, 1985/86, 1986/87, and 1988/89). For some other years in which one or more indices indicate a numerical crossing, one year weakly dominates the other year (1979/80, 1975/78, 1989/90 and 1975/90).

From the description above, one can draw a few conclusions and implications. First, the headcount ratio is not only theoretically deficient as an indicator of the poverty level, it is also

[13] The distribution-sensitive measures even agree on weak versus strong dominance in every case except for the 1975/90 and 1985/90 comparisons.

misleading practically. For five comparisons (1975/76, 1977/78, 1978/79, 1986/87, and 1975/90), the headcount ratio does not accurately record changes in poverty. While the headcount ratio does indicate one important aspect of poverty--the incidence of poverty in the population, the results above warn us not to use changes in the incidence of poverty as an indicator of overall changes in poverty. The incidence of poverty does not account for the depth of poverty, i.e. the income distribution among the poor.

Second, the description by the distribution-sensitive measures provides a clear picture of the overall poverty change from 1975 to 1990. It shows that the years 1977 and 1978 were the lowest-poverty-level years and 1982 and 1983 were the highest-poverty-level years. Except for the 1978-82, 1983-84, and 1989-90 periods, the year-to-year changes in overall poverty are not statistically significant. The fact that the poverty level increased during the last two years of the Carter administration at least qualifies the conventional judgment that policies of the Reagan-Bush administration induced the change in poverty.[14] The initial significant rise in the poverty level was brought on by the 1979 oil shock and its aftereffects. The sharp increase in poverty during the recession of the early 1980s, and the failure of the poverty level to return to the levels of the 1970s may have been the direct result of the Reagan-Bush policies.

Third, it is interesting to examine those years where the poverty level fluctuated. The years 1980/81 and 1981/82, and the subperiods 1978/82, 1982/85, and the aggregate period, 1975/90, indicate strong poverty dominance which implies that the poverty level significantly changed at every poverty line. However, for other comparisons (1978/79, 1979/80, 1983/84, and 1975/78), where distribution-sensitive measures indicate a significant overall change, the changes in poverty indices are significant only at the top poverty lines (all above the official poverty line) while the poverty level of the bottom poor remained relatively stable. This implies that the overall poverty changes were mainly caused by the distributional changes among people in the upper poverty intervals. When examining the results of the headcount ratio, for most of

[14] Here, we are not saying anything about the change in income inequality, which is a separate issue.

this latter group of years (1979/80, 1983/84, 1975/78, and 1985/90) the number of people in the poverty interval just above the official poverty line also decreased. This suggests that the poverty changes in these years may be correlated with the changes in the income distribution and size of the upper poor/lower middle class. The findings here may have implications on the current debate over the diminishing middle class in the U.S.

V. CONCLUSION

The preceding empirical research applies decomposable poverty measures (both traditional and distribution-sensitive) and methods of statistical inference to examine poverty changes in the U.S. This study also features partial poverty ordering, *i.e.* the poverty line varies over a certain range of income instead of focusing only on a single, arguable poverty line. This combination yields more robust results from which conclusions may be drawn with greater confidence.

Applying seven decomposable poverty measures to Current Population Survey microdata, we analyze the changes in U.S. poverty from 1975 to 1990. The simple numerical comparison by each poverty measure fails to rank, on average, about 30 percent of year-to-year poverty changes. All poverty measures together agree only on 6 of 20 comparisons for overall U.S. poverty. However, much of the disagreement arises from sampling variability. The statistical comparison presents a much clearer picture of the changes in U.S. poverty levels. This procedure enables ranking of 19 of 20 comparisons for the U.S. as a whole by all distribution-sensitive poverty measures. The results demonstrate that the combined use of "partial poverty ordering" and statistical procedures is very powerful and very promising in solving several important issues in ranking poverty levels. It has the potential to substantially increase our understanding of the nature and trends of poverty.

An important component of the analysis is the comparison of results from the traditional headcount ratio with those of the distribution-sensitive measures. This study shows that all

"good" poverty measures give very similar conclusions for partial poverty ordering. The headcount ratio and distribution-sensitive measures, though depicting somewhat similar trends in poverty levels, present different patterns of changes in terms of the timing, duration and direction of changes. The headcount ratio may indicate a significant decrease in the poverty level while other measures (sometimes including the poverty gap ratio) show no change or an increase. This empirical analysis provides powerful evidence that the sole use of the headcount ratio may be very misleading regarding trends in poverty and may lead to undesirable policies.

Analysis based on the distribution-sensitive poverty measures reveals some general trends in poverty levels for the 1975-90 period. The overall poverty level decreased from 1975 to 1978, increased sharply from 1979 to 1982-83, decreased from 1983 to 1984 and remained quite stable until the end of the study period. The poverty level bottomed out in 1977/78 and reached its peak in 1982/83. The timing of this pattern qualifies the conventional judgment that the Reagan-Bush administrations were primarily responsible for the general increase in the poverty level during this period. However this conventional judgment is consistent with the failure of the poverty level to return to levels of the 1970s and especially with the relative increase in the depth of poverty at the lower end of the income distribution. Notably, the distribution-sensitive measures indicate that in 1990, at the end of several years of sustained economic expansion, the poverty level was significantly higher than in 1975, which was a recession year. This is rather strong statistical evidence of a worsening of poverty over time.

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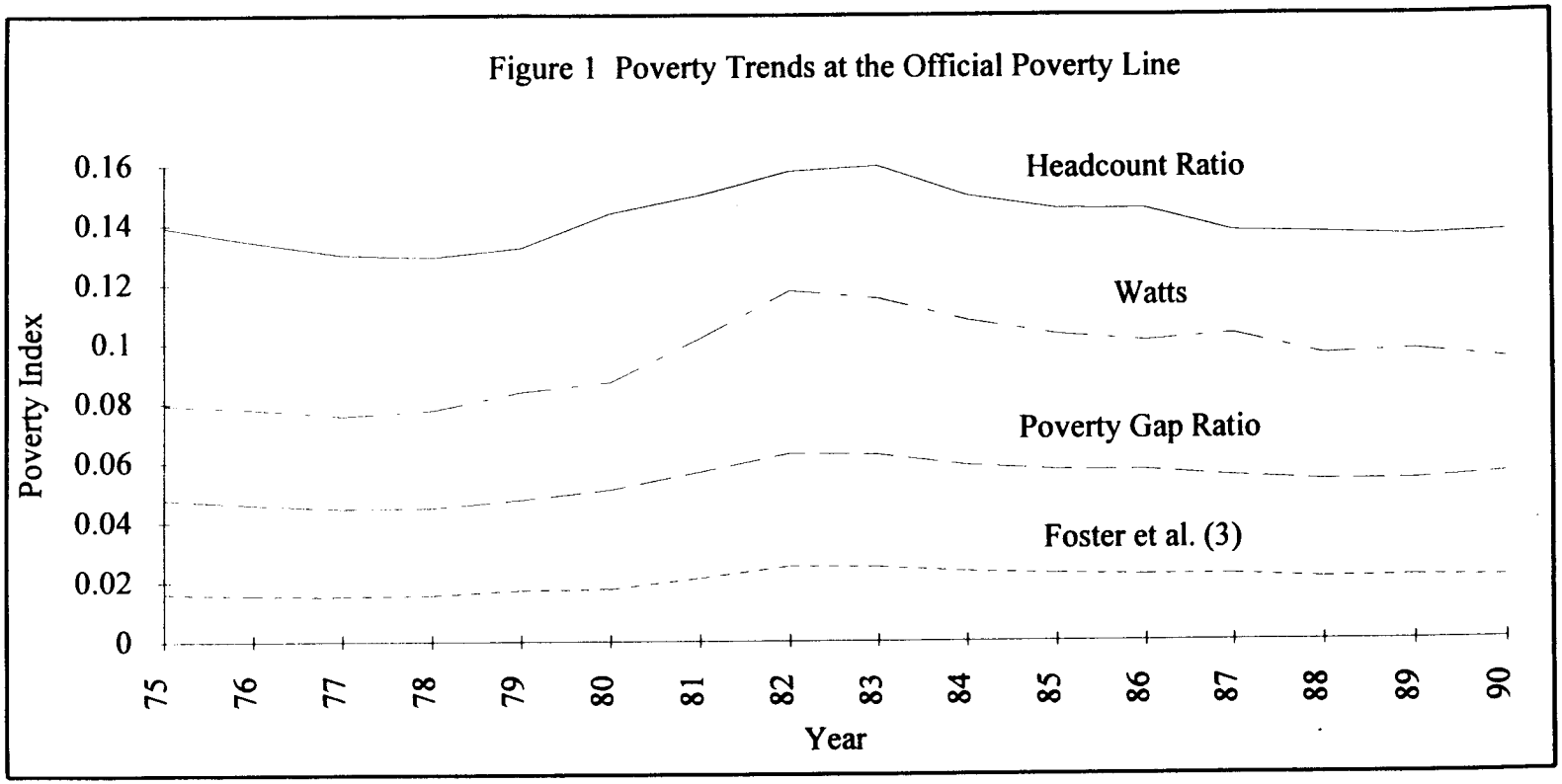
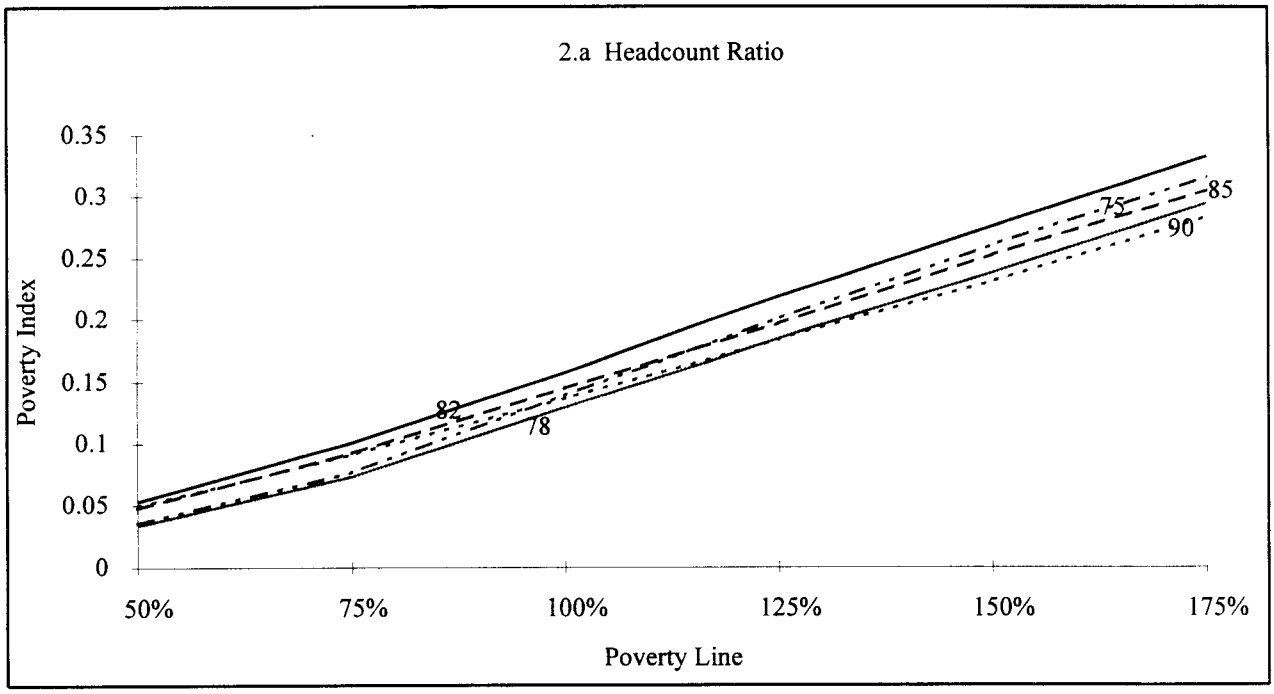


Figure 1 Poverty Trends at the Official Poverty Line
Headcount Ratio
Watts
Poverty Gap Ratio
Foster et al. (3)
Poverty Index
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
Year

Figure 2 Partial Poverty Orderings for the U.S.: 1975, 1978, 1985 and 1990



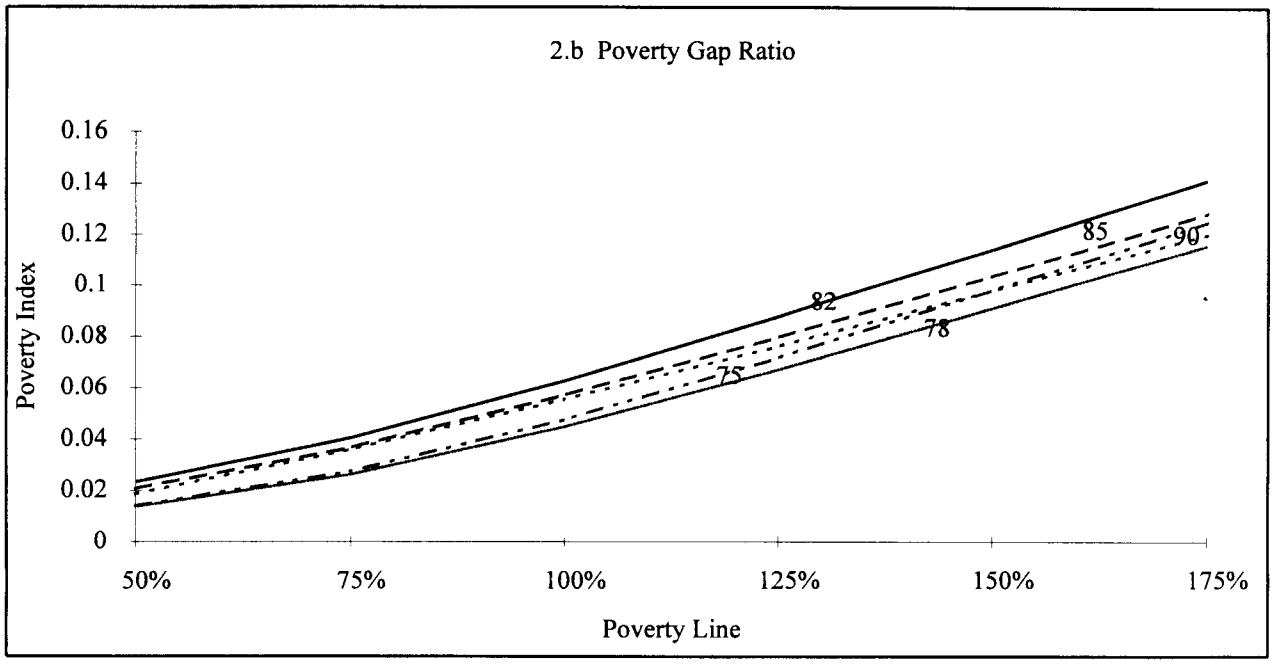
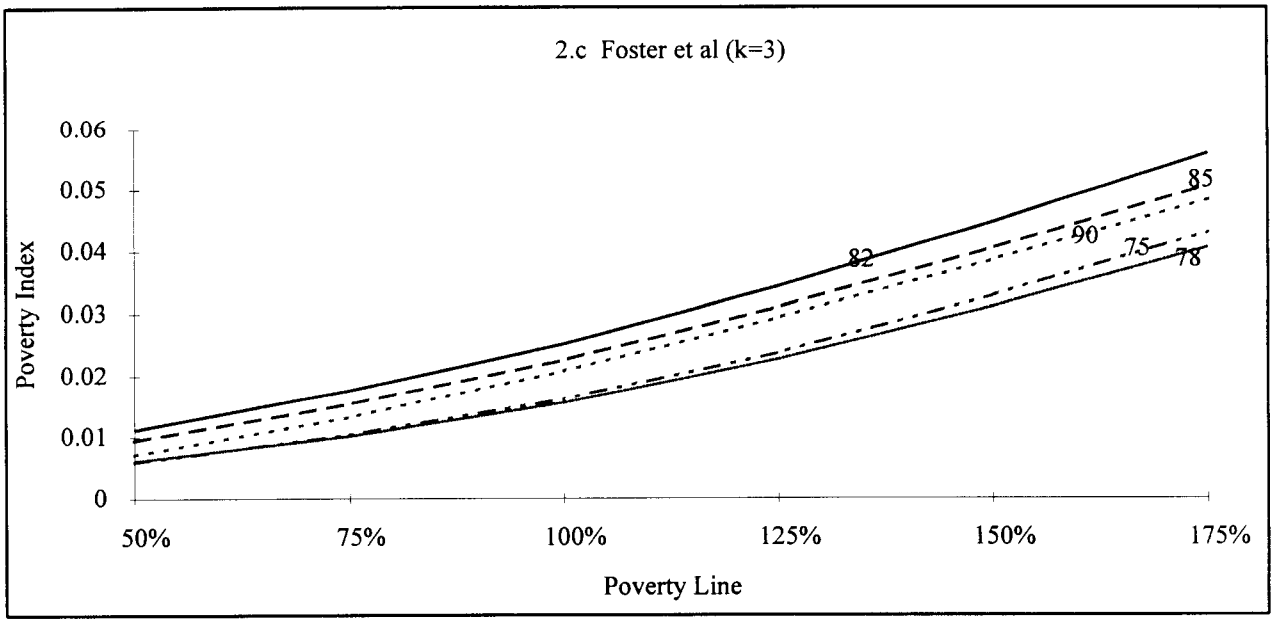


Figure 2 Partial Poverty Orderings for the U.S.: 1975, 1978, 1985 and 1990 (Cont'd)



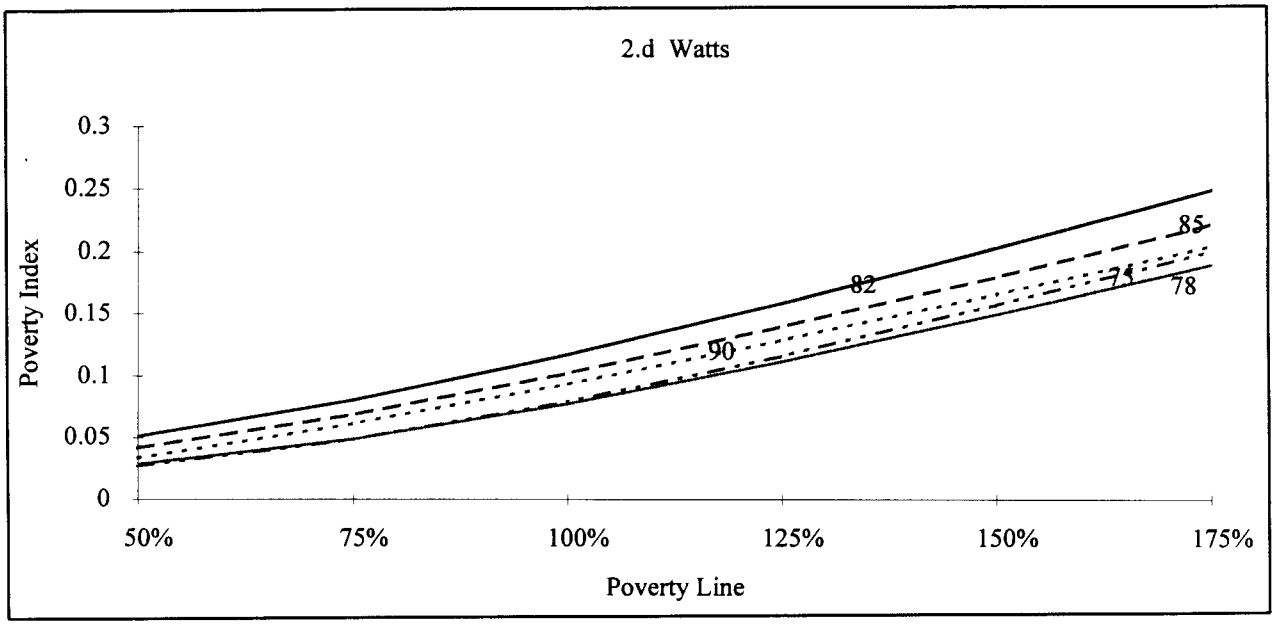


Table 1 Poverty Indices and Test Statistics for Year-to-Year Changes in the U.S. Poverty Level--1975 to 1990--by the Watts Poverty Measure

	Percentage of the Official Poverty Line						
Year	50%	75%	100%	125%	150%	175%	Ranking[3,4]
1975	0.0272	0.0487	0.0794	0.1167	0.1584	0.2025	-------
1976	0.0277	0.0480	0.0779	0.1144	0.1549	0.1977	×, ≈
	[0.3214]	[-0.3749]	[-0.6953]	[-0.9343]	[-1.2751]	[-1.6001]	
1977	0.0269	0.0470	0.0757	0.1110	0.1504	0.1925	⇩, ≈
	[-0.5213]	[-0.5502]	[-1.0511]	[-1.4310]	[-1.7061]	[-1.8068]	
1978	0.0286	0.0490	0.0776	0.1121	0.1503	0.1914	×, ≈
	[1.0924]	[1.0876]	[0.8955]	[0.4588]	[-0.0377]	[-0.3803]	
1979	0.0323	0.0539	0.0837	0.1192	0.1579	0.1987	⇧, ↑
	[1.9371]	[2.1737]	[2.3624]	[2.4516]*	[2.3839]*	[2.1013]	
1980	0.0312	0.0544	0.0868	0.1250	0.1668	0.2111	×, ↑
	[-0.5200]	[0.1986]	[1.0717]	[1.7830]	[2.4776]*	[3.1710]*	
1981	0.0405	0.0670	0.1016	0.1415	0.1848	0.2303	⇧, ⇧
	[3.9698]*	[4.5427]*	[4.6702]*	[4.6574]*	[4.6213]*	[4.5493]*	
1982	0.0511	0.0807	0.1176	0.1592	0.2042	0.2508	⇧, ⇧
	[3.7761]*	[4.1849]*	[4.3354]*	[4.3470]*	[4.3843]*	[4.3032]*	
1983	0.0486	0.0782	0.1149	0.1564	0.2006	0.2462	⇩, ≈
	[-0.8558]	[-0.7348]	[-0.7057]	[-0.6643]	[-0.7868]	[-0.9373]	
1984	0.0450	0.0730	0.1075	0.1467	0.1885	0.2322	⇩, ↓
	[-1.3016]	[-1.6051]	[-2.0236]	[-2.3934]*	[-2.7373]*	[-2.9544]*	
1985	0.0418	0.0689	0.1027	0.1404	0.1810	0.2236	⇩, ≈
	[-1.2421]	[-1.3445]	[-1.3820]	[-1.6283]	[-1.7703]	[-1.8882]	
1986	0.0392	0.0667	0.1005	0.1389	0.1795	0.2215	⇩, ≈
	[-1.0968]	[-0.7679]	[-0.6660]	[-0.4048]	[-0.3676]	[-0.4759]	
1987	0.0446	0.0705	0.1028	0.1395	0.1792	0.2205	×, ≈
	[2.1225]	[1.2580]	[0.6695]	[0.1570]	[-0.0716]	[-0.2212]	
1988	0.0385	0.0641	0.0958	0.1319	0.1707	0.2115	⇩, ≈
	[-2.3502]	[-2.0913]	[-2.0140]	[-1.9707]	[-2.0158]	[-1.9786]	
1989	0.0404	0.0658	0.0971	0.1327	0.1714	0.2120	⇧, ≈
	[0.9167]	[0.6846]	[0.4549]	[0.2508]	[0.1996]	[0.1318]	
1990	0.0335	0.0616	0.0939	0.1294	0.1670	0.2164	×, ↓
	[-4.4536]*	[-2.2421]	[-1.4618]	[-1.3360]	[-1.6110]	[1.4844]	
1975/78	0.0014	0.0003	-0.0018	-0.0046	-0.0081	-0.0111	×, ↓
	[0.8878]	[0.1589]	[-0.8238]	[-1.8530]	[-2.9362]*	[-3.6835]*	
1978/82	0.0225	0.0317	0.0400	0.0471	0.0539	0.0594	⇧, ⇧
	[9.3658]*	[11.336]*	[12.675]*	[13.518]*	[14.219]*	[14.546]*	
1982/85	-0.0093	-0.0118	-0.0149	-0.0188	-0.0232	-0.0272	⇩, ⇩
	[-3.3909]*	[-3.6629]*	[-4.0811]*	[-4.6551]*	[-5.2750]*	[-5.7501]*	
1985/90	-0.0083	-0.0073	-0.0088	-0.0110	-0.0140	-0.0072	⇩, ↓
	[-4.1562]*	[-3.0336]*	[-3.1480]*	[-3.4929]*	[-4.0340]*	[-1.9170]	
1975/90	0.0063	0.0129	0.0145	0.0127	0.0086	0.0139	⇧, ⇧
	[4.2763]*	[7.1450]*	[6.8081]*	[5.1878]*	[3.1488]*	[4.6548]*	

1. *SMM* test statistics of comparing with the previous year are in [ ].
2. An * indicates that the difference is significant at the ten percent level. The critical value is 2.378.
3. In each cell, the first symbol represents partial poverty rankings without using statistical inference, and the second symbol indicates partial poverty rankings with statistical inference.
4. An ⇧ or ⇩ indicates Strong Poverty Dominance and an ↑ or ↓ indicates Weak Poverty Dominance; an ≈ indicates that the change in poverty levels between two years is not statistically significant; an × indicates that two poverty value curves cross.

Table 2 Partial Poverty Orderings of the U. S. by Different Measures: Numerical and Statistical Comparison

Year	Official Measures		Distribution-Sensitive Measures				
	H	HI	F_2	F_3	W	C_1	C_2
1975/1976	⇩, ↓	⇩, ↓	⇩, ≈	↓, ≈	×, ≈	⇩, ≈	⇩, ↓
1976/1977	×, ↓	⇩, ≈	⇩, ≈	⇩, ≈	⇩, ≈	⇩, ≈	⇩, ≈
1977/1978	×, ↓	×, ≈	×, ≈	↑, ≈	×, ≈	×, ≈	×, ≈
1978/1979	×, ≈	⇧, ↑	⇧, ↑	⇧, ↑	⇧, ↑	⇧, ↑	⇧, ↑
1979/1980	⇧, ↑	⇧, ↑	×, ↑	×, ↑	×, ↑	×, ↑	↑, ↑
1980/1981	⇧, ↑	⇧, ⇧	⇧, ⇧	⇧, ⇧	⇧, ⇧	⇧, ⇧	⇧, ⇧
1981/1982	⇧, ↑	⇧, ⇧	⇧, ⇧	⇧, ⇧	⇧, ⇧	⇧, ⇧	⇧, ⇧
1982/1983	×, ≈	⇩, ≈	⇩, ≈	⇩, ≈	⇩, ≈	⇩, ≈	⇩, ≈
1983/1984	⇩, ↓	⇩, ↓	⇩, ↓	⇩, ↓	⇩, ↓	⇩, ↓	⇩, ↓
1984/1985	⇩, ≈	⇩, ≈	⇩, ≈	⇩, ≈	⇩, ≈	⇩, ≈	⇩, ≈
1985/1986	×, ≈	×, ≈	×, ≈	↓, ≈	⇩, ≈	↓, ≈	×, ≈
1986/1987	⇩, ↓	×, ≈	×, ≈	×, ≈	×, ≈	×, ≈	×, ≈
1987/1988	×, ≈	⇩, ≈	⇩, ≈	⇩, ≈	⇩, ≈	⇩, ≈	⇩, ≈
1988/1989	⇩, ≈	×, ≈	×, ≈	⇧, ≈	⇧, ≈	↑, ≈	×, ≈
1989/1990	×, ×	×, ≈	×, ↓	×, ↓	×, ↓	×, ↓	⇩, ↓
1975/1978	⇩, ↓	⇩, ↓	↓, ↓	×, ↓	×, ↓	×, ↓	⇩, ↓
1978/1982	⇧, ⇧	⇧, ⇧	⇧, ⇧	⇧, ⇧	⇧, ⇧	⇧, ⇧	⇧, ⇧
1982/1985	⇩, ⇩	⇩, ⇩	⇩, ⇩	⇩, ⇩	⇩, ⇩	⇩, ⇩	⇩, ⇩
1985/1990	×, ↓	⇩, ↓	⇩, ↓	⇩, ↓	⇩, ↓	⇩, ⇩,	⇩, ↓
1975/1990	×, ×	×, ×	⇧, ⇧	⇧, ⇧	⇧, ⇧	⇧, ↑	×, ↑

1. In each cell, the first symbol represents the dominance of numerical comparison, the second one represents the dominance of statistical comparison.
2. An ⇧ or ⇩ indicates Strong Poverty Dominance and an ↑ or ↓ indicates Weak Poverty Dominance; an ≈ indicates that the change in poverty levels between two years is not statistically significant; an × indicates that two poverty value curves cross.