"Relative Distribution" (2003),
Encyclopedia of Social Science Research Methods,
Edited by Michael Lewis-Beck, Alan Bryman, and Tim Futing Liao.
New York: Russell Sage.

Relative Distribution. Differences among groups or changes in the distribution of a variable over time are a common focus of study in the social sciences. Traditional parametric models restrict such analyses to conditional means and variances, leaving much of the distributional information untapped.

Relative distributional methods aim to move beyond means-based comparisons to conduct detailed analyses of distributional difference. As such they present a general framework for comparative distributional analysis.

The relative distribution provides a graphical display that simplifies exploratory data analysis, a statistically valid basis for the development of hypothesis-driven summary measures, and location, shape, and covariate decompositions that identify the sources of distributional changes within and between groups.

The main idea of the relative distribution approach can be seen in an application to the comparison of earnings. The probability density functions (PDFs) in Figure 1 (a) show the distribution of logged annual earnings for men and women who worked full-time, full-year in 1997. The women's distribution is clearly downshifted, but this graphical display provides little additional information useful for comparison.

The ***relative distribution*** is the set of percentile ranks that the observations from one distribution would have if they were placed in another distribution. In this example it is the set of ranks that women earners would have if they were placed in the men's earnings distribution.

Figure 1 (b) shows the density for the relative distribution of women's to men's earnings. The smooth line encodes the relative frequency of women to men at each level of the earnings scale, the value of this ratio is shown on the vertical axis. The top axis shows the dollar value of the log earnings, the bottom axis shows the rank in the men's distribution. The histogram encodes the fraction of women falling into each decile of the men's earnings distribution. We can see from the histogram that 20% of the women fall in the bottom decile of the men's earnings distribution, and another 18% in the second decile. In all, about 75% of women earn less than the median male (the sum of the first 5 deciles). By contrast, less than 5% of women's earnings reach the top decile of the men's distribution.

The differences between the men's and women's distributions can be divided into two basic components: differences in location and shape. If the women's earnings distribution is a simple downshifted version of the men's, then after matching the medians (or other

location parameter) the two distributions should be the same. Differences that remain after a location adjustment are differences in distributional shape.

The relative distribution can be decomposed into these location and shape components, and Figure 2 shows the residual shape differences in men's and women's earnings. It is constructed by median-matching the women's earnings distribution to the men's (the median earnings ratio is about 1.4), and constructing the new relative distribution. After adjusting for median differences the relative distribution is nearly flat, indicating that most of the difference between the two groups is due to the median downshift in women's earnings. There are some residual differences, however. Women's earnings have relatively less density in the lower tail (as the bottom decile is below 1) and relatively more density in the upper tail. This probably reflects the dramatic losses experienced by low-earnings men in the last 20 years, and the corresponding gains made by high earnings women. The lower tail difference may also signal a minimum wage effect, as the women's median is lower to begin with, so their lowest earnings are closer to their own median than is the case for men. More information on these trends can find in the review article of Morris and Western (1999). Handcock and Morris (1999) is a book length treatment of relative distribution theory, and include historical references.

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Martina Morris

References

Handcock, M. S. and Morris, M. (1999) Relative Distribution Methods in the Social Sciences New York: Springer-Verlag.

Morris, M., and Western, B. (1999) Inequality in Earnings at the close of the 20th Century. Annual Review of Sociology 25: 623-57.

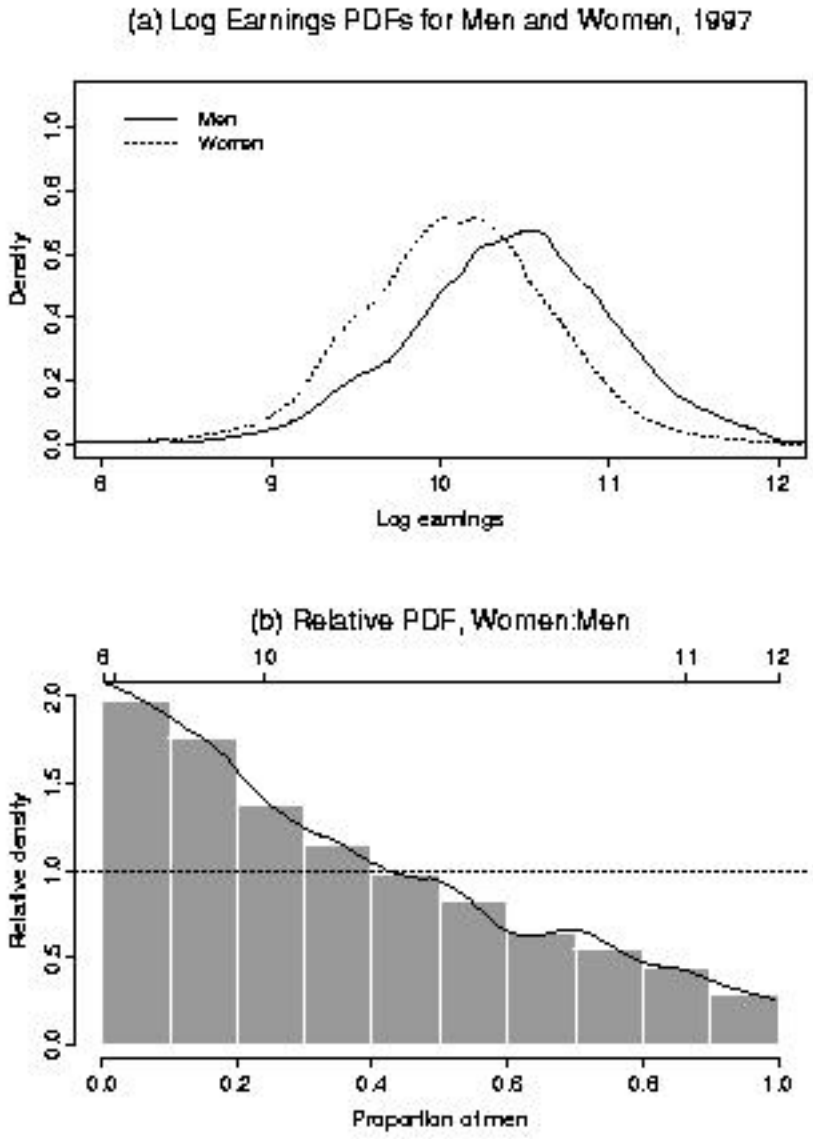
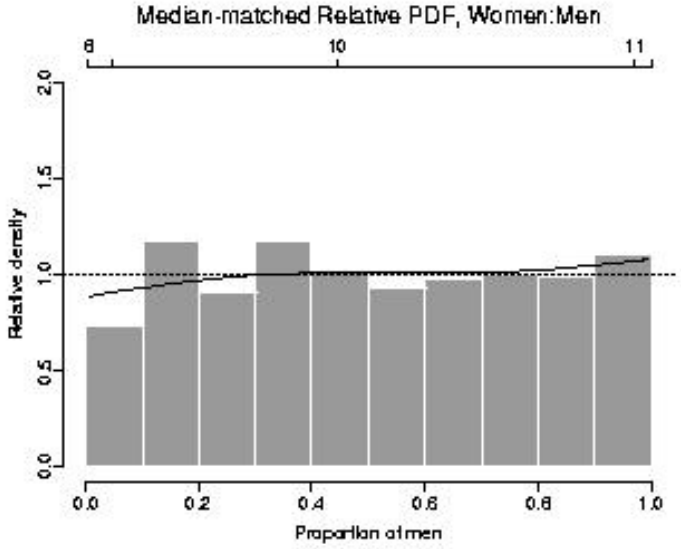
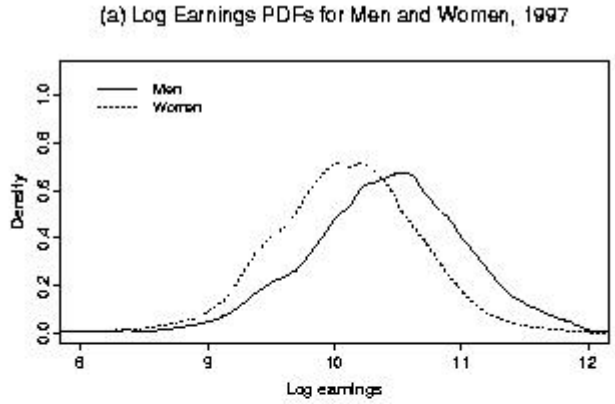

(a) Log Earnings PDFs for Men and Women, 1997
Men
Women
Density
0.0
0.2
0.4
0.6
0.8
1.0
8
9
10
11
12
Log earnings
(b) Relative PDF, Women:Men
8
10
11
12
Relative density
0.0
0.5
1.0
1.5
2.0
0.0
0.2
0.4
0.6
0.8
1.0
Proportion of men

Figure 1:


Median-matched Relative PDF, Women:Men
9
10
11
Relative density
0.0
0.5
1.0
1.5
2.0
0.0
0.2
0.4
0.6
0.8
1.0
Proportion of men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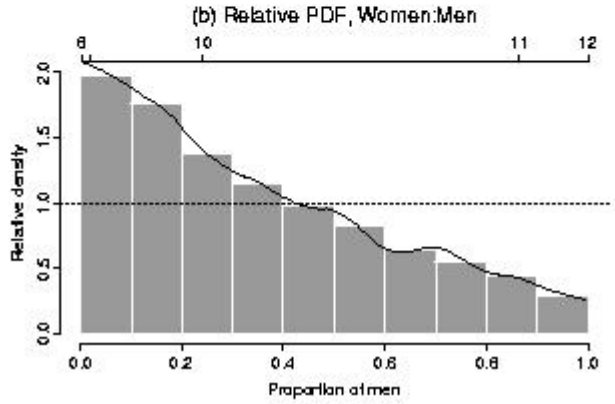
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0.2
0.4
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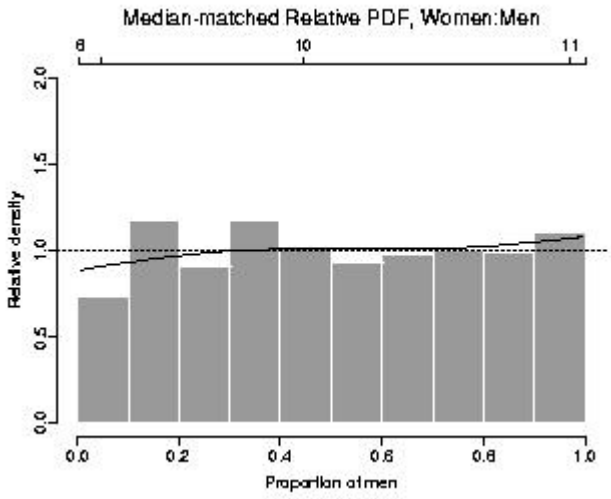
Proportion of men

Figure 2: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8
10
11
2.0
1.5
1.0
0.5
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Relative density
0.0
0.2
0.4
0.6
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Proportion of men