How Much Inequality Can we Explain? A Methodology and an Application to the United States

Author(s): Frank A. Cowell and Stephen P. Jenkins
Source: *The Economic Journal*, Vol. 105, No. 429 (Mar., 1995), pp. 421-430
Published by: Wiley on behalf of the Royal Economic Society
Stable URL: https://www.jstor.org/stable/2235501
Accessed: 02-10-2019 19:22 UTC

The Economic Journal, **105** (*March*), 421–430. © Royal Economic Society 1995. Published by Blackwell Publishers, 108 Cowley Road, Oxford OX4 1JF, UK and 238 Main Street, Cambridge, MA 02142, USA.

HOW MUCH INEQUALITY CAN WE EXPLAIN? A METHODOLOGY AND AN APPLICATION TO THE UNITED STATES*

Frank A. Cowell and Stephen P. Jenkins

We develop two simple measures of how much inequality is explained by individual population characteristics or groups of characteristics, analogous to R^2 in regression analysis. We investigate the measures' empirical implementation using several alternative theoretically consistent approaches to inequality decomposition. Results are illustrated using US PSID income data.

Explaining the level of and trends in inequality is an intriguing topic but one that is often dependent on a researcher's particular approach to inequality measurement. Sometimes the approach is simply one that accords with intuition; sometimes principles of applied welfare economics or statistical analysis are invoked. The particular approach adopted is important: the issue of the 'explanation' of inequality is not just a matter of computational procedure but can significantly affect our understanding of economic inequality and can potentially guide the design of economic policy. In this paper we develop new summary measures of 'explanation' – the income inequality literature's analogue of the R^2-statistic used in regression analysis – using an approach which pays particular attention to theoretically consistent methods for inequality decomposition, and illustrate them using a specially cleaned set of US PSID data.

An important example of the 'explanation' issue that is relevant to current policy debate is the suggestion that personal attributes and labour market status are major determinants of interpersonal income differences. Formal economic models stress the role of labour market opportunities in the structure of the income distribution; other types of analysis emphasise the importance of characteristics such as ethnicity, age and gender. It is commonly supposed that these factors explain a major part of observed income inequality and of changes in inequality. In the case of the United States we show that this conjecture is empirically unfounded: the supposed determinants of inequality in fact account for only a very small part of the actual inequality of broadly-defined personal income.

I. THE STRUCTURE OF INEQUALITY

To develop a summary measure of explanation we need to relate overall income inequality to its constituent components. How should we do this? Answering this question is a logically prior step to that of building an economic model of changes in income distribution, and is a valuable tool in the discussion

* The authors would like to thank Günther Rehme for assistance in computation and Stephen Howes, Robert Plotnick and an anonymous referee for comments. We would also like to acknowledge STICERD for funding.

of trends in income distribution. For example, quantitative discussion of the extent of world income inequality presupposes a coherent picture of the world income distribution expressible as a function of inequality between nations and inequality within nations: the same point would apply on a smaller scale to the assignment of inequality components to the distribution within and between constituent subgroups of the target population in a single country.

Some researchers would like to build on this to take the more ambitious step of constructing possible 'explanations' of the extent of income inequality within one country in terms of specific economic and social characteristics: the life-cycle pattern of income, race differences and sex differences. However, this step requires both a consistent system of ordering distributions by inequality within subgroups and within the population and also a consistent method of aggregating information about the subgroups. There are several important methodological issues concerning the appropriate method of breaking the overall picture of inequality into its component parts that are not always explicitly discussed, but which may significantly affect the way in which the 'explanation' of overall inequality is expressed in terms of its constituent components. One of the most important has to do with the meaning of inequality comparisons, and two aspects of this illustrate the potential pitfalls of uncritically applying standard techniques to the 'how much can we explain' exercise.

First, given the common view of inequality as a concept of 'distance' from perfect equality, it is tempting to interpret this simplistically in terms of Euclidean distance, such as is conventionally used in least-squares regression and in ANOVA. The ANOVA technique would certainly represent a consistent way of representing the composition of the dispersion of observations away from the mean – away from the distribution representing perfect equality. However, in the context of inequality analysis this is of course not the only relevant concept of distance, nor is there a presumption that it is the best concept.

Secondly, it is common to find the concept of inequality being driven by the specific dictates of a particular econometric model. For example, in the human capital literature a standard version of the earnings equation expresses earnings as a log-linear function of education and other personal attributes. An obvious component of such a model is an expression for the variance of log earnings in terms of the variances and covariances of the explanatory variables and the residuals: in other words, a decomposition of the variance of logarithms emerges as a by-product from the specification of the earnings model. Whilst there is a case for using the variance of logarithms as an indicator of dispersion of a distribution, its general suitability as an inequality measure is questionable[1] and it would be unsatisfactory to adopt the variance of logarithms as a standard tool for decomposition analysis by default.

In this paper we reverse the procedure and suggest a more appropriate methodological approach to the issue of how much inequality can be

[1] See for example Cowell (1988, 1995) and Sen (1973).

'explained'. However, in suggesting this alternative approach we should stress that it is very much in line with the mainstream approach to the formal analysis of the structure of inequality that has developed over the last decade or so.

II. ACCOUNTING FOR INEQUALITY IN A DECOMPOSITION

To address such issues we use inequality-decomposition analysis applied to population subgroups. Application of this concept requires the specification of a partition of the population (the collection of sub-groups), which in practice is usually carried out on the basis of some observable characteristic of the population: for example the elementary partition into males and females. The basic intuition is that, given a specific partition Π and a suitable inequality measure, overall inequality I can be written as some function of within-group inequality for the partition $I_W(\Pi)$ and between-group inequality $I_B(\Pi)$ thus:

$$I := f[I_W(\Pi), \mathrm{I_B}(\Pi)]. \tag{1}$$

In principle this functional breakdown would permit the specification of the proportion of inequality 'accounted for' by between-group inequality with reference to a particular population partition Π, and thus the amount of inequality 'explained' by the population characteristic defining Π. If, for a specific partition Π', $I(\Pi') = f(I_W, 0)$ then the characteristic defining Π' explains nothing of I, and if $I(\Pi') = f(0, I_B)$ then the characteristic explains all of overall inequality. With these reference points in mind, we propose two summary measures of the amount of inequality 'explained':

$$R_B(\Pi) := \frac{I_B(\Pi)}{I} \tag{2}$$

and the normalised residual

$$R_W(\Pi) := 1 - \frac{I_W(\Pi)}{I}. \tag{3}$$

But in order to implement indices such as R_B and R_W we have to have a 'suitable' inequality measure. Such a measure should at the very least ensure that the decomposition procedure is consistent for all logically possible partitions Π; if we also require that the measure satisfy the principle of scale invariance when comparing distributions with different means, then we know from standard results that the class of measures suitable for our purpose consists of those that are ordinally equivalent to the generalised entropy class:[2]

$$I(x) = C[G_\alpha(\mathbf{x}), \quad n(\mathbf{x}), \quad \mu(\mathbf{x})], \tag{4}$$

where $\mathbf{x}$ is a finite-dimensional non-negative vector representing the income distribution, C is monotonic increasing in its first argument, $n(\,)$ gives the number of persons in the distribution (the dimension of $\mathbf{x}$), $\mu(\,)$ gives the arithmetic mean and where

$$G_\alpha(\mathbf{x}) := \frac{1}{\alpha^2 - \alpha}\left\{\frac{1}{n(\mathbf{x})}\sum_{i=1}^{n(\mathbf{x})}\left[\frac{x}{\mu(\mathbf{x})}\right]^\alpha - 1\right\}. \tag{5}$$

[2] See Bourguignon (1979), Cowell (1980), Shorrocks (1980, 1984).

Expression (5) specifies a family of inequality contour maps defined on a subset of income distributions with given mean and population. The parameter α indexes the members of the family and can be assigned any real value: specifying a high positive value of α yields a 'top-sensitive' index (that is particularly sensitive to income changes in the upper tail of the distribution); a negative value would yield a 'bottom-sensitive' inequality index which picks up information principally from the lower tail of the distribution; l'Hôpital's rule yields appropriate limiting forms of (5) for the cases $\alpha = 0$, $\alpha = 1$.

There remain two important issues to be resolved: (i) the specific cardinalisation of the inequality measure – the function C in (4); and (ii) the basis for assigning within-group and between-group components of inequality. Although (i) and (ii) are logically distinct they may be interrelated in practice: for different members of the family defined by (5) different cardinalisations C may be appropriate.

There are two main approaches to the cardinalisation issue in the literature. The first is to use a cardinalisation that is statistically or presentationally convenient; this could be (5) itself, or a simple transformation of a member function, as in the case of the coefficient of variation (discussed below). Alternatively, if we introduce an explicit additively separable welfare function as a criterion for evaluating income distributions, then for a cardinalisation of the subclass of (5) corresponding to the parameter range $-\infty < \alpha < 1$ we could use the Atkinson inequality index, defined as

$$A_\epsilon(\mathbf{x}) := 1 - \frac{\xi(\mathbf{x})}{\mu(\mathbf{x})}, \tag{6}$$

where ξ is the representative income (or the equally-distributed equivalent income):

$$\xi(\mathbf{x}) := \left[\frac{1}{n(\mathbf{x})}\sum_{i=1}^{n(\mathbf{x})} x_i^{1-\epsilon}\right]^{\frac{1}{1-\epsilon}} \tag{7}$$

and $\epsilon = 1 - \alpha$ is Atkinson's inequality aversion parameter. In the specified parameter range we have

$$A_\epsilon(\mathbf{x}) = H[G_\alpha(\mathbf{x})] := 1 - [(\alpha^2 - \alpha)\, G_\alpha(\mathbf{x}) + 1]^{\frac{1}{1-\epsilon}} \tag{8}$$

and

$$G_\alpha(\mathbf{x}) = J[A_\epsilon(\mathbf{x})] := \frac{[1 - A_\epsilon(\mathbf{x})]^{1-\epsilon} - 1}{\alpha^2 - \alpha}. \tag{9}$$

III. ACCOUNTING FOR INEQUALITY: DECOMPOSITION METHODS

For any partition Π (i.e. for any exhaustive collection of mutually exclusive subsets of the population $\{1, 2, \ldots, n(\mathbf{x})\}$ we may in principle assign overall inequality to between-group and within-group components, but there are two logically separate and unavoidable difficulties that have to be confronted when doing this.

The Cardinalisation Issue

Although inequality within a given population or group is a purely ordinal concept, the decomposition by component subgroups is contingent upon the specific cardinalisation of the inequality measure. While there may only be few cardinal representations of a given inequality ordering that are likely to be economically interesting or intuitively reasonable it is possible that even a single pair of alternatives can give quite different impressions of what is going on in a comparison of changes in inequality. Take for example the coefficient of variation k which is ordinally equivalent to the generalised entropy measure with parameter 2: specifically $G_2 = \frac{1}{2}k^2$. Now imagine three consecutive time periods in which $k[\mathbf{x}(t_1)] = 1\frac{1}{2}$, $k[\mathbf{x}(t_2)] = 1$, $k[\mathbf{x}(t_3)] = \frac{1}{4}$: inequality certainly fell consistently, but did it fall faster in the first pair of periods than in periods 2 and 3? We find

$$k[\mathbf{x}(t_1)] - k[\mathbf{x}(t_2)] < k[\mathbf{x}(t_2)] - k[\mathbf{x}(t_3)], \tag{10}$$

$$G_2[\mathbf{x}(t_1)] - G_2[\mathbf{x}(t_2)] > G_2[\mathbf{x}(t_2)] - G_2[\mathbf{x}(t_3)]. \tag{11}$$

In some cases it is possible to resolve this ambiguity by appealing to an ethical basis for the inequality contours given in (5): for example if the inequality measure is taken to be functionally related to social welfare and social welfare is individualistic, symmetric, and monotonic in income, then it is arguable that – for $-\infty < \alpha < 1$ – the appropriate cardinalisation is (6) rather than (5). However, this argument cannot be readily applied to members of the contour-family for which $\alpha \geqslant 1$.

The Definition of Between-group Inequality

Since an inequality measure is defined on the set of income distributions of arbitrary dimension, the concept of inequality within any subgroup is straightforward: selection of a measure for the whole population also provides a measure for any group in Π. However the method of aggregation of these intra-group inequalities into a single number representing the within-group inequality component for Π is not self-evident. Two different meanings have been given to this concept: if $\mathbf{x}_s$ is the vector of incomes in any group s in Π then, using an obvious notation[3] the between-group component can be interpreted as inequality of the group-means – as the inequality of the income distribution vector

$$\boldsymbol{\mu}_B := (\underbrace{\mu_1, \mu_1, \ldots, \mu_1}_{(n_1)}, \quad \underbrace{\mu_2, \mu_2, \ldots, \mu_2}_{(n_2)}, \quad \ldots, \quad \underbrace{\mu_S, \mu_S, \ldots, \mu_S}_{(n_S)}), \tag{12}$$

or inequality of the group-representative-incomes – the inequality of the income distribution vector

$$\boldsymbol{\xi}_B := (\underbrace{\xi_1, \xi_1, \ldots, \xi_1}_{(n_1)}, \quad \underbrace{\xi_2, \xi_2, \ldots, \xi_2}_{(n_2)}, \quad \ldots, \quad \underbrace{\xi_S, \xi_S, \ldots, \xi_S}_{(n_S)}). \tag{13}$$

[3] Specifically $n_s := n(\mathbf{x}_s)$, $\mu_s := \mu(\mathbf{x}_s)$ and $\xi_s := \xi(\mathbf{x}_s)$ for any group s where ξ is given by (7).

The second interpretation is more demanding since it requires complete specification of a social welfare function, not just an inequality index.

Two principal forms of decomposition into 'within-group' and 'between-group' components have been suggested, each of which has a particularly convenient interpretation:

Method 1

Decomposition using the G-cardinalisation in (5) is most easily interpreted using the vector of group-mean incomes $\boldsymbol{\mu}_B$:

$$G(\mathbf{x}) = G_W + G_B, \tag{14}$$

$$G_W := \sum_{s=1}^{S} v_s^{\alpha} u_s^{1-\alpha} G(\mathbf{x}_s), \tag{15}$$

$$G_B := G(\boldsymbol{\mu}_B), \tag{16}$$

where u_s is the population share, and v_s the income share of group s.[4]

Method 2

On the other hand, A-decomposition in (6) is most easily interpreted using the vector of group-representative incomes $\boldsymbol{\xi}_B$,[5]

$$A(\mathbf{x}) = A_W + A_B - A_W A_B, \tag{17}$$

$$A_W := \sum_{s=1}^{S} v_s A(\mathbf{x}_s), \tag{18}$$

$$A_B := A(\boldsymbol{\xi}_B). \tag{19}$$

As noted, the between-group inequality-definition issue is distinct from the cardinalisation issue: so the mean-income decomposition (the 'natural' type for the cardinalisation G) could be applied to an inequality measure that is in some other cardinalisation. For example an Atkinson-type measure could be decomposed according to the mean-income decomposition by applying the transformation (9) to all the G expressions in (14)–(16).

For each cardinalisation we could then implement either of the R-indices defined in (2) and (3), whilst noting that, for decomposition methods and cardinalisations other than the case in (14), R_B and R_W will be different for any given partition Π. If, for two alternative partitions Π_a, Π_b corresponding to two population characteristics a and b, we find that $R(\Pi_a)$ is much greater than $R(\Pi_b)$, then it is evidently reasonable to say that in some sense the population characteristic a is more important as a determinant of inequality than is characteristic b. The R-technique can be used to analyse more than one determinant of inequality at a time: this extension simply requires specification

[4] These are, respectively, the proportion of population in group s, $n(\mathbf{x}_s)/n(\mathbf{x})$ and the proportion of income received by group s $[n(\mathbf{x}_s)\,\mu(\mathbf{x}_s)]/[n(\mathbf{x})\,\mu(\mathbf{x})]$.

[5] See Blackorby *et al.* (1981).

of a subpartition of the original partition. For any characteristics a and b it must be the case that:[6]

$$\left.\begin{array}{l} R(\Pi_{a \text{ and } b}) \geqslant R(\Pi_b) \\ R(\Pi_{a \text{ and } b}) \geqslant R(\Pi_a) \end{array}\right\}. \tag{20}$$

Using this technique with a succession of sub-partitions we get a consistent representation of the importance of any specified group-defining characteristic as a determinant of inequality. Of course we still have to resolve the two principal methodological problems mentioned above – the cardinalisation issue and the representation of between-group inequality – and also the problem of the order in which we bring in successive characteristics so as to generate ever finer partitions but these issues can usually be handled pragmatically.

IV. HOW MUCH AMERICAN INEQUALITY CAN WE EXPLAIN?

To apply these decomposition techniques and to see the quantitative importance of principal population characteristics in explaining inequality we employ a particularly rich data set: a cross-section from wave XX of the Panel Study of Income Dynamics.[7] For an ethically consistent approach to the measurement of inequality we examine the distribution of equivalised income per person, where income is total family income and weighted each family unit by the number of persons in it so as to proxy the distribution of income by individuals (cf. Cowell, 1984; Danziger and Taussig, 1979). We isolate three principal population characteristics and one labour market characteristic that may be seen as potential 'explanations' of the structure of inequality: sex of head, race of head, age of head, and employment status of the family. Here race was treated as binary (white/non-white), we selected six age groups (under 25, 25–34, 35–44, 45–54 years), and families were further grouped into two categories according to whether labour income (of head and wife combined) was zero or positive. The overall characteristics of the sample are described in Cowell and Jenkins (1993).

We used the Atkinson inequality index as an appropriate cardinalisation of the class of income-scale-independent decomposable inequality measures.[8] Along with the three Atkinson inequality measures ($A_{\frac{1}{2}}, A_1, A_2$), we used both forms of the between-group inequality definition in order to check the

[6] To see this, note first that from (14) and (17) for a given income distribution $\mathbf{x}$ it must be the case that under alternative partitions of a given population I_W and I_B are negatively related. If we go from a finer partition (a-and-b) to a coarser partition (a or b) then for some of the a & b-subgroups in (16) the fine-group means will be replaced by their common mean in the coarser partition: by the principle of transfers between group inequality must have fallen (so within-group inequality will have risen). Likewise from (18), in merging two or more subgroups within-group inequality must have risen (so between-group inequality will have fallen).

[7] To ensure that the sample was a representative cross-section of the US income distribution in the year 1986 we used the sampling weights provided in the data set. For details of our approach see Cowell and Jenkins (1993). For an introduction to the data set see Hill (1992).

[8] Although we do not report the results for the ordinally equivalent GE indices $G_{\frac{1}{2}}$, G_0, G_{-1} for reasons of space, they are easily computed using (9) and give the same general picture as the A-cardinalisations reported below.

Table 1

The Amount of US Income Inequality 'Explained' is Small (R-Values, 1986)

	$A_{\frac{1}{2}}$		A_1		A_2	
	Method 1	Method 2	Method 1	Method 2	Method 1	Method 2
A. Current income			$R_B = I_B/I$			
Sex	0·0937	0·1011	0·1026	0·1290	0·0997	0·2965
Sex and race	0·1380	0·1423	0·1560	0·1808	0·1637	0·4012
Sex, race, age	0·2167	0·2131	0·2345	0·2475	0·2262	0·4591
Sex, race, age, earner	0·2638	0·2553	0·2978	0·2975	0·3310	0·5185
			$R_W = 1 - I_W/I$			
Sex	0·0878	0·0887	0·0780	0·0988	0·0184	0·1477
Sex and race	0·1297	0·1265	0·1203	0·1404	0·0320	0·2160
Sex, race, age	0·2047	0·1898	0·1848	0·1957	0·0471	0·2587
Sex, race, age, earner	0·2500	0·2288	0·2389	0·2386	0·0772	0·3069
B. 'Permanent' income			$R_B = I_B/I$			
Sex	0·0830	0·0900	0·0911	0·1135	0·1038	0·1786
Sex and race	0·1387	0·1433	0·1587	0·1765	0·1986	0·2649
Sex, race, age	0·1994	0·1971	0·2192	0·2272	0·2534	0·2893
Sex, race, age, earner	0·2419	0·2325	0·2764	0·2674	0·3605	0·3609
			$R_W = 1 - I_W/I$			
Sex	0·0785	0·0805	0·0727	0·0909	0·0379	0·1125
Sex and race	0·1316	0·1290	0·1285	0·1435	0·0776	0·1735
Sex, race, age	0·1899	0·1786	0·1799	0·1869	0·1033	0·1917
Sex, race, age, earner	0·2309	0·2115	0·2299	0·2219	0·1607	0·2476

Source: Own calculations from the PSID wave XX corrected to remove top-coding.

Note: 'Method 1' assumes that between-group inequality is computed on the basis of group mean incomes; 'Method 2' assumes that between-group inequality is computed on the basis of group representative or equally distributed equivalent incomes. See Appendix 1 for the decomposition of inequality for current and 'permanent' incomes.

sensitivity of our results to the specification of the aggregation procedure. We then used the three population characteristics plus employment status to give us partitions of differing fineness.

This was done for two concepts of income. In Table 1, panel *A* we used a measure of current economic status – total family income per equivalent adult distributed by individuals. In Table 1, panel *B* we used a measure of permanent income – found by averaging incomes over a 5-year period to 1986 and again converted to an equivalent-adult basis.[9]

As can be seen, with the exception of A_2, even when we control for the age, sex and race of the family head, 20–25% of total inequality of current income is 'explained' by all these social characteristics jointly by either R_B or R_W. The explanation is rather lower for Method 2 (representative-income basis for the between-group component) than for Method 1 (mean-income basis for the between-group component). If we introduce employment status ('earner' in the Tables) then the amount of inequality explained rises substantially, but not dramatically: 25–30% is now explained. The *R*-values for permanent income are much lower. The case of A_2 is more problematic. This index is very sensitive

[9] For details see Cowell and Jenkins (1993).

to the presence of small incomes and it appears to be this which explains the substantial divergences between R_W and R_B which we observe.

V. CONCLUSION

Standard social welfare analysis – and the R-index in particular – can be used to provide a consistent answer as to the amount of income inequality explained by population characteristics. As we have seen in the case of the United States – current or permanent income – the answer is 'not very much'. The results, which are robust under alternative methods of decomposition and type of decomposable inequality measure, imply that the real story of inequality is to be found within racial groups, within gender groups, within age groups and within employment status groups – a conclusion reminiscent of the old arguments by Jencks *et al.* (1973) about the importance of chance.

London School of Economics

ESRC Research Centre on Micro-Social Change, University of Essex

Appendix I

Inequality within and between groups. United States 1986

	$A_{\frac{1}{2}}$		A_1		A_2	
	Method 1	Method 2	Method 1	Method 2	Method 1	Method 2
A. Current income			Between-group inequality			
Sex	0·0126	0·0136	0·0267	0·0336	0·0587	0·1746
Sex and race	0·0186	0·0193	0·0406	0·0470	0·0964	0·2362
Sex, race, age	0·0292	0·0287	0·0610	0·0644	0·1332	0·2703
Sex, race, age, earner	0·0355	0·0344	0·0775	0·0774	0·1949	0·3053
			Within-group inequality			
Sex	0·1229	0·1227	0·2398	0·2344	0·5780	0·5019
Sex and race	0·1172	0·1176	0·2288	0·2236	0·5700	0·4617
Sex, race, age	0·1071	0·1091	0·2120	0·2092	0·5611	0·4365
Sex, race, age, earner	0·1010	0·1039	0·1980	0·1980	0·5434	0·4082
Total	*0·1347*	*0·1347*	*0·2601*	*0·2601*	*0·5889*	*0·5889*
B. 'Permanent' Income			Between-group inequality			
Sex	0·0095	0·0103	0·0199	0·0248	0·0433	0·0745
Sex and race	0·0159	0·0164	0·0347	0·0386	0·0828	0·1105
Sex, race, age	0·0228	0·0226	0·0479	0·0497	0·1057	0·1207
Sex, race, age, earner	0·0277	0·0266	0·0604	0·0584	0·1504	0·1506
			Within-group inequality			
Sex	0·1056	0·1053	0·2027	0·1987	0·4014	0·3703
Sex and race	0·0995	0·0998	0·1905	0·1872	0·3848	0·3448
Sex, race, age	0·0928	0·0941	0·1792	0·1777	0·3741	0·3372
Sex, race, age, earner	0·0881	0·0903	0·1683	0·1701	0·3502	0·3139
Total	*0·1145*	*0·1145*	*0·2186*	*0·2186*	*0·4172*	*0·4172*

Notes: As for Table 1.

References

Blackorby, C., Donaldson, D. and Auersperg, M. (1981). 'A new procedure for the measurement of inequality within and among population subgroups.' *Canadian Journal of Economics*, vol. 14, pp. 665–85.

Bourguignon, F. (1979). 'Decomposable income inequality measures'. *Econometrica*, vol. 47, pp. 901–20.
Cowell, F. A. (1980). 'On the structure of additive inequality measures.' *Review of Economic Studies*, vol. 47, pp. 521–31.
Cowell, F. A. (1984). 'The structure of American income inequality.' *Review of Income and Wealth*, vol. 30, pp. 351–75.
Cowell, F. A. (1988). 'Inequality decomposition: three bad measures.' *Bulletin of Economic Research*, vol. 40, pp. 309–12.
Cowell, F. A. (1995). *Measuring Inequality*, 2nd ed. Hemel Hempstead: Harvester Wheatsheaf.
Cowell, F. A. and Jenkins, S. P. (1993). 'The changing pattern of income inequality: The US in the 1980s.' *Economics Discussion Paper*, 93–10, University of Wales, Swansea.
Danziger, S. and Taussig, M. K. (1979). 'The income unit and the anatomy of income distribution.' *Review of Income and Wealth*, vol. 25, pp. 365–75.
Hill, M. S. (1992). *The Panel Study of Income Dynamics: A User's Guide*. Newbury Park, CA: Sage Publications.
Jencks, C. *et al.* (1973). *Inequality*. London: Allen Lane.
Sen, A. K. (1973). *On Economic Inequality*. London: Oxford University Press.
Shorrocks, A. F. (1980). 'The class of additively decomposable inequality measures.' *Econometrica*, vol. 48, pp. 613–25.
Shorrocks, A. F. (1984). 'Inequality decomposition by population subgroup.' *Econometrica*, vol. 52, pp. 1369–85.
Shorrocks, A. F. (1988). 'Aggregation issues in inequality measurement.' In *Measurement in Economics* (ed. W. Eichhorn). Heidelberg: Physica Verlag.