Poverty, environmental income and rural inequality: A case study from Zimbabwe

Cavendish, W.[1] & Campbell, B.M[2]

ABSTRACT

Rural households rely heavily on goods and services freely provided by environmental resources. However, there have been very few adequate quantitative analyses due to a lack of appropriate household data sets encompassing economic and environmental data. Standard household budget surveys (HBSs) inevitably lack data on environmental income. We use a 213 household data set from rural Zimbabwe to undertake a quantitative analysis of the impact of environmental income on household welfare. Environmental income, in this case largely from woodland-based resources, is strongly and significantly equalising, bringing about roughly a 30 percent reduction in inequality (as measured in standard HBSs). However, including the value of environmental income leaves analysis of the causes of poverty and rural differentiation unchanged from those done with the standard data. While environmental income is important in mitigating poverty, it is unlikely to be important in lifting people out of poverty.

[1] Department of Health, UK
[2] Centre for International Forestry Research (Indonesia) and Charles Darwin University (Australia)

1 INTRODUCTION

How poor are rural households? How unequal are rural societies? And what explains these phenomena? These questions have a long history and continue to engage leading economists (see for example Sen 1982, Dreze and Sen 1990, Dasgupta 1993, Deaton 1997). At the same time, there has recently been increasing interest in the economic relationship between rural households and environmental resources (in particular, forest resources – e.g. Cavendish 2000; Fisher 2004; Vedeld et al. 2004). It has been suggested that rural households may depend quite heavily on freely-provided environmental goods and services to sustain their welfare, through the provision of both productive inputs and consumption goods. Since these environmental resource uses are classically omitted from standard household budget surveys (HBSs), it has also been suggested that there is a substantial gap in our quantitative understanding of rural households (Dasgupta 1993; Vedeld et al. 2004).

To date, there have been few adequate empirical attempts to quantify the value of environmental resource use, and the impact these have on inequality of rural households. We use a 213 household data set, collected from Shindi in rural Zimbabwe (Cavendish 2000, 2002). This data set is derived from a household budget survey that rather uniquely collected comparable quantity and price data on both environmental resource use and all other economic activities at the household level.3 An earlier, widely-cited publication (Cavendish 2000) has shown that: (a) environmental resources make a significant contribution to average rural incomes; (b) poorer households also depend heavily on these resources, which contribute c.40% to their incomes; (c) richer households, however, use greater quantities of environmental resources in total; and, (d) considerable differentiation exists in the economic characteristics of environmental goods.

Given the quantitative significance of environmental income, we explore the impact that including environmental income has on estimates of inequality by contrasting income measures that included and excluded environmental income. Simply measuring inequality is only one task, though: there is the equally compelling question of the determinants of poverty and inequality. So we also examine whether conclusions concerning the causes of rural differentiation remain unchanged when the rural income measure is changed so dramatically.

The typical rural household survey produces an estimate of income which errs considerably by ignoring freely-provided environmental goods. By contrast, our survey has derived a truer measure of income, incorporating these values. So one can think of this paper as an exploration of the extent to which this particular error in the measurement of rural incomes affects our understanding of rural inequality and poverty: in short, is the traditional view of rural inequality and poverty seriously misleading? To what degree is environmental income inequality-promoting or reducing? And how does including or excluding environmental income affect our understanding of the underpinnings of rural poverty and differentiation? These questions have particular pertinence in the field of poverty analysis, due to fact that both in Zimbabwe and indeed globally, poverty is overwhelmingly a rural phenomenon. For example, in Zimbabwe it is estimated that 88 percent of the poor live in rural areas, while 31 percent of rural dwellers are

[3] This method was used as the basis of the Poverty and Environment Network (PEN) which has embarked on the world-wide collection of a 30+ data sets on forests and household income (http://www.cifor.cgiar.org/pen)

classed as being poor (World Bank 1996).[4] Thus any answers to these questions on the impact of environmental resources on our measurement of rural poverty have potentially wide significance.

The paper proceeds as follows. In the next section we briefly describe the research area, data collection and definitions. In Section 3 we demonstrate the overall quantitative significance of environmental resources to rural households. Section 4 looks at the impact of environmental income on the measurement of inequality, using a range of indices to measure inequality. We find that the inclusion of environmental income dramatically and significantly reduces estimates of inequality. In section 5 the causes of poverty and rural differentiation are explored through the decomposition of poverty and inequality indices. Conversely, here the inclusion of environmental income made little difference to findings as to the causes. Section 6 concludes, stressing the poverty mitigating role of environmental income, but the lack of evidence that environmental income can lift people out of poverty.

2 RESEARCH AREA, DATA COLLECTION, DEFINITIONS

2.1 Research area

The data underlying this study were collected during 13 months of fieldwork (August 1993 to September 1994) in Shindi Ward, Chivi Communal Area, Zimbabwe. Shindi Ward is located in south east Zimbabwe, and is an area of some 200 km^2 comprised of 30 villages. In terms of its economic status, Shindi is typical of Zimbabwe's Communal Areas: that is, it is poor, lacks basic infrastructure (no tarred roads, water supply or electricity), its agricultural system is agro-pastoral (or hoe-based where people have no large livestock), and remittances from non-Shindi sources play an important role in supporting the local economy. In terms of its physical and resource characteristics, it is important to stress given the concerns of this study that Shindi is not an untouched, resource-abundant area. Rather, it has been settled for a long period of time and since the 1950s there has been substantial growth in the settled population both from natural increase and resettlement in Shindi of whole villages from other parts of Zimbabwe. In consequence, the environmental resource base has been much reduced in the last 40 years.

2.2 Data collection

The quantitative data were collected using household-based questionnaires, administered in the local language by a team of six local enumerators. In the absence of an official census, a household roster was compiled consisting of 1,092 households, and 218 households were randomly selected. Five dropped out over the course of the year. The questionnaire used was of the Income, Consumption and Expenditure (ICE) type: however, a number of modifications were made. First, the four quarterly surveys were augmented by beginning- and end-of-period surveys on demographics and household assets, including livestock. Second, the standard ICE framework was expanded to include special sections on the quantitative use of environmental resources. Third, best recall periods for each questionnaire item were investigated locally, and the questionnaires designed accordingly. Forth, a range of special questionnaire modules were added focussing on specific environmental utilizations, for example firewood collection and

[4] These data are drawn from the 1990/91 Income, Consumption and Expenditure Survey conducted by the Zimbabwe Statistics Organisation. Other estimates of poverty in Zimbabwe give higher figures than the ICES. The Poverty Assessment Study Survey of 1995 estimated overall poverty to be 62 percent of the population, while Ravallion and Chen (1996) estimated that, in 1993, 39 percent of the population were living on less than US$1 per person per day.

storage, housing and construction, tree planting, fields and environmental improvements, fencing, agricultural risk etc.

2.3 *Environmental resource use data set*

We briefly outline some of the principles used in producing the data set (Cavendish, 2000; 2002). First, we defined environmental resource as a resource that is freely provided by natural processes, i.e. it can treated as "Nature's bounty." In Shindi, the vast bulk of these resources were derived from areas – such as rangelands, woodlands, aquifers, and rivers – that are held under communal ownership. However, there were some wild species that grow spontaneously on private lands: these we also included in our definition of environmental resources. At least 100 different resource utilisations were identified, and in many cases multiple wild species were used for each resource utilisation. A broad classification of these environmental utilisations demonstrates the range of economic functions offered by these resources (Table 1). It was also clear that hardly any of these utilisations would be picked up by a standard HBS.

Table 1 - A Classification of Environmental Resource Utilisations by Economic Function

Consumption Goods	Inputs	Output Goods	Durables and Stocks
1. Wild fruits	1. Firewood (beer brewing)	1. Wild fruit sales	1. Furniture
2. Wild vegetables	2. Firewood (brick burning)	2. Wild vegetable sales	2. Large utensils (wood)
3. Large wild animals	3. Leaf litter	3. Wild animal sales	3. Firewood store
4. Small wild animals	4. Termitaria	4. Wine sales	4. Construction wood
5. Wine	5. Livestock browse/graze	5. Firewood sales	5. Fencing (wood)
6. Other wild foods	6. Thatching grass	6. Construction wood sales	
7. Firewood		7. Thatching grass sales	
8. Agricultural tools (wood)		8. Other wild good sales	
9. Small utensils (wood)		9. Carpentry sales	
10. Mats (reeds)		10. Woven goods sales	
11. Woven baskets		11. Pottery sales	
12. Pottery		12. Env.-based labour income	
13. Wild medicines		13. Gold sales	

The environmental resource use and non-environmental economic data were valued and aggregated using standard principles for households involved in both market and non-market activities, to produce household income accounts (see Grootaert 1982). In particular, wherever possible, economic transactions – including environmental utilisations – were valued either at households' reported prices or at local market prices; value-added was calculated where relevant, including for subsistence agriculture; and where valuation of resource utilisations was difficult, methods were developed using the best price data available. The household income data were then made welfare-comparable by adjusting for inter-household differences in household attendance, household size and demographic structure: thus in this paper "income" refers to income per adjusted adult equivalent unit (aeu) (Cavendish 2002).

2.4 *Basic definitions: Consumption, income, poverty and inequality*

Consumption versus income

Although it is more common for poverty studies to choose per capita consumption as a measure of individual welfare (Deaton 1980), in our study there is little difference between income and consumption as such a high fraction of household total income is made up of the consumption of own-produced goods and the consumption of own-collected environmental goods, which appear in both income and consumption accounts. We have thus used income as the measure of welfare.

In our analysis of poverty we have used the poverty headcount index. The 1990/91 ICES used lower and upper rural poverty lines of US$61 (Z$209) and US$100 (Z$340), while the 1995/96 PASS used much higher lower and upper rural poverty lines of US$137 (Z$1,180) and US$224 (Z$1,924). If these various US$ poverty lines were ordered and applied to Shindi using the 1993/94 period average exchange rate (Z$7.71 per US$), they would imply poverty lines of Z$470, Z$771, Z$1,056 and Z$1,727 respectively. We have chosen poverty lines fixed with reference to the standard income distribution in our sample, here called the 50th and 75th percentile poverty lines. These are the boundaries between the middle quartiles and the top and second quartiles, respectively. These are roughly equal to the ICES lower and upper rural poverty lines translated into Z$ for 1993/94.

Income measures to be compared

To answer the questions, we first define the different income measures that are to be compared. The first – "total income" – is drawn from the full, environmentally-augmented questionnaire. It is the broadest measure of income that can be derived from those data, and incorporates the value of all measured environmental uses as well as the other three income categories of Table 1.

The second measure we label 'standard income': this comprises cash income (excluding environmental cash income), net gifts and the net value of own production. This measure of income excludes all environmental income sources, and is a plausible estimate of the income measure that would be derived for the sample households if a standard HBS had been implemented over the same period.

We argue that the standard measure is similar to what would be calculated in a standard HBS for two reasons. Firstly, standard HBSs exclude all the questions we included concerning the use of environmental resources, without which it is not possible to calibrate environmental resource use. For example, very few household surveys in developing countries have attempted to value even the household's use of firewood, yet this is the most widely recognised use of environmental resources. As for less well-known resource utilizations – such as wild foods, natural fertilisers, natural construction materials and production inputs – these are completely excluded. Of course, there are some environmental values that a standard questionnaire may pick up in passing. This may be the case especially with environmental sources of cash income, which we have excluded from standard income. Since standard HBSs do have sections on cash income generally, it may be argued that they would pick up this item. However, field experience leads one to be cautious about this assertion. General questions about "other cash sources" rarely pick up even significant cash sources, and this is particularly true of resources which are regarded locally as "small" or "inferior." Many of the data on environmental cash income were only picked up in our questionnaire because there were specific questions asking about these income sources, without which it is unlikely that these data would have been volunteered by the respondents. This goes even for categories like environmentally-derived local labour income, since the activities which comprise this item were thatching, digging termitaria, carving and roof mending. It is reasonable to assume that without questions specifically targeted at these items, they would not have been

they would not have been uncovered.

The second reason that the standard measure is what would be calculated from a standard HBS is that the non-environmental sections of the questionnaire were explicitly modelled on standard HBSs, such as those conducted by national statistical agencies and under Living Standards Measurement Survey of the World Bank. Indeed, the survey questions on resource use were "piggy-backed" onto standard question and categories concerning income, consumption, expenditure and assets.

The results we have derived may depend too heavily on a potentially contestable definition of standard income. In particular, excluding all environmental income from the standard income measure could be thought to be unnecessarily restrictive. We address this problem by defining a third income measure, labelled "expanded income". Here we include environmental income sources that might be captured by a typical HBS, even if there were no questions aimed at environmental income *per se*. There are two sorts of variables that meet this criterion. The first is environmental cash income sources which could possibly be picked up through general questions on cash income. These were income from gold panning; cash derived from the sale of large carpentry items (such as doors, door frames, furniture, mortars, pestles, cart frames, shelving, tables and chairs); and environmentally-based local labour income (eg. thatching, roof mending and digging termitaria). The second is environmental income sources that would have appeared in the typical HBS' income measure through default. The example here is the value of all environmentally-derived fertilisers. In a typical HBS, the data on the value of these would not be collected, so that the value of these inputs would not be deducted from gross agricultural output. To calculate expanded income, then, we have simply taken these various environmental income sources and added them to standard income to produce a more catholic measure of income produced in a typical HBS.

Inequality indices

A plethora of inequality measures exist, and different combinations of these are used in different studies of the issue. We have estimated a wide range of inequality measures. We have done this partly in response to the lack of consensus concerning the theory of inequality measurement, and partly as it allows greater comparison between the results of this study and the results of other works on inequality. But also by using a wide range of inequality indices, we augment the robustness of our findings, in that the results cannot be dismissed as an artefact of the indices chosen. The seven indices calculated were: Relative mean deviation, Coefficient of variation, Variance of logarithms, Gini coefficient, Mean log deviation, Theil entropy index, Generalised entropy-2 (see Kanbur 1984, Shorrocks 1980, Cowell and Kuga 1981, Shorrocks 1984).[5]

As noted earlier, in order to make welfare comparisons conceptually feasible across households, we adjusted the crude household income data by an equivalence scale which made allowances for differences in individuals' needs and for economies of scale in household production (Cavendish 2000). While this makes it plausible to claim that, in our inequality measures, we are comparing welfare across households, it is only feasible to extend that claim to welfare across individuals if we assume that equivalent incomes are equally distributed within the household. While this is an implicit assumption often made in studies of inequality, it is hardly plausible, especially in view of the compelling evidence that intra-household distributions are far from

[5] For more details on last inequality index, see annex 1

egalitarian (Alderman *et al* 1995, Behrman 1997). In other words, all our calculations for inequality will be underestimates, even if we cannot say by how much this is likely to be the case.

3 THE BASIC INCOME ACCOUNTS

Income accounts at a high state of aggregation are presented in Table 2, with income sources booked under one of four categories: cash income, net gifts/transfers, subsistence income and environmental income. This table demonstrates clearly the quantitative importance of environmental resources to rural households (see also Cavendish 2000). In total value terms, environmental resources account for as great a quantity of income as (non-environmental) cash income, while in terms of average budget share, these resources account for 35 percent of total income, just less than that of the largest item, subsistence consumption. Given that the value of these resource utilisations does not appear in standard household studies, these data confirm that there is a substantial quantitative gap in the conventional understanding of rural households. They also lead naturally on to the concerns of this paper. With such a large source of omitted value, how confident can we be of conventional inequality estimates? How does environmental income affect these measures? And does it alter our perspectives on poverty derived from standard analyses?

4 INEQUALITY AND ENVIRONMENTAL RESOURCES

The estimates for the inequality measures for the different measures of income are presented in Table 3. We start by discussing the standard income measure as this by construction is the income measure closest to those produced by standard HBSs. The Shindi community is not wildly unequal. This is supported by comparing the Gini coefficient for Shindi (G = 0.36) against the coefficient for a range of other countries (World Bank 1997). The Gini coefficient for Zimbabwe as a whole is 0.57, while the coefficients for other African countries which are either Zimbabwe's neighbours or which have similar income levels are Côte d'Ivoire 0.37; Egypt 0.32; Ghana 0.34; Guinea 0.47; Lesotho 0.56; Mauritania 0.42; Morocco 0.39; Senegal 0.54; South Africa 0.58; and Zambia 0.46. Shindi also seems to be less unequal than other parts of Zimbabwe: one study of income distribution in 1990/91 for all Communal Areas calculated the Theil entropy index to be either 0.33 or 0.35, depending on the indicator of welfare used (Jenkins and Prinsloo 1995) while another, based on an earlier data set of 1984/85, calculated the all-Communal Areas Theil to be 0.34 (Jackson and Collier 1991).

Adding environmental income into the welfare measure ("total income") produces a sizeable and significant reduction in measured inequality that is consistent across inequality measures. Taking the totemic Gini coefficient, this falls from 0.36 for standard income to 0.30 for total income: a reduction of c.19 percent. In fact, the Gini records the lowest reduction in inequality of all the indices used: more distributionally-sensitive measures such as the log variance, mean log deviation, Theil entropy index, and Generalised entropy-2 record reductions in inequality of 30 to 44 percent. Thus environmental income appears to have a strong equalising effect for rural households. Indeed, the degree of rural inequality revealed in the total income measure is very low indeed: not only is this only roughly half the national Gini coefficient for Zimbabwe, but it is also one of the lowest recorded in international comparisons. So use of the total income measure changes our view of inequality in the sample area: rather than regarding the area as a moderately inegalitarian one, based on standard practice, in fact we should regard it has a fairly equal

society.

Table 2 - 1993/94 Shindi Total Income by Aggregated Income Source (Z$)

Income Sources	Sum of Incomes Per Adj. Aeu	Income Budget Shares [1]
Crop Income	6,935	3.42
Livestock Income	3,359	1.86
Unskilled Labour Income	4,277	2.91
Skilled Labour Income (Teaching)	6,534	1.23
Crafts and Small-Scale Enterprises	6,173	3.03
Remittances	28,405	13.36
Miscellaneous Cash Income	344	0.16
Total Cash Income (Excl Env Cash Income)	**56,026**	**25.96**
Total Net Gifts/Transfers	**4,664**	**1.67**
Consumption of Own Produced Goods	50,111	30.23
Input Use of Own Produced Goods	11,143	6.94
Total Own Produced Goods	**61,254**	**37.17**
Gold Panning	12,313	7.23
Environmental Resource Utilization Cash Income	7,625	4.62
Consumption of Own Collected Wild Foods	9,557	6.29
Consumption of Own Collected Firewood	11,836	7.35
Consumption of Own Collected Wild Goods	952	0.65
Use of Environmental Goods for Housing	4,476	2.70
Use of Environmental Goods for Fertiliser	879	0.57
Livestock Browse/Graze of Environmental Resources	10,186	5.79
Total Environmental Income	**57,825**	**35.20**
Total Income	**179,769**	**100.00**
Summary Data		
Mean Income Per Adj. Aeu	844	
Median Income Per Adj. Aeu	721	

1. Average income shares are calculated as the mean of the individual household's budget shares, rather than the simpler procedure of calculating the aggregate share of the income subcomponent in total income. This reduces the impact of extreme individual household values on the average budget share value.

Table 3 - Inequality Indices for Standard and Total Measures of Income

	1	2	3	4	5	6	7	8	9	10	11	12
Inequality measure	**Standard income**		**Expanded income**		**Total income**		**Inequality reduction from standard to total income (1) vs. (5)**			**Inequality reduction from expanded to total income (3) vs. (5)**		
	In-equality index	Std. error	In-equality index	Std. error	In-equality index	Std. error	Percent reduc-tion	t-test of differ-ence	t-stat signif	Percent reduc-tion	T-test of differ-ence	t-stat signif
Relative mean deviation	0.53	n.a.	0.49	n.a.	0.42	n.a.	20.0	n.a.	n.a.	13.5	n.a.	n.a.
Coefficient of variation	0.83	0.079	0.73	0.067	0.62	0.053	25.1	2.2	0.01	15.3	1.3	0.09
Log variance	0.44	0.056	0.39	0.050	0.28	0.032	36.8	2.5	0.01	28.4	1.9	0.03
Gini	0.36	0.023	0.34	0.021	0.30	0.018	18.6	2.3	0.01	12.7	1.6	0.06
Mean log deviation	0.22	0.028	0.19	0.023	0.14	0.017	35.3	2.4	0.01	25.4	1.7	0.05
Theil entropy index	0.24	0.035	0.20	0.028	0.15	0.021	36.9	2.2	0.02	24.7	1.4	0.08
Generalised entropy-2	0.34	0.065	0.27	0.049	0.19	0.033	43.9	2.1	0.02	28.3	1.3	0.10
Mean income[3]	573		652		844							
Standard deviation[3]	476		480		526							

1. All formulae for the standard errors of inequality measures are taken from Kakwani (1990).
2. Column 9 and 12 presents significance levels for a one-sided t-test.
3. Income is measured in Z$ per adjusted aeu per annum.

The percentage differences in inequality as measured by expanded income and total income is smaller than the differences between standard income and total income. And the differences between expanded and total income inequality measures are less statistically significant. However, for the six inequality measures for which we have conducted tests, all six are significant at the 10 percent level, while two are significant at the 5 percent level. The differences between standard and total income ranged between 19 and 44 percent, while between expanded and total income the differences range only between 13 and 28 percent. Nonetheless this still remains a reasonably large reduction in measured inequality, so that even with a broader conception of standard income, incorporating environmental income still matters in percentage terms.

From this examination of environmental income and inequality, we can draw two conclusions. The first is that environmental income has a significant and substantial equalizing effect on rural income distribution. Secondly, failure to include environmental income in rural household questionnaires in fact leads us to make significant errors in our estimation of the true degree of

aggregate income inequality. Inequality estimates based on standard income – the income concept closest to standard questionnaire practice – will significantly overestimate the degree of rural inequality, probably by about 30 percent. Yet all the evidence we have on rural inequality in fact comes from these types of flawed estimates. Rural communities are hence likely to be more equal than currently suspected.

5 THE CAUSES OF POVERTY AND INEQUALITY

We have seen that accounting for environmental income has a dramatic impact on income measurement (Cavendish 2000) and measures of inequality: will it have a similarly substantial impact on our understanding of poverty and inequality?

5.1 Environmental income and the causes of poverty

We can analyse the causes of poverty by constructing a poverty profile, implemented through the decomposition of the aggregate poverty measure (headcount poverty) by different sub-groups of the population (for the methods see Annex 1). Table 4 shows the results for two different poverty lines and the standard and total income measures.[6]

As to choice of the stratifying variables underpinning the sub-group decompositions, we have focussed on the set of exogenous factors which emerged from the fieldwork as being of potential significance in explaining differentiation within the research area. These were the distribution of productive assets such as livestock, land and human capital; certain household demographic factors such as the type of household head and the size of the household; and the household's economic connections, namely whether individuals connected to the household had been able to enter formal labour market on either a full-time or part-time basis. As well as being key factors identified in the fieldwork, these are close to the sets of variables that are identified as correlates of poverty in other studies of rural households.

Looking at the standard income results, certain stratifying variables appear to have a clear relationship with the headcount poverty probabilities (Table 4). In particular, variations in land distribution and formal labour market access seem to have a substantial impact on the chances of someone being poor. For both poverty lines, individuals living in households with small land holdings have a higher than average probability of being poor, and this probability declines monotonically as land size increases. Likewise, individuals living in households with no one in formal wage employment are more likely to be poor than the average person, but this likelihood falls systematically as household members are increasingly involved in formal labour markets. Indeed, as soon as the household has anyone at all in formal wage employment, the poverty probability falls to half the average or less.

[6] For simplicity the estimates for expanded income are not shown in this section – those results do not change the conclusions reached in this section.

Table 4 - Subgroup Headcount Poverty Probabilities and Significance Tests [1]

Source of Stratification [2]	No. of households in sub-group	50th Percentile poverty line		75th Percentile poverty line	
		Standard Income	Total Income	Standard Income	Total Income
All Households	213	0.50	0.16	0.75	0.46
A. Type of Household Head					
Married Male, Resident	131	1.15 ++	1.24	1.15 +++	1.14 +
De Facto Female	43	0.32 --	0.00 ---	0.56 ---	0.51 ---
De Jure Female, No Married Sons	22	1.00	0.57	0.79 -	0.89
De Jure Female, Married Sons	12	1.49 +	3.13 +++	1.22	1.81
Divorced/Widowed Male	5	1.59	0.00	1.33	0.00 --
B. Age of Household Head					
0 to 30	34	0.53 ---	0.00 --	0.74 ---	0.32 ---
31 to 40	64	0.87	0.59 -	1.02	0.78 -
41 to 50	46	1.13	1.63 ++	1.13 +	1.46 +++
51 to 60	36	1.27 +	1.39	1.00	1.21
61 and over	33	1.27 +	1.52	1.05	1.25
C. Education Level of Household Head					
0 to 3 years	137	1.21 +++	1.42 ++	1.08 +++	1.19 ++
4 to 6 years	31	0.83	0.20 --	1.07	0.98
Primary School Leavers	28	0.50 ---	0.45	0.76 --	0.39 ---
Junior Certificate or more	17	0.47 --	0.00 --	0.63 --	0.64 --
D. Household Size					
0 to 2 Adj. Aeus	28	0.36 ---	0.00 --	0.57 ---	0.16 ---
2 to 4 Adj. Aeus	66	0.81 -	0.28 ---	0.93	0.53 ---
4 to 6 Adj. Aeus	82	1.26 ++	1.38 +	1.17 +++	1.40 +++
6 to 8 Adj. Aeus	24	1.16	1.57	1.11	1.63 +++
8 or more	13	1.38	3.37 +++	1.02	1.50 +
E. Value of Large Livestock Per Adj. Aeu					
Z$0	125	1.08	1.20	1.03	1.10
Z$0 to Z$500	44	0.95	1.42	1.00	1.09
Z$500 to Z$1,000	29	0.96	0.00 --	1.06	0.75
Z$1,000 or more	15	0.53 --	0.00 -	0.62 --	0.43 --
F. Cultivable Land Area Per Adj. Aeu					
0.0 to 1.0 acres	55	1.63 +++	2.39 +++	1.28 +++	1.74 +++
1.0 to 1.5 acres	85	0.94	0.81	1.02	0.89
1.5 to 2.0 acres	34	0.64 --	0.37 -	0.90	0.70 -
2.0 to 3.0 acres	28	0.64 --	0.00 --	0.76 --	0.62 --
3.0 plus acres	11	0.36 --	0.00	0.36 ---	0.00 ---
G. Employment Status of the Household					
No one in Formal Wage Employment	93	1.39 +++	1.62 +++	1.19 +++	1.15
1 or More in Part-Time Wage Employment	73	0.87	0.86	1.04	1.01
1 or More in Full-Time Wage Employment	38	0.52 ---	0.00 ---	0.60 ---	0.80
Full-Time and Part-Time Wage Employment	9	0.00 ---	0.00	0.44 ---	0.24 --

1. Binomial distribution test of the null hypothesis that the subgroup headcount measure equals the overall headcount measure. The binomial distribution test is preferred to a standard t-test due to the small sample size of some of the subgroups. As the subgroup sample size increases, the tests converge. +++ (---) Subgroup P_0 index significantly higher (lower) than the overall P_0 index, 1 percent significance level; ++ (--) 5 percent significance level; + (-) 10 percent significance level.

2. Some of the sub-groups for the sources of stratification are self-evident or are described in the text. Otherwise: A. “Education level of the household head" refers to the highest level of education completed by the household head. Primary School Leavers is a qualification obtained after 7 years schooling and the Junior School Certificate is obtained after 9 years of schooling. B. By "large livestock" is meant cattle and donkeys. Values are Z$ end-period local market prices. C. “Cultivable land area" comprises the total land area in acres which the household either used, owned or rented in 1993/94

Moderate relationships exist between other subgroup decompositions and poverty probabilities. As one might expect, there appears to be a negative relationship between poverty and the education level of the household head. For households where the head has a very low level of education (the most common category), poverty levels are a little above background rates for both poverty lines. These fall as the household head acquires more education, especially after seven years of education. Poverty probabilities also fall as the value of large livestock per person, though this only is marked at values of Z$1,000 per person. Perhaps more surprising is the positive relationship between poverty and household size.[7] Individuals in small households have much lower poverty probabilities, while those in households with 4 or more adj. aeus have poverty probabilities at or above the average. Finally, there is a relationship between some household headship types and poverty. Individuals in *de jure* female headed households, with married sons in the household, have a greater than average chance of being poor, while those in *de facto* female headed households have a poverty risk that is consistently lower than the background rate. This undoubtedly reflects the fact that these households receive remittances from husbands who are away working in formal labour markets: their lower poverty rates are therefore connected to the results linking poverty to labour market access.

Thus, if a conclusion were to be drawn on the profile of the poor from standard income alone, it would be that the poor tend to be in households with older heads; where the head is less well-educated; where the household is larger; but most crucially in households which have little cultivable land per person and which have restricted access to formal wage employment.[8] How far does this profile change if we use analyse poverty using the total income variable instead? The surprising answer is how similar the results are for the two different income measures. In fact, the difference between the poverty probabilities of two income measures appears to be more one of emphasis than one of direction.

Thus, if we examine the two most important correlates of poverty, namely land distribution and the employment status of the household, the figures show that incorporation of environmental income reinforces rather than overturns the results of the standard income measure. For land distribution (and for both poverty lines), incorporating environmental income increases the poverty probability of individuals in households with small amounts of land, and reduces the poverty probability for those with larger land areas. Likewise, for analysis by employment status of the household, use of the total income measure either leaves the poverty probabilities untouched (75th percentile poverty line) or increases the importance of access to the formal labour market in explaining poverty (50th percentile poverty line). A similar story holds for most of the other indicators. Environmental income lowers the poverty probability of households with young heads and increases that for households with older heads; it lowers the poverty probability of small households and increases that of large households; and it also increases the poverty probability of households with a poorly-educated head and decreases that of households with a more educated head. So, by making the distribution of the poverty probabilities starker,

[7] A positive relationship between poverty and household size has frequently been found in studies of poverty. But this is often argued to be an artefact of the equivalence scale used to transform household income or consumption data, for example by using per capita adjustments which overweight children, or by ignoring economies of scale in household production (for a discussion of these points see Lanjouw and Ravallion 1995). However, in our study we have adjusted household income data by using weights for different household members, and we have also included an economies of scale adjustment in our equivalence scale, so these effects should not undermine the result.

[8] These conclusions are very similar to those of Grootaert et al (1996), who found higher per capita welfare associated with being in small households with younger heads, larger farms and a non-farm source of income.

probabilities starker, the use of the total income measure would seem generally to intensify the relationship between the sources of stratification we have analysed and household poverty, rather than altering this relationship. This conclusion is reinforced when we look at statistical tests of significance in the correlates of poverty (Table 4). The most striking feature is how similar the results are for the different income measures and poverty lines. Thus, although excluding environmental income results in very much lower estimates of rural incomes, it does not change our analysis of why poverty exists.

5.2 *Environmental income and the origins of inequality*

The next stage is to explore the causes of the inequality. As for the above poverty analysis, we use decomposition techniques to pursue these questions (see Annex 1 for methods). Decomposition calculations for the Generalized Entropy measure (GE_2) by disaggregated income source are presented in Table 5. The central results are clear: inequality in the sample is overwhelmingly accounted for by variation in cash income from formal wage employment, and this preponderance occurs whichever income measure is used. Thus, for the standard income measure, variation in formal wage employment contributes 61 percent to overall inequality, as against a contribution to mean income of only 29 percent. For total income the values are 47% and 19%, respectively. So this income sources' contribution to aggregate inequality is far higher than its contribution to overall income, and far greater also than the contribution to inequality of any other single income source. Unequal receipts of cash from formal sector employment clearly drive inequality and differentiation in the research area.

Agriculture – in particular variations in the value of own consumption – is the second most important source of aggregate inequality, contributing 12 percent for both standard and total income. Variations in livestock income have only a moderate role to play in aggregate inequality, and environmental income variables play a very small role in explaining aggregate total income inequality. Despite reasonably sizeable subgroup mean incomes, the consumption of wild foods, firewood use, gold panning and environmental cash income account for only 1, 3, 2 and 2 percent, respectively, of overall inequality. Looking at it another way, these four income sources together comprise, on average, 23 percent of aggregate total income while at the same time comprising only 8 percent of aggregate total income inequality. So once again we observe the important role of environmental resources as an equality-promoting income source.

5.3 *Discussion: environmental income and barriers to entry*

The analysis of this section has produced a puzzle. On the one hand, the inclusion of environmental income in the measure of household welfare substantially reduces measured inequality. On the other hand, environmental income has very little effect on the analyses of the causes of inequality and poverty. So the types of conclusions that would be drawn on these issues from more conventional data sets derived from HBSs were found to be very similar to those drawn from the "better" measure of household welfare used in this study. These results seem paradoxical. Given environmental income has such a dramatic impact on measures of inequality and poverty, one might expect it should also have a dramatic impact on measures of the origins of inequality and poverty as well.

Table 5 - Inequality Decomposition by Detailed Income Sources and Standard and Total Income

	1	2	3	4	5	6
			GE_2 - Standard Income		GE_2 - Total Income	
Income Source [1]	**Sub-group Mean Income** [2]	**Sub-group Inequality Index**	**Absolute Contribution**	**Share of Agg. Inequality**	**Absolute Contribution**	**Share of Agg. Inequality**
A. Agriculture				**0.17**		**0.17**
Cash crop sales (net)	10	29.50	0.011	0.03	0.006	0.03
Trad. crop sales (net)	23	1.39	0.006	0.02	0.003	0.02
Consumption of own crops	208	0.15	0.041	0.12	0.024	0.12
B. Livestock				**0.07**		**0.10**
Livestock cash income	16	3.45	0.010	0.03	0.005	0.02
Cons^n of own livestock	27	0.69	0.014	0.04	0.007	0.04
Livestock fodder & browse	48	1.14	n.a.		0.007	0.04
C. Labour Income				**0.61**		**0.47**
Unskilled labour income	20	1.07	0.000	0.00	0.001	0.00
Formal wage employment	164	2.57	0.209	0.61	0.092	0.47
D. Other Productive Enterprise				**0.06**		**0.10**
Crafts and SSEs	29	4.62	0.012	0.03	0.006	0.03
Misc. cash income	2	29.30	0.001	0.00	0.000	0.00
Input use of own production	52	0.62	0.009	0.03	0.006	0.03
Gold panning	58	1.40	n.a.		0.004	0.02
Env. cash income	36	1.58	n.a.		0.003	0.02
E. Gifts				**0.08**		**0.09**
Private gifts (net)	10	115.73	0.029	0.08	0.017	0.09
Government gifts (net)	12	2.62	0.001	0.00	0.001	0.00
F. Environmental Collection and Consumption						**0.07**
Cons^n of wild foods	45	0.22	n.a.		0.002	0.01
Firewood use	56	0.20	n.a.		0.006	0.03
Use of wild goods	5	0.49	n.a.		0.000	0.00
Env. housing inputs	21	2.12	n.a.		0.002	0.01
Environmental. fertilisers	4	2.31	n.a.		0.000	0.00
Total	**844**		**0.344**	**1.00**	**0.193**	**1.00**

1. This table uses the same basic income categories as Table 1, but regroups them by functional classification of income i.e. by agriculture; livestock; labour income; other productive enterprise; gifts; and environmental collection and consumption
2. Income is measured in Z$ per adj. aeu per annum.

We sketch an answer to the problem. If entry into formal labour markets and improved agricultural production can raise household incomes substantially, why do only some households do this? The answer is that both these paths out of poverty are conditional on a pre-existing level of capital accumulation. In the case of remittances, the crucial condition is to have a sufficient level of education to allow entry into the formal labour market. But this education level presupposes that a child's school fees have been paid for a number of years beforehand: in other words many years of investment are required before a household can expect to receive some return in the form of income. Further, since school fees cannot be paid in kind, investment in

education presupposes not a just a steady flow of surplus, but in practice a steady flow of cash income to the household. In a similar fashion, sustained improvements in agricultural yields requires sustained fertilisation of the local area's sandy soils, and this means either a regular flow of cash (to purchase fertiliser), or sufficient accumulation at some time in the past to have purchased livestock.

Thus, entry into income-raising activities involves significant up-front costs which have to be met via cash payment. In other words, substantial entry barriers exist to these two enrichment activities. The existence of these entry barriers has two effects. First, they present a powerful obstacle to poorer, asset-constrained households from entry into income-raising activities. Second, they imply that economic returns will vary systematically with the existence of these entry barriers. For activities with zero entry cost, all rent will be competed away. The only activities which will start to generate a reasonable surplus are those into which entry is restricted. This creates is a poverty trap. Those households which already have sufficient assets to lever themselves into higher-return activities can go on to earn some surplus, and this may allow them to continue further the path of accumulation by alleviating the many production constraints that affect both rural agriculture and rural enterprise development. By contrast, those which start poor will have very restricted earning opportunities: these households have to work hard even to keep still, and they often exist in a "vicious cycle" of poverty characterised by low nutritional status, low labour returns and low crop production. (For models linking asset constraints, entry barriers and rural class formation, see Eswaran and Kotwal 1986 and Dasgupta 1993).

This emphasis on entry barriers as the cause of rural differentiation provides an answer to the conundrum posed earlier, namely the reason why environmental income has such a marked impact on total levels of income and inequality and, but not on the correlates of household differentiation. Since so many environmental collection activities are free entry, so they are activities which are disproportionately undertaken by worse off households. The effect of omitting these activities from the income measure would therefore systematically overstate inequality. However, because environmental income sources are free entry, they are also low return and therefore will play little role in enabling households to overcome the accumulation constraints which bar the household from raising its income significantly. Hence incorporation of environmental resources into the rural income measure will make little difference to the analysis of the underpinnings of rural inequality and poverty. It is for this reason that our earlier decomposition analyses produced such similar results for standard and total income.

6 CONCLUSIONS

In this paper we have been concerned to examine the impact of environmental income on both the measurement and the causes of rural poverty and inequality. We analysed the impact of environmental income on inequality indices by comparing our measure of rural incomes, total income, with that which would be derived from the typical household budget survey, labelled standard income, which excludes by definition all environmental income sources. Dramatic results ensued. The total income measure produced estimates of inequality which were 20 to 30 percent below that of the standard income measure, a similar finding to that of Fisher (2004) for rural Malawi. The results were found to be robust to a range of inequality indices. The quantitative magnitude of the results was reduced somewhat when working with a broader definition of the typical HBS income measure, but the differences in poverty and inequality estimation were still substantial and statistically significant.

There are a number of important corollaries that follow from these findings. The first is that measures of income based on typical household budget surveys are likely to be quite substantially underestimated, while measures of inequality are likely to be substantially overestimated (dramatically so if conducted amongst households more resource-dependent than ours). But these are exactly the type of surveys on which most estimates of rural poverty and inequality are based. Our results suggest that it is reasonable to be cautious in assessing such estimates where attention has not been paid to the bundle of free goods that natural resources offer rural agents. The second, conversely, is that environmental income *per se* is a quantitatively large and significantly equity-promoting income source. Given that the vast bulk of these resources are located in the commons, particularly communal woodlands and rangelands, then the importance of the preservation of the commons (and conversely the equity and poverty impacts of commons degradation or resource privatization) is obvious.

Third, there is a counterpart to this static estimation error in incomes and inequality, and that is a potentially significant dynamic estimation error of rural income growth. This is due to the fact that typical surveys only measure a subset of total income, so that while measured household incomes may be increasing at a certain rate over time, household (true) total incomes may be increasing at a greater or lesser rate, remaining static or even declining. Likewise, measured inequality may be improving based on the standard income measure while at the same time true inequality is worsening. So given the results of this chapter, measurement from other studies of both the statics and the dynamics of rural incomes and welfare may be in question.

Finally, we also examined the causes of inequality and poverty through decomposition analysis. Here it was found that, by contrast, the inclusion of environmental income made very little difference to decomposition results, in that the same variables were found to be significant correlates of rural inequality and poverty whether standard or total income measures were used. Variation in households' access to non-environmental cash income was found to be the most significant source of rural inequality, arising overwhelmingly from differences in households' entry into formal labour markets. However, agriculture was found also to be a significant secondary source of rural differentiation. We hypothesised that the origins of these results lay in the presence of entry barriers for these economic activities. We suggested that the existence of these entry barriers simultaneously explained the importance of formal wage employment in underpinning rural inequality and poverty, the greater dependence of poorer households on free-entry environmental income sources, and the lack of impact on decomposition analysis from including the value of environmental utilizations in the measure of household income. Powerful economic constraints appear to exist to rural accumulation: these constraints are not alleviated in our research area by the presence of environmental resources and the potential for their utilisation. Thus, environmental resources are unlikely to be important as a pathway out of poverty. On the other hand, the large contribution of environmental resources to total income indicate how important they are as a means of mitigating poverty. And on a relative basis, they are much more important to poorer households than richer households.

7 ACKNOWLEDGEMENTS

We are grateful to Harold Alderman, Simon Appleton, Tim Besley, Chris Heady, John Hoddinott, John Muellbauer, Christophe Muller and Francis Teal for earlier comments, and to

the Economic and Social Research Council, the Centre for the Study of African Economies (Oxford) and the World Bank-administered Trust Fund for Environmentally and Socially Sustainable Development for funding the research.

8 REFERENCES

Alderman, H., Chiappori, P-A., Haddad, L. Hoddinott, J. and Kanbur, R. 1995. Unitary versus collective models of the household: is it time to shift the burden of proof? *World Bank Research Observer* 10(1), 1-19.

Behrman, J. 1997. Intrahousehold distribution and the family. In Rosenzweig, M. and Stark, O. (eds.) *Handbook of population and family economics*. North-Holland, Amsterdam.

Cavendish, W. 2000. Empirical regularities in the poverty-environment relationship in rural households: Evidence from Zimbabwe. World Development 28 (11): 1979-2003

Cavendish, W. 2002. Quantitative methods for estimating the economic value of resource use to rural households. In: Campbell, B.M. and Luckert, M.K. (eds.) *Uncovering the hidden harvest: Valuation methods for woodland and forest resources.* People and Plants conservation series. Earthscan, London, U.K.

Cowell, F.A. and Kuga, K. 1981. Additivity and the entropy concept: an axiomatic approach to inequality measurement. *Journal of Economic Theory* 25(1), 131-43.

Dasgupta, P. 1993. *An inquiry into well-being and destitution*. Clarendon Press, Oxford.

Deaton, A. 1980. The measurement of welfare: theory and practical guidelines. LSMS Working Paper No. 7, World Bank, Washington, DC.

Deaton, A. 1997. *The analysis of household surveys: a microeconometric approach to development policy*. Johns Hopkins University Press, Baltimore.

Dreze, J. and Sen, A.K. 1990. *The political economy of hunger*. Clarendon Press, Oxford.

Eswaran, M. and Kotwal, A. 1986. Access to capital and agrarian production organisation. *Economic Journal* 96, 482-498.

Fisher, M. 2004. Household welfare and forest dependence in Southern Malawi. Environment and Development Economics 9: 135-154

Grootaert, C. 1982. *The conceptual basis of measures of household welfare and their implied survey data requirements*. LSMS Working Paper No.19, World Bank, Washington DC.

Grootaert, C., Kanbur, R. and Oh, G-T. 1996. *The dynamics of poverty: why some people escape from poverty and others don't. An African case study*. World Bank Policy Working Paper No.1449, World Bank, Washington DC.

Jackson, J.C. and Collier, P. 1991. Incomes, poverty and food security in the communal lands of Zimbabwe. In Mutizwa-Mangiza,N.D. and Helmsing, A.J. (eds.) *Rural development and planning in Zimbabwe*. Avebury, Aldershot. Ch.2, 21-69.

Jenkins, C. and Prinsloo, E. 1995. *Inequality among households in Zimbabwe: an assessment using the 1990/91 ICES*. Mimeo, Centre for the Study of African Economies, University of Oxford, Oxford.

Jenkins, S.P. 1995. Accounting for inequality trends: decomposition analyses for the UK, 1971-86. *Economica* 62, 29-63.

Kakwani, N. 1990. *Large sample distribution of several inequality measures.* LSMS Working Paper no.61, World Bank, Washington DC.

Kanbur, S.M.R. 1984. The measurement and decomposition of inequality and poverty. In van der Ploeg (ed.) *Mathematical methods in economics*. John Wiley, New York. Ch.16, 403-31.

Lanjouw, P. and Ravallion, M. 1995. Poverty and household size. *Economic Journal* 105, 1415-

34.
Ravallion, M. and Chen, S. 1996. *What can new survey data tell us about recent changes in living standards in developing and transitional economies?* Background paper to World Development Report 1996. World Bank, Washington DC.
Sen, A.K. 1982. *Poverty and famines: an essay in entitlement and deprivation*. Clarendon Press, Oxford.
Shorrocks, A.F. 1980. The class of additively decomposable inequality measures. *Econometrica* 48, 613-25.
Shorrocks, A.F. 1982a. Inequality decompositions by factor components. *Econometrica* 50, 193-212.
Shorrocks, A.F. 1982b. The impact of income components on the distribution of family incomes. *Quarterly Journal of Economics* 98, 311-26.
Shorrocks, A.F. 1984. Inequality decompositions by population subgroups. *Econometrica* 52(6), 1369-88.
Vedeld, P., Angelsen, A., Berg, G.K., and Sjaastad, E. 2004. Counting on the environment. Forest incomes and the rural poor: A study for the World Bank. Paper no. 98. Environment Development Papers. The World Bank, Washington D.C., USA
World Bank 1996 *Understanding poverty and human resources in Zimbabwe: changes in the 1990s and directions for the future*. World Bank, Washington DC.
World Bank 1997 *World development report 1997: the state in a changing world*. World Bank, Washington DC.

Annex 1. The decomposition of poverty and inequality indices amongst different sub-groups

Decomposing headcount poverty

There are a number of ways in which poverty estimates can be decomposed: we use an intuitive one, namely sub-group poverty probabilities derived from the headcount poverty measure. Let the sample be exhaustively partitioned into $j = (1,.....,J)$ mutually exclusive subgroups, with each subgroup having n_j members. The headcount poverty measure for the jth subgroup, $P_{0,j}$, is then equal to q_j / n_j, where q_j is the number of members in the jth subgroup with incomes $x_i \leq z$ (where z is the poverty line, and x_i is the income of the ith member), so that $P_0 = \sum_{j=1}^{J} P_{0,j}\, n_j/n$. Then the sub-group poverty probability is the sub-group headcount measure normalised on the aggregate headcount poverty measure, i.e. $P_{0,j}/P_0 = (P_{0,j} - P_0)/ P_0+1$. This means that if the jth subgroup's poverty probability is greater (less) than one, this subgroup is more (less) likely to be poor than the sample as a whole. So we compare the intensity of poverty across sub-groups by calculating these sub-group poverty probabilities for different poverty lines and for the two different income measures (Table 4).

Decomposing the Generalised Entropy-2 inequality index

Jenkins (1995) presents an outstanding analysis of inequality trends for the UK using decomposition analysis. The material presented in this section of the paper owes a great debt to the methods developed in his work. We have restricted ourselves to the decomposition of Generalized Entropy-2 (GE_2). The Generalised Entropy class of inequality measures is the only one that is symmetric, scale invariant, convex and additively decomposable. Use of GE_2 avoids log transforms, so that it can cope with zero observations, while computation of GE_2 itself can be done simply from group or subgroup means and variances. This is follows from the fact that:

$$\mathrm{GE}_2 = \frac{1}{2}\frac{1}{n}\left[\sum_{i=1}^{n}\left(\frac{x_i}{\bar{x}}\right)^2 - 1\right] = \frac{1}{2n\bar{x}^2}\sum_{i=1}^{n}(x_i - \bar{x})^2 = \frac{1}{2\bar{x}^2}\hat{\sigma}^2$$

This ease of calculation is especially useful when dealing with a large number of decompositions. The formula also shows that $\mathrm{GE}_2 = 1/2(R_2)^2$ i.e. equals half the squared coefficient of variation ($\bar{x}$ is the mean income, while $\hat{\sigma}^2$ is the variance of income).

Specifically, we decompose inequality by income source. Decomposition by income source is aimed at uncovering the particular income sources that have a high inequality "loading": i.e. it highlights the specific economic activities which are associated with rural inequality. This is a particularly attractive procedure for the purposes of this study. Decomposition can be carried out as follows.[9] Let income be partitioned into *F* sub-groups, with the *f*th income source having the sample mean $\bar{x}_f$ and the sample variance $\hat{\sigma}^2{}_f$. Define s_f as the contribution of the *f*th income source to total inequality, so that $\hat{I}_i = \sum s_f$. Then we need to generate suitable values of these s_f's using appropriate decomposition rules. It can be shown that:

$$s_f = p_f \chi_f \sqrt{GE_2 GE_{2f}}$$

where: p_f = the correlation coefficient for the *f*th income source and total income.

$\chi_f = \bar{x}_f / \bar{x}$ = the *f*th income source's factor share.

$GE_{2,f}$ = the GE_2 index for the *f*th group = $\frac{1}{2\bar{x}_f{}^2}\hat{\sigma}_f{}^2$

Note that the degree to which an income source can be said to promote inequality depends on the size of the share variable s_f / GE_2: if this equals zero or is low, then the income source has a negligible impact on overall inequality (or alternatively has an “equality-promoting” role), conversely if this share variable is high then the income source is playing a strong "inequality-promoting" role (see Kanbur 1984, Shorrocks 1980, Cowell and Kuga 1981, Shorrocks 1984).

[9] Decomposition by income source is a difficult procedure, following Shorrocks (1982a, b) which showed that the choice of decomposition rule is totally independent of the choice of inequality index, so that an infinite number of candidate decompositions are compatible with any given inequality measure.