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Household welfare and forest dependence in Southern Malawi

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ABSTRACT. This paper examines the role forests play in alleviating poverty in rural Malawi. Data from three villages in southern Malawi indicate high levels of forest dependence. Gini decomposition shows that access to forest income reduced measured income inequality at the study sites. Tobit analysis of the determinants of reliance on low-return and high-return forest activities indicates that asset-poor households are more reliant on forest activities compared with the better off; reliance on high-return activities is conditioned also by availability of adult male labor and location. Taken together, the study's findings suggest that forests prevent poverty by supplementing income, and may also help to improve the living standards of households that are able to enter into high-return forest occupations. Policy implications are discussed.

1. Introduction

A common narrative in policy discussions about development and the environment is that the poor are both agents and victims of environmental degradation (e.g. WCED, 1987). The implication for forestry is that poverty alleviation can reduce forest pressure and development of forest resources can help alleviate poverty. This viewpoint has been highly influential – as evidenced by the large number of conservation-with-development projects implemented in recent years – yet its apparent simplicity is misleading. The link between poverty and natural resources such as forests is indeterminate. There is limited evidence on the impact of poverty on deforestation, and studies reach different conclusions (for a review see Kaimowitz and Angelsen, 1998). Likewise, forests have potentials and limitations for improving human welfare (Angelsen and Wunder, 2003). Forests may prevent poverty (supplementing income and functioning as safety nets) or reduce poverty (with high earnings); but reliance on forest

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resources can also perpetuate poverty (for a review see Neumann and Hirsch, 2000; Pattanayak and Sills, 2001).

This paper explores the link from forests to poverty for the case of Malawi. In Malawi, as in other tropical countries, forests are increasingly viewed as an important vehicle for poverty alleviation. Its National Forestry Programme states that forests and trees can and should be used to eradicate poverty (GOM, 2000). This study asks if forest-led poverty reduction is possible, and whether economy–environment synergies or tradeoffs are more likely (Wunder, 2001). The analysis begins by examining the ways in which forests contribute to household income and influence overall income distribution for a sample of rural households. Tobit models are used to identify factors associated with forest dependence, defined as the share of earnings derived from forest-based activities. The analysis distinguishes between low-return forest activities, which comprise small-scale commercialization of low-value forest products (e.g. firewood), and high-return activities, which involve marketing of high-value products (e.g. timber) as well as mass production of low-value goods (e.g. charcoal). The distinction is important because the latter are intensive in the use of resources, but also hold promise for helping the poor leave poverty over time. The conclusion highlights policy implications of the findings.

2. Study context and data

Background on deforestation and forest policy in Malawi

A recent estimate for Malawi's deforestation rate is 2.4 per cent per annum, the highest for southern Africa (FAO, 2001 cited in UNEP, 2002). The interplay of high population density, poverty, forest reliance in rural areas, and weak forest management institutions create challenges to conservation of Malawi's forests. Key forest threats are clearing for agricultural expansion and high demand for wood, particularly woodfuels (GOM, 1998a).

The majority of Malawians are engaged in agriculture, cultivating less than a hectare of land on average (PMS, 2000). Smallholder agriculture is characterized by low productivity due to slow adoption of improved techniques and the single short growing season each year (Ng'ong'ola *et al.*, 1997). Farmers often have little option but to clear forest land to grow maize (the staple crop) and other crops to feed their families; and in many communities, customary land is open access due to weakened traditional controls over land allocation.[1] In northern Malawi, shifting cultivation is still common, but demand for land exceeds supply in some areas (GOM, 1998a). Forest clearing remains an obstacle to forest conservation in Malawi, though less so in recent years due to limited availability of arable land, especially in the south (GOM, 1998b).

Tobacco and tea estates use of wood for curing and building storage sheds accounts for nearly 30 per cent of total wood demand in Malawi. Rural and urban households' use of woodfuels for cooking and heating

[1] Estates cleared large tracts of forest before 1994, under the former political regime. Today, estate expansion is controlled and has negligible forest impact (Probyn, 2001).

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makes up an estimated two-thirds of wood consumption (GOM, 1998a). In rural areas, firewood from adjacent forests remains an essentially free and accessible good, and low-cost alternative energy sources are generally not available (Brouwer, 1998). In urban areas, poverty combined with rising tariffs on paraffin and electricity in recent years encourages people to use woodfules for their domestic energy needs (GOM, 1998a). Welfare poverty in rural areas means cheap labor is available to supply woodfuels at low cost, retarding the transition to non-biomass-based fuels. Productivity of Malawi's natural forests, mostly *miombo*, is generally low; at current levels of demand, wood harvest rates exceed sustainable yield (GOM, 1998b).

These and other contextual factors have led some observers to ask if the problem of deforestation in Malawi is 'unsolvable' (French, 1986). However, recent changes in the forest sector may offer hope for Malawi's forests. Malawi's National Environmental Action Plan (NEAP) includes many forest conservation programs: devolution of forest management roles to local communities in some forest areas, programs to intensify agriculture, fuel-saving cook stove programs, and so forth (GOM, 1998b). Other recent developments include increased financial and technical support for conservation efforts from donors and non-governmental organizations (NGOs).

Field sites and data

Data for the study come from a household survey in three villages in southern Malawi, the region of the country that ranks highest in terms of poverty incidence, population density, and scarcity of forest resources (GOM, 1998b; PMS, 2000). Research villages were purposively selected to represent the main forest management types in Malawi; they also provide a spectrum of market access.[2] Village 1 is 10 kilometers from a tarmac road and town and adjacent to the Mulanje Mountain Forest Reserve (MMFR), one of 71 gazetted forests managed by the Forestry Department, representing 22 per cent of forest cover in Malawi.[3] Households in this village have access to relatively abundant forest resources and markets for non-timber forest products (NTFPs) and timber. In Village 2, woodland on customary land is managed as a Village Forest Area (VFA) by the village head and a committee of village leaders. In Malawi, 50 per cent of forest area is on customary land (GOM, 1998a). The VFA system, in which communities set aside woodland areas for conservation purposes, was initiated in the 1920s and rekindled recently by the Forestry Department (Place and Otsuka, 1997). Located 20 kilometers from a tarmac road and town, Village 2 is remote, but is close to Mozambique (5 kilometers), where agricultural and forest goods can be purchased at prices below those in Malawi. The little

[2] Purposive samples are common when researchers want to collect in-depth, reliable data in a small geographical area. Since the research villages were selected purposively, the extent to which the data are generalizable to southern Malawi is not known. That being said, there is no reason to believe the study villages are anomalies.

[3] Since 2001 the forest has been co-managed by local people and Forestry Department.

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remaining woodland on customary land in Village 3 is *de facto* open access due to the breakdown of traditional authority in recent years, characteristic of many customary forests in Malawi (Place and Otsuka, 1997). Village 3 is adjacent to a tarmac road linking it to Blantyre (Malawi's largest city) 40 kilometers away. Most charcoal sold in Malawi's major cities is produced by local people in surrounding rural areas (Makungwa, 1997). Charcoal marketing is common in Village 3. Table 1 summarizes key characteristics of the study villages.

Within the villages, 99 households were randomly selected, representing 12 per cent of the total population in the three villages. Household residents were interviewed monthly from June 1999 to August 2000 on a range of topics, mainly forest use. Some of the methods used to ensure the collection of quality data are: close supervision of enumerators by the author, interviews with groups of household residents to obtain more complete information, and separate interviews with men and women when this was judged to be conducive to respondents' willingness to disclose sensitive data.

3. Forest contributions to aggregate income and a more equal income distribution

Forest contributions to aggregate income at the study sites

Table 2 presents earnings and income shares by source for the sample households. The household income accounts are described in the Appendix and Fisher (2002). The table indicates that income diversification was common at the study sites, in line with other observations in rural Africa (Barrett *et al.*, 2001). Where markets for credit and insurance are missing or thin, diversification is often important for *ex ante* risk mitigation, coping with adverse shocks, and earning the cash needed to buy farm inputs or make investments (Barrett *et al.*, 2001). All households in the sample received income from several sources.

Table 2 shows high earnings shares from forests in Villages 1 and 3, in part a reflection of high participation rates: 82 per cent and 73 per cent of households in Villages 1 and 3 reported forest-based earnings in 1999/2000. Why is forest use so prevalent? One explanation is the ease with which households can initiate forest enterprises; some, such as firewood sales, require only labor and ubiquitous tools. In both villages, forest access was somewhat unrestricted during the study year. The Forestry Department in Village 1 was unable to prevent villagers from extracting firewood at a level exceeding sustainable yield (Knacck Consultants, 1999). In Village 3, forest resources on customary land are open access. The high forest earnings shares also reflect opportunities and high returns to some forest occupations arising from resource endowments and market access. The forest reserve near Village 1 has high-value timber and pine. Local people work as pit sawyers or plank transporters for timber merchants. A few better-off households sold planks to merchants. Village 3 households have access to urban charcoal markets.

The average share of earnings derived from forests by Village 2 households is lower than averages in the other villages. These differences are statistically significant; the calculated F-statistic from analysis of

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Table 1. *Key characteristics of the research villages*

	Village 1	*Village 2*	*Village 3*
Main source of forest resources	Mulanje Mountain covering 640 km^2 comprising miombo woodland and afro-montane forest, and pine plantations. Degradation is most pronounced in the lowlands close to human settlement.	A hill covering 16 km^2 comprising miombo woodland and exotic trees, mainly eucalyptus.	Sparse collections of trees of miombo species. Some villagers walked to Mwanza District, where forest resources are more plentiful, to buy firewood and charcoal for resale.
Forest products available	Most plentiful of the villages: timber and a wide-range of non-timber forest products (NTFPs) (firewood, fruit, mushrooms, bush meat, insects).	Mostly NTFPs: firewood, bamboo, fruit, mushrooms, some bush meat, insects, honey.	Mostly firewood; some villagers cleared woodland to expand their gardens and/or burn charcoal.
Forest management regime	State management (Forestry Department)	Village forest area (customary land)	*De facto* open access (customary land)
Access to markets for forest products	Several local markets within walking distance where firewood is sold. Possibilities to market timber to urban merchants.	Opportunities to buy firewood in Mozambique (5 kilometers) at prices below those in Malawi.	Access to urban charcoal and firewood markets (Blantyre, Malawi's largest urban center, is 40 kilometers away).
Distance to tarmac	10 kilometers	20 kilometers	0 kilometers
Important crops	Maize (staple crop), sorghum, pigeon pea, velvet bean, pumpkin.	Maize and cassava (staple crops), sorghum, pigeon pea, sweet potato, pumpkin.	Maize (staple crop), groundnut, pigeon pea, pumpkin.

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Table 2. *Earnings and income shares by source and by village, sample households 1999/2000*

	Forest[a]	*Farm*[b]	*Self-empl.*[c]	*Wage-work*[d]	*Sales assets*[e]	*Transfers*[f]
Earnings						
Village 1	0.37	0.11	0.04	0.23	0.05	0.20
($N = 39$)	(0–1.00)	(0–0.88)	(0–0.97)	(0–0.96)	(0–0.46)	(0–0.99)
Village 2	0.20	0.23	0.22	0.09	0.07	0.19
($N = 38$)	(0–0.89)	(0–0.93)	(0–0.95)	(0–0.68)	(0–0.34)	(0–1.00)
Village 3	0.41	0.08	0.09	0.26	0.07	0.09
($N = 22$)	(0–0.97)	(0–0.38)	(0–0.64)	(0–0.97)	(0–0.75)	(0–0.71)
Full sample	0.31	0.15	0.12	0.18	0.06	0.17
Total income						
Village 1	0.38	0.35	0.03	0.10	0.02	0.11
($N = 39$)	(0.05–0.85)	(0.05–0.77)	(0–0.75)	(0–0.52)	(0–0.14)	(0–0.77)
Village 2	0.21	0.42	0.15	0.06	0.04	0.11
($N = 38$)	(0.01–0.80)	(0.07–0.91)	(0–0.77)	(0–0.44)	(0–0.29)	(0–0.64)
Village 3	0.41	0.25	0.06	0.18	0.05	0.05
($N = 22$)	(0.04–0.96)	(0.02–0.58)	(0–0.43)	(0–0.83)	(0–0.58)	(0–0.31)
Full sample	0.33	0.36	0.08	0.10	0.03	0.10

Notes: [a] Earnings/profits from forest-dependent income-generating activities (see table 4).

[b] Earnings from sales of crops including fruit crops (e.g. bananas).

[c] Includes non-forest-based businesses: resale of agricultural commodities, tailor, money lending, sales of fish, grocery sales, public transport operation, radio and bike repair, tinsmith, and stone breaking.

[d] Includes non-forest off-farm employment: contract agricultural labor (weeding, field preparation), forestry officer, teacher, mechanic, watchman, and village headperson.

[e] Sales of livestock (cattle, goats, pigs) and poultry, property rental, and sales of personal and household items (radio, bicycle parts, clothing, etc.).

[f] Remittances from household residents (mainly husbands working elsewhere), gifts from relatives, and loans.

variance is 3.80, and a hypothesis of equal means can be rejected. There are several plausible explanations for observed inter-village differences. First, the headman in Village 2 appeared somewhat more successful at reducing forest access compared with the Forestry Department in Village 1 and the head in Village 3. Second, Village 2 has neither accessible timber, nor access to urban charcoal markets. Finally, self-employment activities competed with forest occupations in Village 2 due to proximity to Mozambique. A common, relatively lucrative occupation in Village 2 is to buy agricultural goods from Mozambican farmers to sell in Malawi.

Table 2 also reports average income shares by sector. In the income figures, farm income includes earnings from crop sales and the value of own-consumed maize production; forest income includes forest-based earnings and the value of own-consumed collected firewood.[4] Inclusion of collected firewood in the household income accounts is important, because all sample households used collected wood for cooking and for 69 per cent it was the dominant fuel. Simple calculations demonstrate the high value of collected firewood to household budgets. A family of four cooking three meals a day would use 6.3 kilograms of firewood on average (Brouwer, 1998). Using an estimated local market price for firewood of Malawi Kwacha (MK) 1.09 per kilogram from a survey of firewood sellers ($N = 14$), the annual cost to buy firewood would be MK2,925.[5] This can be compared with the mean income of sample households during the survey year (MK14,698). Clearly, the value of collected forest products like firewood, often left out of household income accounts, is very important to rural Malawians.

In sum, the data show that forest income accounted for about 30 per cent of household income on average, a figure that is not unprecedented. A detailed survey of environmental resource use in Zimbabwe found that extraction contributed 35 per cent of rural household income on average (Cavendish, 1999). Godoy *et al.* (2002) report that earnings from forest activities accounted for 17–45 per cent of household earnings, on average, across four Amerindian villages in the Bolivian lowlands and eastern Honduras.

Forest contributions to a more equal income distribution at the study sites

High participation rates in forest occupations and the importance of forest-collected firewood to households' budgets may indicate that access to forests as a source of income reduces income inequality at the study sites. To examine this, measured income inequality is decomposed by income source, which is indexed by i. Note that in the current context, the term 'income' refers to 'income per household resident'. The Gini coefficient (G)

[4] A few shortcomings of the income data should be mentioned. First, retained maize and collected firewood represent the bulk of home consumption, but households did consume other crop production and other forest-collected products. Thus, farm and forest income are underestimated to some degree. Another source of measurement error is imputation of values where data are missing. See the Appendix and Fisher (2002) for more detail.

[5] During the survey year, the exchange rate was about MK 50 = US$1.

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Table 3. *Decomposition of income inequality by income source, sample households 1999/2000*

	Forest	*Farm*	*Wage-work*	*Self-empl.*	*Sales assets*	*Transfers*	*Total*
Gini coeff. (G_i and G)	0.63	0.52	0.84	0.90	0.90	0.83	0.49
Share in G	0.28	0.25	0.13	0.16	0.06	0.12	1.00
Concentration ratio (C_i)	0.46	0.40	0.53	0.66	0.63	0.58	–
Mean income from source i (MK/person)	1,105	1,104	425	436	160	377	3,607
Share in total income (w_i)	0.31	0.31	0.12	0.12	0.04	0.10	1.00
$w_i\ C_i$	0.14	0.12	0.06	0.08	0.03	0.06	0.49

decomposed into its income source components is given by (Yao, 1999)

$$G = \sum_{i=1}^{I} w_i C_i \tag{1}$$

where I is the total number of source incomes i and w_i represents the share of source income i in aggregate household income. C_i, the concentration ratio of source i, is

$$C_i = 1 - \sum_{j=1}^{N} p_j 2(Q_{ij} - w_{ij}) \tag{2}$$

where p_j is the population share of household j in the total population and w_{ij} is the income share of household j for source i. The variable Q_{ij} is the cumulative income share up to household j for income source i defined by

$$Q_{ij} = \sum_{k=1}^{j} w_{ik} \tag{3}$$

For each source income i, the concentration ratio (C_i) is computed using equation (3) relying on observations sorted in ascending order of aggregate income. I calculate source income Gini coefficients (G_is) using equation (2) sorting observations in ascending order of the given source income i. The Gini coefficient for aggregate income is calculated with equation (1).

Results are presented in table 3. The first row of the table provides Gini coefficients by source income and aggregate income. The aggregate income Gini is 0.49. The World Bank (1995) has estimated the Gini coefficient for rural Malawi smallholders to be 0.57, 14 per cent higher than the estimate here. One possible source of discrepancy is measurement error in the household survey data. It is also possible that the World Bank's estimate is based on a measure of income that did not include forest resources. The income

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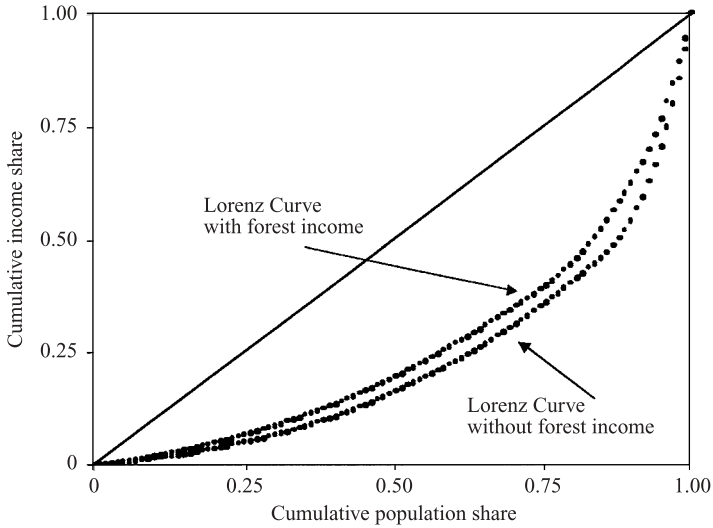


Figure 1. *Lorenz curves for household income with and without forest income, sample household 1999/2000*

data used by the World Bank come from Malawi's National Sample Survey of Agriculture (1992/93). It is unlikely that the survey collected information on home-consumed forest products. If forest income sources are excluded from the analysis here, the estimated Gini coefficient is 0.56, very close to the World Bank's estimate. Figure 1 illustrates the impact of forest income on income inequality. The diagonal line denotes perfect inequality. Lorenz curves are constructed with the data for household income including and excluding forest income. The figure shows that addition of forest income to household income reduces measured income inequality by 12 per cent, all else equal.

Turning to the source income Gini coefficients, each is higher than the aggregate income Gini, indicating that diversification of income reduces income inequality across the sample. However, not all income sources reduce income inequality. The second row of table 3 gives the share of total income inequality attributed to each income source. Forest and farm income contributed the largest shares to total income inequality, largely because income from these sources made up high shares of aggregate income (see row four of the table). To assess whether a given source of income reduces or increases income inequality, refer to equation (1). All else being equal, if $C_i > G$ and the share of source income (w_i) is increased (decreased), then income inequality (G) will increase (decrease). This implies that sources of income with concentration ratios (C_i) with values lower than 0.49 (the aggregate income Gini) help reduce total income inequality. Results in the third row of table 3 indicate that, all else being equal, an increased share of income from the forest or the farm would lower income inequality at the study sites; increased income shares from other sources would yield higher income inequality.

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The data suggest that forests offer a more egalitarian source of income compared with most other sources at the study sites. This is no surprise since collected firewood from adjacent forests represents an important income input for all sample households. In addition, participation in forest occupations is common at the study sites. The finding that forest income lowers income inequality is consistent with other studies. Cavendish (1999) finds that environmental income reduced measured inequality by 20–30 per cent for his sample of Zimbabwean smallholders. Reddy and Chakravarty (1999) found that forest income was associated with a small reduction in income inequality for a sample of northern Indian farmers. The analysis here is one of the first to measure how forest income influences aggregate income inequality with use of decomposed Gini measures.

4. Determinants of forest reliance

Categorizing forest activities

In the previous section of the paper forest occupations were viewed as a homogenous group to assess the overall contribution of forest resources to household welfare at the study sites. The mix of forest activities and the factors that shape reliance on them can vary considerably, however, even within a small geographical area (Byron and Arnold, 1999; Coomes *et al.*, forthcoming; Godoy *et al.*, 2002). Participation rates and earnings shares for the various forest activities present at the study sites are shown in table 4 in ascending order of average annual earnings. Forest activities can be loosely categorized into two groups: low-return (LRFA) and high-return forest activities (HRFA). Mean yearly earnings range from MK626 to MK4,895 for the LRFA and MK5,705 to MK21,710 for the HRFA. Average annual earnings for contract agricultural labor (a low-return activity) and permanent wage-work (high-return activities) are MK2,103 and MK12,980 respectively. The LRFA/HRFA classification is useful for two reasons. First, prospects for forest-led poverty alleviation should differ importantly for the two groups. Second, the activity categories differ considerably in terms of environmental impact.

Table 5 presents pair-wise correlations between the share of earnings from forest activities and income and consumption measures. I use as a comparison group the 12 sample households engaged in remunerative, permanent wage-work. The first column of the table shows a negative correlation between measured income and reliance on LRFA, consistent with the extant literature (for a review see Neumann and Hirsch, 2000). Depending on whether one views income (or wealth) as exogenous or endogenous, one can argue that a negative correlation between wealth and forest reliance implies that forests provide safety nets or are poverty traps (Angelsen and Wunder, 2003). At best, reliance on LRFA helps the poor survive poverty, but is unlikely to reduce poverty.

The second and third columns of table 5 show positive correlations between measured income and earnings shares from HRFA and wage-work during the survey year. This positive correlation can be viewed as indicating that participation in HRFA leads to relatively high income and/or that relatively high income enables entry into remunerative forest occupations.

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Table 4. *Participation rates and earnings shares by forest activity, sample households 1999/2000*

	Participation rate (%)				*Earnings share (%)*			
	Village 1	*Village 2*	*Village 3*	*All*	*Village 1*	*Village 2*	*Village 3*	*All*
Low-return activities (LRFA)	74	71	64	71	22	16	20	19
Sales of crafts[a]	13	34	5	19	2	5	0	3
Roof thatching and brick burning	18	13	9	14	3	2	0	2
Sales of food and drink[b]	59	26	23	38	12	2	5	6
Sales of firewood/bamboo	13	21	45	23	2	4	15	6
Traditional medicine	5	8	5	6	3	2	0	2
High-return activities (HRFA)	38	5	36	25	15	4	21	12
Forest employment[c]	36	0	0	14	13	0	0	5
Charcoal sales[d]	0	0	36	8	0	0	21	5
Timber sales[e]	5	5	0	4	2	4	0	2

Notes: [a] Forest-based crafts found at the study sites are: bamboo baskets and mats, grass brooms, and wood-fired pots.
[b] Items that use wood as a key input: *masese* traditional beer, *kachasu* dry spirit, *chikondamoyo* cakes, cooked beans, etc.
[c] Pit sawing of planks and manual transport of planks from the pit sawing sites on Mulanje Mountain down to the roadside.
[d] Sales of own-produced charcoal as well as charcoal resale.
[e] Marketing of planks from the forest and trees from private landholdings.

Table 5. *Correlation between forest income share and selected welfare indicators, sample households1999/2000*

Variable	*Forest activities*		*Permanent wage-work*
	LRFA	*HRFA*	
Income			
Earnings (Sept. 2000 MK/year)	−0.231*	0.385*	0.287*
Total income (Sept. 2000 MK/year)	−0.231*	0.346*	0.257*
Per capita earnings (Sept. 2000 MK/person/year)	−0.203*	0.239*	0.199*
Per capita total income (Sept. 2000 MK/person/year)	−0.194*	0.194*	0.173
Meal consumption (meals/person/day)	−0.019	0.162	0.176
Number of observations	99	99	99

Note: * indicates statistical significance at the 0.05 probability level.

HRFA may hold promise for reducing poverty, but this depends on the ability of the poor to enter activities, and the time path of opportunities. I empirically examine the former issue below, and discuss the latter in the conclusion.

A second important distinction between HRFA and LRFA is that the former are generally more degrading of forest resources than the latter. Commercialization of NTFPs may have negligible ecological impact in the study area (Konstant, 1999). Firewood collection is an exception, however. Interviews with local people suggest over-harvesting; with each passing year women must travel further to collection sites (Fisher, 2002; Konstant, 1999). There is also evidence of destructive harvesting techniques – reports of trees being felled for firewood and collectors destroying coppices from stumps and saplings, which are required for natural regeneration (Knacck Consultants, 1999).

From an environmental standpoint, the most worrisome commercial forest activities in the study area are charcoal production and timber extraction. Charcoal production involves clear-felling of indigenous trees on customary land, resulting in soil erosion, loss of habitat for plant and animal species, and reduced availability of wood (GOM, 1998b; Makungwa, 1997). Gardens are opened up when trees are felled for charcoal burning; however, much of the remaining forest land in southern Malawi is not suitable for agriculture (GOM, 1998b). Timber extraction in the forest reserve adjacent to Village 1 is also a key concern from an environmental perspective. The bulk of extracted timber comes from government pine plantations, but illegal harvesting of protected trees such as *Mulanje* cedar and other threatened indigenous species is reducing biodiversity and affecting the microclimate, for example (Knacck Consultants, 1999).

The above discussion highlights potential economy–environment tradeoffs in southern Malawi. At issue is that charcoal burning and timber

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extraction are remunerative activities that may enable poverty reduction, at least in the short term, but these activities have adverse environmental effects. This is an issue of considerable relevance to policy interventions; I return to it in the concluding section of the paper.

Empirical analysis

I turn now to an empirical investigation of the factors associated with forest dependence, defined as the share of earnings from forest activities. Data on earnings presented above reveal considerable differences across forest income sources and suggest that various circumstances give rise to forest reliance. In general, dependence on HRFA should be more a matter of choice, a response to opportunities for gainful employment. By contrast, reliance on LRFA may indicate necessity or lack of better options. Whether households are pulled or pushed into the forest sector should in large part reflect the composition of their asset holdings. In the analysis that follows, I examine whether differences in asset positions are key determinants of reliance on LRFA versus HRFA.

Two equations are estimated, one for dependence on LRFA (Model 1), the other for dependence on HRFA (Model 2). In each case, I employ Tobit models because some households did not have earnings from forest occupations. The Tobit technique accounts for censoring in the dependent variables. Explanatory variables are: natural log of relative returns to labor in forest activities and maize production, farm size per capita, number of adult male household residents, goat ownership, age and education of the household head, and village of residence.[6] Model specification draws on Reardon and Vosti's (1995) conceptual framework of low-income farm households' decisions impacting the environment. In the framework, household behavior is a function of the components of household assets (natural resource, human resource, physical, and financial) and external conditioning factors (markets, policies, technologies, prices, institutions, and community assets). Asset decomposition is important where markets (e.g. for credit, insurance, and labor) fail or function poorly, as is the case in rural Malawi. In these settings, fungibility of assets is limited and asset-specific poverty can influence resource use and investment decisions (Coomes *et al.*, forthcoming).

Tobit model results are presented in table 6.[7] In both regressions several key point estimates are individually and jointly different from zero at a

[6] The price of maize is observed only in households that sold maize and hourly returns to forest occupations are observed only in households engaging in these activities. But even when a household chooses not to participate in a given activity, it faces an opportunity price in that sector. For this reason, omitting observations from the equations due to missing price data would bias our results. We impute missing prices and net hourly returns with sub-sample ordinary least squares (OLS). See Fisher (2002) for details.

[7] Diagnostic tests indicate heteroscedasticity in Model 1. Thus, results reported for Model 1 in table 6 account for multiplicative heteroscedasticity with respect to: natural log of returns ratio, farm size per capita, secondary education of the household head, and head aged 35–44 years. I tested for multicollinearity using

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Table 6. *Tobit results for the forest dependence equations*

	Share of earnings from forest activities	
Variable	*Model 1 (LRFA)*[a]	*Model 2 (HRFA)*[a]
Constant	0.242 (3.154)	−0.407 (−1.662)
Natural log of the ratio of forest returns (MK/hour) and maize returns (MK/kg)[b]	0.042 (2.460)	0.398 (5.276)
Farm size per capita (ha/person)	−0.097 (−1.707)	−0.202 (−0.805)
Number of men in the household	0.012 (0.311)	0.513 (4.534)
Number of goats owned	−0.040 (−2.873)	−0.081 (−2.712)
Household head less than 35 years of age (0 = No, 1 = Yes)	0.008 (0.180)	−0.122 (−0.721)
Household head aged 35 to 44 years (0 = No, 1 = Yes)	−0.104 (−1.882)	0.171 (1.003)
Household head attended secondary school (0 = No, 1 = Yes)	−0.106 (−1.929)	−0.415 (−1.946)
Village 1 residence (0 = No, 1 = Yes)	0.016 (0.368)	0.386 (2.240)
Village 3 residence (0 = No, 1 = Yes)	0.050 (1.045)	0.485 (2.754)
Number of observations	99	99
Log likelihood	−15.64	−17.27

Notes: [a] Parenthetical terms are t-statistics.
[b] Includes imputed values for missing observations. Details are provided in Fisher (2002) and available upon request.

90 per cent confidence level. Patterns of significance differ slightly across regressions, however.

As expected, households with higher relative returns to forest occupations had higher forest earnings shares, all else equal. This is true for both HRFA and LRFA. Farm size per household resident should provide a good indication of availability of excess labor to employ off farm and the household's level of food security (Peters, 1996). Thus, households with relatively small landholdings per capita have both the capacity and the need to engage in forest activities. Results show a negative correlation between farm size per capita and forest reliance, consistent with patterns reported in Peru (Coomes *et al.*, forthcoming). The point estimate is statistically weak, however, for HRFA.

variance inflation factors (VIF). The VIFs do not suggest harmful collinearity; the largest VIF had a value of 1.45.

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At the study sites, forest activities are labor intensive in general, but the need for adult male labor is crucial for participation in HRFA. Charcoal burning tends to be male-specific in southern Malawi, although small numbers of women do participate, either assisting their husbands or on their own (usually female heads of household) (Makungwa, 1997). Likewise, only men were employed as plank sawyers and transporters in the forest reserve. Thus, a variable for the number of men in the household is included in the regressions. Findings show a positive association between number of men and the share of earnings from HRFA. The association is positive but statistically weak for LRFA.

In rural Africa, livestock acquisition remains a key form of wealth accumulation (Dercon, 1998). In southern Malawi, cattle rearing is limited by land scarcity. Data from Malawi's Integrated Household Survey ($N = 10{,}698$) show that only 3.7 per cent of households in the south owned cattle; goat ownership is more common (20 per cent of households) (PMS 2000). Goats are a relatively liquid asset that can be sold in response to price signals, to smooth consumption, or to provide financial capital to start a business. Results show a negative correlation between number of goats owned at the start of the survey year and the share of earnings from LRFA and HRFA.[8] The former is as expected, households that own more goats should have less need to engage in low-return activities. The finding of a negative association between goat ownership and reliance on HRFA, however, is somewhat of a surprise and may indicate low requirements of financial capital for engaging in HRFA.

To assess the extent to which forest reliance changes over the life cycle of the household head, I include in the regressions binary variables indicating age of the household head by category.[9] Results suggest that households with a head aged 45 plus were more reliant on LRFA compared with those households with a head aged 33–44 years; there is little statistical support for a hypothesis that age affects reliance on HRFA.

HRFA activities are relatively lucrative, but risky and laborious. Charcoal marketing is illegal in Malawi and discussions with entrepreneurs revealed that charcoal is confiscated by the police about once a month. Pit sawing is physically demanding, as is carrying planks upon one's head from sawing sites on the mountain down to the road, a precarious task in the rainy season. Those with opportunities to engage in less risky, remunerative jobs, such as permanent wage-work, should be less reliant on forests for income. Education may signal one's potential productivity to employers, increasing the likelihood of being hired into attractive labor markets. Thus, I include a binary variable indicating secondary school attendance of

[8] The discussion suggests that wealth is a determinant activity choice (and subsequent earnings); it could also be argued that activity choice conditions wealth accumulation. While wealth is usually endogenous to wages, endogeneity may be less of an issue for the sample data since goat ownership is observed prior to the labor allocation decision.

[9] Age is categorical because respondents generally were not aware of their age. Our approach was to estimate age by reference to a list of historical events.

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the household head. As expected, results indicate a negative association between secondary education and forest reliance.

Binary variables for Village 1 and Village 3 residence were included to capture differences in market access and natural resource endowments that condition forest sector opportunities across villages. Village effects are statistically weak for Model 1, likely due to the ubiquity of LRFA. As expected, the share of earnings from HRFA is higher in Villages 1 and 3 compared with Village 2.

In sum, regression results for Model 1 suggest that households that are poor in land, education, and goat holdings are more reliant on LRFA. This is consistent with studies of income diversification in Africa which show that asset poverty compels diversification into low-return activities (Barrett *et al.*, 2001; Dercon, 1998). Unfortunately, as shown in table 5, reliance on LRFA was associated with lower measured income over the course of the survey year. Participation in LRFA therefore did not reduce poverty during the survey year, though it may have helped the poor survive their poverty, providing supplementary income and a means to cope with adverse shocks.

Regression results for Model 2 show a negative correlation between educational attainment (secondary education) and livestock wealth (goats) and reliance on HRFA. Key factors that constrain some households from taking advantage of opportunities for gainful employment are limited availability of adult male labor and residence in Village 2 (where there is neither high-value timber, nor access to urban woodfuels markets). Thus, households that are poor in some assets (education and animal holdings), but well endowed in others (men and community assets) can participate in and earn high earnings shares from remunerative forest occupations. There may be prospects for forest-led poverty reduction in rural Malawi, given the results here and the positive correlation between reliance on HRFA and income (see table 5). This statement must be qualified. The data concern a single year – a random snapshot of forest-people relationships which can vary considerably across years (Campbell *et al.*, 2002; McSweeney, 2002). In addition, the data are for a small sample of households that may or may not be representative of rural Malawi. There is a need for future work using a nationally representative panel dataset to better explore the patterns observed in the current study.

5. Conclusions and policy implications

This paper reveals and quantifies the important role forests play in alleviating poverty in rural Malawi. The data indicate high levels of dependence on forests for income; sample households derive about 30 per cent of income from forests on average. The data also suggest that access to forests may reduce income inequality across households; the addition of forest income to the household accounts leads to a 12 per cent reduction in measured income inequality. Regression results show that asset-poor households are more reliant on LRFA *and* HRFA, compared with the better off; reliance on HRFA is also conditioned by availability of adult male labor and location. Taken together, the study's findings suggest that forests prevent poverty, and may reduce poverty for households that are able to enter into HRFA. Future work using a nationally representative panel

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dataset is needed to better assess the extent to which access to forest income in rural Malawi can help the poor improve their economic status over time, and to more directly investigate the relationship between growth in the forest sector and income distribution.

The main policy implication of the study is that forests may have a role in poverty alleviation in Malawi, but to reduce economy–environment tradeoffs, careful targeting and a mix of forest-based and other approaches to poverty alleviation is necessary. Results indicate that asset-poor households are reliant on LRFA for earnings; these activities supplement income and may also buffer adverse shocks. Efforts to conserve Malawi's forests, such as restricted access, might lead to reduced welfare because of the high reliance on LRFA among the poor. However, forest protection could in fact benefit the poor if it leads to a rise in prices of NTFPs, for example. More importantly, policies that focus on securing forest access by the poor and maintaining them in LRFA may actually perpetuate poverty, if other development options are overlooked (Angelsen and Wunder, 2003). A more effective pro-poor (and pro-forest) strategy may be one that assists the poor in moving out of LRFA and into more gainful employment. Towards this end, public investment in the (non-forest) wage-work and self-employment sectors may be warranted, for example educational spending, food-for-work interventions, and micro-lending programs. Forest-based approaches, such as market development for under-exploited products like wood and bamboo crafts may be more cost-effective, however. Such programs can increase local incentives to sustainably manage forest resources on which enterprises depend. But careful implementation is necessary, because the rise in value of NTFPs may spur over-harvesting of resources (Neumann and Hirsch, 2000).

Study findings indicate potential for forest-led poverty reduction through participation in HRFA. These opportunities should continue in the near future. Charcoal marketing to urban consumers seems assured in the next few years due to recent elimination of subsidies, rising tariffs on parrafin and electricity, and rapid population growth in Malawi's urban areas (GOM, 1998a; UNCHS, 2001 cited in UNEP, 2002). The FAO predicts an increase in demand for woodfuels in Africa greater than 45 per cent over the next 30 years (FAO, 2001 cited in UNEP, 2002). Likewise, urban population growth should stimulate demand for wood for construction and furniture making.

Economy–environment tradeoffs may be acute. HRFA provide gainful employment but also have adverse environmental impacts. Restricted forest access may be necessary to avoid excessive resource depletion, but this presents a clear challenge. The Malawi government banned charcoal burning in the 1990s, but this has done little to curb production (Makungwa, 1997). Likewise, illegal logging occurs in forest reserves despite high fines imposed on violators (Knacck Consultants, 1999).

Synergies between poverty reduction and forest conservation may be fostered by programs that encourage the planting and use of trees outside of natural forests. One possibility is community–company forestry partnerships; these have proven useful for conserving forests and improving rural welfare in many areas (Scherr *et al.*, 2002). Companies

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typically provide necessary materials, low-interest loans, and technical assistance for establishing and managing small woodlots on farm or customary land. In return, companies have rights to buy the mature trees. The feasibility of such programs in land-scarce areas such as Malawi requires further investigation. Another option is to make use of currently under-utilized eucalyptus timber supplies in government plantations (as has been suggested by some analysts – see Knacck Consultants, 1999). Technical assistance for more efficient charcoal production technologies will also be important. Perhaps the greatest challenges will be faced by village heads and rural communities, to organize and collectively establish and enforce rules limiting charcoal burning and timber harvesting in natural forests on customary land.

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Appendix: The household income accounts

Household income is the sum of earnings from all sources and home consumption, in September 2000 MK. Earnings data are complete. Home consumption is retained maize and collected firewood used for cooking; values were imputed where the data are missing. Imputations are described briefly below and in detail in Fisher (2002).

Maize output data for 2000 are available for 68 households. A Cobb–Douglas production function was estimated using data for the sub-sample. Regression coefficients and observed data were used to impute maize output for 31 missing observations. Mean maize output for the sample (imputed and observed values) is 423 kilograms. This amount of maize would feed a family for about six months (The Lamp, 1999). The six-month self-sufficiency estimate agrees well with other estimates for southern Malawi (e.g. Orr and Mwale, 2001). To estimate retained maize for sample households, I subtracted from maize output the quantity of (after-harvest) sales of maize, available from the earnings accounts. The quantity of retained maize was valued using a price of MK7.42 per kilogram (European Food Security Network, 1999, 2000).

The value of collected firewood for cooking was estimated. Using data from direct measurements with a sub-sample of households ($N = 18$), I obtained an estimate of 0.49 kilograms of firewood per person per meal. This figure agrees well with Brouwer's (1998) corresponding estimate. To obtain household-specific estimates for firewood used for cooking in 1999/2000, I used data for household population, number of meals cooked per day (available monthly), and the dominant cooking fuel used. Assumptions (based on field observations) about the number of months firewood was used were required for households reporting that harvest residues or purchased wood were dominant fuel sources. Estimated firewood quantities were valued at MK1.09 per kilogram, the average price received by firewood sellers ($N = 14$) at a survey area market in February 2000.

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