World Development Vol. 33, No. 7, pp. 1115–1128, 2005

Printed in Great Britain
0305-750X/$ - see front matter
www.elsevier.com/locate/worlddev
doi:10.1016/j.worlddev.2005.04.008

Can Income Programs Reduce Tropical Forest Pressure? Income Shocks and Forest Use in Malawi

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Summary. — Seasonal household data from Malawi are used to study links between income shocks and forest use. A Tobit model is estimated to examine whether household forest use responds to receipt of a positive income shock (delivered as a technology assistance package), and the characteristics of households reliant on forests for shock coping. Results show households experiencing an income boost had lower forest extraction compared to households that did not receive such a shock, *ceteris paribus*. We find households most dependent on forests for natural insurance are those located near woodlands and headed by an individual who is relatively young and male.

Key words — consumption smoothing, safety nets, poverty, deforestation, Malawi, Africa

1. INTRODUCTION

In rural parts of low-income countries, income and consumption risk are pervasive among the poor, and markets that serve to mitigate income shocks—such as those for insurance and credit—are generally absent, ill functioning, or inaccessible to the most vulnerable groups. Research has pointed to the potential negative consequences of adverse income shocks to nutrition and health status (Foster, 1995) and excess mortality (Rose, 1999). More optimistically, a variety of coping mechanisms often emerge to protect consumption when households experience idiosyncratic or covariate shocks. Examples of such mechanisms include precautionary saving of grain, livestock, and financial assets, borrowing in informal credit markets, remittances from family members or relatives residing elsewhere, and reallocation of household labor from the family farm to the wage labor market. These strategies are well documented in the literature (Besley, 1995; Kochar, 1999; Paxson, 1992; Rose, 2001; Rosenzweig, 1988; Udry, 1995).

In this paper, data from southern Malawi are used to study how low-income households at forest margins withstand income shortfalls and the potential consequences for forests. The study is motivated by two research questions: Do rural Malawian households cope with economic disruptions such as crop failure or

* We thank Duncan Chikwita, Busiso Chilambo, the late G.T.N. Kathindwa, R.J. Kaphesi, the late S.A.R. Mjathu, and colleagues at the University of Malawi's Center for Social Research for excellent advice and research assistance during fieldwork in Malawi. Many thanks are due to our respondents at the study sites. Steve Buccola, Ken Foster, Edna Loehman, Will Masters, and three anonymous reviewers provided valuable comments on an earlier version of the paper. This research is based upon work supported by a Fulbright grant and the National Science Foundation under Grant No. 0213750. Final revision accepted: January 19, 2005.

illness of household members in part by temporarily increasing rates of forest extraction to earn cash? [1] And if they do, what are the characteristics of households most reliant on forests for shock coping? Addressing these questions is important from both an environmental and a development standpoint. In places like Malawi, where forest resources are being extracted at a level that exceeds sustainable yield, use of forests for risk mitigation and shock coping contributes to forest degradation. From a human welfare perspective, the concern is that if shocks are frequent and severe, reliance on forests for informal insurance may ultimately represent a strategy that prevents the poor from escaping their poverty, since forest activities generally offer relatively low returns to effort. A downward spiral is possible in which successive adverse shocks are associated with rising poverty, increased reliance on forests for shock coping, and reinforced resource degradation (Zimmerman & Carter, 2003).

Why might low-income households residing at forest margins turn to forests in the face of misfortune? A first reason is that forests are often held under state or communal tenure with forest resources essentially freely available to local populations, either due to government failure to enforce property rights or weakened traditional systems of resource-use regulation (Baland & Platteau, 1996). [2] A second reason is that extraction of forest goods generally requires little in the way of financial and physical capital (Neumann & Hirsch, 2000). Third, forest resources are diverse, providing a range of products and opportunities for income generation. In addition, forest products are often available at times when other income sources are not, for example, when crops fail (Byron & Arnold, 1999; Pattanayak & Sills, 2001). Finally, other coping mechanisms may be less accessible. Poor households often possess few liquid assets to sell at critical times, and may face collateral-related constraints to borrowing in credit markets.

Two recent studies provide empirical evidence that low-income households use forests to cope with risk *ex ante* and shocks *ex post*. Pattanayak and Sills (2001) estimate event-count models of forest collection trips using survey data from households in the Brazilian Amazon. Their empirical model includes a measure of risk (the coefficient of variation of households' reported manioc output of previous years) and a shock variable (household reported agricultural production shortfall). They find positive correlations between forest collection trips and both agricultural shortfalls and agricultural risk.

Takasaki, Barham, and Coomes (2004) examine several strategies used by Peruvian smallholders to cope with covariate and idiosyncratic income shocks. These shock-coping mechanisms include forest product gathering and fishing. They find that forest gathering was important for coping with covariate flood shocks, with 22% of sample households reporting collection as a coping mechanism. Using a two-stage Tobit model, they find that households employing resource extraction to cope with covariate flood shock possessed relatively few physical assets and had relatively more adult household members.

The present paper complements these previous studies in a number of ways. This is the first to employ seasonal household data to examine smallholder use of forests for enduring hardships; earlier work uses cross-sectional data summarizing annual household experiences. In addition, while the studies of Pattanayak and Sills (2001) and Takasaki *et al*. (2004) concern tropical rainforests, the present study was undertaken in another important tropical ecosystem: dry deciduous (*miombo*) woodlands, the dominant vegetation type in Sub-Saharan Africa (Campbell, Frost, & Byron, 1996). The analysis involves estimating a random-effects model of commercial forest extraction with household data from Malawi. We construct a measure of a positive income shock based on the observation of whether or not a household received an agricultural assistance package consisting of a free packet of seed and fertilizer, locally known as a "starter pack". By employing a positive shock measure, we are able to explore a more optimistic narrative than the one described earlier. We ask whether programs designed to reduce the economic vulnerability of low-income households can improve human welfare and reduce forest pressure.

2. STUDY CONTEXT AND DATA

(a) *Background on Malawi's forests*

Malawi's forests are dominated by closed, deciduous woodland known colloquially as *miombo*. These woodlands are the most common vegetation type in central, southern, and eastern Africa (Campbell *et al*., 1996) and provide a wide range of products and services essential to the well-being of rural communities (Cavendish, 2000; Dewees, 1994; Fisher, 2004). Across Sub-Saharan Africa the interplay of forest dependence, rapid population growth, poverty, and weak forest management has resulted in highly degraded forest landscapes. In Malawi, for example, over 95% of existing woodland cover has been heavily modified by intensive use (Dewees, 1994). A recent estimate of the country's deforestation rate is 2.4% per annum, the highest for southern Africa (FAO, 2001 cited in UNEP, 2002).

The key threat to Malawi's forests is clearing land for agricultural expansion (GOM, 1998a). Smallholder farmers often have little option but to clear forest land to grow food to feed their families, and in many communities customary land is open access due to weakened traditional controls over land allocation (GOM, 1998a; Place & Otsuka, 1997). Another key factor in the decline of Malawi's forests is intensive extraction of wood. Approximately 90% of the country's total energy needs is provided by biomass (GOM, 1998a). Moreover, the productivity of *miombo* woodlands is generally low. At current levels of demand, wood harvest rates far exceed sustainable yield. Malawi's Forestry Department estimates that the deficit for woodfuels rose from 1.6 to 4.9 million cubic meters during 1983–90 (GOM, 1998b). [3]

(b) *Field sites and data*

Data for the study come from a household survey completed in three villages in southern Malawi between June 1999 and August 2000. Southern Malawi ranks highest in the country in terms of poverty incidence, population density, and scarcity of forest resources (GOM, 1998b; National Economic Council, 2000). Research villages were selected to represent the main forest management types in Malawi; they also provide a spectrum of market access. Village 1 is 10 km from a tarmac road and town and adjacent to the Mulanje Mountain Forest Reserve (MMFR), one of the 71 gazetted forests managed by the Forestry Department. [4] Together, these managed forests represent 22% of forest cover in Malawi. Households in this village have access to relatively abundant forest resources, ranging from *miombo* woodland at the base of Mulanje Mountain to pine and eucalyptus plantations to afro-montane forest near the mountain's summit. Markets for non-timber forest products (NTFPs) and timber are relatively well developed near Village 1.

In Village 2, *miombo* 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% 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 & Otsuka, 1997). Located 20 km from a tarmac road and town, Village 2 is remote, but is close to Mozambique (5 km), where agricultural and forest goods can be purchased at prices below those in Malawi.

The little remaining *miombo* 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 & Otsuka, 1997). A substantial portion of communal woodland in the village has been cleared, mainly for agriculture and charcoal burning. Most charcoal sold in Malawi's major cities is produced by local people in the surrounding rural areas (Makungwa, 1997). Village 3, adjacent to a tarmac road linking it to Blantyre (Malawi's largest city) 40 km away, is well positioned for charcoal marketing.

The entire sample consists of data from 99 randomly selected farm households, representing 12% of the total population in the three villages. During the study period, residents of sample households were interviewed on a monthly basis on a wide range of topics such as forest use, household assets, income/expenditures, food security, and agricultural production. Some of the methods used to ensure the collection of quality data included close supervision of enumerators by the lead author, interviews with groups of household residents to obtain more complete information, and separate interviews with women and men when this was judged to be conducive to respondents' willingness to disclose sensitive data. Below we describe key data used in the study's empirical analyses.

(i) *Forest extraction at the study sites*

Table 1 presents summary statistics on forest use at the study sites. Woodlands help sample households meet basic needs, providing fuel, construction materials, food, and livestock fodder/browse. While soils in *miombo* woodlands tend to be nutrient poor (Campbell *et al.*, 1996), about half of Village 3 households cleared forest for farmland during the survey

Table 1. *Forest use of sample households, 1999–2000*

	Village 1	Village 2	Village 3	All villages
Subsistence goods derived from woodlands				
Main cooking fuel is forest-collected firewood (%)	100	18	100	69
Wood for heating (%)	97	100	5	78
Wood for construction or repair of household dwelling unit (%)	N/A	87	91	71
Grass for thatching roof of household dwelling unit (%)	92	32	64	63
Wild fruit, vegetables, and mushrooms (%)	67	87	18	64
Insects and honey (%)	0	42	9	18
Bush meat (e.g., monkeys, rabbits, mice) (%)	N/A	61	0	23
Livestock fodder and browse (%)	28	11	41	24
Cleared forest for farm land (%)	3	0	50	12
Area cleared (ha)	0.30	–	0.26	0.26
Commercial woodland uses				
Marketed nontimber forest products (%)	79	74	73	76
Percent of total earnings from forest activities (%)	37	20	41	31
Quantity of wood and bamboo extracted for commercial purposes (kg)	1,092	200	11,009	2,953

year. Table 1 also indicates that households view forests as an important source of earnings, as evidenced by high participation rates in and high earnings shares from forest-based income generating activities.

An index was calculated for the quantity of scarce forest resources (wood and bamboo) extracted by sample households for commercial purposes. Our analysis focuses on commercial forest activities rather than subsistence forest use, because the former tend to be more degrading than the latter. [5] Mean values for the forest extraction index are provided at the bottom of Table 1, by village and overall. There are several plausible explanations for observed intervillage differences. First, during the survey year, the Village 2 headman appeared 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, only Village 3 households engaged in charcoal burning; this activity is the most degrading of forest resources in the study area.

Figure 1 shows moderate temporal variability in commercial forest extraction over the survey year. Seasonal variability of forest use is common in the developing world for several reasons (Byron & Arnold, 1999). One explanation relates to changes in labor availability over a typical year. At the study sites, rates of forest extraction were relatively low during the agricultural period due to a peak in demand for household labor for cropping activities. Rates of forest extraction were higher in the nonagricultural period when labor was more available. A second reason for seasonality of forest use is that some forest activities are easier to perform at certain times of the year. Figure 1 shows that charcoal sales were relatively low in the agricultural period which is also the rainy season; this reflects difficulties with kiln management in rainy conditions. A third explanation is variable demand for forest products across seasons. For example, brick making peaks in the nonagricultural period when home construction/repair is common. Another plausible explanation for observed variability of forest extraction over the survey year is that it reflects household *ex ante* or *ex post* responses to income variability, in line with our research hypothesis.

(ii) *Income shock measure*

The income shock measure used in the study is starter pack receipt. The Starter Pack Scheme (SPS) was a government-run, free-inputs program that ran in 1998–99 and 1999–2000. Under the SPS, all of Malawi's estimated 2.86 million smallholder households were entitled to receive a starter pack containing hybrid maize seeds and chemical fertilizer sufficient to plant about 0.1 ha. Grain legumes were also included to add nitrogen to the soil and provide an alternative source of food and income. The SPS was aimed at promoting food security, increasing productivity of the staple crop

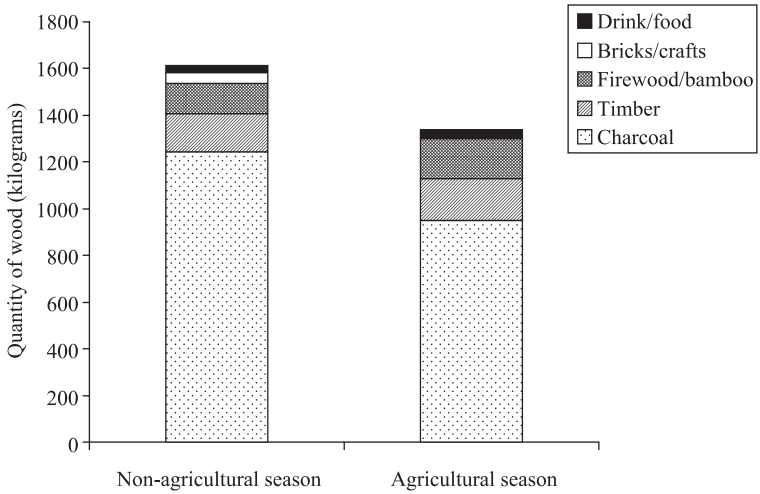

Figure 1. *Forest extraction for commercialization, sample households 1999–2000.*

maize, and improving soil fertility (Longley, Coulter, & Thompson, 1999). [6]

We characterize the starter pack shock as an idiosyncratic income boost. The starter pack shock was idiosyncratic because not all households received one, owing to distribution problems (Longley *et al*., 1999). In the three villages in this study, 68% of sample households received a starter pack in 1999–2000. Corresponding percents of households that received packs in Villages 1, 2, and 3, were 28%, 97%, and 86%, respectively. The relatively low percentage of households receiving a starter pack in Village 1 is explained by the breakdown of the lorry carrying starter packs destined for the village; some of the packs were stolen while the lorry was being repaired. The starter pack shock is also idiosyncratic because it represented a differential income boost across heterogeneous households. For example, although households varied by number of residents, the size and total value of starter packs did not differ across households. Thus, starter pack receipt represented a relatively small income boost for households with many members compared to those with relatively few people. For this reason, we use as our shock variable the value of starter pack inputs divided by the number of household residents. The estimated market value of starter pack inputs was 450 Malawi Kwacha in 1999–2000 (Levy, Barahona, & Wilson, 2000). [7]

The starter pack provided either a direct or indirect income boost for recipients. [8] Evaluation reports suggest that some starter pack recipients sold their packs to finance immediate consumption (Levy *et al*., 2000). Among sample households of the present study, only one reported sale of a starter pack. Nationally and across the study sites, most households used all or part of the starter pack inputs in their gardens. The net contribution of starter packs at the household level was an estimated 70–120 kg of maize in 1999–2000 (NSO, 2000 and Sibale *et al*., 2001 cited in Levy & Barahona, 2002). We focus on the impact on commercial forest extraction of an event (starter pack receipt) rather than behavior (how households chose to use their packs).

Starter pack receipt should provide a useful shock measure for at least three reasons. First, starter pack receipt is truly a shock to income because it was unpredictable. Household members had limited information with which to make judgments concerning the likelihood of receipt of a starter pack. They knew only whether a starter pack was received in the previous year and heard from other villagers, radio announcements, and field assistants compiling registration lists that the SPS was continuing in the current year. Prior to distribution of the packs, households were probably hopeful, but it is unlikely that they changed their behavior prior to receiving their starter packs. [9]

Second, the starter pack shock was quite large and should therefore have precipitated a behavioral response. As mentioned above, households that used the packs in their gardens produced an additional 70–120 kg of maize, on average. This amount of maize could feed a family for over a month. The value of starter pack related incremental maize production was greater than the annual cash income of many farm households in Malawi (Blackie *et al.*, 1998). Finally, starter pack receipt should be a useful shock measure because it can be situated in time. During the study year, starter packs were received around the end of the nonagricultural period. If households changed their behavior due to starter pack receipt, we expect this to have occurred sometime during the agricultural period. [10]

3. MODELING APPROACH AND RESEARCH HYPOTHESES

This paper examines direct consequences for forests of household income shocks. We ask if rural Malawian households cope with income shortfalls partly through increased forest commercialization and, if so, who is most reliant on this coping mechanism? To investigate these questions, a regression strategy is developed making use of seasonal household data from Malawi. The empirical model is a random-7effects Tobit model where the dependent variable Q is the forest extraction index described above. [11] Using subscripts i and t to represent households and time (the agricultural season and the nonagricultural season), the model takes the form:

$$Q_{it} = \alpha_0 + \alpha_1 S + \alpha_2 \theta_{it} + \sum_k \beta_{kt} H_{kit} + \sum_k \delta_{kt} H_{kit} \cdot \theta_{it} + \varepsilon_{it}. \quad (1)$$

Explanatory variables are defined as follows: S is a binary variable indicating the agricultural season. The variable θ, our positive income shock measure, is the household-specific monetary value of starter pack receipt. The variable is equal to the value of the starter pack inputs divided by number of household residents for starter pack recipients, and is zero for nonrecipients. Vector $\boldsymbol{H}$ includes binary variables for residence in Village 1 or in Village 2 as well as a set of household characteristics (including distance from the household dwelling unit to the forest collection site; the age, gender, and education of the household head; and farm size per household resident). [12] Interaction terms $\boldsymbol{H} \cdot \theta$ are products of explanatory variables and the household-specific value of the received income shock. Term ε, an error term with assumed zero expectation, consists of two components:

$$\varepsilon_{it} = \gamma_i + v_{it}, \quad (2)$$

where γ represents omitted variables that vary across individuals, but not over time and v is the usual error term in statistical models. Table 2 provides descriptive statistics of variables used in the regression.

The forest extraction model is used to test the hypothesis that household forest use responds to income shocks. If households use forests for consumption smoothing, then *ceteris paribus* households experiencing a transitory increase in income should have lower rates of forest extraction compared with households that did not experience such an income boost. This is because households receiving a positive income shock are relatively less vulnerable to having low income and therefore have less need to draw on forests for consumption smoothing. Referring to the empirical model described in Eqn. (1), a finding that $\alpha_2 + \sum_k \delta_{kt} H_{kit} < 0$ would lend support to the hypothesis that households turn to forest product sale in the face of misfortune.

Also of interest to this study are the characteristics of households most reliant on forests for shock coping. The inclusion of interaction terms in the empirical model allows us to test a set of hypotheses. We conjecture that households are more reliant on forests for shock coping if they have easy access to forest resources. A key indicator of forest access is existence of forest management institutions, represented here by binary indicators of village of residence. It is expected that households in Village 3 are more likely to use forests to cope with income shocks than households in other villages, due to the open access nature of common forest land in Village 3. Distance to forest and woodlands should also influence forest use, because net benefits to forest extraction fall as the travel time to a collection site increases. Thus, we posit that the response of forest resource extraction to income shocks declines along a spatial gradient.

We hypothesize that stage in the life cycle may be linked with use of forests for shock coping. Households headed by an older individual may be less likely to engage in forest commercialization for consumption smoothing because

Table 2. *Descriptive statistics of dependent and explanatory variables*

	Mean or frequency	Standard deviation
Dependent variable		
Wood extracted for commercialization (kg)[a]	2,953.24	10,038.29
Annual household labor hours in forest activities[b]	1,603.18	1,234.36
Household received a starter pack[b]	0.68	–
Explanatory variables		
Village 1 residence	0.39	–
Village 2 residence	0.38	–
Distance from home to forest collection site (km)	1.11	0.53
Older household head (householder > 44 years)[c]	0.63	–
Female-headed household	0.41	–
Household head completed primary school	0.18	–
Farm size per household resident (ha/person)	0.33	0.32
Value of starter pack (Malawi Kwacha)[d]	85.63	98.13
Dependency ratio (dependents/household size)[b]	0.15	0.17
Household head migrated to village of residence[b]	0.19	–
Household head and village chief have shared ethnicity[b]	0.42	–
Household owns a radio[b]	0.59	–

[a] This is the mean value for all households regardless of whether they marketed forest products or not. Among households engaged in forest product commercialization, the average quantity of wood extracted for marketing was 4,498 kg.
[b] These are dependent variables and explanatory variables used for empirical tests of the robustness of the forest extraction results (see Tables 5 and 6).
[c] In the dataset, age is a categorical variable because many respondents were not aware of their age. We estimated age with reference to a list of historical events.
[d] This is the mean value for all households including starter pack recipients and nonrecipients. The mean value of the starter pack for recipients only is 126 Malawi Kwacha (MK). During the survey year, the exchange rate was about 50 MK = US$1.

they have relatively better access to alternative smoothing mechanisms. For instance, compared to newly established households, older households have had more time to build up their stock of liquid assets and to develop ties within the community. Also, these households are more likely to receive remittances from grown children residing elsewhere. Finally, we conjecture that the poor are more reliant on forests for natural insurance than are the relatively well-off. This is because poor households often possess few liquid assets to sell at critical times and may face collateral-related constraints to borrowing in credit markets. We proxy poverty by three variables associated with low living standards in Malawi: female headship, education, and farm size per household resident (Mukherjee & Benson, 2003; World Bank, 1996). In addition to indicating greater need, farm size per household resident should also measure the (labor) capacity to engage in forest extraction, important given that forest activities are relatively labor intensive (Fisher, Shively, & Buccola, forthcoming).

4. EMPIRICAL FINDINGS

(a) *Forest extraction results*

Table 3 reports coefficients, standard errors, and marginal effects for the forest extraction equation. [13] Calculated Wald statistics shown at the bottom of the table provide support for two hypotheses: joint significance of all explanatory variables and joint significance of the starter pack variable and all interaction terms. Eight of the point estimates in the forest extraction equation are individually different from zero at the 90% confidence level. Given our interest in links between income shocks and forest pressure, we focus the discussion on results for the income shock (starter pack) variables.

Did starter pack recipients have lower levels of forest extraction than nonrecipients, all else being equal? This question is answered by the parameter estimates for the starter pack variable and the interaction terms in Table 3. Using these figures alongside mean values for

Table 3. *Random-effects Tobit model results for commercial forest extraction*

	Coefficient	Standard error[a]	Marginal effect
Constant	7,644.917*	1,078.721	
Nonagricultural season	−160.743	388.635	−49.711
Village 1 residence	−4,448.655*	816.902	−1,325.027
Village 2 residence	−8,721.557*	766.442	−2,520.079
Distance to forest collection site (km)	−607.229	618.211	−187.790
Older household head	−4,220.985*	496.246	−1,382.185
Female-headed household	−585.792	474.283	−180.315
Household head completed primary school	−3,874.809*	576.394	−1,071.506
Farm size per household resident (ha/person)	−1,385.254	1,081.157	−428.399
Value of starter pack (Malawi Kwacha)	−38.328*	10.669	−11.853
Interaction terms (interacted with value of starter pack)			
Village 1 residence	−2.171	11.660	−0.671
Village 2 residence	6.656	8.520	2.058
Distance to forest collection site	12.313*	7.488	3.808
Older household head	16.981*	6.635	5.252
Female-headed household	13.734*	6.797	4.247
Household head completed primary school	−18.730	13.719	−5.792
Farm size per household resident	−2.400	8.149	−0.742
Number of observations		198	
Wald statistic (16)[b]		415.70	
Wald statistic (8)[c]		25.27	

[a] These are Huber/White robust standard errors.
[b] Wald test for joint significance of all explanatory variables, distributed as a χ^2 with a critical value of 26.30 for 16 degrees of freedom at 0.05 probability.
[c] Wald test for joint significance of value of starter pack and all interaction terms, distributed as a χ^2 with a critical value of 15.51 for 8 degrees of freedom at 0.05 probability.
* Significant at the 0.10 probability level or better.

interacted explanatory variables enables one to calculate the association between the value of a starter pack and forest extraction. [14] For a household with average values for all explanatory variables, receipt of a starter pack is associated with a 424 kg reduction in commercial forest resource extraction. This amount of wood is equivalent to about three months of firewood to cook an average-size rural Malawian family's meals. Our results may be indicative of the use of forests for coping with economic disruptions, because we observe higher forest extraction among households that were relatively more vulnerable to having low income, that is, starter pack nonrecipients. In short, findings appear to support a hypothesis that households at forest margins use forests to cope with income shortfalls.

Importantly, results suggest that positive shocks to income can have direct favorable consequences for forests. This is a form of saving; by reducing forest extraction today households should be better endowed in the stock of common forest resources in future periods. This statement, however, must be qualified. Recall that the forest extraction variable is the quantity of forest resources extracted for cash income generation; the variable does not include forest clearing or firewood collection for home use. In a separate work with the same dataset, we conclude that receipt of a starter pack had no measurable effect on forest clearing. Furthermore, for the sample households, we argue that the net effect of starter pack receipt on forest extraction should be negative even if one were to account for increased firewood consumption. As mentioned earlier, the starter pack could be expected to produce an additional 70–120 kg of maize, enough to feed a family for over a month. Among the sample households, an average 135 kg of firewood was used to cook meals for a month. Thus, any starter pack-induced increase in firewood consumption for home use should be well below the estimated 424 kg reduction in commercial forest extraction.

To the extent that starter pack receipt is a useful shock measure, parameter estimates for

Table 4. *Predicted commercial forest extraction (in kg), starter pack recipients and nonrecipients*

	Starter pack[a]		Absolute difference	Percentage difference
	Recipient	Nonrecipient		
By distance to forest				
0.5 km	4,042.12	4,759.93	717.81	15.08
1 km	4,189.05	4,666.04	476.99	10.22
1.5 km	4,335.99	4,572.14	236.15	5.17
By age of householder				
Younger householder	4,670.86	5,511.07	840.21	15.25
Older householder	3,952.95	4,128.88	175.93	4.26
By headship				
Female householder	4,430.38	4,539.82	109.44	2.41
Male householder	4,073.44	4,720.13	646.69	13.70

[a] To calculate predicted forest extraction, explanatory variables are set to mean values. The predicted values are conditional on the mean of the dependent variable falling within the positive portion of the distribution. Thus, predicted values can be compared with the observed value of commercial forest extraction for households that engaged in commercial forest activities, which is 4,498 kg on average.

the interaction terms provide insights on the characteristics of households most reliant on forests for shock coping in the study area. Three of the interaction terms are statistically significant at the 0.10 probability level or better. To aid in interpretation of findings, we predict commercial forest extraction for starter pack recipients and nonrecipients for different values of the statistically significant interacted variables. Results in Table 4 indicate that household forest extraction is less responsive to starter pack receipt among households living relatively far from forest collection sites. This may suggest that use of forests for shock coping is more often employed by households living close to forests. Such a finding is consistent with economic theory—as distance to woodlands increases, costs of forest extraction rise and net benefits fall, reducing incentives to engage in forest activities.

We find that starter pack-induced reduction in forest extraction was lower among households headed by an older *versus* a younger individual. It may be that use of forests for shock coping is less common among well-established households because these households have better access to alternative consumption smoothing mechanisms. Older household heads have had more time to build up their stock of liquid assets and to develop important ties within their respective communities. These households are also more likely to receive remittances from grown children residing elsewhere. In addition, the physical demands of forest activities may make forest shock coping less attractive to older household heads.

Finally, Table 4 shows that commercial forest extraction of female-headed compared to male-headed households is less responsive to receipt of income shocks. This result does not conform to our prior expectation that poor households, proxied by female headship, education, and farm size, are more reliant on forests for shock coping. A plausible explanation is that households headed by males tend to have more labor available, and in particular more adult male labor. Forest activities are labor intensive in general, and commercial activities are most often the pursuit of adult males. As a result, use of forests for shock coping may be less of a viable option for households headed by women.

(b) *Investigation of empirical concerns*

In this section, we explore some concerns with the forest extraction model presented above. One issue is that the observed difference in forest extraction among starter pack recipients and nonrecipients should in part reflect the need to use complementary inputs, namely household labor, with the starter pack inputs. In fact, it could be argued that the observed difference in forest extraction reflects only the need for complementary labor for maize production. To examine this, we estimate an empirical model for annual forest labor hours. [15] We include as explanatory variables the same covariates used in the forest extraction

Table 5. *Ordinary least squares results for annual forest labor hours*

	Coefficient	Standard error[a]
Constant	2,433.814*	416.308
Village 1 residence	473.615	518.579
Village 2 residence	27.314	265.507
Distance to forest collection site (km)	−454.076	359.375
Older household head	370.304*	191.607
Female-headed household	−704.067*	242.298
Household head completed primary school	−505.074*	292.881
Farm size per household resident (ha/person)	−519.564*	303.343
Value of starter pack (Malawi Kwacha)	−2.361*	0.989
Number of observations	99	
R-squared	0.25	

[a] These are Huber/White robust standard errors.
* Significant at the 0.10 probability level or better.

model, but omit the interaction terms due to the small size of our sample.

Results in Table 5 show that the starter pack variable is statistically significant at the 0.05 probability level. The coefficient along with the mean value of the starter pack variable can be used to determine forest labor hours for starter pack recipients and nonrecipients. Findings indicate that during the study year, starter pack recipients with an average value of the starter pack (126 Malawi Kwacha) spent 297 h less on forest activities compared with starter pack nonrecipients. This figure can be compared with the Malawi Ministry of Agriculture's estimate for the amount of time required for a 0.1 ha hybrid maize plot from land preparation to postharvest—5.6 man days or approximately 45–56 h (Longley *et al.*, 1999). In sum, findings do not appear to support a hypothesis that the observed difference in forest extraction reflects only the need for complementary labor for maize production.

A second concern with the forest extraction analysis is the extent to which starter pack receipt is a random event. It is conceivable that starter pack recipients are systematically different from nonrecipients, and would use forests differently even in the absence of starter pack receipt. That is, there may be unmeasured factors that determine both forest use and starter pack receipt and, subsequently, the measured effect on forest extraction of starter pack receipt could be partly spurious. We explore the potential endogeneity of the starter pack variable in two ways.[16] First we estimate a Probit model of starter pack receipt to examine whether starter pack recipients differ from nonrecipients on a range of observables. We then conduct a test of exogeneity using the procedure outlined by Smith and Blundell (1986).

To begin, we ask what factors might be correlated with starter pack receipt. We hypothesize that households more likely to receive a starter pack were relatively wealthy households, with available labor (to travel to distribution site), strong social connections, and access to information. These hypotheses are explored by estimating a Probit model in which the dependent variable is starter pack receipt. Explanatory variables include female headship, education, and farm size (as proxies for wealth); farm size per household resident and a dependency ratio variable (as measures of labor availability); binary indicators of migration status and ethnicity (as indicators of social connectedness) and ownership of a radio (to indicate access to information).

Table 6 reports results from two Probit models; the first includes the full set of explanatory variables; the second is a more parsimonious model. Findings indicate that starter pack recipients and nonrecipients do not differ systematically on the variables included in the models, with the exception of village of residence. The forest extraction model presented previously (Table 3), by including binary variables for village of residence, accounts for potential bias related to association between place of residence and probability of starter pack receipt.

Exogeneity is tested using the approach proposed by Smith and Blundell (1986) for simultaneous limited dependent variable models. This test is essentially one for exclusion of residuals

Table 6. *Probit model results for starter pack receipt*

	Model 1		Model 2	
	Coefficient	Standard error[a]	Coefficient	Standard error[a]
Constant	0.780	0.654	1.120	0.591
Village 1 residence	−2.146*	0.526	−1.880*	0.444
Village 2 residence	1.275*	0.576	1.302*	0.617
Distance to forest collection site (km)	0.327	0.337		
Older household head	0.077	0.410		
Female-headed household	0.019	0.364		
Household head completed primary school	0.116	0.449		
Farm size per household resident (ha/person)	0.343	0.473	0.323	0.461
Dependency ratio (#dependents/population)	−1.067	1.053	−1.008	0.972
Migrant household head	0.061	0.448		
Household head and village chief have same ethnicity	−0.593	0.492	−0.579	0.494
Household owns a radio	0.353	0.386	0.333	0.384
Number of observations	99		99	
Log-likelihood	−33.87		−34.34	
Pseudo-R-squared	0.46		0.45	

[a] These are Huber/White robust standard errors.
* Significant at the 0.10 probability level or better.

from an auxiliary regression of starter pack receipt on all exogenous variables and instruments. Finding at least one suitable instrument—a variable that is (preferably highly) correlated with starter pack receipt but unrelated to forest resource extraction—presents a clear challenge. We use radio ownership as an instrument, acknowledging that it is a rather weak instrument from the standpoint of its correlation with starter pack receipt. That said, we expect that radio ownership does not condition forest extraction. Estimation of a bivariate Tobit model of commercial forest extraction on radio ownership reveals a t-statistic of 1.35 (p-value = 0.18). We employ the Stata program "tobexog" (Baum, 1999) to implement the Smith–Blundell test. Findings indicate that one cannot reject statistical exogeneity of starter pack receipt in the forest extraction equation (p-value = 0.58). This might suggest that starter pack receipt was a random event rather than a choice; but caution is warranted in the interpretation of these findings, given that a more useful instrument for implementing the Smith–Blundell exogeneity test is unavailable.

5. CONCLUSIONS AND DISCUSSION

This paper examined links between income shocks and forest pressure in southern Malawi. We estimated a random-effects Tobit model of forest extraction to investigate whether households living at the tropical forest margin depend on forests to cope with income shocks. Results suggest a negative association between receipt of a positive income shock and forest extraction, in support of our hypothesis that rural households rely on forests for coping with income shortfalls. The implication may be that positive income shocks help to reduce forest pressure in the short term. This result parallels, in reverse, findings reported by Pattanayak and Sills (2001) and Takasaki *et al.* (2004), where adverse shocks lead households to temporarily increase rates of forest product extraction. Study findings also provide insights on the characteristics of households that condition forest-based shock coping. We find that households most reliant on forests for consumption smoothing are those located close to woodlands and headed by an individual who is relatively young and male.

Our study complements a small amount of literature that highlights potential links between risk, shocks, and forest use, but the need for further research is indisputable. We recommend future studies use: (a) panel data spanning several years (to date, most analyses have concerned a single year) and (b) additional shock measures, such as those related to human health and weather variation. If results of the present study are confirmed through additional analyses, then they carry important implications for policy making in tropical areas. For one, the Malawi case study provides some justification for safety-net transfer programs, since results suggest that the SPS, by making households less vulnerable to having low income, reduced incentives to degrade forests. Safety-net transfer programs may be warranted when common shocks, such as flood or drought, threaten rural livelihoods and forest resources. That said, it is important to keep in mind the incentive and implementation issues common to these programs.

Perhaps a more useful set of policies would aim to reduce poor households' vulnerability to shocks in the first place and improve access to alternative, that is nonforest-based, shock-coping mechanisms. Agricultural production and health shocks are particularly problematic in Malawi where floods and droughts are common occurrences, and where HIV/AIDS prevalence for adults is about 14% (UNAIDS, 2004). Public investment in health care provision, health education, and agricultural extension can help reduce vulnerability in rural Malawi. One possible approach to improving household access to alternative shock-coping mechanisms would be to expand microcredit schemes. Access to credit can enable the poor to build up a stock of liquid assets or borrow in difficult times. In implementing these and related policies, approaches that target or provide self-targeting of special-needs groups, such as households headed by relatively young individuals, should receive priority.

NOTES

1. To be sure, rural Malawian households endure hardships by employing a mix of coping strategies. Unfortunately, data are not available to study the full set of coping strategies.

2. Forest resources are not freely available simply because they are held under communal tenure. In many societies, forests have been sustainably managed by long-standing community-based management systems in which norms and rules define the rights of community members to use specific forest resources (Fortmann & Bruce, 1988). Unfortunately, such systems can be transformed into *de facto* open access areas in the face of market, population, and modernization pressures (Blaikie & Brookfield, 1987).

3. Local timber merchants extract selected tropical hardwoods, destined primarily for urban centers within Malawi. Largely because there is little remaining valuable timber, merchants currently play only a minor role in forest degradation.

4. Since 2001, the MMFR has been comanaged by local people and the Forestry Department.

5. Numerous studies document the array of subsistence products that rural households in low-income countries derive from forests (Cavendish, 2000; Godoy *et al.*, 2002) and the important safety-net functions these goods provide (Byron & Arnold, 1999; Kinsey, Burger, & Gunning, 1998). Likewise, evidence from the study area indicates that forest foods (e.g., mushrooms, fruit, bush meat) are used to smooth consumption during the hungry season and in emergency situations. In general, however, forest foods do not tend to be scarce at the study sites (Knacck Consultants, 1999; Konstant, 1999).

6. The starter pack concept emerged in a Rockefeller Soil Fertility Network Research paper (Mann, 1998) and was further developed in a Malawi Maize Productivity Task Force discussion paper (Blackie *et al.*, 1998).

7. Malawi's currency is the Malawi Kwacha (MK). During the survey year, the exchange rate was about 50 MK = US$1.

8. The analysis that follows should be symmetric with respect to the sign of the income shock, but it is debatable whether starter pack receipt represented a positive or negative shock to income. If one takes the viewpoint that households were optimistic about receiving a pack, then not receiving one is a negative shock. We adopt the viewpoint that households were somewhat pessimistic, given a general distrust of government in rural Malawi, and therefore, we characterize the starter pack as a positive shock.

9. This is different from the situation where the shock is, say, weather and household behavior may be influenced by subjective beliefs about moments of the outcome distribution.

10. It is also possible that response to starter pack receipt was delayed beyond the time period of the survey.

11. Tobit analysis is necessary because some households in the sample did not extract forest products for commercialization. The Tobit technique accounts for this censoring in the dependent variable.

12. While ***H*** is time subscripted, only the farm size variable varied during the survey year.

13. In the Tobit framework, a change in the independent variable is decomposed into two separate effects: the effect on the conditional mean of the dependent variable in the positive portion of the distribution, and the impact on the probability that the observation falls in that part of the distribution (see Greene, 2000).

14. The presence of interaction terms means that the association between the value of starter pack and forest extraction is not limited to the coefficient of the starter pack variable. It also depends on the parameter estimates of the interaction terms and the value of interacted explanatory variables. To calculate the effect of starter pack on forest extraction, we set the value of interacted explanatory variables equal to their means.

15. It is not possible to estimate a longitudinal model as we did for forest extraction, because labor hours data are available on an annual rather than on a seasonal basis.

16. The potential specification error is endogeneity rather than sample selection bias. Sample selection bias occurs when the dependent variable is only observed for a restricted, nonrandom sample. For example, wages are only observed for working individuals. Endogeneity refers to situations in which an explanatory variable is a choice variable potentially correlated with the error term. However, the dependent variable is observed for the entire sample (Millimet, 2001).

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