Local Uses of Parks: Uncovering Patterns of Household Production from Forests of Siberut, Indonesia

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This study empirically investigates how tropical forests contribute to rural economies by using household survey data to understand patterns of local forest use on Siberut, Indonesia. We use household production theory to build a model of forest products collected on Siberut as a function of labour, tools, forest condition and household classes. Five forest products—rattan, sago, and wood for construction, carpentry and fuel—are combined into a composite forest product using market prices as weights. Four classes of households are identified through cluster analysis of assets, including land, livestock, productive equipment and consumer durables. The parameters of the estimated forest production functions are consistent with underlying theory and statistically significant. Labour allocated to forest product collection has the greatest overall influence. In turn, labour allocation is significantly influenced by household composition and socio-economic factors. We also find that forest quality is negatively correlated with forest product collection. All things considered, the wealthiest households collect the least amount

Acknowledgements: We acknowledge field support from Abdullah Prawirosamudro, Frans B.M. Dabukke, Jeffry Susyafrianto, Mochamad Fansuri, Sahat Simanjuntak, Sondang Romauli Situmorang and the student interviewers. Data for this article are drawn from a larger project funded by the Asian Development Bank, Government of Indonesia, Duke University, Howard Gilman Foundation and Joshua Trent Foundation. Some of the ideas presented here were developed in a master's thesis by Anik Mehta at Duke University's School of the Environment under the supervision of Subhrendu Pattanayak. For helpful suggestions on earlier drafts of this article, we thank Bradford Barham, an anonymous referee, and seminar participants at the Association of Indian Economics Studies meetings (January 1999) and Southern Forest Economics Workgroup meetings (March 2001).

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***Conservation and Society*, 1, 2 (2003)**
SAGE Publications New Delhi/Thousand Oaks/London

of forest products, and the mid-wealth households invest the most labour in collection. We discuss how the estimated parameters can help us identify potential areas of concern, suggest policy levers, understand heterogeneity in local interests and predict responses to park policies.

Over the past fifteen years policy initiatives and projects have promoted forest product collection from the buffer zones of protected areas as a means to reconcile development and conservation. At the same time, concerns have been raised about the potential ecological impacts of excessive collection of forest products. Quantitative empirical analyses of tropical forest use are required to support rational formulation of policies (Ferraro and Kramer 1997; Gunatilake 1998; Hyde and Amacher 2000; Takasaki et al. 2001). This article identifies patterns of forest product collection by indigenous households in and around Siberut National Park, Indonesia. We use micro-econometric models to relate household collection of forest products to socio-economic and biophysical variables suggested by household production theory.

The specific objectives of this article are to estimate household production and labour allocation functions for forest products, using aggregate measures of forest output and labour. This approach allows us to identify general patterns in forest production collection across classes of households (as determined by their asset holdings), other socio-demographic characteristics and forest condition. We discuss how the estimated parameters can help us identify potential areas of concern, suggest policy levers, understand heterogeneity in local interests and predict responses to park policies.

Forest Dependence

There is a small but growing literature on the relationship between rural households' socio-economic status and their collection of forest products. A common hypothesis is that poorer households are more dependent on the forest (Godoy and Bawa 1993; Reddy and Chakravarty 1999). Byron and Arnold (1999) point out the multitude of definitions of 'forest-dependent', and Wollenberg (2000) highlights the challenges of accurately measuring quantities and values of forest products. Of particular importance is the distinction between relative dependence (for example, percentage of full income contributed by forest products) and absolute dependence (for example, quantities of forest products collected). The relationship between collection of non-timber forest products (NTFPs) and socio-economic characteristics including income or wealth has been analysed most often with cross-tabulations and graphical methods (Bahuguna 2000; Cavendish 2000; Godoy et al. 1995; Hegde and Enters 2000; Kvist et al. 2001; McSweeney 2002; Takasaki et al. 2001), and occasionally with regression models (Godoy 2001; Gunatilake 1998; Pattanayak and Sills 2001; Shively 1997; Wickramasinghe et al. 1996).

Many of these studies find that poor households depend *relatively* more on NTFPs, conditional on an array of other socio-economic, geographical and biophysical characteristics. Findings regarding *absolute* dependence on NTFPs vary, as does the pattern across middle- and high-income households.

Econometric approaches are more common in the fuelwood literature, which often applies the household production framework and includes several measures of wealth, such as landholdings (Amacher et al. 1999; Edmunds 2002), livestock (Joshee et al. 2000; Sills et al. 2003) and counts of possessions (Pattanayak et al., forthcoming). Because these different asset categories affect both production capabilities and preferences, it is not surprising that their influence on forest production and labour depends on the particular asset category and particular setting (Sills et al. 2003). Takasaki et al. (2000) use participatory rural assessment methods to categorise Amazonian households by specific types of wealth. They also find that not only the level but also the type of wealth determines how people use the forest and hence their dependence on NTFPs. As described next, Siberut is a useful setting to evaluate some of the questions raised by this literature about use of tropical forests.

Siberut is a 4,000 sq. km island in western Indonesia, off the west coast of the island of Sumatra. Due to the great biodiversity and endemic species of its forests and to the unique culture of the resident indigenous people, it is recognised by UNESCO as a Man and Biosphere Reserve. Approximately 80 per cent of the island is considered disturbed due to the long history of human use and logging concessions over the past several decades (Ministry of Forestry 1995). In 1993 the Indonesian government declared the western half of the island a National Park, and the eastern half a support or buffer, zone. The management objectives for the Park include: (*a*) maintenance of the biological diversity of the tropical rainforests; and (*b*) generation of enhanced livelihood opportunities and direct economic benefits for local communities (ibid.).

Approximately 23,000 people live on the Island, 90 per cent of whom are indigenous Mentawai. The traditional Mentawai economy is based on forest resources: the people hunt and fish, collect numerous plant and tree products, and clear small areas for limited agricultural production. While the economy is largely subsistence oriented and there is no labour market, many Mentawai households do sell some forest products. This has raised concerns about the sustainability of their collection activities. Restrictions of forest use, however, are difficult to enforce and could undermine the welfare and livelihoods of the Mentawai. The Park has identified a number of communities where these trade-offs are most acute, and has launched an integrated conservation and development project to seek compromise and complementarities between forest use and forest conservation. Effective project planning requires a detailed understanding of the current role of forest resources in the Mentawai economy, including patterns of use across households and factors driving those patterns. Sills (1998) and Kramer et al. (1997) present further details on the economics of conservation in Siberut.

Household Production in the Forest

To evaluate the patterns of forest product collection on Siberut, we used the household production theory to construct a model of household behaviour (Bardhan and Udry 1999; Sills et al. 2003). Specifically, we built a forest 'production' model, relating output to the key inputs of labour, forest condition and physical capital (that is, hand-tools). To test differences across socio-economic classes, we clustered households into four types based on their asset holdings and included these types as shifters in the production function. In order to focus on general patterns and limit the impact of recall errors for specific forest products, our measure of output was a price-weighted index of the key forest products, which is similar to a revenue function, but for total household production rather than just marketed surplus. To empirically implement this model, we estimated a modified Cobb-Douglas equation:

$$Ln(Q) = \quad + {}_{C}C + {}_{L}Ln(L) + {}_{T}T + {}_{F}F + {}_{1} \qquad [1]$$

where Q is the composite of forest products, C is a vector of dummy variables for type of household, L is the labour input into forest product collection, T is tools or capital stock, F is forest condition, ${}_{1}$ is the error term, and (a constant) and s are the parameters to be estimated.

Exogeneity of inputs is an important consideration in the estimation of production functions. Here, we treated forest condition and stock of tools as exogenous (or predetermined) to the forest production decision. We could also treat the labour input as exogenous, as in equation [1]. However, this labour input reflects household choices about how much time to allocate to forest product collection (again, aggregated over the key forest products). Thus, a better approach is to acknowledge that labour allocation and collection are simultaneously determined. Because the Mentawai households operate in incomplete markets, their labour allocation depends on household characteristics rather than just an exogenous wage (Pattanayak and Sills 2001; Sills 1998). Labour allocation is therefore a function of the household socio-demographics, including human capital, age and family composition. To implement this approach, we estimated a three-stage least squares systems (3SLS) that incorporates the error correlation between the collection (${}_{1}$) and labour allocation (${}_{2}$) equations:

$$\begin{aligned} Ln(Q) &= \quad + {}_{C}C + {}_{L}\mathrm{Log}(\hat{L}) + {}_{T}T + {}_{F}F + {}_{1} \\ Ln(L) &= \quad + {}_{C}C + {}_{E}E + {}_{H}H + {}_{2} \end{aligned} \qquad [2]$$

where E is household labour endowment, and H is household socio-demographics, as reflected in factors such as age, health and length of local residence.

Siberut Household Survey

The data used here are drawn from a biodiversity valuation study of two national parks (Siberut and Ruteng) in Indonesia (Kramer et al. 1997). As part of this study, a socio-economic survey was conducted on Siberut Island in January 1996. Approximately 500 households were randomly sampled from communities in and around the park. Based on summary statistics drawn from the household survey, the typical Mentawai household is described next.

The average age of household heads is thirty-three years, and 78 per cent have lived in the same village their entire lives. Others have migrated between villages, resulting in an average time in the current village (local residence) of thirty years. Typically, households have two adult men and two women (medians). There are very limited public health facilities on the island, and households suffer from multiple illnesses (mean count of 2.8). Households are engaged primarily in agriculture and forest product collection, with household labour and natural resources (forests and land) as the major production inputs. Households also own a variety of hand-tools for agriculture and forestry, such as spades, machetes, axes and large knives. We find that the average household spends seventy-eight days per year collecting forest products using the labour measurement approach described later. We assume that households collect from forests near their residence, which are officially owned by the national government and communally managed by the Mentawai. Quality of those forests is measured by an ordinal variable, with 1 representing the least disturbed forests and 4 representing the most disturbed forest. This index was determined by field ecologists from the World Wide Fund for Nature (WWF) and described in a map of forests of Siberut (Mitchell et al. 1982). We overlayed the WWF map on our household sampling map to develop an approximate index of forest quality around each village.

We focus on five major forest products: rattan, sago and three categories of wood. Rattan is used to make furniture, mats and basketry, and is commercially attractive. The trunk of the sago palm is processed into flour, which serves as a dietary staple, livestock feed and an occasional commercial product. The three primary uses of wood are for construction, carpentry and fuel. These five products are collected across the spectrum of household types, as discussed later in discussing socio-economic classes and shown in Table 1.

Data on each product were gathered using the notion of a 'typical trip' for collecting forest products (Pattanayak and Sills 2001; Pattanayak et al. forthcoming). The survey asked households to describe typical collection trips for major forest products (identified through focus groups and pre-testing) in terms of (*a*) frequency of collection trips, (*b*) quantity of forest product collected on each trip, and (*c*) labour time per trip. Quantity of forest product was calculated as the product of 'number of trips' and 'yield per trip'; and quantity of labour was calculated as the product of 'number of trips' and 'time per trip'. In addition, we gathered data on

Table 1
Quantities of Forest Product Collected by Socio-economic Classes

Forest product		*Class 1*	*Class 2*	*Class 3*	*Class 4*	*All*
Construction wood	Mean	1.78	0.98	4.19	4.18	3.80
	50% (median)	0	0.03	0	0.22	0.06
	5–95%*	0–10	0–5	0–20	0–13	0–12
Carpentry wood	Mean	0.17	0.28	0.70	2.00	1.43
	50% (median)	0	0	0	0	0
	5–95%*	0–2	0–1	0–2	0–5	0–3
Fuelwood	Mean	3.14	3.56	2.54	3.02	2.94
	50% (median)	1	2.00	1.67	1.67	1.67
	5–95%*	0–15	0.83–5	0–5	0–10	0–9
Rattan	Mean	15.62	27.66	28.14	53.91	42.98
	50% (median)	0	0	8.00	10.00	10.00
	5–95%*	0–150	0–300	0–100	0–200	0–200
Sago	Mean	24.50	18.99	28.47	12.63	17.86
	50% (median)	2	0.15	5.00	2.86	3.00
	5–95%*	0–100	0–25	0–100	0–48	0–50
Forest products index**	Mean	–0.67	–0.18	0.31	0.12	0.09
	50% (median)	0.67	0.09	0.55	0.70	0.65
	5–95%*	–9.21–2.4	–3.00–2.4	–3.41–3.18	–3.87–3.14	–3.87–3.14
Collection labour index**	Mean	4.44	4.26	4.47	4.30	4.35
	Median	4.16	3.98	4.25	4.09	4.11
	5–95%*	3.69–5.99	3.69–5.99	3.69–5.99	3.69–5.99	3.69–5.99

Notes: * '5–95%' row presents the 5th and 95th percentiles of the distribution.
** See Table 3 and the data section of the text for additional descriptions.

the typical prices of these products.[1] Given our interest in overall forest product collection, the five products were summed to generate a 'forest product index', using the relative price of each product as a weight. We took the natural log of this price weighted sum and of the sum of labour used in collection of the five products to reduce scale differences, improve linearity and pull in outliers.

Assets owned by the Mentawai include land, consumer durables (for example, cooking pans, radios, clocks), productive assets (for example, canoes, sago processors) and livestock (that is, pigs and chickens). Households were segregated into different socio-economic classes based on counts of these assets using cluster analysis (for a recent example, see Sills et al. 2003).[2] To identify classes or 'clusters' of households, we applied the Minkowski distance metric, which is the square root of the sum of squared deviations for the four asset categories, where the deviations are between each pair of households. The algorithm finds the desired number of clusters (*k*) by forming *k* random partitions of the households, assigning each household to the group whose median is closest (has the minimum Minkowski's metric), recomputing group medians after all households have been grouped, and iterating until no household switches groups. At the end of this process, the Minkowski metric is minimised for households in the same cluster.

Through this process, our sample can be clustered into four classes that are described in Table 2. At one extreme, the poorest and largest class of 307 households has the smallest number of consumer durables, productive assets and livestock, and the second smallest amount of land. At the other extreme, the wealthiest class of only thirty-seven households has the highest counts of all asset types, except livestock, for which it has the second highest count. In between these two extremes are two classes of thirty-two livestock-rich households and 125 mid-wealth households. Households in the smallest class own substantially greater amounts of livestock (especially pigs) but the least amount of land and medium levels of the other assets. Households in the mid-wealth class own medium levels of all four asset types. Thus, we find a fairly skewed socio-economic distribution, as might be expected for an isolated, semi-subsistence economy. There are a few wealthy households, a few households specialised in livestock and about 60 per cent of households in the poorest class.

Table 2
Asset Holdings and Socio-economic Classes

Assets		*Class 1*	*Class 2*	*Class 3*	*Class 4*	*All*
Consumer Durables (count)	Mean	3.19	2.84	2.95	2.79	2.87
	50% (median)	3	3	3	3	3
	5–95%*	1–5	2–5	1–5	1–5	1–5
Equipment (count)	Mean	1.59	1.41	1.50	1.27	1.36
	50% (median)	1	1	1	1	1
	5–95%*	0–4	1–2	0–3	0–3	0–3
Land (hectares)	Mean	3.65	2.44	2.86	2.61	2.74
	50% (median)	4	0	2	2	2
	5–95%*	0–10	0–10	0–10	0–9	0–10
Livestock (count)	Mean	558	1,162	167	31	176
	50% (median)	560	1,195	148	25	59
	5–95%*	360–850	970–1,195	94–300	0–75	0–1,195
Number of households	–	37	32	125	307	501

Note: * '5–95%' row presents the 5th and 95th percentiles of the distribution.

Forest Product Collection in Siberut

Table 1 describes forest product collection by socio-economic class. Using the data described in the previous section, we find that the mid-wealth and poor households collect the most forest products overall, with the mid-wealth group clearly collecting the most. While households in all classes collect all five products, there are some indications of specialisation. The poor and mid-wealth households collect the most wood for construction and carpentry. The households with mostly livestock assets collect the most fuelwood, although fuelwood collection is fairly high across all classes. The poor class collects the most rattan, although this is driven in part by a few households collecting a lot. Finally, the wealthy and mid-wealth households collect the most sago. These households also seem to invest the most labour in collection. Note, the small sub-sample sizes for the wealthy and livestock classes suggest that we should use caution in interpreting results specific to these two groups.

Simple tabulations of the kind presented in Table 1 can mask the influences of other household and environmental characteristics. Thus, the next step is to estimate a simple model of forest collection as a function of labour and other inputs, while also controlling for differences across classes through multivariate regression analysis. The variables used in the regression analysis were discussed in the previous section and are defined and summarised in Table 3.

Table 3
Variables Used in Regression Analysis: Definitions and Descriptive Statistics*

Variables	*Definition and units*	N	*Mean*	*5%*	*50% (Median)*	*95%*
Forest products index	*Ln*** (price weighted sum of 5 products)	501	0.09	–3.87	0.65	3.14
Collection labour index	*Ln* (days spent collecting 5 products)	497	4.35	3.69	4.11	5.99
Forest condition	1 being least disturbed and 4 most disturbed (scale)	501	2.64	1.00	2.00	4.00
Tools	Hand-tools used in agriculture and forestry (count)	501	6.35	5.00	2.00	15.00
Local residence	Household head's time in village of current residence (years)	482	31.50	5.00	32.00	53.00
Age	Household head's age (years)	482	36.35	22.00	35.00	54.00
Men	Men in household (number)	501	2.46	1.00	2.00	5.00
Women	Women in household (number)	501	2.15	1.00	2.00	4.00
Illness index	Illnesses among household members (count)	501	2.83	0.00	2.00	8.00
			Percentage of sample			
Class 1	1 is wealthy and 0 is otherwise	501	7.00			
Class 2	1 is livestock wealthy and 0 is otherwise	501	6.00			
Class 3	1 is mid-wealth and 0 is otherwise	501	25.00			
Class 4	1 is poor and 0 is otherwise	501	61.00			

Notes: * All indices (forest products, collection labour and illness) are measured for the survey year. Sample sizes for individual variables smaller than 501 are due to item non-response by households. See the data section of the text for additional descriptions.
** Natural logarithm.

To account for the simultaneity of labour allocation and output choices, we apply 3SLS presenting estimation results for both forest production and collection labour in Table 4. Our ability to explain overall variation is low, as is typical for cross-sectional household survey data, and therefore this model clearly cannot be used for predictive purposes. Nonetheless, the overall significance of the model can help us discern patterns of forest product collection. Thus, the model is best

Table 4
Regression Model of Forest Product Collection

	Coefficient	*Standard error*	*Probability value*
Forest product collection			
Class 1	–1.03	0.43	0.017
Class 2	–0.32	0.46	0.480
Class 3	–0.09	0.28	0.739
Collection labour index	1.25	0.67	0.062
Forest condition	0.19	0.10	0.055
Tools	–0.02	0.02	0.152
Regression constant	–5.50	2.78	0.048
^{2} (overall model)	21.70		0.001
Collection labour			
Class 1	0.15	0.13	0.245
Class 2	0.05	0.14	0.688
Class 3	0.19	0.08	0.012
Local residence	0.01	0.00	0.000
Age	–0.02	0.00	0.000
Men	0.00	0.03	0.912
Women	0.06	0.03	0.058
Illness index	0.02	0.01	0.101
Regression constant	4.22	0.14	0.000
^{2} (overall model)	34.5		0.000
Number of observations	482		

viewed as an important first step in summarising and understanding patterns in micro data (see Deaton [1997] for further discussion of the use of regression models for summary and description).[3]

Starting with the model of forest production, we see that the coefficient on labour is economically and statistically significant and positive. This confirms that labour is a key input to forest production. The significance of the dummy variable for the wealthiest class suggests that these households are able to collect fewer forest products, relative to poor households (the omitted class). This could be because collection is a less important component of their livelihood, as suggested by the literature, or because they have focused on building human capital (knowledge and skills) in farming and off-farm wage labour, rather than forest collection. Along the same lines, we find some evidence suggesting that ownership of hand-tools is negatively correlated with forest product collection, perhaps because these tools are actually used mostly for farming. Finally, we also find a positive coefficient on the forest condition variable, suggesting a negative relationship between forest condition, as measured by the WWF, and forest product collection. This could indicate that secondary forests have more (or more accessible) forest products, that preservation (correlated with good forest condition) restricts local use of the forest or that forests subject to less collection pressure are better preserved. Given the quality of the data, it is difficult to tease out cause from effect.[4]

The second panel of Table 4 presents the results of the labour allocation equation, which can also be interpreted as household labour supply to forest product collection. Age is negatively related to forest collection labour, implying that younger households have both the capability and the need to collect forest products. The coefficient on the length of residence is statistically significant and has the expected positive sign, presumably because long-term residents are familiar with ecological structure, conditions and seasonal patterns in the forests (Pattanayak and Sills 2001). The positive and significant coefficient on the number of women suggests either that forest collection labour is gender-specific or that there is a gender-specific component to household demand for forest products. Households reporting a greater number of illnesses are more likely to collect. One explanation is that the opportunity cost of their time (in off-farm wage labour or farming) is low, freeing more labour for forest product collection.

Only the dummy variable for mid-wealth households is significant. Possible explanations include that these households have more time available to allocate to forest production, that they are more capable in collection of forest products or that they have greater household demand for forest products. Given that we have controlled for household demographics and that the dummy variable for this class is insignificant in the production function, the most likely explanation is a household class fixed effect, which reflects some mix of resources, enterprise and preferences for forest products. Regardless of the explanation, our results clearly show that the poorest households do not allocate more time to forest product collection, controlling for gender-specific household labour endowment and characteristics such as age, residency and illnesses.[5]

PATTERNS OF LOCAL FOREST USE

Although studies of subsistence forest economies based on small and convenient samples have spawned several hypotheses regarding local use of and reliance on tropical forests (see citations in Townson 1994), rigorous analyses based on micro-level data are rare. This study uses household survey data from Siberut Island, Indonesia, to address this gap in the literature with an empirical investigation of tropical forest use by the Mentawai people. We estimate an aggregate production function for five forest products collected in Siberut in order to: (*a*) characterise patterns of household forest use; (*b*) test for differences across classes of households differentiated by their asset holdings; and (*c*) identify lessons for policy makers and park managers. Our results hint at the possibility that absolute dependence on key forest products first increases and then declines at the highest wealth levels, reflecting the debate over how economic growth impacts forest use.

In the estimated production function, labour has the expected significant, large and positive coefficient, suggesting its central role in semi-subsistence rural economies. This labour input is household time allocated to collection, and as expected for economies with incomplete labour markets, the household socio-demographics such as age, length of local residence, number of adult women and illnesses are important determinants of labour supply. Cluster analysis shows that there is considerable heterogeneity in collection of forest products even within seemingly homogenous forest people. The mid-wealth group allocates the most time to forest product collection, in a pattern reminiscent of the environmental Kuznet's curve. After controlling for labour input and forest condition, all classes of households collect about the same level of forest products, except for the wealthiest households, who are less productive. We conjecture that this is because forest products are less important to their livelihood, and therefore they have built their human capital (knowledge and skills) in farming and activities other than forest collection. Although our cluster analysis identified a distinct class of households specialised in livestock, these households prove to be no different from the large class of poor households in terms of labour allocation and output of forest products.

In many ways our results point to the need for further analysis to paint the big picture of forest-based household livelihoods. As one reviewer suggested, one option would be a more ambitious investigation of multiple household production activities and labour allocations. Alternatively, one could dig into the details of labour and output by specific forest products and expand the analysis to consider a wider range of these products, which are collected by different subsets of households. Finally, dynamic development processes using forest resources as springboards for wealth accumulation could also be considered. The advantage of the approach presented here, however, is that it is feasible with typical cross-sectional household survey data, gathered as part of multi-objective projects that are constrained by time and budget. By relying on data reduction approaches such as indices and clusters, we find evidence of relationships without assuming more precision in our data than is realistic. The household production logic used in this article could serve as the framework for any of the extensions discussed earlier.

Our estimation results do provide policy insights, including at least one area of concern. We find that households living near more disturbed forests are more productive in forest collection activities. While potential endogeneity or 'reverse causality' clouds interpretation of this result, it does at least suggest that park managers should not assume that higher quality forests, as judged by forest ecologists, will also be more productive and thus more desirable forests from the local perspective. The results also suggest potential policy levers. For example, if policy makers wanted to reduce collection of forest products, the labour allocation results suggest that investments in public health would complement that goal. Long-term residents collect more forest products presumably because of their knowledge of the ecological structure, composition and seasonal patterns of the forests. Such local knowledge could be harnessed by park managers. Finally, the results should help predict and design projects that account for heterogeneity in local forest use. Clearly, both wealth status and household demographics are important factors in forest collection patterns in Siberut Island. We suspect that household composition, characteristics and economic assets will be useful descriptors of local uses of parks throughout the world.

Notes

1 As markets are expected to operate at a village rather than household level, the price data used represents the *desa*- (village-) level means. This process also reduced recall errors and misreporting. Additionally, we trimmed the data to minimise the influence of unlikely outliers. In the case of fuelwood quantities, values greater than ten times the 95th percentile were replaced by the 95th percentile value. For construction wood price and carpentry wood price, values less than a 10th the 25th percentile were replaced by the 25th percentile value, whereas values greater than ten times the 75th percentile were replaced by the 75th percentile value.
2 Land is measured in hectares. For the second and third asset categories, we use simple counts because we judged the possible variation in value of any individual item (for example, due to age, quality or size) to be as great as the possible variation between items in each category. The livestock count is weighted by price because households across the island consistently indicated that pigs are about eleven times more valuable than chickens.
3 In this spirit of using regression analysis to describe small cross-sectional data sets, we interpret coefficients significant at the 15 per cent level as suggestive of relationships, and coefficients significant at the 10 per cent level as indicating a statistically significant relationship.
4 This result holds irrespective of how we apply this index of forest condition. Following a referee's suggestion, we used three dummy variables instead of the ordinal variable and found the coefficients to be larger for the dummy variables associated with higher levels (more disturbed) on this scale.
5 One referee suggested that labour choices may differ across classes of households—that is, there may be differences in slopes in addition to the intercept differences captured by the dummy variables. We estimated three different regressions for: (*a*) the poorest class; (*b*) the mid-wealth class; and (*c*) the wealthy and livestock group combined. The signs and significance of estimated parameters were unchanged, except for the loss of statistical significance of two parameters. This loss in significance presumably resulted from the smaller size of each of these sub-samples.

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