Child Malnutrition and the Environment: How Women's Work in Collecting Environmental Goods Affect Children's Health in Malawi.

By

Flora Nankhuni
Harvard Center for Population and Development Studies
9 Bow Street, Cambridge, MA 02138

And

Jill Findeis
Department of Agricultural Economics and Rural Sociology and
The Population Research Institute, The Pennsylvania State University
University Park, PA 16802

Introduction

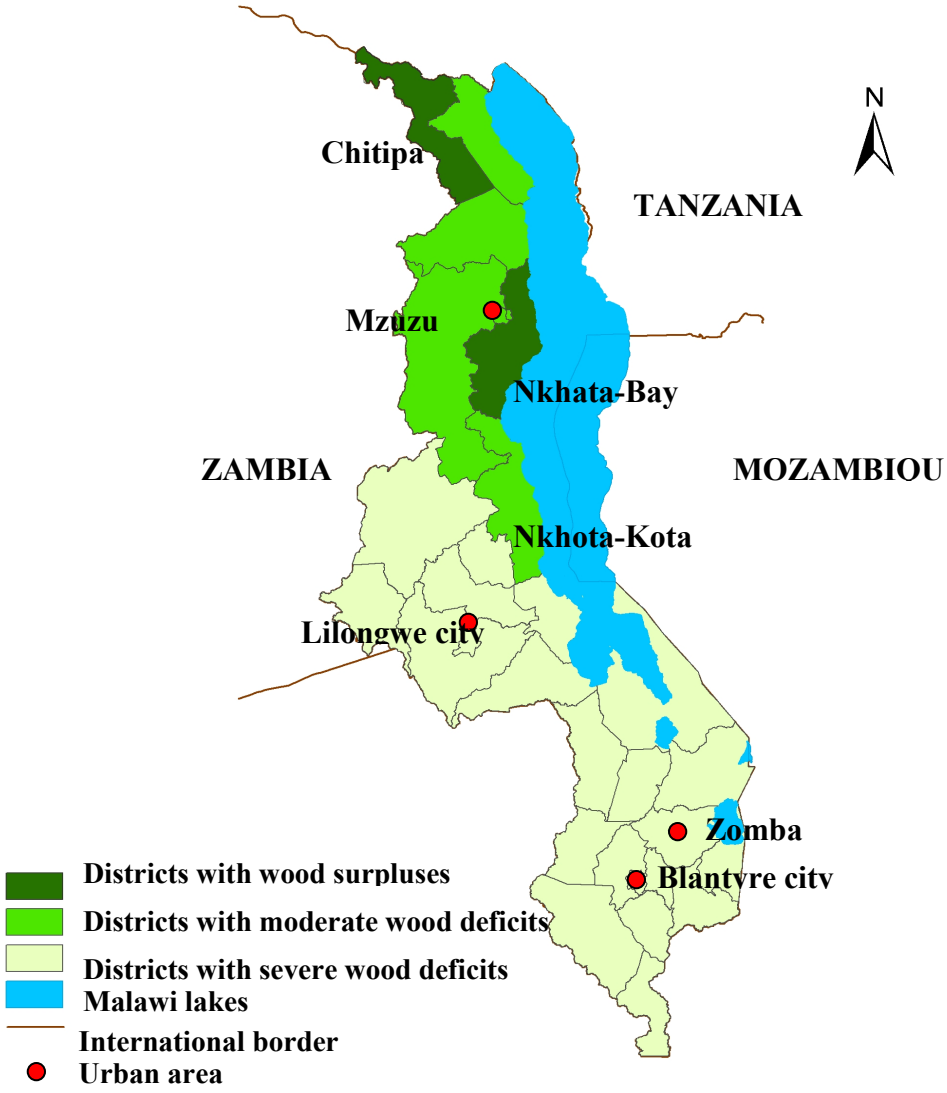
In Malawi, about half (49%) of all children under the age of 5 are reported to be stunted (NSO 2001a). Stunting is measured by a low height-for-age z-score and is indicative of chronic malnutrition[1]. Of the stunted children, about half (or 24% of the total) are severely stunted. The infant (below age of one year) mortality rate is 104 children per 1,000 live births, while the child (between 1 and 5 years of age) mortality rate is 95 per 1,000 live births (NSO 2001a). This is one of the highest mortality rates in the world[2]. Orc Macro (2001) reports that 37% of all deaths that occur to children below the age of 5 in Malawi is attributable to malnutrition[3]. Malnutrition also contributes to lower cognitive ability, academic achievement, and income earning potential (Behrman and Rosenzweig 2003; Glewwe, Jacoby, and King 2001; Alderman, Behrman, Lavy, and Menon 1997) and therefore is one of the factors affecting current as well as future development of a country. Several studies have analyzed the determinants of nutrition/malnutrition in African countries, among which are: Christeinsen and Alderman 2004 and Quisumbing 2003 for Ethiopia, Kennedy and Peters 1992 for Malawi, Kennedy and Haddad 1994 for Malawi and Kenya, Carter and Maluccio 2003 and Burgard 2002 for South Africa. We are not aware of papers that analyzed the environment's effects on time allocation in relation to child nutrition except an earlier paper on Nepal by Kumar and Hotchkiss (1988). However, none have analyzed the role of the environment in contributing to the nutrition problem in Africa. This paper contributes to this scanty literature using Malawi as a case study.

Background Information on Malawi

About 85% of Malawi's population is rural and lives primarily on subsistence agriculture (NSO 2001a). The annual per capita income is $170 (World Bank 2002), and it is estimated that 65.3% of the people lived below the poverty line in 1997-98 (NEC 2000). Malnutrition levels are high as outlined above. In addition, 25% of Malawian children are underweight and 6% are wasted (NSO 2001a). The nutrition status of children has not improved compared to the previous 1992 Malawi Demographic and Health Survey (NSO 2001a). Malawi also faces significant environmental problems. The most significant environmental concern is the high rate of deforestation, which is estimated at an annual rate of 2.4% between 1990 and 2000 (UN FAO 2001). This is the 10th highest rate of deforestation in Africa and is significantly higher than both Africa's average deforestation rate of 0.78% and the world's average deforestation rate of 0.22% (UN FAO 2001). The causes for this high rate of deforestation are high population growth creating pressure on cultivation land, dependence of the population on fuel wood as a source of energy, and use of wood energy for curing tobacco by tobacco estate farmers (Hudak and Wessman 2000, Kalipeni 1992 and 1996). The NSO census report showed that 94% of Malawians use firewood as their main source of cooking energy and only 2% use electricity (NSO 2000). Therefore, a rapid depletion of natural resources such as forest land can have significant consequences for the quality of people's lives.

In terms of fuel wood availability, the south and central regions are the most distressed, both experiencing fuel wood shortages (see Figure 1)[4]. Deforestation is a fairly recent phenomenon in the northern region. In fact, the only two districts in Malawi

Figure 1: Fuel Wood Availability in Malawi



Data source: National Physical Development Plan Study (GOM 1987)

estimated to have fuel wood surpluses in the year 2000, Chitipa and Nkhata-Bay, are located in the north. Similar regional patterns were found in a forest resource mapping and biomass assessment study (GOM and Satellitbild 1993). In terms of proximity to a water source, only 2.5% of the population has piped water inside their dwelling unit and another 7.0% outside their dwelling unit (NSO 2000). In general, 65% of the households have access to a protected water supply (NSO 2001b). The Population Reference Bureau (PRB) reports that 57% of Malawians have access to an improved drinking water source, and only 44% of rural Malawians have this access (PRB 2002)[5]. The report also mentions Malawi as one of the 11 countries in Africa that by the year 2025 will join 14 other countries already experiencing a water scarcity crisis. That is, Malawi will have less than the critical 1,000 cubic meters per person per year of fresh water that is required for basic human nutritional needs.

The degraded status of the environment can have significant consequences on women's domestic work burdens since women shoulder greater than 70% of the rural transport burden (Edmonds, Nyanda, and Nankhuni 1995; Integrated Rural Transport Project (PIRTP) 1994). A large proportion of these tasks such as fuel wood collection and water collection are environmentally related. Malawian women spend an average of 6-9 hours per week on fuel wood collection (UNIMA and SARDC 1997; Brouwer 1992). The average load size is 19 kgs or higher (25kgs, for adult women aged 18-59), which is collected 2-3 times a week over an average distance of 2.8 kms (Brouwer 1992)[6]. Furthermore, Malawian women make an average of 4-5 trips of water collection per day, hauling an average amount of 15-20 liters of water per trip (UNIMA and SARDC 1997). Water collection is the most time intensive activity for Malawian women (UNIMA and

SARDC 1997). Therefore, environmental degradation can be expected to cause women to travel increasingly longer distances to access fuel wood and water sources with negative consequences on children welfare. Women are also significant contributors to farming. In Malawi, women comprise 70% of full-time farmers (Green and Baden 1994, citing World Bank 1991). Since women are also primarily responsible for most of the domestic work, overall they tend to work more hours than men. In Malawi, women's total labor time is twice or more than that of men (Green and Baden 1994). This implies that women are also more likely to face serious time constraints.

The environment-children's health link

The environment affects children's health through women's inability to care for their children due to increased time pressure in the face of environmental goods scarcity. This pathway is mentioned in Smith and Haddad (2001) who state that "women's time allocation decisions will affect income generation (via labor force activity) and child nutrition (via time spent for the child)", p. 56. For example, Ilahi and Jafarey (1996) showed that women who live in degraded areas and spend more time on natural resource collection work are less likely to participate in income-generating activities. Kumar and Hotchkiss (1988) also showed that deforestation in hill areas of Nepal (measured as time per trip for fuel wood collection) was associated with less time spent by men and especially women on household farming activities. Deforestation was also associated with lower food consumption due to low food production activities in deforested areas. Consequently children in these areas were found to be less nourished. The regressions in Kumar and Hotchkiss (1988) give us an indication of the possible routes through which

deforestation affects children's nutrition. In a more recent paper, Paolisso et al. (2002) showed that households with one pre-scholar that had adopted a new agricultural technology in rural Nepal spent less time in childcare activities, indicating that there are trade-offs in time allocation that may disadvantage children's nutrition in the face of increased time pressure in other activities. There is also evidence of women's nutrition status being affected by their time allocation activities (Higgins and Alderman 1997), which may then affect children's health. The paper will analyze determinants of children's nutrition status and mortality including time that women spend on natural resource collection activities as one of the determinants. This paper will also analyze the effects of environmental degradation on women's reported main activity, and its implications for children's nutrition.

Methodology

Data

Cross section data from an Integrated Household Survey (IHS) of 10,698 households conducted in Malawi in 1997-98 by the Malawi National Statistics Office are used. This is a nationwide data set with information on demographic and socio-economic characteristics of individuals and households, including young children's anthropometric measures. The data also include time allocation on domestic activities including the time spent on fuel wood and water collection and information on the main activity of each household member 10 years and older. Information on each household's access to different water sources and whether the household uses modern fuel energy rather than

relying on fuel wood sources of energy is also available. Supplementing these data are estimates of fuel wood availability (GOM 1987).

Theoretical framework

Freeman (1993) proposes that the basis for measuring the economic value of changes in resource environmental systems is the effects on human welfare. Therefore, the starting point for analyzing the impacts of environmental degradation is utility theory. The household production-utility model based on Becker (1965, 1993) will be the theoretical approach utilized in this paper. Some applications of this model in the environment literature are Kumar and Hotchkiss (1988), Amacher *et al*. (1996), Larson, B.A., Barnes, Rogers, and Larson, G. (1996), Cooke (1998), and Aggarwal *et al*. 2001.

Following the application in Aggarwal et al. 2001, Let

$$U = U(N, h, z) \qquad Ui > 0 \text{ for } i = N, h, z \qquad (1)$$

be the utility function of the household where N represent number of children, h the health and nutrition status of each child and z an aggregate consumption good. The utility is maximized subject to production functions for N, h and z, time constraints for the mother and a full income constraint:

$$N = N(T_N, x_N, s) \qquad (2)$$

where N is the production function for number of children produced in the household, T_N is the time input of the mother into child procreation, x_N the purchased goods for the each child, and s a measure of the degraded nature of the environment or scarcity of natural resources.

$$h = h(T_h, x_h, s), \qquad h_1>0, h_2>0, h_3<0 \qquad (3)$$

where h is the child health/nutrition production function that is an increasing function of the time the mother spends on activities that promote health of the child, T_h, and of the purchased good inputs into production of the child's health, x_h. However, an increase in scarcity of natural resources affects child's health negatively ($h_3 < 0$). The degraded nature of the environment also affects the productivity of the other inputs into child quality, that is, the marginal products of other inputs are lowered, $h_{i3} < 0$, for i= T_h, x_h. For example, due to a more degraded environment, women would take longer to collect fuel wood, water and other forest products and spend less time on childcare activities such as cooking.

$$z = z(T_z, x_z, s) \qquad z_1 > 0, z_2 > 0, z_3 < 0 \qquad (4)$$

where z is the production function of the aggregate consumption good, also and increasing function of the time the mother spends on production of the good, T_z, purchased goods used in production of the consumption good, x_z, but a decreasing function of the degraded nature of the environment, s. The environment also affects the marginal productivity of the other inputs, T_z and x_z so that $z_{i3} < 0$, for i = T_z, x_z. The mother allocates her total time (T) to child-bearing activities (T_N), child health enhancing activities (T_h), production of the aggregate consumption good (T_z) and working in the labor market or on the household farm (T_L).

$$T = NT_N + NT_h + T_z + T_L \qquad (5)$$

In this formulation, the children do not contribute to the production of N, z, and h because the analysis of child health is limited to children aged 5 and below who ordinarily do not contribute to household chores.

The full income constraint is

$$p(Nx_N + Nx_h + x_z) = wT_L + I \quad (6)$$

where p is the price of the purchased goods, w is the wage rate, and I is exogenous income. Maximizing (1) subject to (2)-(6) gives the following first order conditions with respect to N, T_h, x_h, and T_L.

$$U_1 – U_3z_1(T_N + T_h) - U_3z_2(x_h + x_N) = 0 \quad (7)$$

$$U_2h_1 – U_3z_1N = 0 \quad (8)$$

$$U_2h_2 – U_3z_2N = 0 \quad (9)$$

$$U3z2W/p –U3z1 = 0 \quad (10)$$

Manipulating 8 to 10 yields $z_1/z_2 = h_1/h_2 = w/p$ (11)

This means that the marginal rate of substitution between time and market inputs in the production of the aggregate good z and the production of child health h is equal to the opportunity costs (w/p). Equation (7) shows that the marginal benefit from having a child (consumption of a child as a consumer good) is equal to the opportunity cost of having a child in terms of forgone consumption of the aggregate good z, due to the time the mother spent on rearing the child and the marketed goods invested in the child's health. Solving the system for reduced form equations yields various endogenous variables in the system (N, h, z, xN, X_h, x_z, T_N, T_h, T_z, T_L) as functions of the exogenous variables (s, w, p, V). The equations of interest are on the effects of the environment on 2 key variables, h and T_h. It is expected that an increase in resource scarcity increases the price of child health. This can come from the lower productivity of time that the mother spends on child health enhancing activities T_h, and on increased cost of the home produced goods that are also an input into child health, z_h. Therefore demand/production for child health will be lower.

Estimation procedures

A probit model for child stunting is estimated at the child's individual level and probit. We use data on anthropometric measures of children, in particular their height for age z-scores and the household child and infant mortality rates as indicators of child health. We believe that the quality of the antropometric data is reliable since the survey produced a 49% proportion of stunted children, the exact percentage produced by the 2000 Malawi DHS data. We do not have reliable data on women allocation of time to child health enhancing activities, however, we use the time that women older than 15 years in the household old spent on collecting water and fuel wood as a measure of scarcity of natural resources. This is expected to have an inverse relationship with time spent on child health enhancing activities.

Determinants of Children's Health

The probit model of stunting is estimated for children aged 5 years and below because anthropometric measures were collected for children in this age range. A multinomial logit model for choice of women's main activity is also estimated to show the relationship between the environment (lack of fuel wood) and women's preoccupations. Children's stunting is explained by women's time spent on fuel wood or water collection as well as by women's choice of main activity. The women included in this analysis are all spouses of male household heads and their characteristics, to enable a bargaining power interpretation of results[7]. Results for the child's stunting probit model are presented in Table 1. Access to safe water is included among explanatory variables. The results show that female children are 12% less likely to be stunted than male

children. This result is consistent with studies that show more gender equality in children's health in Africa relative to Asia and Latin America. The child's birth order also affects their health, with the oldest children being more likely to be stunted compared to later born (5^{th} or later born)[1] children. Most of the sibling effects are not significant except that children with a larger number of younger brothers are less likely to be stunted. Generally, older children are more likely to be stunted, probably indicating resource crowding as more children are being born, as parents strive to maintain the health of newborn and very young children. The older children would also be those that are already weaned from breastfeeding and hence more vulnerable to malnutrition.

Contrary to evidence of intra-household resource allocation issues where children seem to be advantaged in households where women have a higher bargaining power, in this model, the female head (i.e., female spouse of male head), education and employment variable coefficients (marginal effects) are largely not significant while the corresponding male head variables are statistically significant. However, male head age is associated with an increased likelihood of stunting for the children. This may mean that older heads are the ones who are more demanding of traditional values that may compromise children's health, relative to younger male heads. In terms of education, only those male heads who have completed senior primary school have less stunted children compared to those male heads who never attended or completed the first four years of primary education. None of the female education variables is statistically significant.

Similarly, all types of male head employment relative to the home-worker male-head reference group are statistically significant in reducing the likelihood of stunting

[1] There were few children in the 0-5 age range that are 5^{th} or later born, therefore, no further disaggregation of later born children into 5th or $\geq 6^{th}$ born was done.

among children, while for women only those who are self-employed have less stunted children. Self-employment here includes working on own-farm and non-farm activities. The non-farm activities are mostly farm-related, such as beer-making (Swaminathan 2003). Therefore, overall, self-employment would be the closest activity related to agricultural production. The self-employed women have less stunted children compared to those who stay at home (pre-occupied more with household tasks), probably due to higher agricultural output from households where women are more involved in agriculture. This suggests that house-workers are less likely to be involved in agriculture production and other income-generating activities, and therefore, are unable to provide adequate nutrition for their children. However, those who are employed in some kind of wage work (employees) or in their own-family business (family business workers) do not necessarily have less stunted children than the home-workers. This may be explained by the superiority of self-employment over wage employment, termed 'ganyu' employment in Malawi. Swaminathan (2003) found that women in Malawi preferred to be self-employed rather than be employed as wage-laborers because the latter is seasonal and unreliable as well as low-paying. Wage work is sometimes used as a safety net when the household is desperate for food. It also tends to compete with the laborer's own-farm needs since its demand is highest during the peak agricultural period (Alwang and Siegel 1999). Another reason why women's self-employment is beneficial to children's nutrition may come from the work's compatibility with childcare responsibilities, while women involved in wage work may be less able to bring their children to work or to find proper care for them.

Household poverty is also associated with higher levels of stunting as expected. However, the only environmental variables that are prominent in the children's health equation are related to water scarcity or cleanliness. Young children in households that have access to safe water are about 4% less likely to be stunted. Safe water includes piped water in the household or outside the household dwelling unit and water from a borehole or a well-protected well. One reason why safe water is related to stunting of children may be a lower likelihood of the child getting ill from diseases such as diarrhea. Children who are healthy are more likely to keep the necessary calories in their bodies and therefore are less likely to have chronic malnutrition (stunting). This result is common. Strauss and Thomas (1995) give a review of studies indicating a negative correlation between quality of drinking water and child mortality rates.

Children who live in households where women (aged 15 and above) spend more hours on water collection are more stunted, while the hours spent on fuel wood collection are not statistically significant[8]. This means that women's allocation of time to menial household tasks can have negative impacts on children's health[9]. The significance of water collection hours may be explained by the fact that water collection is a woman's daily activity and is on average more time intensive than fuel wood collection (UNIMA and SARDC 1997).

The multinomial logit results for women's time allocation to housework, self-employment, and wage employment (including family business work) are presented in Table 2. The results show that women who live in districts with moderate or severe wood deficits are more likely to be working at home but less likely to be self-employed. The marginal effects on the employee category are not conclusive. Since self-employed

women have less stunted children, this means that environmental degradation is affecting children's health through its effect on women's time allocation to income-generating activities. This result is also consistent with the result from the previous section where hours that women spend on water collection are associated with increased stunting of children. This implies that children's health is being affected through the increased time that women spend on menial collection work at the expense of work that directly enhances children's health. A similar fuel wood availability-women's time allocation relationship was found by Ilahi and Jafarey (1996) where fuel wood scarcity was associated with decreased participation of women in market work.

Other determinants of women's choice of main activity are education and household composition variables. A woman who completed junior or senior primary education is more likely to be a home-worker but less likely to be self-employed or to be an employee than one who never attended nor completed the first four years of primary school education. A woman who is highly educated (i.e, one who completed secondary or higher education) is also more likely to be a home-worker or to be an employee than to be self-employed. The education-employment relationship here is probably skewed by the fact that the labor market for very highly educated women is different from that for other less educated women who are in the labor market for 'ganyu' rather than salaried employment.

Presence of more young children in a household increases a woman's probability of staying at home but decreases the probability of her being self-employed or being an employee. Presence of more girls (age 11 to 14), adult young women (age 19 to 24), working women (age 25 to 64) and old women, all decrease the likelihood of a woman

being a home-worker but increases their probability to engage in wage employment. This suggests an existence of work sharing among the women that enables them to engage in income-generating activities outside the home. The presence of more men in a household (especially those older than 18 years) is statistically significant in increasing the likelihood of a woman staying at home and in decreasing the likelihood of the woman being self-employed or working in wage employment. This may be reflecting the male-female specialization of labor in these different activities rather than women not being allowed to become involved in employment outside the home. The implications of these employment complementarities and substitutabilities between men and women in a particular household on children's welfare is not very clear, and needs to be explored further.

Conclusion

This paper looked at the relationship between scarcity of natural resources and nutrition status of children in Malawi. The results suggest that women in areas that are deforested are more likely to have homework as their main occupation but less likely to be self-employed. This affects children's nutrition status through an income effect, as the nutrition probit model showed that children whose live in a household where the female head is self-employed, are less likely to be stunted. In addition, women's involvement in water collection is also associated with increased probability of stunting indicating that women's time spent on this task is probably at the expense of time the mother would spend on child health enhancing activities such as cleaning, cooking and accessing health facilities.

Table 1: Probit Model For Stunting of Children Aged Five and Below.

Variable	Coefficient	Marginal effects	Means
Constant	0.189	0.075	-
Child characteristics			
Female	-0.116***	-0.046***	0.521
Biological child	-0.138	-0.055	0.912
Birth order 1	0.395*	0.156*	0.237
Birth order 2	0.271*	0.108*	0.234
Birth order 3	0.043	0.017	0.226
Birth order >5	-0.122	-0.048	0.041
Number of old brothers	0.083	0.033	0.878
Number of young brothers	-0.081*	-0.032*	0.203
Number of old sisters	0.068	0.027	0.883
Number of young sisters	-0.037	-0.015	0.209
Environmental variables			
District with moderate wood deficits	-0.019	-0.008	0.091
District with severe wood deficits	0.060	0.024	0.856
Household with safe water	-0.097**	-0.039**	0.472
Household with modern fuel energy	-0.013	-0.005	0.028
Women's water work hours	0.005**	0.002**	7.106
Women's fuel wood work hours	-0.004	-0.002	4.374
Household characteristics			
Age of male head	0.008*	0.003*	36.834
Age of female head	-0.008	-0.003	30.254
Standard 4 male head education	0.012	0.005	0.214
Standard 8 male head education	-0.125**	-0.050**	0.440
Highly-educated male head	0.040	0.016	0.067
Standard 4 female head education	-0.047	-0.019	0.253
Standard 8 female head education	-0.065	-0.026	0.317
Highly-educated female head	-0.292	-0.115	0.017
Employed male head	-0.146*	-0.058*	0.247
Family business worker male head	-0.223**	-0.088**	0.053
Self-employed male head	-0.127*	-0.051*	0.558
Employed female head	-0.173	-0.069	0.024
Family business worker woman female head	0.062	0.025	0.056
Self-employed female head	-0.136***	-0.054***	0.293
Household poverty	0.113**	0.045**	0.661
Household demographic composition			
Girls 15-18 yrs	-0.079	-0.031	0.190
Boys 15-18 yrs	-0.013	-0.005	0.206
Young adult girls 19-24 yrs	-0.074	-0.030	0.367
Young adult boys 19-24 yrs	-0.067	-0.027	0.189
Women 25-64 yrs	-0.031	-0.012	0.754
Men 25-64 yrs	-0.002	-0.001	0.946
Old women ≥ 65 yrs	-0.161	-0.064	0.026
Old men ≥ 65 yrs	-0.150	-0.060	0.035
Regional/urban residence			
South region	-0.008	-0.003	0.091
Central region	-0.135	-0.054	0.364
Urban	-0.062	-0.025	0.498

Table continued on next page

Table 1: Probit Model For Stunting of Children Aged Five and Below (continued).

Variable	Coefficient	Marginal effects	Means
Model performance indicators			
Log *L*	-2364.31		
Predicted 1s that were actual 1s	55.6%		
Predicted 0s that were actual 0s	56.3%		
Overall correct predictions	60.0%		
Number of observations	3,470		

***, **, * represent significance at 1%, 5%, and 10% respectively.

Table 2: Multinomial Logit Model for Women's Choice of Main Activity.

Variable	Homeworker (Marginal effects)	Self-employed (Marginal effects)	Employee (Marginal effects)	Means
Constant	0.021	-0.116	0.096	-
Women characteristics				
Woman's age	-0.001	0.012***	-0.011***	33.547
Woman's age squared	0.000	0.000***	0.000***	1293.559
Standard 4 woman education	0.342***	-0.138***	-0.203***	0.411
Standard 8 woman education	0.340***	-0.154***	-0.186***	0.449
Highly-educated woman	0.132*	-0.214***	0.082**	0.128
Household characteristic				
Household poverty	-0.020	0.050***	-0.030***	0.565
Environmental variables				
District with moderate wood deficits	0.230***	-0.152***	-0.078**	0.111
District with severe wood deficits	0.284***	-0.424***	0.139***	0.844
Household demographic composition				
Infants	0.067***	-0.027*	-0.040***	0.169
Girls 1-5 yrs	0.016	0.002	-0.018**	0.404
Boys 1-5 yrs	0.034***	-0.017*	-0.017	0.373
Girls 6-10 yrs	0.028***	-0.029***	0.001	0.391
Boys 6-10 yrs	0.000	-0.012	0.013	0.385
Girls 11-14 yrs	-0.035***	0.006	0.028***	0.277
Boys 11-14 yrs	0.013	0.000	-0.014	0.263
Girls 15-18 yrs	-0.022	-0.004	0.026***	0.225
Boys 15-18 yrs	-0.017	-0.015	0.032***	0.247
Young adult girls 19-24 yrs	-0.042***	0.001	0.041***	0.424
Young adult boys 19-24 yrs	0.047***	-0.060***	0.013	0.237
Women 25-64 yrs	-0.109***	0.003	0.106***	0.879
Men 25-64 yrs	0.215***	-0.136***	-0.078***	0.728
Old women ≥ 65 yrs	-0.159***	0.038	0.121***	0.063
Old men ≥ 65 yrs	0.194***	-0.138***	-0.056***	0.056
Regional/urban residence				
South	-0.390***	0.388***	0.002	0.441
Central	-0.524***	0.558***	-0.034	0.383
Urban	0.147***	-0.174***	0.027**	0.182
Model performance indicators				
Log *L*	-4963.70			
Predicted homeowners that were actual homeowners	58.1%	-	-	
Predicted self-employed that were actually self-employed	-	57.9%	-	
Predicted employees that were actually employees	-	-	65.9%	
Overall correct predictions	63.6%			
Number of observations	6,096			

***, **, * represent significance at 1%, 5%, and 10% respectively.

N = 6,096 for women above age 18 (excluding students), of which 62.3% were homeworkers, 21.2% were self-employed, and 16.5% were employees. Employees, in this model, included those who reported main activity as family business worker and those who reported being an employer.

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Notes

[1] If a child's height-for-age z-score is more than 2 standard deviations below the median of the US National Center for Health Statistics (NCHS) population, the child is considered to be malnourished; if the child is more than 3 standard deviations below this reference, the child is considered severely malnourished (NSO 2001a). Wasting is a low weight-for-height and is indicative of acute malnutrition (as what happens in cases of famine). Underweight, a low weight-for-age, is a mixture of the effects of stunting and wasting (NEC 2000).

[2] The average world infant mortality rate is 54, the average for Africa is 86, and for sub-Saharan Africa, 91 (PRB 2002b).

[3] Malnutrition was implicated in more than half of all world's child deaths that occurred in 1995, most of which (about 3/4) was attributable from mild rather that severe malnutrition (UNICEF 1998, Pelletier, Frongillo, Schroeder and Habicht 1994; Murray and Lopez 1996).

[4] The south and central regions are also densely populated. The south has a population density of 146 people per square km, the central region has 114 people per square km, whereas the north has only 46 people per square km (NSO 2001).

[5] UNICEF (1998) reports even lower access to safe water in rural Malawi, i.e., 32% in 1990-96. The discrepancies in part are due to differences in the way protected water supply is defined.

[6] Brouwer's study covers a few villages in one district of Malawi (Ntheu).

[7] Here, female-headed households were excluded because they did not have corresponding male head variables. However, in a model in which female head was included and only household head variables were included, the female headship dummy variable was not statistically significant.

[8] Water collection hours may be related to fuel wood collection hours, therefore, different regressions were estimated with these entered separately. The results are similar to those presented here. Similarly, other work burdens were entered separately. Cleaning time was associated with less stunting, while cooking time was associated with more stunting but this may be reflecting the fact that those who use fuel wood for cooking take longer to cook than those with efficient stoves or electricity.

[9]This result is confirmed in the multinomial logit model.