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Off-farm labour allocation decisions in small-scale rural households in Zimbabwe

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Abstract

The double hurdle model is used to analyse the off-farm labour decisions of small-scale agricultural household members in the Shamva District of Zimbabwe. The approach permits the joint modelling of the decision to participate in the labour market and the decision regarding the amount of time allocated to work. Results indicate that a number of variables (notably, gender, education and assets) indeed have effects which are qualitatively and quantitatively different in terms of participation and hours worked. Overall, the empirical analysis confirms the importance of individual characteristics (such as gender and education) and household/farm characteristics (e.g. land area accessible to the household, productive assets, remittances and the agricultural terms of trade) in influencing the labour market decisions of rural household members.

JEL classification: Q12; C24; J22

Keywords: Off-farm labour supply; Zimbabwe; Double hurdle model

1. Introduction

There is mounting evidence that rural non-farm income is an important resource for rural households and that policy-makers are showing increasing interest in non-farm activities as a means of creating favourable conditions to reduce poverty in rural areas (FAO, 1998). Although there is some debate about the impact of non-farm employment on the distribution of income (see, for example, Reardon et al., 2001), it is generally agreed that non-farm income is a significant input to rural household economies and contributes to food security by allowing better access to food. It also has positive spin-offs in agricultural performance by providing cash for productivity-enhancing inputs, thus easing credit constraints, and in turn, a more dynamic agricultural sector enhances the scope and scale of the non-farm sector. If policy interventions are to be directed at increasing economic activity and employment in rural areas, a better understanding of the labour allocation decisions of rural households is required. This paper aims to contribute in this regard by analysing the off-farm labour decisions of households in the Shamva District of Zimbabwe.

The focus of the empirical work reported here is the labour allocation decisions regarding off-farm work of adult members of rural households. The analysis, based on survey data on 1183 adults, investigates the

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influence on those decisions of personal characteristics, household characteristics (such as household composition) and exogenous factors (such as location). The double hurdle model is chosen as the research method as it allows the joint modelling of: (i) the decision whether or not to participate in the labour market; and (ii) the amount of time the participant allocates to off-farm work.

The layout of this paper is as follows. In Section 2, a brief description of the theoretical context, based on the agricultural household model, is presented. Section 3 outlines the double hurdle model, the approach chosen for the empirical analysis. Section 4 introduces the dataset used, and the empirical findings are considered in Section 5. The paper concludes with a discussion of policy implications.

2. The theoretical model

The popular rural household economic model (see, for example, Singh et al., 1986; Sadoulet and de Janvry, 1995) provides a theoretical basis for exploring labour supply decisions. Here, we adapt a version suggested by Benjamin and Guyomard (1994). Assume for simplicity a two-person household which seeks to maximise a utility function in leisure time and household income, $U(L_e^m, L_e^f, Y; E^m, E^f, H)$, where L_e^m and L_e^f denote the leisure time of the male and female household member, E^m and E^f the vectors of their individual characteristics, such as human capital, Y the household income, and H a vectors of household characteristics. A household comprising only one male and one female is chosen simply to illustrate a multi-person household and should not be taken as indicative of a typical household in the study area. In fact, within the sample, there are farmers (mostly female) with absentee spouses, farmers with children but no spouses, households headed by children or young adults, and other household types.

The household faces the following constraints:

$$T^j = L_i^j + L_o^j + L_e^j \quad (j = m, f), \tag{1}$$

$$L_i^j \geq 0, \qquad L_o^j \geq 0, \qquad L_e^j \geq 0 \quad (j = m, f), \tag{2}$$

$$Y = \pi(p, v, L_i^m, L_i^f, A, E^m, E^f, H) + w_o^m L_o^m + w_o^f L_o^f + R, \tag{3}$$

where L_i denotes labour time spent on the farm, L_o the labour time off-farm, and each member has a fixed availability of time, T^j. Household income, Y, is related to: (i) the restricted conditional profit function (π), which in turn depends on the price of agricultural output (p), variable input prices (v), on-farm labour of household members (L_i^j,) and their individual attributes (E^j), household characteristics (H), and other fixed farm inputs (A), such as land; (ii) off-farm income, comprising off-farm work time (L_o^j), valued at the respective wage rate (w_o^j); and (iii) remittances (R).

Assuming the usual regularity properties for the profit and utility functions, an optimum allocation of household time can be derived. Given our focus on off-farm work, it is convenient to further assume an interior solution for all choices except L_o^j. Then, the necessary conditions for a maximum are:

$$-\frac{\partial U/\partial L_i^j}{\partial U/\partial Y} = \frac{\partial \pi}{\partial L_i^j} \quad (j = m, f), \tag{4}$$

and

$$-\frac{\partial U/\partial L_o^j}{\partial U/\partial Y} - \frac{\lambda^j}{\partial U/\partial Y} = w_o^j \quad (j = m, f), \tag{5}$$

where λ^j denotes the Lagrange multipliers associated with positivity constraints on off-farm work.

Eq. (4) indicates that the marginal rate of substitution of on-farm family labour for money income should be equated to the shadow price of that labour. If the household member works off-farm, Eq. (5) states that the marginal rate of substitution of off-farm work for income should equal the market wage rate. If the marginal rate of substitution of off-farm work for income exceeds the off-farm wage rate, the household member does not work off farm.

For an individual household member, the decision whether or not to participate in off-farm employment will depend on a comparison of the market wage rate and the individual's reservation wage, w_r^j, such that:

$$L_o^j = 0, \quad \text{if} \quad w_r^i \geq w_o^j \quad (j = m, f), \tag{6}$$

and

$$L_o^j = 0, \quad \text{if} \quad w_r^i < w_o^j \quad (j = m, f). \tag{7}$$

The reservation wage is an endogenous variable, which will depend on the other exogenous variables in

the model (output and input prices, fixed farm factors, individual and household characteristics). Variables that raise the reservation wage reduce the probability of participation, while variables that raise the market wage rate, increase the probability of seeking off-farm employment.

3. The statistical model

The study is based on micro-level data collected over a relatively short survey period. As is typical of such data, some households and some individuals within households have no observed labour time allocated to some household activities. This poses a problem for the researcher, as standard regression analysis can be misleading in these circumstances. Zero observations on off-farm labour time may arise for a number of reasons. An individual may not be a participant in the labour market, because of personal preferences, inadequate qualifications or other disability. Alternatively, some individuals may be participants (potential workers) who chose not to work at the current level of economic incentives.[1]

One approach would be to use the well-known Tobit model.[2] However, a disadvantage of that model is that all zero observations on hours worked are interpreted as corner solutions, i.e. the individual is assumed to be a participant in the labour market who chooses not to work at the current level of exogenous variables, such as wages. A further restriction of the Tobit is that both the decision to participate and the amount of hours allocated to an activity given participation are determined by the same variables, and that a variable that increases the probability of participation also increases the number of hours worked. Thus, for example, the possibility that an individual's education has a strong positive impact on the decision to work off farm but a negligible or even negative effect on the number of hours worked would be precluded.

An alternative is to model as two separate decisions: (i) whether or not to participate in the labour market; and (ii) the amount of time the participant allocates to off-farm work. The reasons for separating these decisions are twofold. First, due to social or psychological drives, the individual may prefer not to engage in off-farm work whatever the values of exogenous variables. Second, an individual may be a potential participant in the off-farm labour market but for certain levels of relevant variables, decide not to work off-farm. The former represents abstention, the latter a corner solution.

One widely used approach in this context is Heckman's sample selection model (Heckman, 1979), which is designed to account for the fact that the observed sample may be non-random. A Probit model for the participation or 'selection' equation is estimated and a regression model, which is corrected for selectivity bias,[3] is specified to account for the level of activity. Although preferable to the Tobit, this approach is still restrictive.[4] None of the zero observations are due to a corner solution in the hours of work equation. If a variable affects the hours of work, it cannot sequentially lead to reduced and then zero hours worked, although if it appears in the participation equation, it may have that effect (Ghadim et al., 1999).

The double hurdle model, developed initially by Cragg (1971), offers a more general approach to modelling participation and hours worked as two separate decisions. The approach has been widely adopted in the consumer demand literature (Atkinson et al., 1984; Garcia and Labeaga, 1996; Jones, 1989; Blaylock and Blissard, 1992; Burton et al., 2000) and the agricultural technology adoption literature (Coady, 1995; Ghadim et al., 1999). Although it has also been used to study labour supply decisions (e.g. Blundell et al., 1987), it has not been applied, to our knowledge, in any study

[1] A third possibility is that, due to other household commitments, off-farm work may be undertaken only on an infrequent basis and the survey is conducted at a time when no off-farm work was sought. However, given the survey design and the timing of our survey, this is unlikely to arise in our study and is not investigated here.

[2] Some recent studies have modelled the participation decision in isolation and estimated a Probit model (e.g. Lanjouw, 2001; Ferreira and Lanjouw, 2001) or a Logit model (e.g. Ruben and Van den Berg, 2001). These studies ignore the potentially important 'hours of work' decision.

[3] Specifically, the estimated inverse Mills ratio, derived from the Probit results, is used as an additional regressor in the OLS equation.

[4] Johnston and DiNardo (1997, Section 13.12.2) also caution that the Heckman approach is sensitive to violations of underlying assumptions.

of labour decisions of rural agricultural smallholders in developing countries.

In the double hurdle model, if we observe hours of work a two-stage process must have been completed. First, the individual has decided to participate in the labour market, and second, has allocated some amount of time to off-farm work. The corollary is that no work time may be observed either because of the participation decision or the hours of work decision. It may be presumed that for each decision the individual weighs up the utility difference of each course of action but as these calculations cannot be observed directly, the model operates by assuming the existence of two latent variables: y_1^{**}, associated with the individual's decision to participate in the off-farm labour market, and y_2^{**}, associated with the decision of how many hours to work off farm. These are linear functions of the first and second hurdle regressors, x_1 and x_2, respectively:

$$y_1^{**} = x_1\beta_1 + u_1, \tag{8}$$

$$y_2^{**} = x_2\beta_2 + u_2. \tag{9}$$

Thus, x_1 represents those variables used to explain the participation decision and x_2 represents those variables used to explain the hours of work decision. If we denote an (unobservable) index variable as $y_1^* = 1$, if the individual decides to participate, and $y_1^* = 0$, otherwise, then:

$$y_1^* = 1, \quad \text{if} \quad y_1^{**} > 0,$$

and

$$y_1^* = 0, \quad \text{otherwise.}$$

If it is assumed that the error term u_1 is normally distributed, the first hurdle corresponds to a Probit model. Turning to the hours of work equation, conditional upon clearing the first hurdle, off-farm labour, y_2^*, is generated as:

$$y_2^* = y_2^{**}, \quad \text{if} \quad y_2^{**} > 0,$$

and

$$y_2^* = 0, \quad \text{otherwise,}$$

i.e. the second hurdle takes the form of a Tobit model, and is capable of generating zero levels of off-farm labour, independent of the first hurdle.

The observed hours of work, y, is determined by the interaction of both hurdles:

$$y = y_1^* y_2^*. \tag{10}$$

Thus, if we observe an individual working off-farm, he/she must be both a participant in the market, and have decided on a positive level of work time. Zero hours of off-farm work can be generated by a 'failure' at either or both of the hurdles.

It is further assumed that the latent variables have a bivariate normal distribution:

$$(u_1, u_2) \sim \text{BVN}(0, \Sigma), \quad \Sigma = \begin{bmatrix} 1 & \rho\sigma \\ \rho\sigma & \sigma^2 \end{bmatrix}. \tag{11}$$

As Blaylock and Blissard (1992) point out, this general model nests a number of other formulations. For example, when ρ is restricted to being equal to zero the model collapses to the independent Cragg model.[5] The Tobit model is nested within the independent double hurdle model ($\rho = 0$) when it is further assumed that the probability of participation is 1.

4. Data

The survey that generated the dataset used in this study was conducted over 34 weeks during the 1996–1997 crop year as part of a project on meso-scale rural market changes in the Shamva District of Zimbabwe. The district is divided into 24 wards, of which 13 are located in communal areas and 6 in resettlement areas. The sample, representing 10% of the total number of households in the area, was drawn from across the district in an attempt to capture a wide range of socio-economic and geographical conditions. The data are based on a very short recall period and most of the responses were, wherever possible, verified. The survey was designed to gather data on a wide range of issues including a comprehensive study of the household economy.

The focus here is on individual adult members of the household and on how each decides, firstly, whether to participate in the off-farm labour market and, secondly, on the hours allocated to work away from the family farm. The dataset contains information on all

[5] The independent Cragg model assumes a feedback effect from the level of possible allocations to the participation decision (see Atkinson et al., 1984; Haines et al., 1988).

individuals whether they undertook off-farm work or not. The questions on off-farm labour allocation were two-fold: (i) do you work off-farm? and (ii) if so, how much time did you allocate this week for this activity? All members who had non-zero allocation of off-farm labour time were then observed working off farm to verify their responses.

An immediate problem in implementing the theoretical model with the sample data is the absence of reliable information on individuals' wage rates. As other studies (e.g. Adams, 1991) have shown, there are vibrant labour markets in one form or another in rural areas throughout most of rural Zimbabwe. However, the local economy in the Shamva District, while offering diverse income-generating opportunities, is characterised by a relative scarcity of formal employment and non-monetary payments for labour are common. There is also the difficulty of calculating a shadow wage rate for those individuals who did not work during the survey period. Furthermore, there are likely to be measurement errors in recorded wage data due to the unreliability of survey responses in this regard. In line with other studies (e.g. Benjamin and Guyomard, 1994), we choose to include a set of exogenous variables, such as individual and household characteristics, which might affect an individual's shadow price of time and the reservation wage rate.

An additional problem arises because the theoretical model outlined in Section 2 suggests that the individual's labour decision depends on both his/her attributes and those of the other household member. This theoretical specification is quite easy to represent in empirical analysis of households comprising a farmer and a spouse (see, for example, Benjamin and Guyomard, 1994) but in our dataset there is a variety of household types (farmers with an absentee spouse or no spouse, households headed by children or young adults, households with several adults and so forth). It is not clear in this case how the characteristics of other household members can be represented in modelling the labour decision of the individual decision-maker. Although we experimented with alternative approaches,[6] it was decided that the empirical model should exclude other household members' individual characteristics, so that the final specification incorporated the decision-maker's own attributes (age, gender, education), general household's characteristics (ethnic group, numbers in various age groups, etc.) and farm characteristics (area planted, importance of cash crops, etc.).

All the variables used in this study together with their definitions, means and standard deviations are presented in Table 1. The dependent variables in the two hurdles of the model are participation (participate) and hours worked off-farm (offhours). The individual characteristics included in the analysis are age, gender and education (level of schooling). The latter is included to represent human capital, which many studies (e.g. Huffman, 1992; de Janvry and Sadoulet, 1997) suggest plays an important role in the labour time allocation of agricultural households. The household is characterised by the ethnic group of the head of household, the household's composition, its productive assets and availability of credit, and the level of remittances. The farm characteristics are the proportion of cash crops grown, the area planted and the agricultural terms of trade. These household and farm characteristics feature in a number of studies of labour supply in developing countries. The dataset is completed with two locational variables, which are expected to influence the participation decision:[7] the distance from commercial centres and the quality of the infrastructure.

Several of the sample means in Table 1 are higher than the corresponding national averages for rural areas in Zimbabwe. This can be explained partly by the significantly higher agricultural potential of the Shamva District compared to other locations and by the fact that this district has a highly diversified economy thanks to its agricultural potential and significant mineral wealth. However, since small-scale producers are located in pockets of poor and/or inaccessible land throughout the whole country regardless of agro-climatic region, the demographic variables reflect levels that are typical of rural areas in general. Mean land area accessible to the household is close to the national average. The effective area is about 1.9 acres

[6] Specifically, including aggregate variables which would depict the characteristics of other household members (total years of schooling, gender ratio, etc.) did not improve the overall fit and, in any case, the effects of these variables were difficult to interpret.

[7] Reardon et al. (2001), for example, emphasise the importance of transport infrastructure, mainly roads, in stimulating the growth of non-farm employment in Latin America.

Table 1
Descriptive statistics of model variables

Variable	Description	Mean	Standard deviation
Dependent variables			
Participate	Participation (1 = the individual participates in the off-farm labour market; 0 = otherwise)	0.6652	0.3348
Offhours	Labour time allocated to off-farm skilled work (hours)	31.5472	14.1358
Individual characteristics			
Age	Age of individual household member	37.8619	18.6617
Education	Number of years of schooling of individual household member (that is, the total number of years after the first 14 years)	4.4556	5.5238
Gender	Gender of the individual household member (1 = female; 0 = male)	0.6083	0.4159
Household and farm characteristics			
Ethnic	Ethnicity of the household head (1 = Zezuru; 0 = other)	0.7181	0.4504
Adults	Number of adults in the household	2.0372	0.7569
Chld49	Number of children between the ages of 4 and 9 years	0.5275	0.7319
Chld1016	Number of children between the ages of 10 and 16 years of age	1.0176	1.0462
Infants	Number of infants in the household	0.6586	0.7519
Assets	Total value of household productive assets (Z$)	9210.51	11810.54
Credit	Dummy for the accessibility of credit (1 = if household is member of farmer group; 0 = otherwise)	0.3817	0.7636
Remittance	Total value of remittance income (Z$)	350.62	542.44
Cash crops	Proportion of the land area of the family farm under cash crops	0.1707	0.2304
Area	Area actually planted in the survey crop year (acres)	4.9435	7.9264
Tot	Ratio of agricultural prices to that of non-agricultural products—the 'terms of trade'	0.2358	0.7707
Locational characteristics			
Distance	Average distance to the nearest shopping or urban centre and to commercial farms or other employment centres (km)	14.2819	11.0888
Infras	Dummy for the quality of roads, bridges and communication infrastructure in the area in which the farm household is located (1 = good; 0 = other)	0.5370	0.4576

larger than in other areas (for example, in the midlands it is 5 acres per household, in Matabeleland South it is 5.5 acres and in Masvingo it is 4.5 acres (CSO, 1990)). The closeness of the areas of arable land accessible to the household in the district to the national average is due to the uniform discriminatory policy (embodied in the Land Apportionment Act of 1930) that was behind the formation of rural areas (native reserves) across the country. In the sample period, a total of 302 households allocated some time off farm. This figure includes all those households that undertook any activity that is primarily for purposes of the production of goods and services for sale and formal and informal employment.

All the other variable means are close to the corresponding national averages. The wide variations in education levels, remittance income and assets reflect the typical unequal distribution of these variables in rural areas. The time worked is much higher than one would expect. However, it is worth remembering that these data were collected over the 34 busiest weeks of the year. Time worked also falls within the range of results for agricultural labour time allocation from a study of small-holders by Massell and Johnson (1968). When one considers that during this time of the year it is quite possible that the labour week can be as long as 6 days, these data do not appear unrealistic.

5. Results

The double hurdle model was estimated for all individual adult household members in the sample (1183 cases). The choice of explanatory variables to include in each of the two hurdles is problematic (Atkinson et al., 1984). As Ghadim et al. (1999) note, "It is usually thought necessary to impose some exclusion restrictions across the two vectors of explanatory vari-

ables in order to adequately identify the parameter estimates. However, theory seldom allows one to be precise as to which variables should appear in which vector." (p. 9). So the selection is inevitably somewhat arbitrary. The approach taken here is to include in the participation equation all those socio-economic characteristics which might determine preferences towards work and which might proxy the reservation wage.

Table 2 presents the results of the joint maximum likelihood estimation[8] of the two equations of the independent double hurdle model explaining the probability of participation and hours of off-farm work. A Tobit model version containing the same second stage variables is also presented. On the basis of a likelihood ratio (LR) test, the restrictions implied by the Tobit model were rejected (LR = 315.95, with a critical χ^2_{19} value of 30.14). The implication of this result is that participation and hours of work decisions are not based on the same decision-making process. The independent double hurdle is favoured because a LR test of the significance of the covariance term (ρindicates that the independent double hurdle model is appropriate (ρ=0, cannot be rejected on the basis of a LR test statistic of 0.689, against the critical χ^2_1 value of 3.84). This implies that participation and hours of off-farm work are distinct, unrelated decisions.

These results vindicate the choice of a two-stage modelling approach to labour allocation, since it is apparent that the effects of the explanatory variables are more complicated than the Tobit regression would imply. This is well illustrated by considering the variable denoting the gender of the individual. The double hurdle results suggest that a female member of the household is less likely to work off farm but if she does decide to undertake such work, she will work longer hours than her male counterpart, ceteris paribus. Hence, as the impact of gender on participation is opposite in direction to that on hours of work, drawing inferences about the effect of gender on off-farm labour allocation from the Tobit or other single equation regression would lead to erroneous conclusions.

The variable coefficients presented in Table 2 can be used to establish the magnitudes of the effects of a change in an explanatory variable for the particular hurdle. In the participation equation, for example, the interpretation of the variable coefficients is that each one-unit increase in a given variable leads to an increase in the Probit index[9] by standard deviations equal to the magnitude of the coefficient. For example, a 1 acre increase in the actual area planted leads to a decrease in the Probit index by 0.35917 standard deviations.[10]

Variables for age and educational background are included to capture the effect of age, experience and formal training, characteristics which may be linked to the shadow wage rate. The quadratic life-cycle effect on off-farm labour time is as expected: at young ages, the hours of work increase with age, but at older ages the hours worked decrease as age increases. In terms of participation, however, the coefficient on age is negative, but insignificant. The quadratic term in age is positive and significant, suggesting for older workers the probability of participation in the off-farm labour market increases with age. This is a somewhat surprising result in terms of much of the literature (see, for example, Benjamin and Guyomard, 1994; Abdulai and Delgado, 1999), although Ruben and Van den Berg, 2001), obtain a similar result for off-farm self-employment in Honduras. As has been found in other studies (e.g. Ferreira and Lanjouw, 2001), the probability of engaging in off-farm activities is positively and significantly related to the level of education. Specifically, an individual educated beyond 14 years is found to be more likely to work off farm. Thus, the hypothesis that years of formal education make members more employable (for example, because they would be more knowledgeable of employment opportunities and more adaptable in the range of tasks that they can perform as a hired worker or self-employed) is confirmed by these results. However, education does not significantly affect the hours worked in off-farm employment.

Female adults are less likely to participate in off-farm work. This may not only reflect the greater time commitments of women within the household, but also the significant gender biases in labour time allocation in this area, a result which would be in

[8] STATA 5 was used to obtain all econometric estimates.

[9] If the Probit model is defined as $\Pr(y_i \neq 0|x_i) = \Phi(x_i b)$, where x_i are the explanatory variables and Φ the standard cumulative normal with mean zero and variance 1, then $x_i b$ is the Probit index.

[10] In other words, the interpretation of these coefficients requires one to think in the so-called *Z*-metric, which is a way of interpreting the changes in standard deviations.

Table 2
Double hurdle and Tobit model estimation results

Variable	Double hurdle			Tobit		
	Estimate	Standard error	Z^a	Estimate	Standard error	Z^a
Participation						
Age	−0.42388	0.82106	−0.51626			
Age^2	0.55096	0.19067	2.88959			
Education	2.69721	0.76155	3.54174			
Gender	−0.31172	0.06444	−4.83736			
Adults	0.15468	0.05639	2.74304			
Chld49	−0.27642	0.61008	−0.45308			
Chld1016	0.71595	0.75067	0.95374			
Infants	−0.27845	1.69632	−0.16415			
Gender × infants	−0.24076	0.14968	−1.60849			
Ethnic	−0.24270	0.10163	−2.38807			
Assets	2.48e−06	5.67e−07	4.37389			
Remittance	−0.16606	0.06893	−2.40911			
Credit	−0.34518	0.32467	−1.06317			
Area	−0.35917	0.06616	−5.42880			
Cash crops	−1.68951	0.58562	−2.88499			
Tot	−0.05735	0.06792	−0.84438			
Infras	0.60966	1.00923	0.60408			
Distance	−0.12009	0.10790	−1.11297			
Constant	−4.95434	1.51677	−3.26637			
Hours of work						
Age	1.31782	0.50471	2.61104	2.05936	0.61509	3.34806
Age^2	−0.30637	0.10151	−3.01813	−0.44856	0.12167	−3.68669
Education	−0.29566	0.64613	−0.45759	3.71749	−0.84519	4.39841
Gender	0.37751	0.21497	1.75610	0.28115	0.12094	2.32471
Adults	0.21981	0.09156	2.40072	4.10859	1.80393	−2.27758
Chld1016	10.28375	9.19075	1.11892	17.51946	14.41627	1.21526
Chld49	−6.34059	10.12551	−0.62620	−20.26829	61.27772	−0.33076
Infants	−9.00368	12.17784	−0.73935	−13.21918	26.86568	−0.49205
Gender × infants	−0.74837	0.23944	−3.12550	−1.02838	0.36398	−2.82538
Assets	−0.62631	0.13902	−4.50517	−1.61482	0.29283	−5.51453
Remittance	−0.35861	0.15388	−2.33045	−1.60563	0.49731	−3.22863
Area	−1.91946	0.59278	−3.23806	−2.18847	0.72826	−3.00507
Tot	−0.11829	0.05237	−2.25874	−0.64073	0.21938	−2.92064
Constant	7.13138	1.66121	4.29288	11.28284	2.46398	4.57911

For the double hurdle model, log likelihood = −1605.3749 and R^2 = 0.3687. For the Tobit, log likelihood = −1763.3512.
[a] The Z-statistic is the ratio of the coefficient to the standard error.

line with numerous studies in similar communities.[11] Those women who do work off-farm are most often to be found in low paid, low productivity occupations. Further evidence that domestic commitments are an important determinant of female participation is provided by the negative, significant coefficient on the interaction of gender and the number of infants in the household: females in households with young children are less likely to engage in the off-farm labour market. As noted earlier, when women do participate in the labour market, they work more hours off-farm than their male counterparts, but again this response is tempered when there are infants in the household.

[11] Several studies are based on gender-disaggregated data (e.g. Amin and Chipika, 1993; Abdulai and Delgado, 1999). Disaggregation along gender lines between and within households can better explain labour allocation behaviour because, it is hypothesised, the way males and females between and within households behave is different.

Turning to household characteristics, the number of adults in the household increases the household's capacity for diversifying its income-generating activities and so it is unsurprising that the larger the number of adults the greater the probability of an individual adult participating in off-farm work and the longer the hours worked. On the other hand, the presence of children per se has no significant effect on labour time allocation to off-farm work. This finding concurs with results from other studies in rural areas in developing countries that child-rearing and off-farm work are not necessarily competing activities (Sahn and Alderman, 1993; Skoufias, 1994). In these rural communities, members of the extended family take care of children in the absence of the parents. However, as we have already seen, the presence of infants does affect the off-farm labour decisions of female adults in the household.

The ethnicity of the household head is another household characteristic which has a significant impact on the participation decision. This variable may influence preferences for off-farm work or may reflect biases in this labour market. Here we find that individual members from households of Zezuru extraction are less likely to participate in off-farm work, contrary to expectations.

Unearned income in the form of remittances has a negative effect on both the likelihood of participation and on the hours worked. By easing the constraint on household income, remittance income reduces the need to undertake off-farm work. Productive assets, which are mostly agricultural, together with land area, can be seen as proxies for socio-economic group or wealth. Members of households which are relatively well-off are more likely to participate in off-farm work but when they do, they spend relatively less time in this activity. The other indicator of financial status in the model, credit availability, is not found to affect the participation decision.

The farming system adopted by the household is represented in the model by the proportion of cash crops in the crop mix. Not surprisingly this variable negatively affects participation in off-farm work. This result suggests that households who grow cash crops tend to generate cash income for market purchases from this source rather than off-farm work. This result might also reflect the fact that most cash crops grown in this area tend to be labour intensive. This fact, coupled with the other demands for household labour within the family, increases the reservation wage of this labour. Another farm characteristic which has a significant impact on labour decisions is the size of arable land available to the household: the larger the area the less likely is participation in off-farm work and the less time devoted to it by those who choose to participate. This is consistent with farmers undertaking off-farm work because of constraints in getting access to arable land, which in turn may lower their reservation wage for such work.

Farmers in Shamva are sensitive to relative prices of farm and non-farm products, but only the hours of work decision is significantly affected, i.e. an increase in the level of agricultural product prices relative to non-agricultural ones leads to less time being allocated off-farm.

Although both of the locational variables (denoting the quality of the infrastructure and the distance from commercial markets) have the expected estimated impact on participation, neither is statistically significant. Admittedly, the measure of infrastructure quality, a simple dummy variable, is rather crude. That distance does not have a more significant effect may reflect the fact that off-farm work has been defined in this study to include all forms of paid employment and that local labour markets offer adequate opportunities of employment in one form or another. Moreover, as the terms of trade are closely related to distance to the nearest centre, multicollinearity may be influencing the precision of estimation of their respective coefficients.

Finally, we may note that the overall fit is satisfactory[12] both in terms of R^2 (0.37) and the estimated model's predictive ability (Table 3). Of the 1183 adults in the sample, 559 worked off-farm. The model correctly predicts 466 (83%) of these observations, while the remaining 93 individuals were predicted not to clear the first hurdle. Of the 624 individuals in the sample who did not work off-farm, 550 individuals (88%) were correctly predicted not to allocate any time off-farm (373 were predicted to fail at the first hurdle, 116 to fail to clear both hurdles and

[12] Here, $R^2 = 2(\mathrm{LL_m} - \mathrm{LL_0})/[2(\mathrm{LL_m} - \mathrm{LL_0}) + N]$, where $\mathrm{LL_m}$ is the value of the log likelihood function of the full model and $\mathrm{LL_0}$ the log likelihood value of a model with only constants in both hurdles. N is the number of observations (1183).

Table 3
Distribution of predicted versus actual participating individuals

			Actual values	
	First hurdle	Second hurdle	0	1
Predicted values	0	0	116	
	0	1	373	93
	1	0	61	
	1	1	74	466

61 are predicted to be potential participants but are at a corner solution in the hours of work equation). However, the model fails to correctly predict the behaviour of 74 individuals (12%), who were observed not allocating any time off the farm but who were predicted by the model to clear both hurdles and so record some time in off-farm activities.

6. Discussion

The use of the double hurdle approach to modelling labour decisions in this context has been justified. Not only was the Tobit model formally rejected by the data, but some variables, such as productive assets, had a different qualitative as well as quantitative impact at each decision stage. A single equation approach such as the Tobit would have conflated these effects and given misleading results.

Nevertheless, the analysis has a number of shortcomings which should be borne in mind when considering the policy implications discussed below. First, the lack of reliable data on wages precludes using potentially one of the most powerful economic variables in the model and one of the main variables that is traditionally a target for policy in this sub-region. It would have been instructive to explore whether their role is important for rural small-holders in Shamva and whether policy measures to address low wages in these areas are appropriate.

Second, this approach implicitly assumes uncontrolled 'expenditure of time'. If an individual with the requisite characteristics is willing to work, it is assumed he or she will work, i.e. paid work will be found or time will be allocated to an activity that produces goods and services primarily for sale. This is clearly not the case. There are limits as to the availability of work and it would have been informative if these limits could have been included within the model. However, although variables such as the unemployment rate in each locality or the density of the population in a particular village or ward could have been built into the model, in a cross-section study these variables would exhibit relatively little variation and they would merely pick up the effect of location.

Finally, this analysis ignores a number of potentially important factors. The riskiness and periodicity of agricultural production (Matshe, 1997), inter-year variations and seasonal constraints on grain and cash holdings can have implications for the amount of time allocated to different activities and for pluriactivity. However, it is difficult or impossible to incorporate these factors in a single season cross-section study. Health considerations also may have influenced the results. At the time of the survey, the stigma attached to HIV/AIDS made it impossible to get meaningful explanations for some apparently inconsistent observations (such as no off-farm participation even though the characteristics of the household and those of the individual would have suggested otherwise). Another consideration to be borne in mind when assessing these results is that the survey was conducted during a transitional phase of economic reform, from a heavily centralised economic system to a more liberal and market-oriented one. Specifically, the government had just abolished the centralised marketing of most grains, had relaxed laws governing the mining of small mineral deposits, had shifted most of the management of local authorities to the local community through elected District Councils, had abolished the licensing of agricultural produce marketing and generally was implementing measures consistent with the Structural Adjustment Programme.

6.1. Implications for rural development policy

Increasing off-farm work in rural areas is important because of the potential it has to ameliorate the effects of low agricultural productivity and low agricultural incomes which are associated with poverty in rural areas. Government policy should be directed not just at agricultural development but to promoting the rural economy as a whole. This entails policies directed towards providing incentives that encourage households to participate in rural non-farm activities,

as well as increasing the capacity of households to respond to such incentives (Reardon et al., 2001). In this regard, there is particular scope to promote manufacturing, commerce and services which link to the needs of modern agriculture.

Our results suggest that in the Shamva District, the main factors influencing labour allocation off farm are land accessibility, asset holding, education and gender. The government's current policy of redistributive land reform would relieve the land constraint on the allocation of labour to farm work and would, according to our results, reduce the incentive to participate in the off-farm labour market. This may see household labour being drawn back on to the farm and may discourage rural–urban drift, but in the absence of other measures to encourage agricultural development (including technology promotion, enhanced human resources, etc.), the impact on rural household incomes will be muted.

Rural households with productive assets have the capacity to diversify into off-farm employment and the higher the level of assets the more likely they are to engage in these off-farm activities. The government policy of subsidising draught livestock through restocking schemes (and in some areas actually restocking depleted herds) and the subsidised provision of agricultural implements for rent is thus expected to release some household members for work off farm. On the other hand, our results suggest that increasing household assets reduces the amount of time spent off farm. This throws into sharp focus the difficulty of drawing ready conclusions about the effect on rural incomes of the exogenous provision of assets to rural households.

As the level of education is strongly and positively linked to participation in the off-farm labour market, skill-building and training of human resources is an essential aspect of promoting both agricultural development and rural off-farm employment. Moreover, policies and programmes to facilitate rural women's access to the off-farm labour market are called for, if the current gender bias in labour markets is to be reversed.

7. Conclusions

In this paper off-farm labour allocation of adults in the Shamva District of Zimbabwe is modelled as a two-stage (double hurdle) process, which distinguishes the participation decision and the hours of work decision. This provides a more realistic model of the labour market. In particular, it avoids the assumptions that all non-participants do not want to work and that the same factors influence the participation and work-time decisions in the same directions. The approach is vindicated by the data, with the single equation, Tobit model being clearly rejected, and some variables (e.g. assets and gender) having qualitatively and quantitatively different effects on the two labour allocation decisions.

Our results confirm that education and gender are important individual characteristics determining labour allocation off farm. Farm/household characteristics (the number of adults in the household, the level of remittances, the area accessible to the household and its level of asset-holding) are also significant factors in off-farm work time allocation. In the study area, off-farm work is stimulated at least in part by the inability of household to increase agricultural output and therefore agricultural income.

Given the importance of non-farm income in alleviating the problems of low agricultural productivity, poverty and food insecurity, policies should be directed towards providing incentives to households to participate in rural non-farm activities, as well as increasing their capacity to take advantage of such opportunities. This would entail an approach in which the rural economy is viewed as a whole, so that, in addition to policies aimed at agricultural development, manufactures, commerce and services essential for modern agriculture are also promoted.

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