Market imperfections, liquidity and labor allocation: the case of rural South Africa

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March 30, 2008

Abstract

Assets endowment and market imperfections shape the organization of agricultural production and lead to different production regimes within rural farm households in South Africa. This paper uses a farm household model to explain the presence of three main households groups determined on the basis of the labor regime adopted: small peasants (working both on and off farm), self cultivators (autarkic in labor) and hiring in households. A partial generalized ordered logit model is used to test the main predictions of the model and a Brant test on coefficient constancy is performed to identify the household specific factors affecting labor market participation. The results show that liquidity and market imperfections matter in the choice of the labor strategy adopted by the household.

1 Introduction

Household endowments and market imperfections shape the organization of agricultural production and lead to different production regimes within rural farm households. There is a substantial differentiation across households engaged in agricultural activities which suggests the presence of quite distinct categories (classes\(^1\)) of households. Using data on rural South Africa we have identified three main categories of landed farm households on the basis of the labor regime adopted: small peasants (sellers of labor), self-cultivators (self

\(^1\)A class is define as a group of individuals who share a common "endowment-necessitated behavior" Carter and May (1997).
sufficients in labor) and hiring in households (buyers of labor). The labor regime adopted by the household is the result of an optimizing behavior where market imperfections and liquidity play a relevant role in shaping household decisions. Understanding the determinants of farm household membership in the three categories can help to identify and target rural policies. Saudolet et al. (1998) suggest a model which considers transaction costs in the labor market and lead to the identification of the three regimes above mentioned. Departing from this model we incorporate an additional liquidity constraint to show that the lack of pre-harvesting liquidity also has an influence on the labor strategy adopted. Eswaran and Kotwal (1986) also use a farm household model and consider credit and labor market imperfections to analyze the membership in different modes of cultivation. In their model the amount of credit received depends on land ownership which, however, cannot be applied to rural South Africa where land does not serve as collateral and the agricultural credit sector is underdeveloped (Fenwick and Lyne, 1999). The inclusion of a pre-harvesting cash constraint seems to better represent the constraint face by South African households.

Empirical analyzes conducted using data on rural South Africa suggest the presence of quite distinct household categories. Carter and May (1997) identify 8 classes on the basis of the livelihood strategies undertaken by each group. Such categorization is the result of not only differences in both tangible (land and labor) and intangible assets (welfare rights, social reciprocity) but also of the constraints on the ability to effectively exploit such endowments. The usefulness of households categorization emerges also in Eastwood et al. (2006). The authors define the household categories on the basis of their specialization by income source and identify three groups within rural households in a former homeland area of the Limpopo Province (South Africa): factor-reliant, migrancy-dependent and pension-dependent households.

We also intend to exploit the information obtainable by the categorization of farm households into homogenous group based on the labor regime adopted. The membership in the different categories is explained using a theoretical framework built on the classical agricultural household model literature.

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2Their model follow the endogenous class formation framework of Roemer (1982) who first formalized household labor regime adoptions.

3These classes are: Marginalized households, Welfare dependent households, Remittance dependent households, Secondary wage dependent households, Primary wage dependent households, Mixed income households with secondary wages, Mixed income households with primary wages and entrepreneurial households.
erature (Singh et al., 1986). A growing literature has focused on the role of transaction costs in the household supply decision process (Key et al. (2000) and Makhura (2001)). Our model also incorporates transactions costs in the labor market which lead to differences in the selling and buying prices of labor (wage differentials).

In the farm household framework, labor market participation is explained by the relation between the on farm marginal productivity of labor and the opportunity costs of family labor for buyers and sellers. The opportunity cost is given by the off farm and hiring in effective wages respectively, which incorporate transaction costs, augmented by an endogenous marked up linked to the liquidity position of the household. A liquidity constrained household gives a higher value to off farm opportunities reflecting the fact that extra incomes help ease the liquidity constraint. The opposite effect is expected on the decision of hiring in workers. A partial generalized ordered logit is used to test the main predictions of the model and a Brant test is used to identify the household specific factors affecting the opportunity costs of on farm labor. Liquidity is found to be a concern mainly for small peasants and the results show that cash shortage forces the household to sell labor off farm. Little effects are found, instead, on the decision of hiring in labor which is mainly influenced by having access to information through medias and contacts with extension officers.

The paper proceeds as follows: section 2 presents the theoretical model where the three household groups are analyzed separately, section 3 introduces the empirical specification and the data used, in section 5 the results are reported and discussed and, finally, section 6 concludes.

2 A theoretical model to explain labor market participation

This model provides the theoretical explanation for the emergence of different household categories in a imperfect markets scenario. In particular we consider imperfections in the labor market, allowing for the presence of transaction costs which are directly translated into the effective cost of labor. The model departs from the one presented in Saudolet et al. (1998) allowing for the presence of a liquidity constraint and including non-labor inputs as additional components of the farm production function. The effective cost
of hiring labor \((h)\) is given by the market wage plus search and supervision costs and is defined as \(w_h\). The effective off farm wage includes search and other transaction costs and is different between unskilled \((w_1^o)\) and skilled labor \((w_2^o)\). The imperfections in the labor market are therefore translated into the following relation \(w_1^o < w_h < w_2^o\). Family labor is also allocated to on farm activities (skilled and unskilled, \(f_1^q, f_2^q\)) and to leisure \((f_1^l, f_2^l)\). We also assume homogenous unskilled family labor implying that all members are supposed to possess the same on farm productivity. The lack of access to inputs such as seeds, fertilizer, pesticides as well as to technical knowledge are some of the major problems faced by South African farmers. This is partly due to the lack of liquidity in the pre-harvesting period and the transaction costs in the input market (the latter are incorporated into the effective price of non-labor production inputs, \(p_x\)). As reported by several authors\(^4\), in rural South Africa, income from non-agricultural sources, such as wage employment, is important in providing working capital for the purchase of seeds, fertilizers, and other production inputs; to take this into account we include a liquidity constraint on pre-harvesting period transactions:

\[
p_x x + w_h h + K \leq w_1^o f_1^q + w_2^o f_2^q + S
\]

where \(x\) represents non-labor production inputs, \(K\) are fixed setup costs, and \(S\) is the pre-harvesting amount of exogenous transfers. The household maximizes utility which is a function of leisure and income, \(y\). Maximization is subjected to the above liquidity constraint together with additional non-negativity constraints on labor demand and supply and on the amount of inputs and leisure time:

\[
\max_{f_1^l, f_2^l, f_1^q, f_2^q, x} U(f_1^l, f_2^l, y)
\]

where \(y = pq(A, h + f_1^q + f_2^q, x) - w_h h - w_x x - K + w_1^o f_1^q + w_2^o f_2^q + T\) and \(f_1^l = f^1 - f_1^q, f_2^l = f^2 - f_2^q - f_2^q\). The lagrangian function for this problem and the respective first order conditions are reported below.

\[
L = U(f_1^l, f_2^l, pq(A, h + f_1^q + f_2^q, x) - w_h h + w_1^o f_1^q + w_2^o f_2^q + T) + \lambda (w_1^o f_1^q + w_2^o f_2^q + S - p_x x - w_h h - K) + \mu_k f_k^n + \mu_h h + \mu_x x
\]

\(^4\)The complete list of study suggesting such conclusions is reported in Van Zyl et al. (1995).
with \( k = q, o, l \) and \( n = 1, 2 \).

1a) \( h : u_y(pq_L - w_h) + \mu_h - \lambda w_h = 0 \quad h \geq 0 \quad \mu_h h = 0 \)

2a) \( f^1_q : u_y p q_L - u_1 + \mu^1_1 + \mu^1_2 = 0 \quad f^1_q \geq 0 \quad \mu^1_1 f^1_q = 0 \)

3a) \( f^2_q : u_y p q_L - u_2 + \mu^2_1 - \mu^2_2 = 0 \quad f^2_q \geq 0 \quad \mu^2_1 f^2_q = 0 \)

4a) \( f^1_o : u_y w^1_o - u_1 + \mu^1_1 - \mu^1_2 + \lambda w^1_o = 0 \quad f^1_o \geq 0 \quad \mu^1_1 f^1_o = 0 \)

5a) \( f^2_o : u_y w^2_o - u_2 + \mu^2_1 - \mu^2_2 + \lambda w^2_o = 0 \quad f^2_o \geq 0 \quad \mu^2_1 f^2_o = 0 \)

6a) \( x : u_y (pq_x - p_x) + \mu_x - \lambda p_x = 0 \quad x \geq 0 \quad \mu_x x = 0 \)

7a) \( \lambda : w^1_o f^1_o + w^2_o f^2_o + S - p_x x - w_h h - K \geq 0 \quad \lambda \geq 0 \)

\[ \lambda (w^1_o f^1_o + w^2_o f^2_o + S - p_x x - w_h h - K) = 0 \]

8a) \( \mu^n_l : f^n_l \geq 0 \quad \mu^n_o \geq 0 \quad \mu^n_l f^n_l = 0 \quad n = 1, 2 \)

where \( \lambda \) is the marginal value of liquidity, \( T \) are exogenous transfers mainly represented by pensions and remittances and \( A \) is the fixed amount of land cultivated by the household. Since land in South Africa is mainly allocated by local or tribal authorities which provides only use rights, land is assumed to be fixed and cannot serve as collateral for credit (Fenwick and Lyne, 1999).

The inclusion of a liquidity constraint does not affect farm labor allocation of skilled household members. As in Saudolet et al. (1998) skilled members do not work on farm. This can be directly derived from the initial assumption \( w_h < w^2_o \), which implies that there are no incentives for the household to employ their skilled members on farm since the foregone wage is higher than the cost of hiring labor. This is also consistent with the conditions derived above since substituting equations 1a and 5a into 2a we obtain \( \mu^n_q = u_y (w^2_o - w_h) + \lambda (w^2_o - w_h) + \mu^n_o + \mu_h > 0 \) which implies zero on farm skilled labor.

This model does not explain the presence of households both hiring in and out unskilled labor, however this category constitutes only a small percentage of our sample and will not be considered in this study. Given the initial assumption, \( w^1_o < w_h \), the cost of hiring in labor exceed the forgone wage off farm for unskilled members, therefore the household has the incentive to replace hired workers with family labor. The same intuition can be derived substituting equations 1a and 2a into 4a and considering households with positive hired labor (\( \mu_h = 0 \)) to obtain \( \mu^n_o = u_y (w_h - w^1_o) + \mu_1 + \lambda (w_h - w^1_o) \geq 0 \). This implies that, when the household hires in workers no unskilled members works off farm\(^5\).

\(^5\)On the other side, considering households which members work off farm, no hired labor is admitted.
Following the same assumptions of Saudolet et al. (1998) we focus on unskilled family labor assuming that once a skilled member is employed off farm little flexibility remains in the choice between time worked and leisure, therefore $f_o^2 = kf^2$. The model can be simplified and reduced to the following:

$$\max_{h,f_1,f_2} U(f_1^1, f^2(1 - k), y)$$

$$s.t. \quad p_x x + w_h h + K \leq w_o^1 f^1_o + w_o^2 k f^2 + S$$

where $y = pq(A, h + f^1_q, x) - w_h h - p_x x - K + w_o^1 f^1_o + w_o^2 k f^2 + T$ and $f_1^1 = f^1 - f^1_q - f^1_o$. The first order conditions for this problem are reported below:

1) $h: \quad u_y(pqL - w_h) + \mu_h - \lambda w_h = 0 \quad h \geq 0 \quad \mu_h h = 0$

2) $f^1_q: \quad u_y pqL - u_1 + \mu^1_q - \mu^1_l = 0 \quad f^1_q \geq 0 \quad \mu^1_q f^1_q = 0$

3) $f^1_o: \quad u_y w^1_o - u_1 + \mu^1_o - \mu^1_l + \lambda w^1_o = 0 \quad f^1_o \geq 0 \quad \mu^1_o f^1_o = 0$

4) $x: \quad u_y (pq - p_x) + \mu_x - \lambda p_x = 0 \quad x \geq 0 \quad \mu_x x = 0$

5) $\lambda: \quad w^1_o f^1_o + w^2_o f^2_o + S - p_x x - w_h h - K \geq 0 \quad \lambda \geq 0$

6) $\mu^1_l: \quad f^1_l \geq 0 \quad \mu^1_l \geq 0 \quad \mu^1_l f^1_l = 0$

**Landed workers.** We now specify a lower bound on household assets (including land, human capital and agricultural capital) such that households below this threshold will consider cultivation unprofitable. This is explained by the presence of fixed set-up costs, $K$. As reported in Eswaran and Kotwal (1986), a household will engage in farming activities only if its maximized utility, $U^*_a$, obtainable from engaging in farming activities exceeds the utility of being a pure worker, $U^*_w$. We define $Z_0$ as the set of household characteristics such that:

$$U^*_a(f^1_1, f^2(1-k), w_o, y^*_a(f^1, f^2, A, w^*, K)) > U^*_w(f^1_1, f^2(1-k), y^*_w(f^1, f^2, w_o, A))$$

This conditions determines the emergence of a category of landed workers. For households with $Z > Z_0$ we analyze below the characteristics of each category separately.

**Self-cultivators.** This category includes only households self sufficient in labor that do not hire labor and which members do not work off farm.
The model reduces to the following 4 equations:

1c) \[ pql = u_1/u_y = w^* \]
2c) \[ p_l = p_x(1 + \lambda/u_y) = \tilde{p}_x \]
3c) \[ w_o^2f_o^2 + T - px - wh - K \geq 0 \quad \lambda \geq 0 \nabla \lambda(\lambda w_o^2f_o^2 + S - px - K) = 0 \]
4c) \[ y = pq(A, f_1, x) - px + w_o^2(kf^2 + T - K) \]

The marginal productivity of labor in the autarkic case, from now \( w^* \), is a function of household characteristics and technology and will be used as a benchmark for the identification of the other categories. It is also influenced by the presence of a liquidity constraint which affects the shadow price of purchased inputs \( \tilde{p}_x \). When the liquidity constraint is binding, the price of inputs is given by the effective price, which includes transaction costs, plus an endogenous markup \((\lambda/u_y)\) representing the marginal utility of liquidity. Therefore:

\[
w^* = w^*(A, f^1, f^2, T, K, p, \tilde{p}_x) = w^*(A, f^1, f^2, T, K, p, p_x, S) \quad (1)
\]

Since \( w_h > w_o \), the marginal productivity of labor lays in between the two thresholds, \( w_o < w^* < w_h \). The proof of this result will emerge from following subsections.

**Small peasants.** Households belonging to this category allocate labor both on and off farm while no hired labor is required. Considering equations 2b and 3b, appropriately adapted to this specific case \((\mu_1 = 0 \text{ and } \mu_o = 0)\), we obtain the following expression:

\[
pql = \frac{u_1 + \mu_1}{u_y} = w_o^1 \left(1 + \frac{\lambda}{u_y}\right) = \tilde{w}_o^1 \quad (2)
\]

The on farm marginal productivity of labor equals the shadow wage off farm \((\tilde{w}_o^1)\) which is given by the effective price of labor augmented by an endogenous markup caused by the presence of a liquidity constraint (liquidity premium). Since the marginal productivity of labor is a decreasing function of labor it is expected to be higher than \( w^* \). The condition determining the membership in this category is the following:

\[
w^* < \tilde{w}_o^1
\]
The household will sell labor if the opportunity cost given by the effective off farm wage and the liquidity premium is greater than the on farm remuneration they would get if all family members worked in the household farm ($w^*$). The presence of a binding liquidity constraint increases the opportunity cost of being self-cultivator, therefore shifting the threshold delimiting this category (Figure 1).

**Hiring in households.** Households belonging to this category hire in labor in addition to their own family members. Members do not work off farm and, considering equations 1b and 2b with the opportune adjustments ($\mu_h = 0$ and $\mu_q = 0$), it follows that:

$$pq_L = \frac{u_1 + \mu_q^I}{u_g} = w_h \left(1 + \frac{\lambda}{u_g}\right) = \tilde{w}_h$$

(3)

Because the marginal productivity of labor is a decreasing function of labor, then $w^* > \tilde{w}_h$. If the household buys labor, family labor can be substituted by hired workers; in this case its opportunity cost, $\tilde{w}_h$, is given by the cost of hiring in workers plus a liquidity markup. If $w^*$ is higher than the opportunity cost of family labor, the household will hire in labor. The presence of a binding liquidity constraint rises the opportunity cost and discourage the hiring of workers; the upper threshold in Figure 1 is shifted upward.

The role played by household characteristics, lack of liquidity and transaction costs in determining the household labor allocation strategy is illustrated in Figure 1. To simplify the graphical representation, leisure has been considered fixed\textsuperscript{6}, and the total amount of household unskilled labor is denoted by the vertical line; changes in household composition are represented by movements in the line. The off farm shadow wage, $\tilde{w}_o^I$, lies below the hiring in shadow wage, $\tilde{w}_h$, and the marginal productivity of labor in autarky, $w^*$, corresponds to the intersection between farm labor demand and supply. Three cases have been considered. In the first case, $w^*_A$ lies between the two external wages and all family labor is employed on farm at price $w^*_A$, the household is autarkic in labor. In the second case, a lower demand for labor

\textsuperscript{6}This assumption has been introduced only to simplify the graphical representation, it has not been employed in the theoretical household model.
intercepts the supply curve below the off farm wage \( (w_o^*) \), the household will employ only part of the family labor on farm at price \( \tilde{w}_{1o} \), selling the rest on the market, \( f_{1o} \). The third case is associated to higher labor demands such that the \( w^*_C \) exceeds the hiring in wage. The household will hire in workers \( (h) \) at price \( w_h \).

Figure 1: Wage bands and class structure

Household characteristics influence the demand and supply of labor as well as the shadow wages. These effects can be summarized as follow. First, transaction costs \( (C_o, C_h) \) which depend both on household specific characteristics and on other factors exogenous to the households, determine the effective market wages, variations in such costs are depicted by shifts of the horizontal lines. An increase in the transaction costs in the labor market, for example, will shift upward the hiring in wage line and downward the off farm wage one. At the same time, changes in assets endowments and other characteristics affect the liquidity position of the household and are also represented by movements in the wage bands. For a liquidity constrained household, the price of hiring out family labor has an additional value given by the liquidity premium and summarized by \( \lambda \). Finally, households endowments determine also the position of the demand and supply curve. An increase in farming land, for example, will shift the demand curve and the interception upward.
Therefore, depending on the initial conditions, changes in the above mentioned factors could cause the switch from small peasants to self-cultivator or from self-cultivators to the hiring in category and viceversa. The graph shows how household characteristics determine the location of both the external wage bands and the demand and supply of labor curves. These effects cannot be separated from a theoretical point of view and the issue will be addressed during the empirical estimation with the support of a Brant test on coefficient constancy.

Table 1: Results of the comparative statics exercise

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<th>Effect</th>
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<tr>
<td>$\frac{\partial w^*}{\partial f_1}$</td>
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<tr>
<td>$\frac{\partial w^*}{\partial T}$</td>
<td>+</td>
<td>$\frac{\partial w^*}{\partial \tilde{p}}$</td>
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<td>$\frac{\partial w^*}{\partial A}$</td>
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The dynamic illustrated in figure 1 can be also depicted through a comparative statics exercise which, in addition, identifies the sign of the effects and offers a set of conditions that can be empirically tested. Table 1 summarizes the expected signs that have been derived using the procedure reported in Appendix A. Larger endowments of land and higher income transfers are expected to have a positive impact on $w^*$ therefore, ceteris paribus, lowering the probability of selling labor and increasing the probability of hiring in agricultural workers. In this exercise the shadow price of inputs, $\tilde{p}$, which has been fixed to simplify the mathematical derivation, negatively affects $w^*$. It follows that, factors affecting positively the liquidity level of the households, through their negative effect on the non-labor input shadow price, are expected to affect positively $w^*$. Moreover, larger endowments of unskilled family labor are expected to lower the marginal productivity of labor causing the switch from the hiring in labor category to self-cultivators and to small peasants category (depending on the initial conditions). Finally, the effect of skilled labor is ambiguous. These predictions will be tested using a partial generalized ordered logit as described in the following section.
3 Data and empirical specification

The membership in one of the three household categories is determined by the endogenous marginal productivity of labor, \( w^* \), function of the household characteristics and technology, and the shadow wages band which is influenced by household specific transaction costs and liquidity position. The three household groups can be ordered in accordance with the underlying latent shadow wage and the probability of belonging to one of the three categories can be estimated considering the framework reported below:

\[
\begin{align*}
P(d_j = 1) &= P(i \in \text{Small peasant}) = P(w^*_i + \varepsilon < w^1_{oi}(C_{oi}, \lambda_i)) \\
P(d_j = 2) &= P(i \in \text{Self sufficient}) = P(w^1_{oi}(C_{oi}, \lambda_i) < w^*_i + \varepsilon < w_{hi}(C_{hj}, \lambda_i)) \\
P(d_j = 3) &= P(i \in \text{Hiring in households}) = P(w^*_i + \varepsilon > w_{hi}(C_{hi}, \lambda_i))
\end{align*}
\]

Where \( j \) indicates the \( j \)-th household, \( C_{hj} \) and \( C_{oj} \) are the determinants of transaction costs associated with hiring in and out labor and \( \lambda_i \) represents the household specific liquidity status. The model will be tested using a partial generalized ordered logit which allows for household specific thresholds. This procedure relaxes the assumption underlying the classical ordered logit model in which the relationship between the explanatory variables and the response one does not vary across categories (parallel equations assumption). The standard order logit model estimates common thresholds, which in this model means equal effective shadow wages across categories. It is widely recognized in the literature (de Janvry et al., 1991) that households are not affected by market imperfections with the same intensity and many environmental, social and cultural factors affect their specific ability to participate in the markets. Households with different characteristics are, therefore, expected to face different transaction costs, i.e. different effective market wages. Moreover, the thresholds are also related to the liquidity position of the household. The used of a partial generalized ordered logit allows for household specific thresholds, but, however does not completely address the issue. It is not always possible \textit{a priori} to correctly discriminate between the household characteristics determining the endogenous shadow wage (shifting the demand and supply curve in Figure 1) and the factors affecting, instead, the thresholds (establishing the width of wage bands in Figure 1). The presence of uneducated family labor, for example, may affect the shadow wage but also the ability of the household to negotiate and avoid transaction costs. Starting from a classical ordered logit, a coefficient constancy test
(Brant test\textsuperscript{7}) is a useful instrument to determine which variables are determinants of the thresholds, that are those failing the test. Once the test is performed, the independent variables are allocated either to the thresholds or to the latent response regression and the partial generalized ordered logit is performed.

The marginal productivity of labor in autarky, $w^*$ is assumed to be a linear function\textsuperscript{8} of the shadow price of inputs $\tilde{p}_i$ and of those household characteristics, $X_i^w$ which the Brant test have identified as determinants of the latent variable:

$$w^*_i = X_i^w \alpha_w + \tilde{p}_i \theta + \varepsilon_{wi} \tag{4}$$

where $\alpha$ is a vector of coefficients and the error $\varepsilon_w$ has a standard logistic distribution\textsuperscript{9}. The shadow price of inputs, such as seeds, fertilizers and chemicals can be also linearly approximated by:

$$\tilde{p}_i = \gamma_p + X_i^p \beta_p + \varepsilon_{pi} \tag{5}$$

where the explanatory variables, $X_i^p$, are representative of both the demand and the supply of inputs. Given the relationship reported in equation 1, we can substitute 5 into 4 to obtain the reduced form expression for the shadow wage:

$$w^*_i = X_i^w \beta_w + (X_i^p \beta_p + \varepsilon_{pi}) \theta + \varepsilon_{wi}$$

Collecting terms and setting the intercept to zero, the expression reduces to the following:

$$w^* = X \beta + v$$

The two thresholds are assumed to be a linear function of the household specific determinants of transaction costs:

$$w_n = \delta_0 + Z \delta_n + \varphi_n$$

\textsuperscript{7}An alternative method to test threshold constancy is presented in Pudney and Shield (2000).

\textsuperscript{8}The same linear approximation has been used also in Bedi and Tunali (2005).

\textsuperscript{9}In this specification $w^*$ can also be interpreted as an index of the endowment position of the household.
where \( n = o, h \) which indicates the off farm and hiring in wage respectively\(^{10}\).

First a standard ordered logit is estimated, meaning that thresholds are considered equal across classes (parallel equation assumption). Then a Brant is performed to assess whether or not the coefficient are the same across categories. For those variable presenting a significant test statistic the constancy assumption has to be rejected. Once the variables have been allocated either to the thresholds or to the response regression, a partial generalized order logit is estimated to characterize the membership to the three household categories. The log likelihood function is therefore the following:

\[
\begin{align*}
   l_i(\beta, \delta) &= 1[d_i = 0] \log[\Lambda(w_o - X\beta - Z\delta_o)] + 1[d_i = 1] \log[\Lambda(w_h - X\beta - Z\delta_h)] \\
   &\quad - \Lambda(w_o - X\beta - Z\delta_o)] + 1[d_i = 2] \log[1 - \Lambda(w_h - X\beta - Z\delta_h)]
\end{align*}
\]

where \( \beta \) is the vector of coefficients satisfying the parallel regression assumption and \( \delta_n \) are the vector of coefficient that vary across household categories\(^{11}\).

The estimation is based on data collected by the Rural Survey in 1997. The Survey collected information on 6000 rural households located in the former homeland areas. Within the ”old” South Africa, 10 homelands (Bantustans) were created, four of which were granted ”independence” by South Africa (not recognized by any other country in the world): Transkei (*1976), Bophuthatswana(*1977), Venda (*1979), Ciskei(*1981), KaNgwane, KwaN-debele, Kwazulu, Gazankulu, Qwaqwa and Lebowa\(^{12}\). Households engaged in both hiring in and out of labor have been excluded and constitute the 3% of the entire sample. The sample has been additionally restricted to those household only involved in maize production (75%). Three classes have been identified on the basis of the allocation of unskilled family labor\(^{13}\) and on the presence of hired labor. Households with members working both on and off

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\(^{10}\)For identification purpose each variable has to be excluded at least from one of the three equations (the shadow wage and the two thresholds equations), using the Brant test it is also possible to address this issue.

\(^{11}\)The model has been estimated using the stata command gologit2 (Williams, 2006).

\(^{12}\)The asterisk precedes the year of independency declaration.

\(^{13}\)Skilled labor includes those household members with a level of education higher than the compulsory general education and training which runs from grade 0 to grade 9 (Department of Education, Republic of South Africa). In the South Africa education system there are other two educational bands: further education and training (from grade 10 to 12) and the higher education and training which includes undergraduate and postgraduate degrees, certificates and diplomas.
farm are defined "small peasants" while "self-cultivators" devote all family labor to the own farming activities and constitute the largest category in the sample (54%). Hiring in households, besides family labor, employ additional hired workers and correspond to the 13% of the sample. As shown in Figure 2, self-cultivators seems to be the dominant category in all the observed provinces while hiring in households represent only a small fraction of total farm households with the exception of the Eastern Cape province where the percentage of hiring in households reaches the 22%. Categories characteristics are summarized in Table 2.

Agricultural assets are represented by the hectares of land used for growing field crops\(^{14}\), by household human capital (proxied by the age of the household head\(^{15}\)) and by a dummy variable which signals the presence of structures or buildings on the farm or homestead. About 70% of rural house-

\(^{14}\)Grazing land is mainly communal and no information is available on the disposal size.

\(^{15}\)If the head of the household belongs to the skilled labor forces employed off farm than the oldest member working on farm is considered.
hold has access to land however one third of them cultivate a field which is smaller than 1 hectare. An index of land quality is derived from the average productivity of land (in terms of maize) by district.

Table 2: Descriptive statistics by category

<table>
<thead>
<tr>
<th>Variables</th>
<th>Small peasants (33.65 %)</th>
<th>Self-cultivators (53.75 %)</th>
<th>hiring in hhs (12.6 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land hectares (mean)</td>
<td>1.77</td>
<td>2.14</td>
<td>2.60</td>
</tr>
<tr>
<td>Unskilled members (male - mean)</td>
<td>2.76</td>
<td>2.11</td>
<td>2.08</td>
</tr>
<tr>
<td>Unskilled members (female - mean)</td>
<td>3.00</td>
<td>2.59</td>
<td>2.47</td>
</tr>
<tr>
<td>Skilled members (mean)</td>
<td>1.16</td>
<td>1.21</td>
<td>1.25</td>
</tr>
<tr>
<td>Household with access to pensions (%)</td>
<td>15.72</td>
<td>29.19</td>
<td>27.11</td>
</tr>
<tr>
<td>Household with migrants (%)</td>
<td>47.11</td>
<td>66.86</td>
<td>68.87</td>
</tr>
<tr>
<td>Age of the household head (mean)</td>
<td>51.93</td>
<td>55.62</td>
<td>56.14</td>
</tr>
</tbody>
</table>

Exogenous transfers are represented by pensions and remittances and are measured by the number of retired members and employed migrants in the household. Additional variables are included and concern the access to information (through media and contacts with the agricultural extension officers) the length of residency in the area and an index of labor market development constructed as the average number of employed and unemployed members in the household by district. In contrast with most of the African countries, in South Africa, unemployment is higher in rural area than in the urban centers. In particular, with the adoption of apartheid policies, millions of Africans has been segregated in the former homelands which are, in general, characterized by poor land quality. The agricultural sector, therefore, given also the large support to capital-intensive agriculture promoted by past governments, has not been able to absorb rural unemployment which still constitute a major issue for policy makers.

In the 1997 the South Africa pension system provides a maximum benefit of 370 rand a month (around half of household average income) to all women over the age of 60 and men over the age of 65 which can be reduced on the basis of individual incomes including income from assets (Case and Deaton, 1998).
To test the main predictions of the theoretical model we employ a partial generalized ordered logit with household specific thresholds. To understand the procedure applied, it is useful to start from a standard order logit specification which assumes constant thresholds and can be summarized as follows:

\[
P(d_j = 1) = P(w^*_i < w_o) \\
P(d_j = 2) = P(w_o < w^*_i < w_h) \\
P(d_j = 3) = P(w^*_i > w_h)
\]

where \(w^*_i = M\beta + v\) is the latent regression and \(M\) is a set of households characteristics and other factors exogenous to the household. According to the theoretical model the thresholds correspond to the effective market wages: \(w_o\) and \(w_h\) are the hiring out and in wages respectively. The loglikelihood function for this model is the following:

\[
l_i(\beta) = 1[d_j = 1] \log[\Lambda(w_o - M\beta)] + 1[d_j = 2] \log[\Lambda(w_h - M\beta) - \Lambda(w_o - M\beta)] + 1[d_j = 3] \log[1 - \Lambda(w_h - M\beta)]
\]

In this model a unique vector of \(\beta\) coefficients is estimated and, considering only one independent variable, \(m\), the cumulative probability outcomes are:

\[
P(d \leq 1|m) = F(w_o - \beta m) \\
P(d \leq 2|m) = F(w_h - \beta m)
\]

which are represented in Figure 3. The two curves are parallel as a consequence of equal coefficients across categories implied by the parallel regression assumption (or proportional odds assumption in the case of ordered logit) underlining standard ordinal models.

It is now possible to introduce a new feature in the model. Transactions costs and liquidity position are household specific, therefore, the thresholds are expected to differ across households and across categories. This can be implemented using a generalized ordered logit which allows for heterogenous thresholds. Assuming, for the moment, that the above mentioned set of
characteristics, $M$, affect also the thresholds\(^\text{17}\):

$$w_n = \delta_0 + M\delta_n + \varphi_n$$

where $n = o, h$, then the loglikelihood functions of the generalized ordered logit model is:

$$l_i(\beta, \delta) = 1[d_j = 1] \log[\Lambda(w_o - W(\beta - \delta_o))] + 1[d_j = 2] \log[\Lambda(w_h - W(\beta - \delta_h))] - \Lambda(w_o - W(\beta - \delta_o))] + 1[d_j = 3] \log[1 - \Lambda(w_h - W(\beta - \delta_h))]$$

The estimation gives two distinct vectors of coefficients which differ across categories ($\beta - \delta_o$ and $\beta - \delta_h$). This suggests that the parallel regression assumption can be tested comparing each pair of coefficients. A Brant test, which performs a Wald test on coefficient constancy for each variable, tests the null hypothesis that there is no difference between each pair of coefficients ($H_o : \delta_o = \delta_h = 0$). Variable presenting a significant test statistic violate the parallel regression assumption and are used as regressors in the threshold equations. Defining $Z$ as the subset of variables which fail the test and $X$ its

\(^{17}\)Note that, in this case, when variables appeared in both the latent and the threshold equations then the two effects can not be separated, only the differences $\beta - \delta_o$ and $\beta - \delta_h$ are identified.
complement, the model reduced to:

\[ P(d_j = 1) = P(X\beta + v < w_o) \]
\[ P(d_j = 2) = P(w_o < X\beta + v < w_h) \]
\[ P(d_j = 3) = P(X\beta + v > w_h) \]

where \( w_n = \delta_0 + Z\delta_n + \varphi_n \). The loglikelihood function for the partial generalized logit model is the following:

\[
l_i(\beta, \delta) = 1[d_j = 1] \log[\Lambda(w_o - X\beta + Z\delta_o)] + 1[d_j = 2] \log[\Lambda(w_h - X\beta + Z\delta_h) - \Lambda(w_o - X\beta + Z\delta_o)] + 1[d_j = 3] \log[1 - \Lambda(w_h - X\beta + Z\delta_h)]
\]

and corresponds to the function estimated in this study which results are reported in Table 4.

4 Results

The results of the coefficient constancy test, reported in Table 3, determine the allocation of each variable either to the thresholds or to the response regressions. Variables presenting a high Chi-square statistic do not satisfy the parallel regression assumption, their coefficients differ significantly across categories and have been classified as regressors in the thresholds equations. Land, labor (skilled and unskilled) and capital endowments (physical and human) are determinants of the marginal productivity of labor, \( w^* \). The length of residency is also included in the response equation. In contrast with the empirical specification of Saudolet et al. (1998), the Brant test suggests that pensions and remittances have to be included as regressors in the thresholds equations. While this finding does not alter the overall interpretation of their impact on class structure, which remains in line with previous findings, it confirms the presence of a binding liquidity constraint which affects household participation in the labor market. Considering for example equation 2, the threshold delimiting this category, \( \tilde{w}_o^1 \), incorporates a liquidity premium.

This implies that, when households face a binding liquidity constraint (\( \lambda > 0 \)), off farm earnings are valued more than their effective price (\( w_o \)). This is supported by the above results where pensions and remittances, which are supposed to relax the liquidity constraint, having, therefore, an impact.
Table 3: Brant test on Parallel Regression Assumption

<table>
<thead>
<tr>
<th>Variable</th>
<th>chi2</th>
<th>p&gt;chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land (ha)</td>
<td>3.20</td>
<td>0.074</td>
</tr>
<tr>
<td>Buildings (dummy)</td>
<td>0.13</td>
<td>0.718</td>
</tr>
<tr>
<td>Index of land quality (by district)</td>
<td>0.15</td>
<td>0.698</td>
</tr>
<tr>
<td>Unskilled labor - male</td>
<td>1.76</td>
<td>0.185</td>
</tr>
<tr>
<td>Unskilled labor - female</td>
<td>2.15</td>
<td>0.143</td>
</tr>
<tr>
<td>Skilled labor</td>
<td>0.05</td>
<td>0.819</td>
</tr>
<tr>
<td>Age of household head</td>
<td>3.19</td>
<td>0.074</td>
</tr>
<tr>
<td>Length of residency</td>
<td>2.42</td>
<td>0.120</td>
</tr>
<tr>
<td>Gender of household head</td>
<td>10.16</td>
<td>0.001</td>
</tr>
<tr>
<td>Labor market dev. index (by district)</td>
<td>7.86</td>
<td>0.005</td>
</tr>
<tr>
<td>Access to information (dummy)</td>
<td>10.93</td>
<td>0.001</td>
</tr>
<tr>
<td>Contact with extension officer (dummy)</td>
<td>8.17</td>
<td>0.004</td>
</tr>
<tr>
<td>Members receiving pensions</td>
<td>8.23</td>
<td>0.004</td>
</tr>
<tr>
<td>Migrants</td>
<td>8.84</td>
<td>0.003</td>
</tr>
</tbody>
</table>

on $\lambda$, have been found to affect the thresholds. It follows that, households in rural South Africa face a liquidity constraint which affects their labor allocation choice. The magnitude and the sign of such effects will be discussed through the interpretation of the partial generalized ordered logit results. Finally, access to information, the frequency of contacts with extension officers and the level of development of the local labor market also affect the thresholds through their influence on transaction costs.

The results of the partial generalized ordered logit are reported in Table 4. In the first column, where the determinants of the marginal productivity of labor are reported, variables with a positive coefficient are expected to have a positive effect on $w^*$ increasing the probability of belonging to a higher category. Results confirm the predictions of the comparative static exercise. Larger land size increases the marginal productivity of labor and lowers the probability of working off farm while increasing the probability of hiring in labor. The number of unskilled male and female members affects negatively the marginal productivity of labor implying that larger families tend to sell labor off farm and are less likely to hire in workers.

To interpret the last two columns of coefficients, results can be related to those from two binary logit models in which the first category (small peasants) is related to the other two and, in the last column, the first two classes are compared to the highest (hiring in households). Coefficients can be interpreted as representing the effect of the selected variables on the probability of being in a higher class through their influence on the threshold delimiting
Table 4: Results of the partial generalized ordered logit

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Small peasants</th>
<th>Self-cultivators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land (ha)</td>
<td>0.054***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buildings</td>
<td>-0.085</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.127)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unskilled labor - female</td>
<td>-0.173***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unskilled labor - male</td>
<td>-0.188***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skilled labor</td>
<td>0.056</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of household head</td>
<td>0.003</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of residency</td>
<td>0.006***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor market dev. index</td>
<td>-0.615***</td>
<td>-0.384</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.174)</td>
<td>(0.205)</td>
<td></td>
</tr>
<tr>
<td>Gender of household head</td>
<td>-0.783***</td>
<td>-0.290**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.111)</td>
<td>(0.134)</td>
<td></td>
</tr>
<tr>
<td>Access to information</td>
<td>0.007</td>
<td>0.715***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.124)</td>
<td>(0.188)</td>
<td></td>
</tr>
<tr>
<td>Contact with extension officer</td>
<td>0.086</td>
<td>0.724***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.176)</td>
<td>(0.177)</td>
<td></td>
</tr>
<tr>
<td>Members receiving pensions</td>
<td>0.713***</td>
<td>0.217*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.117)</td>
<td>(0.118)</td>
<td></td>
</tr>
<tr>
<td>Migrants</td>
<td>0.271***</td>
<td>0.077</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.055)</td>
<td>(0.057)</td>
<td></td>
</tr>
</tbody>
</table>

Province and area dummies omitted. Numbers reported in parentheses are the standard errors; *, ** and *** indicates a significance at the 10%, 5%, and 1% level respectively.

the category and reported in the table. Exogenous transfers lower the liquidity premium, $1 + \frac{\lambda}{\bar{u}_y}$, and decrease $\bar{w}_o$ (equation 2); as expected, households receiving pensions and remittances are less likely to sell labor off farm. On the other hand, transfers play a less relevant role in the decision of hiring in labor suggesting that liquidity may be a concern only for small peasant households. The degree of development of the local labor market is positively related with the effective off farm wage since a better developed market implies lower transaction costs and favors participation in the labor market; however no effect is found on the hiring in decision. Access to information, through media and contacts with extension officers, has a positive impact on the probability of being hiring in households which could be attribute to its effects on reducing searching and supervision costs. Finally, results suggest that a male headed household is more like to send members to work off farm.
and less likely to hire in labor; because in rural South Africa male heads usually tend to migrate to urban centers (Makhura, 2001), their presence in the household seems to signal a liquidity shortage which affects the labor strategy adopted.

5 Conclusions

This paper explores how, in the presence of labor market imperfections, asset endowments and liquidity affect the labor regime adopted by the household. Households are categorized on the basis of the labor strategy adopted (small peasants, self-cultivators and hiring in households) and a standard farm household model is used to explain the membership in the three groups. Labor market imperfections are translated into wage differentials where transactions costs determine the difference between the hiring in and out wages. The presence of a binding liquidity constraint rises the opportunity cost of family labor, making off farm opportunities more attractive and the hiring in of labor harder. A partial generalized ordered logit is used to test the main predictions of the model and a Brant test on coefficient constancy is employed to empirically identify household specific determinants of transaction costs and liquidity position. Results support the theoretical specification. The lack of liquidity induces household members to work off farm confirming what has been previously found in the literature (Van Zyl et al. (1995) and Fenwick and Lyne (1999)). This suggests the need for policy reforms in the rural credit sector which, according to the results, should mainly be addressed to small peasants since their labor decisions appear to be more affected by liquidity shortages. On the other hand, when non-farm activities constitute the only solution to cope with liquidity shortage, then the promotion of the development of the local labor market and infrastructures can help farmers to gain alternative income sources and escape poverty.
Appendix

A Comparative statics

The shadow wage, $w^*$ in the case of labor-autarkic households will be implicitly estimated and used as a latent decision variable in the empirical section of this study. To analyze how household characteristics and exogenous factors affects household membership in the three categories, we need first to analyze the shadow price response to changes in its determinants. To simplify this analysis we first consider the shadow price of inputs, $\tilde{p}$ as exogenously given and later we examine the factors affecting the endogenous price of non-labor inputs and how they impact the shadow wage.

For the first part we considered the following four equation which are sufficient to determine $f_1^i, w^*, x, y$:

$$
\begin{align*}
  u_1 &= u_y pqL \\
  pqL &= u_1/u_y = w^* \\
  pq_x &= \tilde{p}_x \\
  y &= pq(A, f_1^i, x) - p_x x + w_0^2 k f^2 + T - K
\end{align*}
$$

Following Singh et al. (1986) we totally differentiate these first order conditions arranging them in a matrix framework:

$$
\begin{pmatrix}
  a & -u_y pqLx & 0 & u_{1y} \\
  -pq_{LL} & -pq_{Lx} & 1 & 0 \\
  -pq_{L} & 0 & 0 & 1 \\
  -pq_{Lx} & -pq_{xx} & 0 & 0
\end{pmatrix}
\begin{pmatrix}
  df^2 \\
  dx \\
  dw \\
  dy
\end{pmatrix}
= 
\begin{pmatrix}
  u_{11} df^1 & b df^2 & cdA & (u_{1y} - u_{yy} pqL) dT & (-u_{1y} x - u_{yy} pqLx) d\tilde{p} \\
  0 & 0 & pq_{LA} dA & 0 & 0 \\
  0 & w_0^2 df^2 & pq_{A} dA & 1 & xd\tilde{p} \\
  0 & 0 & pq_{x} dA & 0 & d\tilde{p}
\end{pmatrix}
$$

where: $a = -u_{11} + u_{1y} pqL - u_{yy} pqLpqL - u_{yy} pqLL$, $b = u_{12} (1 - k) + u_{1y} w_0^2 k - u_{yy} pqLw_0^2$ and $c = u_{1y} pqA - u_{yy} pqLA - u_{yy} pqA$. Recalling Cramer’s rule, the
marginal effect of the k-th exogenous variables, $z_k$, on the shadow wage can be determined as follow:

$$\frac{\partial w^*}{\partial z_k} = \frac{1}{D} D_{wk}$$

where $D$ is the determinant of the first matrix reported above and $D_{wk}$ is the determinant of the matrix obtained substituting the k-th column in the last matrix into the third column of the first. Applying this rule to the above system of equations we obtain:

$$D = u_y(pq_{LL}pq_{xx} - pq_{Lx}pq_{Lx}) - u_{1y}pq_{Lx}pq_{xx} + u_{11}pq_{xx} - u_{1y}pq_{Lx}pq_{xx} + u_{yy}pq_{Lx}pq_{Lx}$$

In order to guarantee the existence of a maximum in the case of multiple inputs production function, the following condition need to be satisfied: $q_{LL}pq_{xx} - pq_{Lx}pq_{Lx} > 0^{18}$, therefore the overall sign of the determinant is positive.

Now it is possible to derive the sign of the arguments in the shadow wage function as reported below:

$$\frac{\partial w^*}{\partial f_1} = \frac{1}{D} - u_{11}(pq_{Lx}pq_{Lx} - q_{LL}pq_{xx}) < 0$$

$$\frac{\partial w^*}{\partial f_2} = \frac{1}{D} [u_{1y}(pq_{Lx}w^2_{pq}pq_{Lx} - pq_{LL}w^2_{pq}pq_{xx}) - (pq_{LL}pq_{xx} - pq_{Lx}pq_{Lx})] \leq 0$$

$$\frac{\partial w^*}{\partial T} = \frac{1}{D} (pq_{LL}pq_{xx} - pq_{Lx}pq_{Lx})u_{1y} + u_{1y}pq_{Lx}pq_{xx} - u_{yy}pq_{Lx}pq_{Lx}pq_{xx}) > 0$$

$$\frac{\partial w^*}{\partial \tilde{p}} = \frac{1}{D} u_{11}pq_{Lx} + u_{yy}pq_{Lx}(pq_{Lx}pq_{Lx} + pq_{LL}pq_{xx} + pq_{Lx}pq_{xx})$$

$$-u_{1y}pq_{Lx}(pq_{Lx}x + pq_{Lx}pq_{Lx}) < 0$$

$$\frac{\partial w^*}{\partial A} = \frac{1}{D} [u_{1y}pq_{Lx}(pq_{Lx}pq_{Lx} - pq_{Lx}pq_{xx} + pq_{Lx}pq_{xx})] + u_{11}(pq_{Lx}pq_{xx} - pq_{Lx}pq_{xx})$$

$$+ u_{yy}pq_{Lx}pq_{Lx}(pq_{Lx}pq_{xx} - pq_{Lx}pq_{xx}) - 2u_{yy}pq_{Lx}pq_{LL}pq_{Lx} - u_{1y}pq_{Lx}pq_{xx}] > 0$$

Given the negative relationship between non-labor input price and the shadow wage, factors relaxing the household liquidity constraint and, consequently, negatively affecting the shadow price of inputs are expected to have a positive impact on the endogenous shadow price.

---

18This condition is be used also to determined the sign of derivatives.
References


