Labor Supervision and Transaction Costs: Evidence from Bicol Rice Farms

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Abstract

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Abstract

This paper analyzes labor supervision activities reported in a survey of rice farmers in the Bicol region of the Philippines. We present a simple model that relates supervision intensity to transaction costs. The empirical estimates use different institutional conditions to proxy for transaction costs. The results confirm the prediction of the theoretical model that supervision increases with transaction costs.

Introduction

Labor markets in all economies are subject to transaction costs associated with recruiting and monitoring workers. These transaction costs typically arise due to information problems of two types: (1) the productivity of heterogeneous workers is not known with certainty (adverse selection), which leads to recruiting costs, and (2) work effort is not completely observable, verifiable and enforceable (moral hazard), which leads to monitoring costs. The exact definition of transaction costs varies in the literature. Here we adopt the expansive view that transaction costs "…involve the costs of information, search, negotiation, screening, monitoring, coordination and enforcement" (Sadoulet and de Janvry, p. 254). Transaction costs depend on various institutional arrangements (Lin and Nugent). They will be lower in environments where contracts are easily enforced, information on workers and employers is readily available and labor markets are well connected. Transaction costs will be higher if communication and transportation networks are weak and labor markets are segmented. The level of transaction costs affects labor and land contract choices and determines the extent to which family labor is advantageous over hired labor (Kikuchi and Hayami). Rural labor market transactions in developing economies, where institutions such as labor and contract law and formal employment assistance mechanisms are not in place, are regarded to be particularly sensitive to transaction costs. A number of studies of

contract choice support this contention (Hayami and Otsuka, 1993a). Other studies have argued, however, that certain transaction costs, such as information costs associated with recruitment, may be lower in close-knit village communities (Lanjouw; Otsuka, Chuma and Hayami). Transaction costs are particularly important in agricultural labor arrangements, because "…most work is not standardized and requires personal judgments…" (Hayami and Kikuchi, p. 33). The inherent difficulty of measuring transaction costs, however, has limited the empirical study of this topic.

Employers may find it beneficial to directly supervise hired workers under certain conditions in order to guarantee adequate effort by the workers. While supervision itself is costly, the increase in productivity could outweigh the cost of supervision. This is more likely if the opportunity wage of employers is low, if the cost of hired labor is high, and in environments with stronger legal institutions.

In this paper, we report an analysis of supervision activities based on a cross-section survey of rice farmers in the Bicol region in the Philippines. Philippine rice farmers are known to rely heavily on hired labor (Hayami, p. 261). This survey is unique because it provides supervision data for each farm labor activity in each plot, in addition to information on production activities and household characteristics over a range of institutional conditions. It also provides barangay (village) level variables that we use to proxy the institutional conditions. Our primary concern is to analyze the allocation of time to supervision activities on survey farms. We develop estimates of the effect of different institutional conditions on the probability of supervision and on the intensity of supervision.

Only a few studies have formally studied the demand for supervision. Empirical studies are especially rare because most micro-level surveys have not explicitly measured supervision intensities.[1] Several studies have related the demand for supervision to wages and the size of work groups. The relationship between supervision and wages can be either

negative or positive. The theoretical reasons for a negative correlation include efficiency wage models that suggest that supervision may be substituted by wage premiums when monitoring is costly (Bulow and Summers). In addition, low supervision and high wages may be both correlated with worker ability that is observable to the employer but unobservable to the econometrician. The arguments in favor of a positive relationship include (1) the compensating differentials theory which argues that workers will tolerate high levels of supervision only if they are duly compensated for the inconvenience; (2) the occupational differences argument that holds that some occupations lend themselves to high levels of shirking, making employers respond with both supervision and efficiency wage premiums; and (3) the substitution argument which says that, if labor and supervision are substitutable in production, a higher relative wage for labor would lead the employer to substitute labor with more supervision. In other words, the employer would attempt to restore the "effective labor" lost due to higher wages by supervising the existing labor more intensively. Empirical studies have found both negative (Groshen and Krueger; Kruse) and positive (Neal) correlations. Supervision also depends on the size of the work group (Taslim, Kruse, Ewing and Payne), but the sign of the effect is ambiguous: scale economies in supervision make monitoring more cost-efficient in larger work groups; on the other hand, large work groups are more difficult to supervise. Some studies have argued that the well-known inverse farm size-productivity relationship can be explained by supervision problems that "impose an effective restriction on the scale of agricultural production and dampen land productivity on farms which employ substantial amounts of hired labor" (Taslim, p. 55).

Most studies in the literature have focused on the manufacturing sector in developed countries. Among the handful of studies that deal with farm supervision in the developing country context (Taslim, Dong and Dow), none to our knowledge incorporates an explicit measure of supervision.[2] In addition, the literature has not addressed the relationship between

institutional conditions (or transaction costs) and supervision. Our unique data allows us to bridge this noticeable gap in the literature. We hypothesize that supervision intensity will be greater in environments with weak market institutions and, all else equal, possibly in larger impersonal markets.

In the next section, we develop a simple model of the determination of supervision intensity. We also perform a comparative static analysis that focuses on the effects of labor market conditions, the skill level of family labor, and transaction costs on supervision intensity. Then we present the data set, the explanatory variables, and provide descriptive statistics. After that, we present the empirical methodology we adopt for the empirical analysis. In the following section, we summarize the data. After that we report and discuss the supervision demand estimates. The final section concludes.

A Simple Model of Supervision Intensity

Assume that production is a function of effective labor (E) that is composed of family labor and hired labor[3], according to the following specification:

$$E = \mu L^f + [\alpha(\tau) + \mu g(L^s/L^h + \beta L^f/L^h)] L^h \quad (1)$$

where L^f is family labor, L^h is hired labor, and L^s is supervision (all in hours). Hence, family members provide two separate types of labor: (1) conventional labor input; and (2) direct supervision of hired workers. The parameter μ indicates the level of skills of family labor. The effectiveness of hired labor is determined by α, by the direct supervision intensity (L^s/L^h) and by the indirect supervision intensity (L^f/L^h). Assuming $g(0)=0$, α stands for the efficiency of hired labor (relative to family labor) if there is no direct or indirect supervision. We assume that due to incentive problems, α is between zero and one, implying that if only

hired labor is employed, the effectiveness of a unit of hired labor is lower than that of a unit of family labor if only family labor is employed, even if family labor has only the minimum skill level (μ=1). The most obvious reason for this assumption is moral hazard.[4] α is therefore assumed to be a function of village level institutional conditions, denoted here by τ. Bardhan acknowledged the heterogeneity of family and hired labor but claimed that hired labor could be more efficient under certain conditions. Empirical support for the heterogeneity of family and hired labor is provided by Deolalikar and Vijverberg. On the other hand, Benjamin could not reject the hypothesis that family and hired labor are equally productive.

Indirect supervision refers to the fact that family members working together with hired workers increase the effectiveness of the hired workers even if no direct supervision is performed. β, which is assumed to be between zero and one, determines the effectiveness of indirect supervision relative to direct supervision. The latter is naturally assumed to be more effective (β<1). If family members and hired workers are employed concurrently, the inequality $\alpha+\mu g()$<1 has to be satisfied, otherwise it would be more efficient to use family workers for direct supervision only. The concept of effective labor used here follows Feder and Frisvold, but their models allowed for indirect supervision only. Carter and Zimmerman distinguished between informal family supervision and specialized supervision by hired supervisors. Our treatment of direct supervision as a distinct choice variable is therefore unique and goes beyond the existing literature.

Other than working on the farm or supervising hired workers, family members also have the possibility to work off the farm. We allow the off-farm wage rate to be different from the wage paid to hired workers. Family members will work off the farm only if their earnings capacity is higher than that of hired workers. If family members and hired workers are similar in their earnings capacity then the opportunity wage is expected to be lower than

the wage that must be paid to hired workers due to transaction costs. In this case it will not be profitable for family members to work off the farm.

The farm household is assumed to maximize income, which is the sum of farm income and off-farm income:

$$I = A \cdot f(E) + w^n (L - L^f - L^s) - w^h L^h \quad (2)$$

where I is income, A·f(E) is the production function, where A is a scale parameter (reflecting non-labor inputs as well as technology) which also includes the price of farm output, L is total time devoted to work activities by family members, w^n is the off-farm wage and w^h is the wage paid to hired workers. We could have assumed a utility maximization problem in which L is a choice variable, but this would have little effect on the results. In particular, the interior solution is exactly the same as the one shown below.

Income maximization provides optimal values for hired labor, family labor, off-farm labor, and direct supervision. Any of these variables can of course be zero. Hired labor may be zero on small farms in which the returns to family labor are higher than off-farm wages (Sadoulet et al.). In this case there will obviously be no direct supervision. Family labor may be zero on farms in which the returns to family labor are lower than off-farm wages. Direct supervision may be zero on farms in which indirect supervision is almost as efficient as direct supervision. Substituting (1) into (2) and accounting for the possible corner solutions yields the following Largangean:

$$A \cdot f\{[\mu L^f + \alpha(\tau) + \mu g(L^s/L^h + \beta L^f/L^h)]L^h\} + w^n (L - L^f - L^s) - w^h L^h +$$
$$+ \delta^h L^h + \delta^f L^f + \delta^s L^s + \delta^n (L - L^f - L^s) \quad (3)$$

where δ^h, δ^f, δ^s and δ^n are the Lagrange multipliers of the constraints $L^h \geq 0$, $L^f \geq 0$, $L^s \geq 0$, and $L - L^f - L^s \geq 0$, respectively. The Kuhn-Tucker conditions for the maximization of (3) include, in addition to the constraints and the complementary-slackness conditions:

$$A \cdot f'(E)[\alpha(\tau) + \mu g(L^s/L^h + \beta L^f/L^h) - \mu(L^s/L^h + \beta L^f/L^h)\, g'(L^s/L^h + \beta L^f/L^h)] - w^h + \delta^h = 0 \quad (4)$$

$$A \cdot f'(E)\mu[1 + \beta g'(L^s/L^h + \beta L^f/L^h)] - w^n + \delta^f - \delta^n = 0 \quad (5)$$

$$A \cdot f'(E)\mu g'(L^s/L^h + \beta L^f/L^h)] - w^n + \delta^s - \delta^n = 0 \quad (6)$$

Rearranging (4), and simplifying notation by using $x \equiv L^s/L^h + \beta L^f/L^h$, we obtain:

$$A \cdot f'(E)[\alpha(\tau) + \mu g(x)] \leq w^h + A \cdot f'(E) \cdot x \cdot \mu g'(x) \quad (4)'$$

Strict equality of (4)' is the condition for hiring labor. The left-hand side is the contribution to production (and income) of a unit of hired labor, while the right-hand side is the cost of hired labor, which is composed of the direct cost (wage) and the indirect cost (an additional unit of hired labor reduces the effectiveness of all units of hired labor, given the level of supervision). It is easy to verify that farm scale (A) increases the propensity to hire labor.

Before discussing the other corner solutions, we prove the following proposition:

Proposition 1: a single interior solution for all variables is not feasible.

Proof: Assume an interior solution (all Lagrange multipliers equal zero). From (5) and (6) we obtain $1+\beta g'(x) = g'(x)$. Denote the value of x that solves this equation as x*, and notice that it is determined by β alone. Denote by g* and g'* the functions μg and $\mu g'$, respectively, evaluated at x*. Divide (4) by (5) and use x=x* to obtain: $(\alpha+g^*-x^* \cdot g'^*)/(\mu+\beta g'^*) = w^h/w^n$. Note that the left-hand side is determined by α, β and μ alone. Hence there is a single value

of w^h/ w^n that is compatible with an interior solution, and given this value we have to solve two independent equations for three unknown variables.

The proposition implies that if the household provides off-farm labor and hires labor for the farm, family members could either work on the farm (and indirectly supervise hired workers) or engage in direct supervision, but not both.[5] This result is supported by our data, which show that family labor and direct supervision coexist in the same task in only about 3% of the cases. Eswaran and Kotwal assumed that supervision time is a function of hired labor input rather than a decision variable. In their model it is possible for farm operators to both work and supervise. Our model is more general, allowing for direct and indirect supervision, and conforms better to our data.

If the household does not hire labor there is no need to supervise, and the problem reduces to a farm and off-farm labor allocation decision. A corner solution for family labor is not relevant in this case, given that we deal with active farms. If the household hires labor and the off-farm wage is high enough relative to the hired labor wage, household members could specialize in off-farm work and use only hired labor on the farm. If the off-farm wage is not high enough to guarantee specialization in off-farm employment, household members will either work or supervise. From (5) and (6), one satisfied with equality and the other remains an inequality, we obtain that at low levels of effective labor, family members will work on the farm, until the threshold E* defined implicitly by $\mu A \cdot f'(E^*) = (1-\beta)w^n$. Once effective labor rises above E*, family members will switch to supervision activities. Assuming that $f''(E)<0$, E* and the probability of supervision increase with farm size and productivity (A) and with the skill level of family labor (μ), other things equal. The role of farm attributes such as ownership of productive assets as determinants of labor regimes was emphasized by Roemer, Carter and Zimmerman, Eswaran and Kotwal, and Kevane. It is easy to see that E* and the probability of supervision are decreasing with off-farm wages. Hired

labor wages, on the other hand, decreases the amount of hired labor and hence decreases the probability of supervision, other things equal.

Given positive supervision, the level of supervision can be determined by equations (4) and (6) after setting $L^f = \delta^s = \delta^n = \delta^h = 0$. It is easier to work with supervision intensity, defined as $s = L^s/L^h$, rather than with supervision time. Optimal supervision intensity is defined implicitly by $\alpha(\tau) + \mu g(s) = \mu g'(s)(s + w^h/w^n)$. Given the reasonable assumption that g() is a well behaved twice differentiable function with g'()>0 and g''()<0, we obtain the following comparative static results with respect to the off-farm wage, w^n, the hired labor wage, w^h, the skill level of family labor, μ, and the institutional conditions, τ, respectively:

$$\frac{\partial s}{\partial w^n} = \frac{g'(s)w^h/(w^n)^2}{g''(s)[s + w^h/w^n]} < 0 \tag{7}$$

$$\frac{\partial s}{\partial w^h} = \frac{g'(s)}{-g''(s)w^n[s + w^h/w^n]} > 0 \tag{8}$$

$$\frac{\partial s}{\partial \mu} = -\frac{\alpha}{\mu g''(s)[s + w^h/w^n]} > 0 \tag{9}$$

$$\frac{\partial s}{\partial \tau} = \frac{\partial s}{\partial \alpha}\frac{\partial \alpha}{\partial \tau} = \frac{1}{g''(s)[s + w^h/w^n]}\frac{\partial \alpha}{\partial \tau} < 0 \tag{10}$$

(this last inequality holds because we assume that $\partial\alpha/\partial\tau>0$). It is interesting to note that supervision intensity is not affected by farm size and productivity. More productive farms use more hired labor and more supervision, but the ratio remains the same.[6]

Equation (7) implies that supervision intensity decreases with off-farm wages. The reasoning is quite straight-forward because off-farm wages increase the opportunity cost of the farmer's time. Equation (9) implies that supervision intensity increases with the skills of family labor. This is the opposite of the previous case because skills affect the efficiency of

farm labor and supervision only, relative to off-farm labor. Equation (8) implies that the hired labor wage has a positive effect on supervision intensity. This is because a higher wage increases the cost of hiring labor and reduces the amount of hired labor through a movement along the demand curve. Effective labor can be partly restored by increasing the supervision intensity. This can be achieved by reducing family supervision proportionately less than the reduction in hired labor, or by increasing the absolute amount of supervision. Here, we have ignored the efficiency wage argument that wages higher than the reservation wage are paid to reduce shirking by increasing the cost of shirking to the worker (Rebitzer; Vandeman et al.).

Assuming that the quality of institutional conditions τ is reducing transactions costs, (10) implies that supervision intensity decreases when institutional conditions improve. This is because better institutional conditions, reflected by a high α, decrease transaction costs through their negative effect on opportunistic behavior of the workers, namely shirking. We expect less shirking in areas with well-developed market institutions that provide alternative methods for work effort enforcement. For example, if there is an effective incentive scheme (piece rate contracts, long-term contracts, tenancy etc.) that acts as a self-enforcement mechanism for worker effort, the need for direct supervision is lower. Therefore, weaker institutional conditions lead to a lower α and more supervision.

When the off-farm wage is low enough, a corner solution with no off-farm work is possible. The properties and comparative statics of this solution are shown in the appendix. We do not go into the details here because over 72% of the households in our sample include at least one member who is engaged in wage labor. Hence, our empirical analysis will focus on the two recursive binary decisions, hiring labor and providing direct supervision, and if these decisions are made positively, on the internal solution of supervision intensity.

Data and Descriptive Statistics

The data used in this research are from the 1994 Bicol Multipurpose Survey, which was conducted in Camarines Sur, the main province of the Bicol region of the Philippines. The sample consists of 691 households from 59 different villages (barangays). The survey collected detailed information on demographics, health, income, expenditures, and farm production. The most detailed information collected was on the 264 households engaged in rice cultivation. Some of the households were cultivating rice on more than one plot, and most of them had two crops per year. Hence, we have a total of 652 observations on rice cultivation units by farm, plot, and season.

For each cultivation unit, labor input is reported for each of 16 work activities. Not all activities are reported for each plot, hence our data set includes a total of 6710 work activities. After deleting observations with missing values, 5437 observations are left for the empirical analysis. In each work activity, the labor input is reported separately for hired labor, family labor, and exchange labor. Exchange labor is ignored because it occurs in less than one percent of the activities. In most work activities, either hired labor or family labor is reported. Hired labor and family labor are reported for the same work activity in less than 3% of the cases. Figure 1 shows the number of cases in which hired labor is employed and those in which hired workers are supervised. The cases in which hired labor is employed constitute slightly more than one half of all cases.[7] Almost two thirds of the hired labor activities are supervised by family members.

Table 1 includes definitions of the explanatory variables and their descriptive statistics. We divide the explanatory variables into several groups. The first group includes a set of barangay-specific variables which proxy for institutional conditions and fixed costs of supervision. These are the distance to the nearest poblacion (market), the distance to the nearest extension service, an index of urbanization, an index of road conditions, and the

village population. The village population has a somewhat different interpretation because, all else equal, a larger market size would involve larger information costs, hence its effect on supervision intensity is ambiguous.

The second group of explanatory variables includes labor market conditions. These are the wage paid to hired workers and the off-farm wage earned by employers, which come straight out of our theoretical model. The wage of hired workers is positively related to supervision at the farm task level because, as explained earlier, supervision and hired labor are imperfect substitutes in farm production. The efficiency wage theories would, on the other hand, predict the opposite. Because efficiency wages are set individually by employers, we use village level average wages to abstract from efficiency wage consideration and to circumvent endogeneity problems that arise from the joint determination of supervision and individual-level wages (Rebitzer).

The third group includes household head characteristics and household demographic variables. Household head characteristics include gender, age and education, and they could affect the effectiveness of supervision through the skill parameter (μ). Household demographic variables include the numbers of males and females in the household. These affect the amount of time devoted to work by family members (L). The fourth group consists of farm characteristics which affect the choice to supervise hired labor through the scale parameter (A). These include the land area of the farm, a dummy for the rainy season, two dummies for using gravity irrigation and pump irrigation (the excluded group is rainfed plots), and a dummy for plots which are located in the same barangay as the residence of the farm operator. The last group of explanatory variables includes employee characteristics. These are the number of hired workers, a dummy for hired workers that were hired through a labor contractor (team contract), a dummy for hired workers that are employed under a time rate contract (as opposed to a piece rate contract), and a dummy for a strong personal bond

between the workers and the employer. These variables are naturally relevant only for activities in which hired labor is employed.

Empirical Specification

Our theoretical model dictates an empirical specification with three components: the binary decision to hire labor, the binary decision to directly supervise hired labor, and the continuous decision on the supervision intensity. Supervision intensity is conditional on the decision to supervise, which in turn is conditional on the decision to hire labor. Our first choice for a suitable empirical model would be a bivariate probit model with sample selection (Greene, p. 713) for the two binary decisions, and a selectivity-corrected linear regression for the supervision intensity. However, the bivariate probit model did not perform well: in some cases the correlation coefficient approached the boundary of its permissible range (plus or minus one). Therefore we do not present these results. Alternatively, we chose to model the two binary decisions as a multinomial choice model:

$$
\begin{array}{llll}
Y = & 1 \quad \text{if} \quad L^h \le 0 & \text{(no hired labor)} & \\
& 2 \quad \text{if} \quad L^h > 0 \text{ and } L^s \le 0 & \text{(hired labor, no supervision)} & (11) \\
& 3 \quad \text{if} \quad L^h > 0 \text{ and } L^s > 0 & \text{(hired labor, supervision)} &
\end{array}
$$

We adopt the multinomial logit specification (Greene, p. 720), yielding the following choice probabilities:

$$
\text{Prob}(Y_i = j) = \frac{e^{\beta_j' x_i}}{1 + e^{\beta_2' x_i} + e^{\beta_3' x_i}} \quad \text{for} \quad j = 1,2,3 \quad \text{and} \quad \beta_0 = 0 \qquad (12)
$$

where x_i is a vector of explanatory variables and β_j is a choice-specific vector of coefficients. The multinomial logit model is based on a somewhat restrictive set of distributional assumptions, however a Hausman (1978) test of the independence from irrelevant alternatives (Greene, p. 724) supported the use of this model in all cases except for one.[8] Subsequently, we estimate the supervision intensity equation by a log-linear regression, using only observations with positive supervision. This equation is corrected for selectivity using the method suggested by Bourguignon, Fournier and Gurgand. This method involves adding selectivity-correction terms, one for each possible choice in the first stage, to the linear regression that is estimated in the second stage. These terms are computed using transformed residuals from the first stage. Further details are in Bourguignon, Fournier and Gurgand.

In addition, we want to correct for the fact that the choice between time-rate and piece-rate contracts may be endogenous to the supervision decisions. This may be the case if piece-rate contracts are used as a self-monitoring mechanism when direct supervision by the employer is costly. The literature on the piece rate vs. time rate choice has distinguished "effort" shirking from "quality" shirking. "Effort" shirking occurs when a worker fails to produce the highest possible amount of output in a given time. "Quality" shirking occurs when a worker fails to produce the best possible quality of output given an observed level of effort. It has been argued that piece rate contracts are designed to minimize "effort" shirking by rewarding the worker with a pay proportionate to observed effort (Stiglitz, Lucas, Roumasset and Uy). "Quality" shirking, on the other hand, can only be mitigated by supervision. The choice between piece and time rate is therefore a function of the magnitudes of quality and effort shirking as well as the marginal effect of supervision on each type of shirking. Piece rates would also be preferred if workers are heterogeneous and there is a need to screen workers to prevent adverse selection (Stiglitz). However, they are not appropriate if

it is difficult to set the appropriate implicit wage. In this case, there is an additional excess burden due to this uncertainty where the implicit wage is not equal to the opportunity wage.

The different enforcement advantages of piece and time rate contracts are seen clearly by how different tasks are assigned to the two contracts. Land preparation, weeding and planting in the Philippines are usually undertaken under "Pakyaw", a form of piece rate where workers are paid according to the land area covered (Roumasset and Uy). Harvesting is largely carried out under the traditional piece rate arrangement while chemical application is almost always under time rate. Quality shirking is easy to monitor in harvesting, but hard to monitor in chemical application. In addition, because harvesting is highly seasonal and requires large amounts of labor, screening is difficult. Both these attributes make harvesting especially amenable to piece rates.

Therefore we want to reconstruct our empirical model to account for the fact that labor contract and supervision choices are made jointly.[9] Because of the difficulties in identifying the two effects in a system of simultaneous equations, we adopt a modified selection model whereby the supervision intensity equations are estimated conditional on both the choice to supervise and the choice of labor contract. The resulting choice model is:

$$
Y = \begin{cases} 1 & \text{(no hired labor)} \\ 2 & \text{(hired labor, time-rate contract, no supervision)} \\ 3 & \text{(hired labor, time-rate contract, supervision)} \\ 4 & \text{(hired labor, piece-rate contract, no supervision)} \\ 5 & \text{(hired labor, piece-rate contract, supervision)} \end{cases} \tag{13}
$$

The supervision intensity equations are then estimated separately for choice 3 and choice 5, correcting for selectivity as explained above.

Estimation Results

We have estimated the model separately for four different types of work activities: land preparation, planting, caring and harvesting, and also for the whole data set. In each case we also included dummies for the different work activities. We report only the results for the whole data set. The type-specific results were not much different qualitatively, and their statistical significance was in many cases lower due to the smaller number of observations. Those results are available from the authors upon request.

Table 2 includes the multinomial logit coefficients of the "hire and supervise" equation, where the base category is "hire and not supervise". Therefore, the coefficients measure the effect of explanatory variables on the probability to supervise, conditional on hiring labor. The coefficients of the "not hire" equation are not reported here, they are available from the authors upon request. Table 3 includes the supervision intensity coefficients. In both tables, we report the results for the whole sample and also the results of the model in which the labor contract is endogenous. For the latter, we have different coefficients for time-rate contracts and piece-rate contracts. In the following paragraphs, we discuss the results of both stages for the five different sets of explanatory variables.

1) Barangay Variables

The probability of supervision decreases with the distance to extension services, and increases with the index of road conditions. These results could be due to a fixed cost of supervision. The probability of supervision also decreases with the level of urbanization, indicating a greater need to supervise in more rural areas, perhaps because of higher labor market transaction costs. Village population decreases the probability of supervision, contradicting our hypothesis that information costs in larger impersonal markets will lead to

more supervision. This last result is valid for piece-rate contracts as well, whereas the other institutional effects are valid for time-rate contracts only.

Supervision intensity is increasing with the distance to the nearest market and decreases with the level of urbanization (table 3). These results support our hypothesis that higher transactions costs in more remote and rural areas increase the need to supervise hired workers. However, this is true only for time-rate contracts. It appears, therefore, that piece-rate labor contracts indeed provide a self-enforcing mechanism that substitutes for direct supervision. Supervision intensity also increases with the index of road conditions, but the effect disappears after controlling for the type of labor contract, hence we do not attach much importance to this result. Village population does not have a statistically significant effect on supervision intensity.

The coefficients of the barangay variables imply that institutional conditions are important determinants of the demand for supervision time, but fixed costs of supervision also play a role in the decision to directly supervise hired workers. The fact that institutional conditions are more likely to positively influence supervision in time rate contracts is not surprising because the need for supervision is removed to a large extent by piece rate contracts. Typically, the employer's two choices are piece rate with little supervision and time rate with substantial supervision.

2) Labor Market Conditions

The wage of hired workers is positively related to both the probability of supervision and supervision intensity. This is consistent with our theory (equation 8). Since supervision time is provided by the employer, his opportunity wage is expected to be negatively related with supervision intensity (equation 7). This is supported by our empirical results only for the

case of time-rate labor contracts. The opportunity wage does not have a statistically-significant effect on the decision to supervise.

3) Employer Characteristics

Considering the characteristics of the household head (who we assume to be the farmer), we find that male household heads are more likely to engage in direct supervision. In addition, older employers are more likely to supervise (with the exception of piece-rate employees). However, these two variables do not have statistically significant effects on supervision intensity. Education of the employer reduces the probability of supervision (in the case of time-rate contracts only) and also reduces supervision intensity. This is contrary to our theoretical expectations (equation 9). The household labor endowments increase the family to hired labor ratio and thereby the scope for supervision (Taslim). However, they do not have statistically significant effects here, except for a negative effect of the number of female adults on supervision intensity. This could be due to social considerations that may prevent females from supervising the largely male hired workforce.

4) Farm Characteristics

According to our theoretical model, farm characteristics affect the propensity to supervise hired labor but not supervision intensity. We find that farm size decreases the probability of supervision, especially in the case of piece-rate labor contracts. The effect of farm size, controlling for the number of supervisors and supervisees, depends on whether there are spatial scale diseconomies to supervision. It could be that as the farm size increases, the need for supervision increases because workers are more spatially dispersed, and this may induce some farmers to give up supervision altogether. When we estimated the model

separately for each type of work activity, we found that this is indeed the case for planting and caring tasks, the two types of tasks that tend to be relatively more spatially dispersed.

The use of irrigation should increase the productivity of labor and therefore increase the benefits of supervision. As expected, we find that irrigation increases the probability of supervision. Having a plot in the same barangay of residence decreases the probability of supervision, but the effect is only marginally significant.

5) Employee Characteristics

Although we do not know the age, education and other demographic characteristics of the workers, we have information on the number of workers (size of work group), the relationship of workers to the employer, the form of wage contract (piece rate vs. time rate) and whether the workers were hired as a team. These variables cannot be used in the first-stage selection model, because they are observed only for the cases with hired labor.

Work group size may either increase or decrease supervision intensity depending on scale economies of the technology of supervision. We find that the number of workers decrease supervision intensity, but mostly in piece-rate contracts. The effect of a team contract is not statistically significant, while a time-rate contract decreases supervision intensity. This last effect may be a result of the endogeneity of choice of contract, and we take care of this by estimating the joint selection model. A close personal relationship between worker and employer reduces the need for supervision, and this is evident in the case of time-rate labor contracts.

Conclusions

Direct supervision of hired workers is a directly unproductive activity that diverts a farmer's valuable time from other income generating activities. A farmer would engage in

direct supervision only if the effort of workers cannot be enforced adequately by self-enforcement mechanisms such as contracts, and only if the benefits of supervision in terms of increased productivity of hired workers outweigh the costs of supervision in terms of opportunity wages of family members.

The primary objective of this paper was to establish whether farmers respond to a weak institutional environment (where there is little scope for formal contracting) by increasing the direct supervision of workers. We develop a theoretical model that extends the existing literature by treating direct supervision time as a distinct decision variable, thereby allowing us to capture the effects of supervision in more detail. Our unique data set from the Bicol region in the Philippines allows us to explicitly estimate supervision intensity equations. We proxy institutional conditions with barangay (village) level indicators of urbanization and access to markets. Our results confirm that barangay-level transaction costs increase the intensity of supervision. This result has policy implications: improving labor and contract laws and the access to markets will reduce transaction costs of labor contracts. This will reduce the need for direct supervision and enable farmers to intensify their own labor inputs on the farm or work in off-farm activities.

Predicted supervision intensity could be used as an explanatory variable in the estimation of farming efficiency. Transaction costs reduce efficiency, but farmers can mitigate some of this effect by increasing supervision intensity. An empirical study along these lines could add to the empirical literature on transaction costs, which has so far been limited to a handful of studies (Lanzona and Evenson).

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Appendix

When off-farm labor is zero, the internal solution is characterized, using the notation in the text, by the following two conditions:

$$(1-\beta)L^f + x^*L^h = L \qquad \text{(A1)}$$

$$(\alpha+\mu g^*-\mu x^*\cdot g'^*)Af'(E) = w^h \qquad \text{(A2)}$$

Given (A1), it can be shown that $E = \mu g'^*L + (\alpha+\mu g^*-\mu x^*\cdot g'^*)L^h$. Hence, (A2) provides a solution for L^h. Comparative static analysis of (A2) shows that hired labor is decreasing in wage (w^h), family labor skills (μ) and family labor availability (L), and increasing in farm size and productivity (A). The effect of transaction costs on hired labor is ambiguous and depends on β. Differentiating (A1), we obtain that $dL^s = -dL^f = g'^*(x^*dL^h - dL)$. Therefore, supervision moves in the same direction as hired labor. For supervision intensity (s), however, the only unambiguous comparative static result is that it increases with family labor availability (L). The other effects could go either way, depending on β.

Turning to the corner solutions, it can be seen from (A1) that families will not supervise if $L^h < \beta L/x^*$ and will only supervise if $L^h > L/x^*$. Here we cannot rule out that family members will both work and supervise. In any case, the probability of supervision moves in the same direction as the level of supervision and hired labor, namely decreasing in wage (w^h), family labor skills (μ) and family labor availability (L), and increasing in farm size and productivity (A).

Notes

[1] Some examples of empirical studies are Groshen and Krueger, Kruse, Neal, Ewing and Payne, Dong and Dow, Rebitzer, Taslim.

[2] Kruse and Neal are the only studies that we found that use hours of supervision time even for developed countries.

[3] Khandker specified "effective input" as a nonlinear function of supervision time.

[4] It is quite possible that moral hazard problems would exist even among family members, especially for children of the owner whose consumption level may be independent of their effort in farm work. We, like most other studies of family and hired labor, assume that the intra-family incentive schemes function well compared to incentives faced by wage laborers.

[5] This result is an implication of the linearity of x in L^f and L^s.

[6] This does not hold if off-farm labor is zero, in which case family size (L) will also affect the choice of labor allocation regime and supervision intensity. Complete comparative static results for this case are available from the authors upon request.

[7] There are vast differences in labor utilization patterns between different types of activities. Hayami and Otsuka (1993b) report that transplanting and harvesting are generally conducted by hired workers in the Philippines, while land preparation and caring are normally the responsibility of family members. In an earlier version we have analyzed each type of activity separately, but the results were not meaningfully different.

[8] We have used the Huber-White estimate of the covariance matrix which is consistent under heteroscedasticity

[9] Alston, Datta and Nugent studied the simultaneous determination of direct supervision and contractual choice in the presence of transactions costs in American plantation farms.

Table 1 : Descriptive Statistics

Variable Name	Mean	St. Dev.	Range	Definition
Barangay variables				
Distance to Market	5.2424	5.1368	0-31	Distance from barangay (village) to the nearest Poblacion (market), km
Distance to Extension Service	2.2887	2.7009	0-8	Distance from barangay (village) to the nearest extension service, km
Urbanization Index	3.6947	1.1895	1-5	Index of urbanization (1=lowest, 5=highest)
Road Conditions Index	3.0237	0.8859	1-4	Index of road conditions (1=worst, 4=best)
Village Population	2355	1432	690-9000	Population of the barangay (village)
Labor market conditions				
Average Worker Wage	74.2378	24.0518	40.8-258.2	Daily wage of hired workers (peso)
Employer Opportunity Wage	52.2978	17.2445	10.0-123.1	Daily off-farm labor earnings of family members, peso
Employer characteristics				
Male Employer	0.7946	0.4041	0-1	Dummy for a male head of household
Age of Employer	58.2286	11.0056	37-87	Age of household head
Education of Employer	6.8207	3.5614	0-17	Years of schooling of the head of household
Male Adults	3.8315	2.0979	0-13	Number of adult male household members
Female Adults	3.8816	1.7881	0-10	Number of adult female household members
Farm characteristics				
Farm Size	1.8433	3.3540	0.1-30.2	Land area of the farm (hectares)
Rainy Season (Dummy)	0.5328	0.4990	0-1	Dummy for the rainy season
Gravity Irrigation (Dummy)	0.4221	0.4939	0-1	Dummy for using gravity irrigation
Pump Irrigation (Dummy)	0.1922	0.3941	0-1	Dummy for using pump irrigation
Local Resident (Dummy)	0.7988	0.4009	0-1	Plot located in the same barangay as the residence of the household head
Employee characteristics (cases with hired workers only)				
Number of Workers	4.2446	5.8649	1-54	Number of hired workers
Team Contract (Dummy)	0.1194	0.3243	0-1	Dummy for hiring workers through a contractor
Time Rate Contract (Dummy)	0.6114	0.4875	0-1	Dummy for a time-rate labor contract
Relationship (Dummy)	0.7602	0.4270	0-1	Worker has a strong personal bond with employer

Table 2: Multinomial Logit Results, Supervision versus Hiring with no Supervision

	All Hired Workers		Workers on Time Rates		Workers on Piece Rates	
Variable	Coefficient	Z-ratio	Coefficient	Z-ratio	Coefficient	Z-ratio
Intercept	-0.0726	-0.06	-0.1073	-0.07	-0.9886	-0.54
Barangay variables						
Distance to Market	0.0019	0.03	0.0307	0.33	-0.0134	-0.11
Distance to Extension Service	-0.1339	-2.13 *	-0.3466	-4.21 **	0.2068	2.03 *
Urbanization Index	-0.1282	-2.95 **	-0.1773	-3.23 **	0.0011	0.02
Road Conditions Index	0.1803	3.22 **	0.2353	3.4 **	0.0889	0.92
Village Population	-0.4443	-4.28 **	-0.3570	-2.64 **	-0.5304	-3.22 **
Labor market conditions						
Average Worker Wage	0.7637	3.97 **	0.4532	1.74	1.3302	4.22 **
Employer Opportunity Wage	0.0166	0.15	0.2425	1.69	-0.3303	-1.77
Employer characteristics						
Male Employer	0.6931	6.72 **	0.7126	5.44 **	0.6468	3.7 **
Age of Employer	0.0148	3.52 **	0.0215	4.17 **	0.0030	0.42
Education of Employer	-0.0207	-1.53	-0.0341	-2.02 *	-0.0060	-0.28
Male Adults	0.0016	0.08	0.0112	0.41	-0.0063	-0.19
Female Adults	-0.0244	-1.08	-0.0444	-1.58	0.0151	0.41
Farm characteristics						
Farm Size	-0.0830	-2.19 *	-0.0482	-1.03	-0.1570	-2.51 *
Rainy Season	-0.0172	-0.22	-0.0702	-0.7	0.0506	0.39
Gravity Irrigation	0.2051	1.93	0.0076	0.06	0.4211	2.47 *
Pump Irrigation	0.4462	3.95 **	0.3942	2.64 **	0.5160	2.92 **
Local Resident	-0.1086	-1.01	-0.3443	-2.49 *	0.2859	1.69

* significant at 5%; ** significant at 1%; activity dummies not shown.

Table 3: Supervision Intensity Results, Cases with Positive Supervision

	All Hired Workers		Workers on Time Rates		Workers on Piece Rates	
Variable	Coefficient	Z-ratio	Coefficient	Z-ratio	Coefficient	Z-ratio
Intercept	-2.7216	-3.95 **	-3.2342	-3.18 **	-2.7895	-1.55
Barangay variables						
Distance to Market	0.1285	3.20 **	0.2483	3.53 **	-0.0422	-0.65
Distance to Extension Service	0.0496	1.17	0.1402	1.44	0.1043	1.17
Urbanization Index	-0.1019	-3.70 **	-0.1103	-1.61	0.0483	0.85
Road Conditions Index	0.0734	1.97 *	0.0462	0.51	-0.0446	-0.59
Village Population	0.0625	0.72	0.1788	1.12	0.1346	0.89
Labor market conditions						
Average Worker Wage	0.4680	3.48 **	0.6848	2.71 **	0.2897	1.19
Employer Opportunity Wage	-0.1253	-1.72	-0.3403	-2.46 *	-0.0894	-0.86
Employer characteristics						
Male Employer	-0.0217	-0.21	-0.1413	-0.77	-0.3430	-1.92
Age of Employer	-0.0008	-0.27	-0.0068	-0.92	-0.0047	-0.87
Education of Employer	-0.0346	-3.73 **	-0.0275	-1.72	-0.0234	-1.33
Male Adults	0.0069	0.62	-0.0064	-0.33	0.0089	0.50
Female Adults	-0.0465	-3.03 **	-0.0393	-1.24	-0.0166	-0.71
Employee characteristics						
Number of Workers	-0.2024	-7.99 **	-0.0466	-1.11	-0.3598	-11.19 **
Team Contract	-0.0318	-0.46	-0.0837	-0.72	0.0187	0.22
Time Rate Contract	-0.1522	-3.06 **				
Relationship	-0.0655	-1.31	-0.1673	-2.45 *	0.0700	0.89

* significant at 5%; ** significant at 1%; activity dummies and selectivity-correction terms not shown.

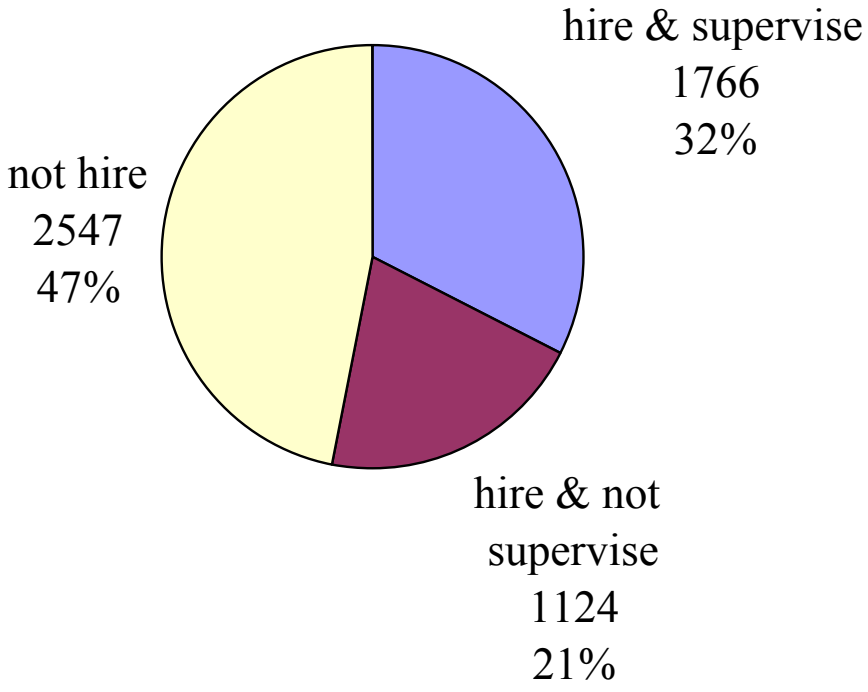

Figure 1: Statistics on Hiring and Supervision Decisions