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HOUSEHOLD BEHAVIOR WITH IMPERFECT LABOR MARKETS

by

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Abstract

A household model with differential asset endowments and idiosyncratic transactions costs in accessing labor markets is developed to (1) explain membership of farm households to alternative labor regimes (sellers, employers, or self-sufficient in labor), (2) test for recursivity between production and consumption decisions selectively by labor regime, and (3) identify the determinants of differential labor productivity across labor regimes. The model is applied to a 1994 household survey of the Mexican land reform sector.

JEL classification: D1: Household behavior; J22: Time allocation and labor supply; J23: Employment determination, demand for labor, self-employment.

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I. Uneven Market Integration and Tests of Recursiveness in Household Models

Farm households are typically characterized by differential asset positions that influence their family labor supply (depending on endowments in different labor skills) and their demand for farm labor (depending on land and fixed capital). In addition, the labor markets to which they relate are typically characterized by large transactions costs that make effective wages received when selling labor and effective wages paid when hiring labor diverge, creating wide idiosyncratic price bands around the market wage. The consequence of these two features is that farm households are differentially integrated into labor markets, with some selling labor services, others hiring labor, and yet others opting for labor self-sufficiency.

This differential market integration has two important consequences for the analysis of labor decisions. One is in the modeling of household behavior. If households sell or hire labor and family labor can be substituted for hired labor in production, the opportunity cost of family labor is the effective wage received if they are sellers and paid if employers. In this case, if there are no other market failures, production decisions can be taken independently from consumption decisions: the solution to the household model is recursive, with the production problem being solved before the consumption problem, and the two are linked through the income level achieved in production (Singh, Squire, and Strauss, 1986). If, by contrast, the household is self-sufficient in labor, then production and consumption (which includes leisure) are linked through the time constraint, and the two problems must be solved simultaneously. The determinants of consumption choices need to be included in the analysis of production decisions. The second consequence is that membership to different labor regimes as sellers, employers, or self-sufficient, implies differential responses to policy interventions that affect the market wage or transactions costs. Categorizing rural households by type of market integration is consequently useful to analyze the differential impact of policy interventions across households and to design differentiated interventions for particular household types.

The most celebrated such categorization of households by type of labor market integration is in the work of Roemer (1982) on endogenous class formation, and it was rigorously applied to agrarian classes by Eswaran and Kotwal (1986). In this latter case, rural households are endowed with different levels of assets, and they maximize utility in an environment characterized by access to working capital constrained by collateral ownership and by moral hazards associated with hired labor, implying the need to incur supervision costs. Rational choice by these households leads them to choose differential labor strategies and thus to belong to different labor regimes, i.e., social classes. Behavioral choices also explain performance, such as the labor/land ratio and factor productivity, and hence the eventual existence of the celebrated inverse relation between yields and farm size [Bardhan (1973), Feder (1985), Lipton (1985)].

Frisvold (1994) estimated the supervision response function that is essential for the Eswaran and Kotwal model, obtaining a significant but low elasticity of labor effort with respect to supervision by family members. Carter (1990) quantified the structural form of the Eswaran and Kotwal model, specifying particular functions describing credit rationing and supervision. This allowed him to simulate the shape of the restricted profit (land rent) function across classes. The farm class at which this function peaks is expectedly the class toward which land transactions would make farm holdings converge. These empirical efforts are important steps toward making the Eswaran and Kotwal-type endogenous classification of rural households by labor regime usable for policy analysis.

In this paper, we construct a model of household behavior that predicts membership in different labor regimes and provide a rigorous test of recursiveness selectively by labor regime. The model specifies household labor qualities with differential opportunity costs and transactions costs in access to labor markets. The model predicts that high-skill family labor should work off-farm. It also predicts that landed households may be categorized into three labor regimes--sellers of labor, self-sufficient in labor, and employers--according to the value of the shadow wage of unskilled family labor relative to the wages received when working off-farm and paid to hired labor. The predictors of the shadow wage are the household's asset position: agricultural assets, unskilled and skilled labor endowments, and exogenous transfers. We use data from a 1994 survey of ejidatario (land reform sector) households in Mexico to validate these propositions. An ordered probit approach shows the predictive power of this typology and helps identify other variables that explain household membership in these categories.

The model postulates that recursiveness holds for labor sellers and buyers, while non-recursiveness applies for the labor self-sufficient households. Recursiveness implies that labor intensity and labor productivity do not vary with the asset position of households, while they are affected by asset position when recursiveness does not hold, providing a test of the model. This test of the recursiveness hypothesis selectively by household types differs from previous tests of recursiveness which looked for recursiveness globally across all households. In a pioneering paper, Lopez (1984) had shown that there is imperfect substitution between on-farm and off-farm labor, and thus rejected recursiveness globally. Similarly, Benjamin's (1992) test on the role of household demographic variables on labor use in planting, weeding, and hoeing (which should be zero if recursiveness holds), led him to reject recursiveness globally across the whole sample of rural Javanese households analyzed. Jacoby (1993) derived the shadow wage from estimation of a production function and rejected the hypothesis that it is equal to the market wage across the whole sample of rural Peruvian households analyzed, implying global non-recursiveness. A similar result was obtained by Skoufias (1994) with a sample of Indian rural households.

Identification of the determinants of labor productivity by household category also allows for the tracking of differential impact of policy instruments across household types and designing of differentiated policy interventions. The paper thus provides an identification of the determinants of membership in labor regimes, a test of recursiveness selective by labor regime, and an identification of the determinants of differentiated labor productivity levels across labor regimes. It also illustrates how the approach offers an effective tool for the micro-level analysis of policy in a context of heterogenous market integration.

II. A Model of Household Behavior and Endogenous Labor Regimes

The purpose of our model is to accommodate a commonly observed fact that households both sell and hire labor. It also capture the existence of high transactions costs in relating to labor market which amount to a large price difference (price band) between low effective wages received and high effective wages paid (Lopez, 1986; Sadoulet and de Janvry, Chapter 6, 1995).

The household considered has two categories of family labor, unskilled labor in quantity f^1 and skilled labor in quantity f^2. These two labor categories have different opportunity costs w_o^1 and w_o^2 on the labor market. The household can also hire *h* workers at unit cost w_h. Hired workers are unskilled workers, typically originating in other farm households with a labor surplus who need to be paid the market wage and on whom additional unit costs are incurred for search and supervision, resulting in an effective cost w_h. Unskilled household labor is defined as family members who are cheaper than unskilled hired workers, while skilled labor are family members with opportunity cost on the labor market higher than hired workers' cost to the farm. Hence, $w_o^1 < w_h < w_o^2$. Family labor allocates its time (f^1 and f^2) between on-farm work (f_i^1 and f_i^2), off-farm activities (f_o^1 and f_o^2), and home time or leisure (f_l^1 and f_l^2).

The household produces a single output *q* with a fixed amount of farm assets *A* and labor.[1] Family labor and hired workers are perfect substitutes in agricultural activities, despite their differential skills and opportunity costs. The household maximizes a utility function in the home time of unskilled and skilled family members and in income *y*:

$$\max_{h, f_i^1, f_i^2, f_o^1, f_o^2} u\left(f^1 - f_i^1 - f_o^1, f^2 - f_i^2 - f_o^2, y\right), \text{ where income is}$$

$$y = pq\left(A, h + f_i^1 + f_i^2\right) - w_h h + w_o^1 f_o^1 + w_o^2 f_o^2 + T,$$

subject to the non-negativity constraints

[1] This assumes that there is no land market, which is largely true in the Mexican ejido. Hence, for given fixed assets, all adjustments are made on the labor market.

$h, f_i^1, f_i^2, f_o^1, f_o^2, f_l^1 = f^1 - f_i^1 - f_o^1$, and $f_l^2 = f^2 - f_i^2 - f_o^2 \geq 0$.

In these equations, p is output price, and T are exogenous transfers. The production function q and the utility function u are assumed to be increasing, strictly concave, and continuously differentiable in their arguments. We also assume complementarity between inputs in production, $q_{AL} > 0$ (where $L = h + f_i^1 + f_i^2$), and between leisure and income, $u_{1y}, u_{2y} > 0$. We add the simplifying assumption that $u_{12} = 0$, i.e., that the marginal utility of leisure of unskilled family members is unaffected by the leisure of skilled family members.

These assumptions on $q(.)$ and $u(.)$ ensure that the problem admits only one solution given by the Kuhn-Tucker conditions:

(1) $u_y\left(pq_L - w_h\right) + \mu_h \leq 0,\ h \geq 0,$ and $h\left[u_y\left(pq_L - w_h\right) + \mu_h\right] = 0,$

(2) $u_y pq_L - u_1 + \mu_i^1 - \mu_l^1 \leq 0,\ f_i^1 \geq 0,$ and $f_i^1\left[u_y pq_L - u_1 + \mu_i^1 - \mu_l^1\right] = 0,$

(3) $u_y pq_L - u_2 + \mu_i^2 - \mu_l^2 \leq 0,\ f_i^2 \geq 0,$ and $f_i^2\left[u_y pq_L - u_2 + \mu_i^2 - \mu_l^2\right] = 0,$

(4) $u_y w_o^1 - u_1 + \mu_o^1 - \mu_l^1 \leq 0,\ f_o^1 \geq 0,$ and $f_o^1\left[u_y w_o^1 - u_1 + \mu_o^1 - \mu_l^1\right] = 0,$

(5) $u_y w_o^2 - u_2 + \mu_o^2 - \mu_l^2 \leq 0,\ f_o^2 \geq 0,$ and $f_o^2\left[u_y w_o^2 - u_2 + \mu_o^2 - \mu_l^2\right] = 0,$

(6) $\mu_m^n \geq 0,\ f_m^n \geq 0,$ and $\mu_m^n f_m^n = 0$ for $m = i, o, l$ and $n = 1, 2,$

(7) $\mu_h \geq 0,\ h \geq 0,$ and $\mu_h h = 0,$

where q_L is the marginal productivity of labor, u_1 and u_2 the marginal utilities of leisure for unskilled and skilled labor, respectively, u_y the marginal utility of income, and $\mu_h, \mu_i^1, \mu_i^2, \mu_o^1, \mu_o^2, \mu_l^1,$ and μ_l^2 the slack variables and Lagrange multipliers associated with the non-negativity constraints.

These non-negativity conditions imply the following properties for the solution:

Proposition 1. *Skilled family labor never works on farm.*

This is shown by substituting (1) and (5) in (3), which gives:

$$\mu_i^2 = -u_y pq_L + u_2 + \mu_l^2 = u_y\left(w_o^2 - w_h\right) + \mu_o^2 + \mu_h > 0,$$

and hence $f_i^2 = 0$.

Proposition 2. *If there is hired labor, no unskilled family labor works off-farm. Conversely, if unskilled family labor works off-farm, there is no hired labor*.

If the household is hiring, $h > 0$ and $\mu_h = 0$. From (1), $pq_L = w_h$, and (2) and (4), we get $\mu_o^1 = \mu_i^1 + u_y\left(w_h - w_o^1\right) > 0$, and hence $f_o^1 = 0$. If $f_o^1 > 0, \mu_o^1 = 0$, and substituting (2) and (4) into (1), gives $\mu_h = -u_y pq_L + u_y w_h = \mu_i^1 + u_y\left(w_h - w_o^1\right) > 0$, and hence $h = 0$.

We now turn to the derivation of the household's optimal labor strategies. Solution of the problem reveals that the household's optimal strategy depends on its initial endowments in land and in unskilled and skilled family labor, and on exogenous transfers. This result thus explains how differential labor strategies emerge endogenously as a consequence of rational choice behavior in the context of unequal initial asset distribution.

In principle, skilled labor time is allocated between home time and off-farm work in order to equalize the marginal utility of home time with the wage, i.e.,

$$u_2 - u_y w_o^2 = 0.$$

However, we can simplify behavior in the model by assuming that, once a skilled family member has decided to work outside the household, little flexibility remains between time worked and home time. This is because the time commitment to skilled labor employment is lumpy (e.g., 8 to 5 jobs or fixed seasonal migration). In this case, f_o^2 is a fixed share *k* of total time available, i.e., $f_o^2 = kf^2$.

The choice of h, f_i^1, f_o^1 is determined by:

$$\max_{h, f_i^1, f_o^1} u\left(f^1 - f_i^1 - f_o^1, (1-k)f^2, y = pq(A, h + f_i^1) - w_h h + w_o^1 f_o^1 + w_o^2 kf^2 + T\right). \tag{8}$$

Define now the shadow wage w^* of unskilled labor as its marginal productivity if the household were self-sufficient in labor. The equilibrium labor allocation under self-sufficiency, f_i^{1*}, and the shadow wage w^* are defined by the system of three equations:

$$\begin{aligned} &u_1\left(f^1 - f_i^{1*}, (1-k)f^2, y^*\right) = u_y pq_L\left(A, f_i^{1*}\right), \\ &w^* = pq_L, \\ &y^* = pq\left(A, f_i^{1*}\right) + w_o^2 kf^2 + T. \end{aligned} \tag{9}$$

The shadow wage is thus a function of the household's farm and labor assets and exogenous incomes,

$$w^* = w^*\left(A, f^1, f^2, T\right).$$

To sign the arguments of this function, we take the total differential of these three equations. After substituting to eliminate df_i^1 and dy, we get the following expression:

$$dw^* = \frac{1}{D}\left[\left(u_{1y} - u_{yy}pq_L\right)\left(pq_L pq_{AL} - pq_A pq_{LL}\right) - pq_{AL}\left(u_{11} - u_{1y}pq_L\right)\right]dA +$$
$$\frac{1}{D}pq_{LL}\left(u_{1y}pq_L - u_{11}\right)df^1 +$$
$$\frac{1}{D}pq_{LL}\left[-u_{1y}w_o^2 k + pq_L\left(u_{yy}w_o^2 k + u_{2y}(1-k)\right)\right]df^2 +$$
$$\frac{1}{D}pq_{LL}\left(u_{yy}pq_L - u_{1y}\right)dT,$$

where $D = -u_{11} + u_{1y}pq_L - u_y pq_{LL} - \left(u_{yy}pq_L - u_{1y}\right)pq_L > 0$.

In this equation, the first term is positive, the second negative, and the last positive. The sign of the term in df^2 is ambiguous since the effect of df^2 on the marginal utility of income has two opposite effects:

an income effect, $\left(-u_{1y} + pq_L u_{yy}\right)w_o^2 k < 0$, that decreases the marginal utility of income,

a leisure effect, $(1-k)u_{2y} > 0$, that increases the marginal utility of income,

with an ambiguous net effect. If, as expected, the income effect dominates, the sign of the effect of f^2 on w^* will be positive, but this is an empirical question. The shadow wage is thus an increasing function of farm assets and transfers, a decreasing function of unskilled family labor, and ambiguously related to the skilled family labor endowment, i.e.,

$$w^*\left(+A, -f^1, \pm f^2, +T\right),$$

where the sign in front of a variable indicates the direction of change in comparative statics.

The optimal household strategies regarding the allocation of unskilled family labor and the potential employment of agricultural workers are as follows:

Proposition 3. *Membership to labor regimes depends on asset position relative to unskilled family labor*.

Let A_0 be defined by $pq_L(A_0, 0) = w_o^1$. The three labor regimes are the following:

a. For $A < A_0$, $f_o^1 > 0$, $f_i^1 = 0$, and $h = 0$. The household does not cultivate, and all family labor is hired out.

b. For $A \geq A_0$ and $w^*\left(A, f^1, f^2, T\right) < w_o^1$, $f_o^1 > 0$, $f_i^1 > 0$, and $h = 0$. The household cultivates with family labor, and hires out.

c. For $A \geq A_0$ and $w_o^1 \leq w^*\left(A, f^1, f^2, T\right) \leq w_h$, $f_o^1 = 0$, $f_i^1 > 0$, and $h = 0$. The household is self-sufficient in farm labor.

d. For $A \geq A_0$ and $w^*\left(A, f^1, f^2, T\right) > w_h$, $f_o^1 = 0$, $f_i^1 \geq 0$, and $h > 0$. The household cultivates with family labor and hired workers.

Households whose farm asset position A is so low that the marginal productivity of even one unit of their labor would be inferior to the off-farm opportunity wage w_o^1 do only off-farm work for a wage. Once $A \geq A_0$, households allocate their labor to both own-farm work and work hired out. They are thus worker-peasants or semiproletarians. As assets (i.e., A and T for given f^1 and f^2) become more abundant, the shadow wage rises and all unskilled family labor is absorbed in the family farm. There is a range of asset positions that corresponds to the family farms. With yet more assets, the households hire labor in.

This proposition is demonstrated as follows. Consider first the case where there is off-farm work of unskilled labor, $f_o^1 > 0$ and $\mu_o^1 = 0$. From proposition 2, there is no hired labor, and equations (2) and (4) give $pq_L(A, f_i^1) = w_o^1 - \mu_i^1/u_y$. Since $q_L(A, f_i^1)$ is an increasing function of A and a decreasing function of f_i^1, for $A < A_0$, $pq_L(A,0) < w_o^1$, hence $\mu_i^1 > 0$ and $f_i^1 = 0$. There is no cultivation, and all family labor is hired out.

For land assets above A_0, allocation of unskilled family labor between on-farm and off-farm work is defined by:

$$(10) \qquad pq_L\left(A, f_i^1\right) = u\left(f^1 - f_i^1 - f_0^1, (1-k)f^2, y\right)/u_y = w_o^1 \quad \text{(sellers)}.$$

The first two terms of this equality are equal to $w^*\left(A, f^1 - f_o^1, f^2, T\right)$ which is greater than $w^*\left(A, f^1, f^2, T\right)$.

As A and T increase relative to f^1 and f^2, off-farm labor decreases, until all family labor only works on-farm. This threshold is defined by:

$$w^*\left(A, f^1, f^2, T\right) = w_o^1.$$

For assets above this threshold, there is no off-farm work by unskilled family labor. Consider now the case where there is hired labor, $h > 0$. From proposition 2, there is no off-farm work by family labor, and equations (1), (2), and (4) give:

$$(11) \qquad pq_L\left(A, f_i^1 + h\right) = u_1\left(f^1 - f_i^1, (1-k)f^2, y\right)/u_y = w_h = w_o^1 + \mu_o^1/u_y \quad \text{(employers)}.$$

Hence, the marginal utility of family labor and the marginal productivity of hired labor are equal to w_h. Since q_L is a decreasing function of labor, $w^* > w_h$. This labor strategy is chosen for sufficiently large values of A and T relative to f^1 and f^2. The lower limit at which the household hires workers is defined by:

$$w^*\left(A, f^1, f^2, T\right) = w_h.$$

Since $w_h > w_o^1$, this leaves a range of values for $w^*\left(A, f^1, f^2, T\right)$ for which households neither hire workers in nor hire unskilled family labor out. This defines the range of family farms where labor allocation to on-farm work is defined by:

(12) $\quad pq_L\left(A, f_i^1\right) = u_1\left(f^1 - f_i^1, (1-k)f^2, y\right)\Big/u_y = w^*$ (self-sufficient).

This establishes proposition 3.

These labor strategies give the following typology of households, where household classes are named according to two criteria: their asset position and their position on the labor market as seller, self-sufficient, or employer.

Classes	Assets A and shadow wage $w^*(A, f^1, f^2, T)$	f_o^1	f_i^1	h	f_o^2	f_i^2	Cost of farm labor
Agricultural worker	$A < A_0$	+	0	0			
Without skilled labor					0	0	
With skilled labor					+	0	
Worker-peasant (seller)	$A \geq A_0$	+	+	0			w_o^1
Without skilled labor	$w^* < w_o^1$				0	0	
With skilled labor					+	0	
Family farmer (self-sufficient)	$A \geq A_0$	0	+	0			w^*
Without skilled labor	$w_o^1 \leq w^* \leq w_h$				0	0	
With skilled labor					+	0	
Rich farmer (employer)	$A \geq A_0$	0	+	+			w_h
Without skilled labor	$w^* > w_h$				0	0	
With skilled labor					+	0	

Proposition 4: *Recursiveness by labor regime*.

Labor intensity $\left(f_i^1 + h\right)\Big/A$ (or equally land yield) is independent of f^1, f^2, and T for the worker-peasant class; strictly increasing in f^1, decreasing in T, and ambiguous in f^2 for the family farmer; and again independent of f^1, f^2, and T for the rich farmers. Labor productivity $q/(f_i^1 + h)$ follows the reverse pattern, being independent of f^1, f^2, and T for the worker-peasant and rich farmer classes; and strictly decreasing in f^1, increasing in T, and ambiguous in f^2 for the family farmer.

Proposition 4 derives directly from the variation of marginal productivity of farm labor across classes established above in equations (10), (11), and (12). The test of proposition 4 provides a test of recursiveness of the household model, selective by labor regime.

We now proceed to test propositions one to four. In so doing, we will validate the model, identify the determinants of household membership to labor regimes, test for selective recursiveness by labor regime, and identify the determinants of labor productivity by labor regime.

III. The Data

The Mexican land tenure system, established by the land reform of 1917, divides property rights over land between the private sector and the social sector. Each sector occupies approximately half of Mexico's arable land and half of the irrigated land. The social sector is composed of 28,056 ejidos (communities), some of which are indigenous communities, which each contain a number of families that can range from as few as 20 to as many as four or five hundred, with an average of some 100 families. In this sector, the land title is held by the community and individual households have usufruct of a plot of land and often access to common grazing and forestry lands. While households in the ejidos were in principle forbidden to divide the land among descendants, in practice much division has occurred. In the indigenous communities, divisions were legal. The result is that the social sector today is highly heterogenous. It includes households with very small farms who engage in both subsistence agricultural production and the sale of labor; a large number of households who are self-sufficient in labor; and households with farms that are larger and/or better endowed in productive assets or with smaller families, and who engage in the hiring of salaried labor.

The data we use are from a 1994 survey of the social sector conducted by the Ministry of Agrarian Reform (SRA) and the University of California at Berkeley. The survey consists of a stratified random sample of 1,416 observations of households in ejidos. The Mexican extension service regroups these farms in Rural Development Districts (DDR) which are defined to have agroecological homogeneity and which we use to characterize the regional context of each ejido.

Before using the model to categorize households by labor regime and explain performance within labor regimes, we test the validity of the model by confronting to data propositions 1 and 2.

Proposition 1 asserts that skilled family labor does not work on-farm. Using years of schooling to characterize skill level, Figure 1 shows that there is indeed a significant negative relation between years of schooling and the percentage of individuals working on-farm within each schooling cohort, ranging from

52% with zero years of schooling to 0% with 18 years of schooling. Each additional year of schooling reduces the percentage of individuals working on-farm by 2.9%.

Proposition 2 asserts that, if there is hired labor, no unskilled family labor should work off-farm. This theoretical result is based on the assumption that, on the demand side, labor is homogenous and defined on an annual basis, and, on the supply side, workers are perfectly substitutable and can allocate their time in any proportion between on-farm, off-farm, and home time. This is a far cry from the reality of work, particularly agricultural work, in which labor demand is very seasonal. Hence, it cannot be surprising to see households which both sell labor and hire some workers, either for specific tasks or for high seasonal demand, while family members may be engaged in longer term employment. Using nine years of schooling to create a dichotomy between unskilled and skilled workers, Table 1 shows, however, that only 12.9% of the surveyed households are on both sides of the unskilled labor market. Furthermore, we contrast the percentage of households who sell unskilled labor between households who hire labor and who do not hire labor. Hired labor is calculated separately for all tasks and for only non-harvest tasks. The expectation is that the contrast would be sharper for non-harvest tasks since many households need to hire for harvesting. The test is that the percentage of households who sell unskilled labor is less for those who hire, and the differences are significant in both cases. Calculating the average number of unskilled family members working out, the results also show that it is significantly inferior among households who hire labor.

IV. Membership in Labor Regimes

We now turn to an ordered probit model to predict membership in the three unskilled labor regimes: sellers of unskilled labor, self-sufficient, and employers (Table 2).[2] Labor regimes are not defined on the whole household labor force, but just on its unskilled labor force, since all skilled labor is expected to be working off-farm. Proposition 3 indicated that labor regimes depend on the comparison between the position of the household in terms of farm asset, unskilled labor, and non-farm asset endowments represented by the index $w^*\left(A, f^1, f^2, T\right)$, and the effective price of labor hired w_h or sold w_o^1. These costs typically include search costs, time spent traveling, and underemployment on the selling side, and search costs and supervision on the hiring side. As these two effective prices vary across observations, we estimate an ordered probit with household-specific thresholds. Theory thus predicts that membership in the three labor categories is uniquely determined by the value of the single indicator $w*$ relative to the

[2] We do not consider the households who both sell and hire unskilled labor for two reasons. First, their number is relatively small (12.9% of all households for all tasks in Table 1). Second, our model does not explain this labor strategy. A more detailed model would be needed for this purpose with features such as heterogenous labor inputs (e.g., plowing not done by women) and off-farm employment with fixed costs or lumpiness that prevent marginal adjustments of off-farm labor.

opportunity costs on the labor market for sellers and buyers. For this reason, we do an ordered probit instead of the usual multinomial probit or separate probits for sellers and buyers, as done for example by Goetz (1992). The ordered probit is defined as:

$$
\begin{aligned}
&\Pr(k \in \text{buyer}) = \Pr\left\{w_k^*\left(A_k, f_k^1, f_k^2, T_k\right) + \varepsilon_k > w_{hk}\left(TC_{hk}\right)\right\},\\
&\Pr(k \in \text{self-sufficient}) = \Pr\left\{w_{ok}^1\left(TC_{ok}\right) < w_k^*\left(A_k, f_k^1, f_k^2, T_k\right) + \varepsilon_k < w_{hk}\left(TC_{hk}\right)\right\},\\
&\Pr(k \in \text{seller}) = \Pr\left\{w_k^*\left(A_k, f_k^1, f_k^2, T_k\right) + \varepsilon_k < w_{ok}^1\left(TC_{ok}\right)\right\},
\end{aligned}
\tag{13}
$$

where k is the observation subscript, TC_{hk} and TC_{ok} are transactions costs in hiring and selling labor, respectively, and ε_k is an error term assumed to be normally distributed. We assume linear functions for the index w^* and the threshold functions:

$$
\begin{aligned}
&w^* = \alpha_1 f^1 + \alpha_2 A + \alpha_3 f^2 + \alpha_4 T\\
&w_o^1 = \beta_0 + \beta' z\\
&w_h = \gamma_0 + \gamma' z.
\end{aligned}
\tag{14}
$$

Note that for identification of all the parameters, each variable z must be absent of at least one of the three index and threshold functions. This holds in our analysis where neither household labor force f, productive assets A, nor transfers T are considered determinants of transactions costs. If this were not the case, our estimation could only identify differences β - α and γ - α (Bedi and Tunali, 1996). Without loss of generality, the intercept in the function w^* has been set equal to zero. This ordered probit, where thresholds are function of household characteristics, is estimated by maximum likelihood.

In the empirical analysis, unskilled family labor f^1 is disaggregated in male and female unskilled labor. Agricultural productive assets A are characterized by area in irrigated and rainfed land, agroclimatic regions, and human capital (age of household head). f^2 is the number of skilled family members. In the context of this survey, the sources of non-farm income are principally labor income and remittances from migration. There is almost no income from self-employment in non-agricultural activities and very little other transfers (de Janvry, Sadoulet, and Gordillo, 1996). T is thus principally composed of remittances. Although these are poorly measured in the survey, we have a detailed characterization of the household's migration history; thus, we use for T the household's migration assets measured as the number of permanent migrants in the direct family.

Transactions costs TC_h and TC_o are predicted by regional characteristics that reduce costs in agricultural production, particularly the availability of organizations in the district where the ejido is located. We characterize this availability by the percentage of households from the district that pertain to

organizations for infrastructure, input acquisition, credit, marketing, or any of these services. Finally, to allow for some regional variation in access to the labor market and in the wage rate, we characterized the depth of the local labor market by the average number of off-farm workers per household in the district.

For reasons that pertain to the subsequent analysis of labor intensity and labor productivity, estimation is restricted to the 592 households who produce corn as a monocropped activity and have complete data on labor used in corn production. Results are reported in Table 2. A positive coefficient in the w^* equation indicates that the variable increases w^* and hence the probability that the household belongs to the buyer category, while a negative sign indicates that the variable increases the probability that the household belongs to the seller category. In the estimation of the thresholds, variables that reduce transactions costs are expected to increase the selling price of labor (hence a positive sign on w_o^1) and reduce the hiring cost (hence a negative sign on w_h). All coefficients have the expected signs:[3] the number of unskilled male and female laborers are strong predictors of group membership and they increase the probability of being a labor seller. Both skilled labor and migration assets increase the probability of hiring labor. The agricultural productive assets that remain in the equation all show a positive influence on the probability of being a labor buyer. The ratio of coefficients on unskilled male labor and land in temperate regions indicate that any additional man can take care of 1.44 hectares of irrigated land without affecting the index w^* and hence the household position on the labor market. Among the organizational variables characterizing transactions costs, availability of organizations for infrastructure, for marketing, and the overall availability of organizations decrease the relative cost of labor and hence increase the probability of being a buyer of labor. Finally a more developed labor market increases the probability of selling labor.

A Chi-square test of the goodness-of-fit of the ordered probit with estimated idiosyncratic thresholds used here against a standard ordered probit with estimated constant thresholds (and the community variables in the w^* function) clearly rejects the latter (see results in the goodness-of-fit section of Table 2).

Figure 2 illustrates these results by showing how households' labor strategies respond to land and labor endowments. Using coefficients of the w^* functions for the tropical areas, male and female family labor are aggregated in male-equivalent units, and rainfed and irrigated land in irrigated-equivalent units. Setting all other exogenous variables to their sample means for the predicted self-sufficient households, the figure shows the land-labor endowment combinations that would equalize the estimated w^* to the estimated

[3] In this estimation, as well as all others in this paper, the variable selection procedure consists in starting with all candidate explanatory variables. We proceed stepwisely by removing the variable with the lowest t-statistic for as long as the aggregate goodness-of-fit criterion (adjusted R-square for a regression, significance of Chi-square for a probit) continues to increase.

thresholds w_o^1 and w_h.[4] For the self-sufficient households, for example, the two boundaries between the labor strategies drawn in Figure 2 are given by (equation 14):

$$\hat{\alpha}_1 f^1 + \hat{\alpha}_2 A = \hat{\beta}_0 + \hat{\beta}'\bar{z} - \hat{\alpha}_3 \bar{f}^2 - \hat{\alpha}_4 \bar{T}, \quad \text{and}$$
$$\hat{\alpha}_1 f^1 + \hat{\alpha}_2 A = \hat{\gamma}_0 + \hat{\gamma}'\bar{z} - \hat{\alpha}_3 \bar{f}^2 - \hat{\alpha}_4 \bar{T},$$

where $\hat{\alpha}, \hat{\beta},$ and $\hat{\gamma}$ are the estimated parameters from Table 2 and $\bar{f}^2, \bar{T},$ and $\bar{z}$ are the sample means of the corresponding variables among self-sufficient households. Point A in Figure 2 locates the average labor and land endowments of this group of households with 0.78 ha of irrigated-equivalent land and 1.64 male-equivalent family labor. This household would require an additional 2.04 ha of land to become net employer (at point B). Similarly, the average endowments of the group of labor sellers are 0.34 ha of irrigated-equivalent land and 2.46 unskilled male-equivalent family labor (point C). This household would require an additional 1.05 ha of land or a loss of 0.98 male-equivalent labor to retain all its family labor on its own farm and become self-sufficient (point D). Figure 2 also shows that the average seller household faces narrower labor strategy boundaries with a higher lower threshold, which indicates lower transactions costs and a higher effective wage received.

Policy implications are interesting. Say that the objective of policy is to help households become successful small scale entrepreneurs who start hiring labor. For this purpose, the key instrument is to increase the asset endowment of households--particularly irrigation and greater access to rainfed land, tractors, and animals--and their membership to local organizations that help reduce transactions costs. This stresses the importance of institutional development in a context where government support for infrastructure has been reduced as a consequence of privatizations and descaling of government budgets. Reconstructing new institutions that are able to deliver these services to households of the social sector is thus fundamental to help them become successful employers of labor.

V. Performance Indicators and Tests of Recursiveness by Labor Regimes

If the household model with differential labor skills and with price bands in accessing the labor market is correct, the reduced form of the model predicts that all production decisions, including labor intensity, should be unrelated to f^1, f^2, and T in the seller and employer categories, and they should be strictly increasing in f^1, decreasing in T, and ambiguous in f^2 in the self-employed category. As was shown in

[4] Like with any probit estimation based on ranking, the functions w^*, w_o^1, and w_h are only identified up to a common monotonic transformation. Hence, computation of meaningful thresholds in monetary value is not possible, and only comparison of these indices as done on Figure 2 is feasible.

proposition 4, this is because the first two categories have exogenous labor costs equal to w_o^1 and w_h, respectively, while the shadow wage w^* of unskilled family labor in self-sufficient households is a function of *A*, f^1, f^2, and *T*. Hence, the household model is recursive for the seller and buyer regimes and is non-recursive for the self-sufficiency regime. In Table 3, we test this proposition by giving the results of a regression analysis of labor intensity in corn production within each labor regime. Because of potential selectivity bias, we use the Inverse Mills Ratio derived from an ordered probit reported in Table 2.

The regularities predicted by proposition 4 are tested on labor per hectare used in producing monocropped corn by households who only produce corn as a monocropped activity.[5] As we restrict the analysis to labor intensity in corn production, the variable *A* has to be redefined. Farm assets that do not affect corn production (*A non-corn*) but are sources of income for the household now belong to the group of variables that solely explain income, like *T*. Hence, they should influence corn decisions only in the self-sufficient regime and not in the seller and employer regimes. *A non-corn* includes total land assets (irrigated and rainfed area). Agricultural assets that affect the productivity of labor specifically in corn production (*A corn*) affect labor intensity in all labor regimes. Potential economies or diseconomies of scale are now captured through the area in corn. Another aspect of corn production in Mexico is its linkage with cattle raising. Cattle raising and corn are largely joint products, as residues from corn production are used as complementary feeding to grazing. However, since most grazing land is under the regime of common property in the village, the indirect value of corn for feed decreases as the area of common pasture increases. To capture this particular linkage between corn and cattle, we have considered the number of heads of cattle and common pasture area per household in the village as factors affecting corn production decisions directly (i.e., among the *A corn* variables). Finally, all explanatory variables are clearly exogenous, except the area planted in corn, which may well be simultaneous with labor intensity. Using a Hausman specification test, the null hypothesis of no simultaneity of the area planted in corn cannot be rejected for the buyer and self-sufficient regimes. However, for the buyer regime, exogeneity is rejected and the predicted value of the area in corn is used in that regression.

Results in Table 3 show that the labor intensity predictions of proposition 4 are overwhelmingly verified.[6] The six test variables are insignificantly related to labor per hectare among labor sellers and

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[5] Households produce both monocropped and intercropped corn, with the first accounting for 91% of the total area in corn. Intercropping is done with a variety of other crops and with an uneven density of corn relative to these other crops. As a result, labor per hectare in intercropped corn is highly uneven. The survey gives labor use in corn without separating between intercropped and monocropped for households who produce under both forms. Hence, proposition 4 can only be tested on households exclusively engaged in monocropped corn cultivation. There are 592 such households in the survey which have complete data on labor used in corn production.

[6] In Table 3, the variables f^1, f^2, *T*, and *A non-corn* which test proposition 4 are systematically kept, even if not significant. For all other variables, we proceed as mentioned in footnote 3.

buyers. The number of unskilled men and women in the household affect positively labor per hectare among self-sufficient households. The rainfed and irrigated area and migration assets reduce labor per hectare in that household class. Only the variable skilled family labor, expected to have a negative effect on labor intensity, shows no significant effect. A test of the null hypothesis that all six parameters are jointly equal to zero cannot be rejected for the seller and buyer labor regimes while it is rejected for the self-sufficient: under the null hypothesis, the probability of obtaining values greater or equal to the computed F-statistics are 81.2%, 2.3%, and 53.1%, respectively, for the three labor regimes.

There are a number of exogenous variables which affect labor per hectare that have important policy implications. The area planted in corn systematically reduces labor per hectare across all labor regimes, indicating that there are economies of scale in corn production, i.e., that the inverse relation holds within corn. A higher profitability in corn production also affects labor per hectare. This is the case for the agroecological quality of the environment, measured by average corn yields in the district where the ejido is located. The higher the local yields, the higher labor per hectare in the ejidatario's farm. The area in common property pastures reduces labor per hectare among sellers and self-sufficient households, indicating substitutability between corn and pasture for livestock in these household groups.

For self-sufficient households, tractor ownership is labor saving and allows family labor per hectare to be reduced. By contrast, ownership of means of transportation (truck and pick-up truck) reduces transactions costs and increases labor per hectare. For labor sellers, being also a seller of corn lowers labor per hectare. This is because sellers receive a price for their corn that is lower than the purchase price for net buyers and than the shadow price for self-sufficient households (de Janvry, Sadoulet, and Gordillo, 1996). Regional availability of organizations to access equipment such as sprayers, sorters, and harvesters increase profitability of the crop, and also labor per hectare. Existence of organizations in the district where the ejido is located is also a factor that helps reduce transactions costs, inducing the use of more labor per hectare. Finally, membership in an indigenous community as opposed to an ejido increases labor per hectare. This reflects the technological backwardness of the community, by far the least advantaged and most impoverished members of the social sector, where use of labor savings devices is systematically less advanced. Regional dummies, with the South Pacific states (Region 5) as the reference point, suggest that states in the Gulf are best endowed for corn production and have higher labor intensities.

Proposition 4 also implies that labor productivity is unrelated to *A non-corn*, f^1, f^2, and T in the seller and employer categories, while it is related to these variables in the self-employed category. Estimating a labor productivity equation is more demanding than estimating a labor intensity equation since output level is affected by weather and other non-observables. In spite of this, a joint test on the significance of the *A non-corn*, f^1, f^2, and T variables clearly cannot reject the recursiveness hypothesis

for the seller and buyer groups but it can for the self-sufficient. The probabilities of obtaining values that are greater than the computed F-statistic under the null hypothesis are equal to 61.3% for the seller group, 0.08% for the self-sufficient group, and 74.2% for the buyer group. Results (not reported here) show that households in indigenous communities have systematically lower labor productivity; the area planted in corn displays the usual economies of scale in terms of labor productivity; and tractor ownership allows labor saving and hence raises labor productivity. There are two sets of variables with policy implications to raise labor productivity. The first is variables associated with access to bank loans which increases labor productivity, showing the importance of relaxing the liquidity constraint to increase the productivity of labor in the ejido. Access to PRONASOL (National Solidarity Program) loans has a negative sign, due to the fact that this credit is selectively targeted to the poor and most dispossessed. The second is the role of organizations for access to equipment and to reduce transactions costs in marketing. They increase the productivity of labor through labor saving and higher farm prices, respectively.

VI. Conclusions

We have shown that a household model which allows differential household asset positions and labor market imperfections characterized by an idiosyncratic price band between effective wages received and paid has the ability to predict household membership in different labor regimes: labor sellers, self-sufficient, and employers. The results support the hypothesis of recursiveness of the household model selectively for the seller and employer labor regimes. They also give an explanation of labor productivity differentials within these categories.

This approach provides a useful analytical tool for the micro-level analysis of policy reforms and for the design of differentiated policies. In the case of Mexican households in the land reform sector, this suggests in particular that greater access to irrigation, tractors, and animals, as well as access to liquidity through migration and to local organizations to reduce transactions costs, are key in achieving the status of employer of labor in corn production. To increase the productivity of labor, tractor ownership, access to bank loans, and availability of organizations to improve machinery services and reduce transactions costs in marketing are also fundamental. These results demonstrate the fundamental importance of consolidating a network of supportive institutions for households in the ejido sector to allow them to achieve higher levels of labor productivity. These institutions are needed to replace the parastatals which were delivering credit, infrastructure, equipment, and marketing services before implementation of structural adjustment policies.

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Table 1. Proposition 2: Labor hiring and sale of unskilled family labor

	Households with hired labor	Households with no hired labor	Test of difference
All tasks			
Number of households	608	800	
Distribution (% of total number of households)			Chi-square
Sell unskilled labor	12.9	21.7	9.89**
Do not sell unskilled labor	30.3	35.2	
Average number of unskilled family members working out	0.44	0.56	t-test 2.58**
Non-harvest tasks			
Number of households	553	847	
Distribution (% of total number of households)			Chi-square
Sell unskilled labor	11.3	23.3	14.1**
Do not sell unskilled labor	28.2	37.2	
Average number of unskilled family members working out	0.36	0.47	t-test 2.37**

** Significantly different from zero at the 99% confidence level.

Table 2. Proposition 3: Unskilled labor endowments and labor regimes
Ordered probit analysis: Probability of being a seller, self-sufficient, or buyer of labor.

	Coefficient	Asymptotic t-ratio	Sample mean of variables: Sellers	Self-sufficient	Buyers
Assets position index (w^*)					
Household endowment in unskilled labor (f^1)					
Unskilled male family labor	-0.367	6.2	2.17	1.48	1.08
Unskilled female family labor	-0.057	1.0	1.50	1.27	1.16
Farm assets affecting the productivity of labor in agriculture (A)					
Irrigated area (ha)	0.047	0.9	0.11	0.38	0.56
area*temperate zones dummy	0.208	1.7			
area*tropical zones dummy	0.296	2.3			
Rainfed area (ha)	0.038	2.9	4.76	5.97	9.58
area*temperate zones dummy	-0.017	1.1			
area*tropical zones dummy	-0.014	1.0			
Human capital: Age of the household head	0.016	4.2	45.6	47.2	54.3
Household endowment in skilled labor (f^2)	0.150	2.7	0.22	0.37	1.06
Household migration assets[b] (T)	0.228	3.1	0.00	0.19	0.47
Threshold between self-sufficient and seller status (w_o^1)					
Intercept[a]	-0.953	4.2			
Depth of the labor market in the district[c]	0.618	4.3	0.94	0.43	0.53
Threshold between self-sufficient and buyer status (w_h)					
Intercept[a]	1.108	4.7			
Organizations for infrastructure in the district[c]	-0.005	1.3	8.2	11.3	32.8
Organizations for marketing in the district[d]	-0.025	2.1	0.1	0.4	3.2
All organizations in the district[d]	-0.003	1.3	29.7	37.6	66.4
Region dummies: North	0.796	3.9			
North-pacific	0.616	1.9			
Center	-0.008	0.1			
Gulf	0.256	1.3			

Goodness-of-fit				
	Pseudo – R^2	0.17		
	Log-Likelihood (constant only)	-638.4		
	Log-Likelihood (ordered probit)	-527.7	P-value (ordered vs constant)	0.000
	Log-Likelihood (ordered, cst. thresholds)	-538.8	P-value (cst. vs variable thresholds)	0.000

	Predicted			
Observed	Seller	Self-sufficient	Buyer	Total
Seller	64	72	16	152
Self-sufficient	36	161	52	249
Buyer	11	72	108	191
Total	111	305	176	592
% correct	57.7	52.8	61.4	56.3

[a] Regional dummy variables not reported
[b] Number of permanent migrants in the direct family.
[c] Measured as the average number of off-farm workers per household in the district.
[d] Measured as the percentage of ejidatarios in the district (DDR) participating to such organizations.

Variables included but not retained:
(A) Indexes of land quality: average regional yields of rainfed and irrigated land
Human capital: dependency rate
(w_h and w_o^1) Corn seller dummy
Ownership of transportation means
Regional organizations for credit and input acquisition

Table 3. Proposition 4: Labor intensity across labor regimes

Endogenous variable: labor (man-day) per hectare in monocropped corn. t-statistics in parentheses

	Labor regimes		
	Seller	Self-sufficient	Buyer
Test of proposition 4: Recursiveness by labor regime			
Household endowment in unskilled labor (f^1)			
Unskilled male family labor	1.10	4.23	0.06
	(0.68)	(2.34)	(0.02)
Unskilled female family labor	1.40	2.30	2.56
	(1.03)	(1.69)	(1.35)
Non-corn assets affecting the utility of home time (A non-corn)			
Irrigated area (ha)	1.31	-1.47	-0.24
	(0.70)	(1.62)	(0.20)
Rainfed area (ha)	-0.18	-0.43	0.22
	(0.69)	(2.49)	(1.07)
Household endowment in skilled labor (f^2)	0.81	-1.19	0.05
	(0.39)	(0.84)	(0.03)
Household migration assets (T)	0.06	-5.04	1.12
	(0.02)	(2.45)	(0.60)
Other explanatory variables			
Assets affecting the productivity of labor in corn production (A corn)			
Area planted in corn (rainfed equivalent ha)[a]	-1.61	-2.63	-3.46
	(1.60)	(4.25)	(3.27)
Common pasture area per member (ha)	-0.07	-0.07	
	(2.13)	(3.74)	
Tractor ownership (dummy)		-6.18	
		(1.05)	
Regional characteristics			
Average regional corn yield irrigated land (ton/ha)	11.50		
	(2.19)		
Household characteristics/management			
Age of houshesold head (years)		-0.20	-0.26
		(1.97)	(1.87)
Dependency ratio	3.51	3.28	
	(1.91)	(1.95)	
Characteristics affecting transactions costs (p, w_h, w_o^1)			
Truck and pick-up ownership (dummy)		9.38	
		(2.68)	
Seller of corn (dummy)	-7.25		
	(2.05)		
Indigenous community (dummy)	14.48	9.19	
	(2.72)	(2.26)	
Availability of organizations for equipment in the district		0.60	0.42
		(2.34)	(1.65)
Availability of organizations in the district	0.13		0.08
	(2.42)		(1.34)
Other exogenous variables			
Region 1 (North)			-27.49
			(3.73)
Region 2 (Pacific North)			-16.48
			(2.23)
Region 3 (Center)		-1.75	-8.00
		(0.57)	(2.41)
Region 4 (Gulf)	22.90	14.94	-6.42
	(4.02)	(4.32)	(1.43)
Inverse Mill's ratio (from ordered probit for corn producers)	-1.44	-12.79	9.95
	(0.30)	(3.36)	(1.16)
Constant term	5.40	41.47	47.06
	(0.51)	(6.50)	(3.07)
Goodness-of-fit			
Number of observations	152	249	191
Joint test of recursiveness hypothesis (P-value)	0.81	0.02	0.53
R^2	0.34	0.34	0.25

[a] Exogeneity cannot be rejected for the seller and self-sufficient regimes. However, for the buyer regime, exogeneity is rejected and the predicted value for the area in corn is used in that regression.

FIGURE 1

PROPOSITION 1: SKILLED FAMILY LABOR AND ON-FARM WORK

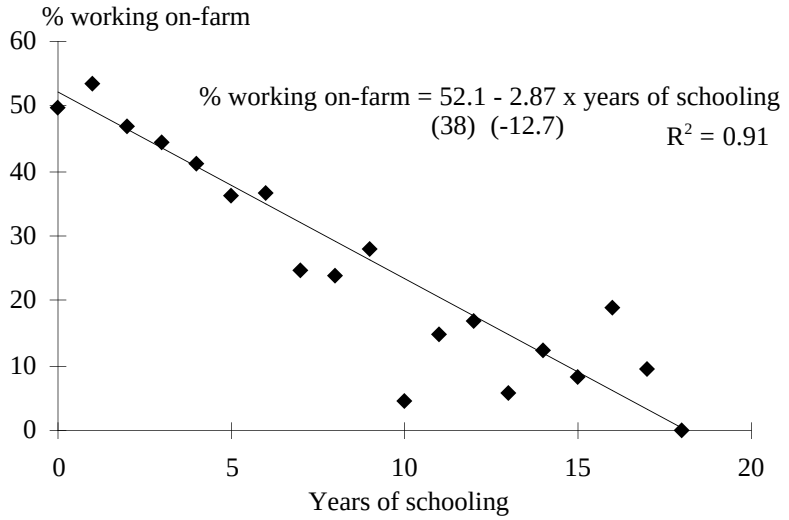

FIGURE 2

LABOR MARKET PARTICIPATION BY LAND AND LABOR ENDOWMENTS