Farm Labor: Key Conceptual and Measurement Issues on the Route to Better Farm Cost and Return Estimates

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ABSTRACT: This paper examines methods frequently used by agricultural economists to measure the cost of farm labor, including operator and other unpaid, and to provide insights for improving them. The tradition is broken of treating labor and management separately, and labor is defined as encompassing all the productive activities of individuals or human agents used in a business, including farming. Conceptual issues are first addressed: (1) the nature of economic cost and the cost of unpaid labor and (2) time allocation in agricultural household models where an individual's annual time endowment is allocated potentially to leisure, farm work, and off-farm work. Measurement issues are addressed second: (1) specific methods for improving the measurement of the cost of farm labor and (2) specific procedures for estimating the opportunity cost of operator and unpaid farm labor. The overall goal is to obtain better farm cost and return estimates.

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Labor is one of the important inputs in agricultural production. How it is measured and valued is important for establishing the marginal cost of agricultural commodities and labor's share of the cost of production. Historically in agricultural commodity cost-return methods, labor and management have been treated as distinct, unrelated, or disconnected inputs. A variety of reasons undoubtedly exist for this separation. The perspective that leads to a separation of labor and management, however, is not in tune with advances over the past two decades in the modern concept of labor from labor economics or with econometric studies of off-farm labor supply of farm household members and agricultural production.

The objective of this paper is to provide a perspective on past methods used to measure the cost of farm labor and management and to provide recommendations for improved procedures. This latter task also involves providing an assessment and evaluation of alternative procedures.

Here, "labor" is viewed as encompassing ***all*** the productive activities of individuals or human beings used in a business. This includes a wide range of human services, including physical ability to do work and decision making. Farm labor is a subset of all labor, and farm labor is viewed broadly as encompassing

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a wide range of human activities required in farming, for example, human time spent in planning, managing, marketing, supervising, producing, accounting, and technology assessment. For some purposes, it may be useful to refer to the input category as "labor and related services." The related services include all those purchased services that are highly substitutable for unpaid and hired farm labor, i.e., all labor or human services acquired through farm labor contractors, mechanics, repair services, information and management services, and bookkeepers.

The task is undertaken in the following sections.

A Brief Review of the Cost of Labor

In the cost-return methods used by the Agriculture and Rural Economy Division, ERS, USDA (Morehart et al. 1992, p. 6-7), unpaid farm labor, which is the time contributed by the operator, partners, and in some cases family members, has been treated differently than hired farm labor. The Division has adopted an arbitrary classification of "economic costs." Their "economic costs" are supposed to be full-ownership costs from a long-term perspective. These costs are defined as variable cash expenses, general farm overhead, taxes and insurance, capital replacement, allocated returns to the capital invested in the production process, unpaid labor, and land (Morehart, Johnson, and Shapouri 1992). Expenditures on hired labor are counted as "variable cash cost," but the Division does not estimate variable "noncash costs." Its variable cost measure ignores unpaid farm labor and other unpaid factors. Hence, it does not obtain marginal cost of production estimates!

The Division's "economic cost" of production can be described as an approximation to average cost of production. In this economic cost calculation, a value to unpaid farm labor is imputed based on estimated hours worked on the farm and the average wage rate for hired farm labor (Morehard, Shapouri, and Dismakes 1992, p. 7). A residual is also defined as gross value of production less total "economic costs" and labeled "return to management and risk." This residual is clearly commodity price (market price or ex post) determined, and hence it is not commodity price determining. Furthermore, it is most likely primarily measuring effects of random events, including weather and measurement errors.

In making "economic cost" estimates of particular agricultural commodities, ARED has allocated noncash costs to each commodity based upon its share of the total value of agricultural production. This allocation scheme ignores differences in and information about the unpaid farm labor intensity of different agricultural commodities and has important implication for relative cost of production.

Methods similar to those employed by the ARED have been used by some agricultural economics in making cost-return estimates. See Klonsky 1992, p. 151 for a summary; also see Miller 1992a; b, p. 359. Another approach is to charge "current family living expenses" against the farm business as a cost of unpaid family labor as in beef cow-calf budgets, e.g., McGrann 1991. This approach might seem at first to be appealing because a farm family must certainly "make a living." Under more careful examination, however, we realize that this measure of cost is primarily determined by the preferences of the household (for leisure relative to purchased inputs to consumption) and the total resource constraint has only a minor connection to farming, e.g., since 1975 the farm share of farm household net cash income from all sources has averaged less than 50 percent (USDA 1990, 1991c).

The Resources and Technology Division of ERS is in charge of creating agricultural productivity and efficiency statistics (see Hauver 1989). Before 1985, "labor requirement data," which assumes a level of efficiency that may be quite different from actual efficiency, were used in the USDA's productivity statistics, but starting in 1985, farm labor usage has been survey based. In the new procedure, total labor use on farms is estimated using information contained in two surveys, the Farm Costs and Returns Survey and the Current Population Survey. These new data do not provide commodity-specific information on farm labor use.

The R&T Division has valued the farm labor input using an opportunity cost concept, but the exact procedure has changed. First, they used the average wage rate for hired farm labor as the value of all farm labor (Hauver 1989). More recently, they have valued unpaid farm labor at the wage or salary for "similarly skilled" wage and salary workers in U.S. agriculture, where homogenous skill groups are defined by gender, age, education, and occupational group. This procedure is similar to the one used by Jorgenson, Gollop, and Framueni (1987) in their 30+ sector multifactor productivity analysis of the U.S. economy. Thus, although productivity and cost-returns data are created for different purposes, one might reasonably ask why the procedures for measuring costs are so different between productivity and cost-returns approaches.

Research on off-farm labor supply decisions of farm households has contributed to improved modeling of human time use and valuation for farm household members. In this work, models for an individual have a constraint of 7,860 hours per year to allocate to farm work, off-farm work, and leisure (or household and personal activities). In these models, husband's and wife's time are treated as being heterogeneous because they possess different skill, and the opportunity cost of time allocated to farm work is the maximum of the marginal value of a unit of time allocated to off-farm work or leisure. For off-farm work to occur, the opportunity cost of an individual's time becomes his or her off-farm wage rate, and this is the price of unpaid family labor for making household and farm resource allocation decisions and for entering the calculation of the marginal cost of agricultural commodities (Huffman 1996). See Huffman (1980), Sumner (1982), Huffman and Lange (1987), and Tokle and Huffman (1991), and Hallberg, Findeis, and Lass (1991) for further discussion of these models and the empirical results.

The above examples provide evidence that very different procedures are used by agricultural economists today for defining the economic cost of agricultural commodities, including major inconsistencies in the treatment of unpaid farm labor. These differences have major implications for the marginal cost of agricultural commodities, including the relative marginal cost of commodities.

The Nature of Cost and the Cost of Unpaid Labor

The first subsection contains an examination of the concept of economic, or opportunity cost, placing particular emphasis on unpaid farm labor. In the second subsection, the fixed costs associated with employment are considered. In the third subsection, an economic model of farm household decisions is presented. In this subsection, a conceptual framework is presented in which the decisions of farm households on consumption and production are formulated jointly. This framework is useful for helping to see the "big" picture on the complex resource allocation decisions of farm households. The model is about plans and is an important guide to the real data that one needs for meaningful measures of the marginal cost of production. It is one that requires simplifying and ignoring some of the secondary decisions. The approach, however, can be expected to lead to a better approximation to the "true" economic and resource allocations of farm households. After grasping the overall approach, it is fairly easy to make application of the basic principles to secondary decisions. In the fourth section, the issue of getting the price/cost of unpaid farm labor right, not too high and not too low is addressed.

The Nature of Cost.

Although historic cost is the primary concept used by accountants (and the IRS), economic costs are a different concept.[1] The basic concept of **economic cost** is **opportunity cost**: "The cost of any productive service to use A is the maximum amount it could produce (or be paid or sold for) elsewhere. ***The foregone alternative is the cost***. Note that the alternative cost sets the **value** of the resource to use A" (Stigler 1966, p. 105).

Although it is seldom the case that a direct quote is in the correct context for the task at hand, direct quotations from Stigler (1966) are an exception in this case because he spent a number of years at Iowa State College attempting to solve and improve the thinking about resource allocation problems of Iowa farmers and later received a Nobel Prize. Furthermore, he uses a number of examples that are directly relevant to our task.

The **alternative use** of a resource depends upon the context or use to which the cost is being reckoned:

1. "The cost of an acre of land to agricultural uses is the amount the land could yield in nonagricultural uses (residences, parks, and so on).

2. The cost of an acre of land to the wheat growing industry is the amount it would yield in other agricultural crops (oats, corn and so on), as well as in nonagricultural uses.

3. The cost of an acre of land to wheat farmer X is the amount the land could yield to other wheat farmers, as well as all non-wheat uses.

If all land were homogenous in all relevant respects (including location, fertility, and the like), obviously all three of these alternative costs would be the same. For if land yielded more in nonagricultural uses than in agricultural uses, some of it would be transferred to the nonagricultural uses, and the transfer would go on until the yields in all uses were equal (under competition). Equality of yields of a resource in every feasible use is necessary to maximum return for the individual owners of the resource; any discrepancy in yields is (with competition) an opportunity to someone to increase his income. But if the land is not homogeneous, it is not necessary that these alternative costs be equal." (Stigler 1966, p. 105-106.)

Suppose that due to locational and other factors, an acre of one type of land will yield \$50 in wheat, \$30 in other farm crops, and \$5 in nonagricultural uses. Then the economic cost of the land to the wheat industry is \$30 an acre--the best forgone alternative. This cost is, however, **decisive** to the land's use: even if a declining demand forces the yield in wheat down to \$31, the land will not be transferred to other uses. But from the viewpoint of any tenant wheat farmer, a land rent of \$50 is the cost because at \$49.99 it will be rented to another farmer. Furthermore, a superior farmer, it might be believed, can get more than the average yield from the land. So he (or she) can, but it is the value of the marginal product of land that constitutes its yield, and this marginal product will not differ in equilibrium between superior and inferior farmers. (See Stigler 1966, p. 106.) Thus, using opportunity cost as the appropriate concept of economic cost clearly avoids the paradoxes encountered by historical costs. ***All productive services, inputs, or commodities that are identical necessarily have the same alternative cost, no matter what the differences in their historical costs***.

Of course, the alternative uses of a resource will frequently be different, and in fact fewer, in the short run than in the long run. This is obviously true for a machine: during its life it can be used only for the purposes for which it was designed, or as scrap. For labor, however, there are more options even in the short run (Stigler 1966, p. 107). A farmer has as alternative occupations only those occupations that can make use of his general ability and skill at farming. But given sufficient time to be retrained, he(she) can work in occupations that require other skills. Given still more time, many individuals who otherwise would have entered this occupation can enter one of a hundred or more occupations, requiring similar inherent abilities.

The alternatives to a given use of a resource frequently include nonmonetary elements. In the employment of labor, they include conditions of work, prestige, riskiness and other similar factors. These nonmonetary elements obviously must be reckoned with monetary returns in analyzing the allocation of resources among uses because they affect decisions (Stigler 1966, p. 108). The equilibrium difference in monetary returns will measure the difference in nonmonetary elements ***only at the margin***. For example, if the equilibrium money labor income of a farmer is 20 percent less than that of a comparable urban worker, there will be many farmers for whom the value of nonmonetary aspects are larger, and some who would not leave farming even if labor income fell to 50 percent of the urban level. ***Those farmers who would be willing to remain in farming even at a 50 percent differential are earning an economic rent on their "scarce preference" when the equilibrium differential is only 20 percent*** (Stigler 1966, p. 109).

The surplus of actual labor earning over what can be earned in the best alternative use is called a **rent, or quasi-rent** (Stigler 1966, p. 106). As the name suggests, economists first attached this concept of a price or return higher than needed to hold a resource in a particular use, to land. The concept has since been generalized to include such returns as received by labor or other owners of heterogenous resources (Stigler 1966, p. 106). ***Thus, the opportunity cost of a resource is price determining or an important signal for production (and consumption) units, but the surplus or quasi-rent is price determined, an ex post phenomena***. The rent might be important for future human capital investment decisions. This helps to distinguish which concepts of cost are relevant for affecting current resource allocation decisions and the marginal cost of producing agricultural commodities. ***The relevant concept is opportunity cost and not historic cost, actual cash outlays or quasi-rents***.

Some fine-tuning of the opportunity cost of labor in rural labor markets that do not function smoothly can be achieved, Harberger (1971) concludes that measuring the opportunity cost of labor in rural areas by the value of the product forgone is generally inferior to some other measures. He concludes that ***the preferable measure of opportunity cost is "the supply price of marginal units of labor for given skill characteristics and labor market areas where the workers will work and live"*** (Harberger 1971, p. 559). He also concludes that the best wage is the one where a majority of the firms are motivated by profit and no one firm dominates employment. In particular, the wage rate paid government employees and paid by companies in "one-company towns" is not a good measure of the opportunity cost of labor. Furthermore, by using the real wage rate for the area where the employees will live and work, this corrects properly for cost of living differences between sending and receiving areas (when they differ). He also argues that when one uses the market clearing wage, there is no need to adjust the wage rate for local or national cyclical unemployment (differences).

Thus, the story from Stigler and Harberger about the opportunity cost of unpaid farm labor is as follows:

1. The cost of a unit of unpaid labor used in farming is the supply price or market price for the labor in nonfarm employment.
2. The cost of a unit of unpaid farm labor used in livestock production is the value of the labor used in crop production or in nonfarm employment.
3. The cost of a unit of unpaid farm labor used in swine production is the value of the labor to other livestock enterprises, to crop enterprises, or to nonfarm employment.

In labor market equilibrium, the marginal value of a unit of homogeneous labor will be the same in all of these uses, i.e. the opportunity cost of a marginal unit of unpaid labor using in farming is the market price of labor in nonfarm use. Furthermore, ***if the value of the marginal product of a unit of unpaid farm labor (in farming) is larger than the off-farm wage rate for similar skilled labor, the economic cost of this unpaid labor remains at the off-farm wage***. The excess of the value of the marginal product over the off-farm wage is an economic rent or quasi-rent. But reductions in the price of farm output can occur to the point that this rent is slightly above zero and not affect optimal resource allocation between farm and nonfarm uses or among farming enterprises. Furthermore, ***the opportunity cost of unpaid farm labor is not generally affected by the size of the farming enterprise***, i.e., a unit of unpaid farm labor for an operator of a large and a small farm has the same cost, if they have they face the same off-farm wage! In fact, small farming operations may be a signal of high opportunity cost of the operator.

There is no problem in principle with the opportunity cost of a marginal unit of unpaid farm labor being its value in leisure or household activities. This is frequently the correct choice for particular farms. The value of human time used in leisure or household activities, however, is not the appropriate choice for a national cost-returns methodology. The reason is that each individual and household has its own subjective assessment of the value of a unit of leisure time, and it is not easy to identify what it is. Thus, for a general methodology and one that represents a good approximation, we need an ***objective yardstick*** for determining the opportunity cost of labor, i.e., we need farmers to tell us the hours of farm work but we need an outside estimate of the marginal value of a unit of farm work.

Although some might object that the functioning of the labor market is "unfair," a market where voluntary exchange of labor among a sizeable number of buyers and sellers is occurring is an incredibly effective and efficient mechanism for pooling together information from diverse sources and assessing quality differences objectively (see Rosen 1986; Willis 1986; Harberger 1971). In other words it is an effective mechanism for settling disputes about economic value. Although the market price may in some cases need to be modified for external effects and taxes and subsidies to attain correct measures of the social opportunity cost of labor (e.g. see Just, Hueth, and Schmitz 1982), there really is no good substitute for starting from a base of market prices or wage rates.

Fixed and Transactions Costs Associated with Employment

Costs associated with entry and exit of workers from firms are a type of firm-specific investment in employees, or part of the whole-farm cost of farm labor. These are sometimes referred to as fixed labor costs or once-over costs because they occur before any productive work has occurred or at termination of an employee. These costs are largely independent of the number of hours or the intensity with which an employee works and can be whole farm or commodity specific. To the firm, the costs of new employees take the form of lost output of the person(s) engaged in hiring and screening prospective workers and the trainees and persons leading or supervising the training. Also, there is a finite probability that a firm will at some stage wish to dispense with the services of any employee it hires. The firm thus incurs a future expected set of once-over fixed costs each time it hires a new employee--the potential cost to the business or firm associated with unsatisfactory performance (Elliott 1991, p. 252).

Thus, once a firm and employee have chosen to cooperate, the fixed costs associated with employment tend "to lock" them together in long-term relationships. In agriculture, the fixed costs, sometimes called transactions costs, are frequently large enough to block the use of skilled or specialized "outside" labor services.

This is an issue addressed many years ago by Coase (1937) when he considered the nature of the firm and by Stigler (1951), Rosen (1983), and Becker (1989) when they considered the division of labor. The issue is which activities are conducted within a firm or business and which ones are obtained through an exchange with other firms. They concluded that the size of the costs associated with business contracts are a critical factor in the outcome. When transactions costs are low for interfirm exchanges, firms specialize and do business with each other. When interfirm transactions costs are high, a given firm or company conducts a wide range of activities through intrafirm or vertically integrated activities.

For farm households, the fixed cost of finding labor services and paying for the time in transit for having them come to the farm (i.e. the trip charge) or for finding, showing, or training someone to complete a small job are too large to be a profitable undertaking. For example, very few farms can rely on nonfarm repair services to fix daily breakdowns in farm machinery and equipment. The transaction costs, including time delays, of getting a repair service to the farm are too large. Thus, most farm businesses have some employee, possibly the farm operator, who has adequate skills for making daily repairs of equipment and machinery. Major overhauls of equipment, e.g., tractor engines, are, however, usually obtained from skilled mechanics located in major nonfarm repair shops where the needed instruments and tools are present. Likewise, the transaction costs of having a veterinarian come to a farm are too large in most cases to be a profitable activity for performing routine delivery of offspring, castration and vaccination of farm animals. Problem births and treatment of sick or diseased animals, however, largely require the skills of licensed veterinarians. Farmers and ranchers, however, know that treating sick animals is a very labor intensive activity, hence expensive, and they can and do reduce the need for veterinary services by investing in preventative medicine, e.g. vaccination for contagious diseases, use of medicated feeds and water.

In fruit and vegetable production, much of the hiring of workers is for seasonal or relatively short-term employment, although the work reoccurs on an annual basis generally. Thus, the fixed cost of hiring and training these workers plays an important role in where, when, and how this activity is conducted. The 1986 Immigration Reform and Control Act (IRCA) requires all employers of new hired farm labor to check documents within 24 hours to see if each worker appears to be eligible to work. For seasonal agricultural service workers, the employer must record information about workers and send it to the Immigration and Naturalization Service (INS).

In California, Arizona, and Florida, the institution of farm labor contractors (FLC) has evolved rapidly after IRCA and serves as an intermediary between growers and seasonal farm workers to reduce employment-related transactions costs (Martin and Holt 1987; Martin 1987; Econ. Dev. Dept. 1990, EDD 1990). The growers contact with the farm labor contractors (FLC) for labor services, the FLC then becomes the employer, and the farm labor contractors handle all of the hiring, transporting, housing, supervising, and paying of the workers. This institution seems to have reduced the liability of growers associated with using undocumented foreign workers, for housing, and for health and safety in the fields (Martin 1991). Also it has reduced the cost of checking workers' documents because farm-labor contractors generally employ crews for a whole season and the crews usually work for a number of different growers. This arrangement also has the indirect effect that the growers have much less knowledge about the quantity and quality of work being done by seasonal agricultural workers in their fields.

An Economic Model of Farm Household Decisions

One very useful way to gain insights about how economic costing of agricultural commodities should be undertaken is to first model the consumption and production decisions of farm households and then think about how one would collect data so as to provide good empirical measures of our concepts. The model presented here is one in which an agricultural household makes plans, say at the beginning of the calendar year, on all of its household and farm decisions for the year. See Huffman (1991a), Strauss (1986), and Hallberg et al. (1991) for a review of these agricultural household models. To simplify and to cut to the essence of basic economic issues, these decisions are considered in a static model with certainty. Also, the financial aspects of farm household decisions is ignored here.

The household receives utility or satisfaction from the direct (or indirect) consumption of the farm operator's and spouse's leisure, L_f and L_s respectively, and from goods purchased in the market, X:

(2) $U = U(L_f, L_s, X; \tau)$ where τ is a taste (technology or environmental) parameter. The household receives an annual endowment of human time for the operator and spouse

($\bar{T}_f$ and $\bar{T}_s$). Although approximately 10 percent of the farm operators are women (Kalbacher 1985), this analysis proceeds under the assumption that all farm operators are male and all spouses are female. This time of the husband and wife is assumed to be heterogenous because of human capital, physical strength and other differences. Each person's time is allocated potentially to leisure (L_i), own-farm work (H_{i1}), and off-farm work (H_{i2}):

(3) $\bar{T}_i = L_i + H_{i1} + H_{i2}$, $H_{i1} \geq 0$, $H_{i2} \geq 0$, i=f, s,

where boundary constraints are imposed on wife's farm work and husband's and wife's off-farm work to insure zero or positive optimal hours of wife's farm work and (or) zero hours of husband's and wife's off-farm work.

Heterogenous unpaid and hired farm labor. The technology of farm production is represented by the asymmetric representation of the transformation function:

(4) $Q_1 = F(Q_2, H_{f1}, H_{s1}, Y; \gamma)$

where Q_1 and Q_2 are outputs, for example Q_1 could be an aggregate of crop outputs and Q_2 an aggregate of livestock outputs or they could represent particular commodities. H_{i1} is hours of unpaid farm work, Y is a vector of purchased inputs, which can include hired farm labor, and γ is a technology or efficiency parameter. Both the transformation function and utility function are assumed to be continuous and strictly concave functions.

The farm household is assumed to face a real cash income constraint in making plans:

(5) $X = P_1 Q_1 + P_2 Q_2 - W_y Y + W_f H_{f2} + W_s H_{s2} + V - C_o$

where P_j, j = 1,2, is the real price of farm outputs; W_y is the real price of purchased farm inputs; W_i, i=f,s, is the real wage per hours of off-farm work by the husband and wife; $V\text{-}C_o$ is real household nonfarm asset income less real fixed cost associated with the household and farm, including "trip charges" for service calls and one-time direct training and hiring cost for hired labor. Net household real cash income is spent on X, the purchased input for consumption; and all nominal magnitudes in the cash-income constraint have been converted to real magnitudes by dividing through by the price of X, P_x. Saving is ignored in this static model, and if a household does not market Q_j in the year of production, the household can obtain a zero interest loan at the market price per unit of the unsold commodity and it uses calendar-year accrual-based accounting.[2]

The household/business faces competitive prices for all outputs and inputs. The wage rate for off-farm work is assumed to depend on the individual's (or husband's or wife's) attributes (ξ) and local labor market and job characteristics (ψ):

(6) $W_i = W_i(\xi_i, \psi)$.

Two separate wage functions are suggested primarily because of differences in the quality of measured individual characteristics (E's) and possibly due to wage differences that have gender differences due to thin rural labor markets, including discrimination. See Willis (1986), Rosen (1986), Topel (1986), Briggs (1986).

This representative household faces 10 major household consumption and farm production decisions and is assumed to make them by maximizing utility, equation (2), subject to equality constraints on cash income and technology of farm production (equations (4) and (5) combined), and human time of the operator and spouse, equation (3). There are also three inequality constraints on human time allocation. The solution to the optimizing problem is important because it provides information about the marginal value of unpaid farm labor and the marginal cost of agricultural commodities.

The first-order conditions for optimal allocation or plans are obtained from equation (7):

(7) $\phi = U(L_f, L_s, X, \tau) + \lambda_1 [P_1 F(Q_2, H_{f1}, H_{s1}, Y, \gamma) + P_2 Q_2 - W_y Y$

$+ W_f H_{f2} + W_s H_{s2} + V - C_o - X] + \lambda_2 [\bar{T}_f - L_f - H_{f1} - H_{f2}]$

$+ \lambda_3 [\bar{T}_s - L_s - H_{s1} - H_{s2}]$

with first-order conditions for an optimum of:

(8) $\partial\phi/\partial L_f = U_{L_f} - \lambda_2 = 0$

(9) $\partial\phi/\partial L_s = U_{L_s} - \lambda_3 = 0$

(10) $\partial\phi/\partial X = U_x - \lambda_1 = 0$

(11) $\partial\phi/\partial Q_2 = \lambda_1 [P_1 F_{Q_2} + P_2] = 0$

(12) $\partial\phi/\partial H_{f1} = \lambda_1 P_1 F_{H_{f1}} - \lambda_2 = 0$

(13) $\partial\phi/\partial H_{s1} = \lambda_1 P_1 F_{H_{s1}} - \lambda_3 \leq 0, H_{s1} \geq 0, H_{s1} (\lambda_1 P_1 F_{H_{s1}} - \lambda_3) = 0$

(14) $\partial\phi/\partial Y = \lambda_1 [P_1 F_y - W_y] = 0$

(15) $\partial\phi/\partial H_{f2} = \lambda_1 W_f - \lambda_2 \leq 0, H_{f2} \geq 0, H_{f2} (\lambda_1 W_f - \lambda_2) = 0$

(16) $\partial\phi/\partial H_{s2} = \lambda_1 W_s - \lambda_3 \leq 0, H_{s2} \geq 0, H_{s2} (\lambda_1 W_s - \lambda_3) = 0$

(17) $\partial\phi/\partial\lambda_1 = P_1 F(\cdot) + P_2 Q_2 - W_y Y + W_f H_{f2} + W_s H_{s2} + V - C_o - X = 0$

(18) $\partial\phi/\partial\lambda_2 = \bar{T}_f - L_f - H_{f1} - H_{f2} = 0$

(19) $\partial\phi/\partial\lambda_3 = \bar{T}_s - L_s - H_{s1} - H_{s2} = 0$

where $U_\ell = \partial U/\partial\ell$, $\ell = L_f, L_s, X$, and $F_r = \partial Q_2/\partial r = \partial F/\partial r$, $r = H_{f1}, H_{s1}, Y$. (Note $F_{Q_2} < 0$ or additional output Q_2 requires a reduction in Q_1, holding inputs constant.)

For an interior solution on all these optimal quantities, equation (15) and (16) imply that $W_f = \lambda_2/\lambda_1$ and $W_s = \lambda_3/\lambda_1$. Then, from equations (8) and (10): $U_{L_f}/U_x = \lambda_2/\lambda_1 = W_f$ and from equations (9) and (10): $U_{L_s}/U_x = \lambda_3/\lambda_1 = W_s$; but from equation (12) $P_1 F_{H_{f1}} = \lambda_2/\lambda_1 = W_f$ and from equation (13) $P_1 F_{H_{s1}} = \lambda_3/\lambda_1 = W_s$. Thus, under these conditions:

(19) $\frac{U_{L_f}}{U_x} = P_1 F_{H_{f1}} = W_f$, and (19) $\frac{U_{L_s}}{U_x} = P_1 F_{H_{s1}} = W_s$, or for an optimal plan,

the time of the husband (wife) is allocated such that for an optimal plan the marginal value of an hour is the ***same*** for leisure, own-farm work, and off-farm work. Furthermore, these values are market determined (rather than internal to consumption and (or) farm production decisions) or equal to the individual's real wage for off-farm work.[3] Thus, because of the comprehensive accounting for an individual's time in this and similar models, the opportunity cost of time ***can*** ***never be zero***. The reason is human time always has a positive value in leisure, even in the short-run.

Human attributes that affect wage offers generally differ across individuals, and the local conditions are different when households reside in different localities. Across households the real wage (or demand for labor faced by the i-th individual) is in general different because the wage is a function of the individual's attributes (ξ), e.g., years of schooling completed, potential labor market experience, and local (relative to residence) economic conditions (ψ), i.e., the anticipated local growth in jobs, anticipated unemployment rate, and amenities and unanticipated shocks to local labor demand and unemployment.

Looking further at the production decisions, equation (11) implies that the optimal quantity of output Q_2, e.g., of livestock, is where marginal revenue from an added unit of Q_2 equals the marginal loss of revenue from the associated reduction in output Q_1, e.g., of crop output, required to free up enough resources to increase Q_2. Equation (14) implies that the optimal quantity of purchased farm inputs is such that the value of the marginal product of the input equals its marginal cost. Because the "prices" of Q_1, Q_2, H_{f1}, H_{s1}, and Y are determined in the market, the marginal conditions associated with these choices meet the criterion of profit maximization. ***Profit, however, is defined to include the opportunity cost of operator's and spouse's farm labor***:

(21) $\Pi = P_1 F(Q_2, H_{f1}, H_{s1}, Y; \gamma) + P_2 Q_2 - P_y Y - W_f H_{f1} - W_s H_{s1} - C_o^*$

where C_o^* is fixed cost associated with the farm business. Furthermore, there might be difficulty in separating the fixed cost of joint-use fixed items, and this would prevent separability and cause jointness of production and consumption decisions.

Assuming separability of farm from consumption decisions, the optimal decision rules for these variables can be obtained by considering the farm production decisions separate from the household consumption and labor supply decisions:

(22) $Z^* = \Omega_z\,(P_1, P_2, P_y, W_f, W_s, \gamma)$, $Z = Q_2, H_{f1}, H_{s1}, Y$,

and the supply function for Q_1 is obtained by substitution:

(23) $Q_1^* = F(Q_2^*, H_f^*, H_s^*, Y^*; \gamma) = S_{Q^1}(P_1, P_2, P_Y, W_f, W_o, \gamma)$.

Because of an economic duality between the maximization of output subject to a cost constraint and minimization of cost for given technology, we can recover the farm cost function for Q_1 and Q_2 associated with the solution to profit maximization. The marginal cost function can then be derived from "the" cost function (Diewert 1973; Chambers 1988). We can then obtain the minimum cost function:

(24) $C = C(Q_1, Q_2, P_y, W_f, W_s, \gamma)$.

By differentiating (24) with respect to Q_j, we can obtain the marginal cost functions:

(25) $MC_j = \dfrac{\partial C}{\partial Q_j} = C_j'(Q_1, Q_2, P_y, W_f, W_s, \gamma)$, j = 1,2.

In general, the marginal cost of Q_j depends on the exogenously determined (to the household) farm inputs prices P_y, W_f, and W_s, the technology parameter γ, and the output rates Q_1 and Q_2. If the technology for the two outputs is separable (not joint) and constant-return-to-scale in variable inputs exists, then two separate marginal cost functions can be written so that they do not depend on the quantity of Q_1 or Q_2 produced. $MC_j = C_j'(P_y, W_f, W_s, \gamma)$, or it, depends only on exogenous to the business input prices and the technology parameter. If we have data on prices and quantities, we can in essence estimate the parameters of an algebraic representation of the cost function. From it we can obtain the implied marginal cost function for a particular commodity.

Given a maximum for Π, say Π^*, the household can make second-level decisions on consumption and labor supply. It chooses L_f, L_s, and X subject to the modified budget constraint of

(26) $\Pi^* + W_f(\bar{T}_f - H_f^* - L_f) + W_f(\bar{T}_s - H_s^* - L_s) + V = X$,

where $H_{i2} = \bar{T}_i - H^*_{1i} - L_i$, i = f,s, has been substituted for H_{i2} in the net cash income constraint. (Note that variables possessing a superscript of * are no longer choices but are an optimal behavioral function.) The optimal rules for L^*_f, L^*_s and X^* are:

(27) $E^* = \phi_E(W_f, W_s, V + \Pi^*, \tau)$, $E = L_f, L_s, X$,

which are functions of the (real) off-farm wage rates of the husband and wife, (W_is), "exogenous real net income" $V + \Pi^*$, and the taste parameter τ. Furthermore, the optimal quantity of off-farm work is obtained residually:

(28) $H^*_{i2} = \bar{T}_i - H^*_1 - L^*_i = S_{H^{i2}}(P_1, P_2, P_y, W_f, W_s, V\text{-}C_o, \gamma, \tau)$, and it is a function of all the exogenous parameters in the general household decision problem $(P_1, P_2, P_y, W_f, W_s, V\text{-}C_o, \gamma, \tau)$.

Returning to the issue of the cost of unpaid farm labor, it is the "opportunity cost" or value of an hour of forgone off-farm work, or the off-farm wage W_i. Furthermore, if we incorporate an income tax at a constant marginal rate t on cash income into the analysis, the marginal return to an hour of off-farm work is $(1 - t)W_i$ and farm work is $(1 - t)P_1 F_{H_{i1}}$ so no distortion occurs in the allocation of time between these two time consuming activities. However, because the tax does not apply directly to leisure, the leisure-market-goods choice is distorted by the tax, i.e., $U_{L_i}/U_x = (1\text{-}t) W_i$, or the leisure versus work decision is distorted by the income tax.

If the husband and (or) wife do not work off-farm, the marginal value of the time of the nonworking individual is no longer tied directly to the market. Its marginal value is ***internal*** to a household's consumption and farm decisions. In these cases, all the consumption and farm production decisions of a household must be solved jointly as one large optimizing problem; the farm decisions cannot be separated from the household consumption (and labor supply) decisions. Now $W_i < \lambda_i/\lambda_1 = U_{L_i}/U_x = P_1 F_{H_{i1}}$, provided $H_{1i} > 0$, or ***the optimal allocation of the husband's (wife's) time is such that the marginal value of an hour used in farm work equals its marginal value for leisure, and this marginal value is larger than the off-farm wage***. Furthermore, the cost of an hour of unpaid farm labor is the value of the forgone leisure.

Although a farm household may be located in a region of the country where off-farm work opportunities appear bleak, the household ***always***, irrespective of location, has the option of using time of its members for leisure, which is sometimes called household production time (Michael and Becker 1973). Thus, agricultural economists who model farm business decisions as if there are N hours of time of a farm operator (spouse) that are "available" for farm work are making an artificial and likely misleading approximation. ***The problem becomes potentially serious when they also assume that this time has a zero opportunity cost in nonfarm, including household, uses***.

Taking a long-term perspective, one important aspect of leisure is time invested to affect ones future health status. A week or two of vacation per year and days off regularly during weekends and holidays are an input to future good physical and mental health which enhances long-term labor productivity. Performing domestic services around the house, caring for and supervising children, shopping for goods, interacting with friends and relatives, and sleeping are regular uses of human time that have positive and significant value in a well functioning household, too (Juster and Stafford 1991). Not participating in these activities is ***always*** one opportunity cost of farm work.

Homogeneous unpaid and hired farm labor. Up to this point, we have assumed that hired farm labor (nonfamily members) is a different input than operator's or spouse's farm labor, i.e., they are heterogenous inputs. Given that some agricultural economists have implicitly assumed homogeneity, it seems useful to examine this hypothesis. Furthermore, we assume that the local wage for farm and off-farm work for an adult of a given gender is the same. The main modification to the model of household decision making is to exclude hired labor from the purchased farm inputs (Y) and to define new measures of farm labor inputs and a new budget constraint as:

(29) $H'_{1f} = H_{f1} + Y'_f$

(30) $H'_{1s} = H_{s1} + Y'_s$

(31) $P_1 F(\cdot) + P_2 Q_2 - W_y Y - W_f(Y'_f - H_{f2}) + W_s(Y'_s - H_{s2}) + V - C_o = X$

(32) $Q_1 = F(Q_2, H'_{1f}, H'_{1s}, Y', \gamma) = F(Q_2, \bar{T}_f - L_f + Y'_f, \bar{T}_s - L_s + Y'_s, Y', \gamma)$

where Y_f' and Y_s' are annual hours of male and female hired farm labor, respectively, and equation (3) has been used to substitute away H_{f1} and H_{s1}. If $Y_i' - H_{i2} > 0$, the farm household is a net buyer of labor of gender type i, and if $Y_i' - H_{i2} < 0$, it is a net seller. ***It will be nonoptimal*** for both $H_{i2} > 0$ and $Y_i' > 0$, i.e., ***to both sell and buy labor of a given gender at the same time, given homogeneity by gender and some fixed costs associated with working***.

When equation (2) is maximized subject to equations (31)-(32), new first-order conditions of central importance are:

(33) $\partial\phi/\partial Y_f' = \lambda_1(P_1 F_{H_{f1}} - W_f) = 0$

(34) $\partial\phi/\partial Y_s' = \lambda_1(P_1 F_{H_{s1}} - W_s) = 0.$

Thus, the optimal allocation of male (operator's) time is:

(35) $U_{L_f}/U_x = P_1 F_{H_{f1}} = W_f$, if $Y_f - H_{f2} \neq 0,$

and of female/spouse's time is:

(36) $U_{L_s}/U_x = P_1 F_{H_{s1}} = W_s$, if $Y_s - H_{s2} \neq 0.$

The conclusions from this modification is the cost of operator's farm labor and leisure is now the wage rate for hired farm labor. Thus, the key condition for making the cost/price of unpaid family be the wage rate for hired farm labor is for hired labor and family labor to be perfect substitutes 1-for-1 in farm work.

The option of hiring farm labor that is homogeneous to farm family labor is a mechanism for increasing the gender-specific time constraint of the farm household. For example, an additional 100 hours of hired farm labor can in principle substitute perfectly for 100 hours of farm family labor, and a household might choose to increase a member's consumption of leisure as a result. Alternatively, the husband or wife could be freed from "physical farm work" and apply this time to farm-business decision-making--managing, marketing, examining new technologies.

Is it likely that hired farm labor is a perfect substitute for farm family labor? Workers of a given gender are relatively homogenous in their ability to do physical work. They, however, differ dramatically in abilities to do work requiring particular skills. In the United States, family members have superior skill on average (see

Tables 1 and 2 for some evidence; USDA 1963, 1983, Huffman 1996). Also, farm family members generally have a stronger motive for timely, responsible work decisions, e.g., to notice diseases, pests, or other problems and to act to take care of them, to complete harvesting when conditions are right, because they can reasonably expect to share in the profits of the farm business. It is very difficult to establish incentives for hired farm labor so that they have similar loyalties and responsibilities as farm family members (Huffman 1991c). Thus, several reasons exist in the United States for farm family and hired (nonfamily) farm labor to be imperfect substitutes in farming.

Getting the Price/Cost of Family Labor Right

In the previous section, implications for the cost/price of unpaid farm labor were obtained. Here we examine the effects on the economic organization of farm production, and the marginal cost of agricultural commodities of failing to get the cost/price of unpaid farm labor "right." Consistent with the model in the previous subsection, unpaid family labor is a variable cost of agricultural production, and it is valued at its opportunity cost.

To illucidate the issues, assume (i) the technologies for producing Q_1 and Q_2 are separable, (ii) they require only two inputs, unpaid farm labor (H_1) and a composite of purchased inputs (Y), i.e., $Q_i = F_i(H_1, Y)$, i = 1,2, (iii) for any given relative input price ratio, Q_1 is ***always more unpaid labor intensive*** than Q_2, (iv) each technology exhibits constant-returns-to-scale in the variables inputs, and (v) no fixed costs, $C_o = 0$. Given these assumptions, all our information about cost-minimizing production decisions can be represented on a unit-isoquant graph, i.e., $Q_i = 1$. To make the example clearer, think of Q_1 as dryland corn (or soybean) production and Q_2 as dryland wheat production, or Q_1 as dairy (or swine) production and Q_2 as range cattle (cow-calf) production. These commodity "pairs" represent reasonable good approximations to the above conditions currently for U.S. agriculture in terms of the average unpaid labor intensity of production.

The Lerner-Pearce diagram (see Johnson 1971, pp. 17-20) is used to display the production information for the two-input two-output cost minimizing problem (See figure 1). The initial situation is defined using relative input-price line C_oC_o' in figure 1. Cost minimization occurs at e_1 on isoquant $Q_1 = 1$ and at e_2 on isoquant $Q_2 = 1$, and the marginal (and average) costs of producing 1 unit of Q_1 and Q_2 are the same. Given that the price of Y is going to remain fixed in our analysis, the cost of production can be measured in units of Y in figure 1, i.e., Y is the numeraire good or the yardstick. Thus, MC_i and AC_i (i=1,2) are initially represented by the distance C_o0, in figure 1. For Q_1, the initial optimal input ratio is k_1^{*o}, and unpaid labor's share of the cost of production is represented by $C_oY_1^o/C_o0$. For Q_2, the optimal input ratio is k_2^{*o}, and unpaid labor's cost share is $C_oY_2^o/C_o0$. Clearly, Q_1 is more unpaid labor intensive to produce than Q_2, and unpaid labor's share is larger for Q_1.

Suppose the line C_oC_o' represents a relative price of unpaid labor that is ***too low*** and the "correct" relative price/costs line is represented by the line C_2C_2' tangent to isoquant $Q_2 = 1$ at e_2' and by the line C_1C_1' tangent to isoquant $Q_1 = 1$ at e_1'. This change in W/W_y resulted from an increase in W, holding W_y constant. How have the economics of the problem changes? First, the cost/price of unpaid labor has increased relative to the price of other variable inputs (Y). This causes changes in the economic organization of production. There is a substitution in production away from the input that has become more expensive in the production of both outputs, i.e., ***the production of both outputs becomes relatively less unpaid labor intensive***, i.e., $k_i^{*o} > k_i^{*\prime}$. Second, ***the marginal cost of producing both farm outputs is increased***. For Q_1 the new MC (AC) is represented by the distance $C_10 > C_o0$, and for Q_2, the distance $C_20 > C_o0$. Third, the marginal (and average) cost of producing Q_1, the relatively unpaid labor intensive output, has increased proportionally more than the marginal (and average) cost of producing Q_2. Thus, ***the relative marginal cost of Q_1 to Q_2 (MC_1/MC_2) has increased when we increased the cost/price of unpaid farm labor***.

Clearly "undervaluing" unpaid farm labor (relative to the price of other inputs) has very important implications for the economic organization of production. The production of Q_1 and Q_2 is ***too (unpaid) labor intensive***, the ***marginal*** (and ***average) cost of both outputs is too low, and the relative MC is distorted***. Whether the input-cost shares change depends on the size of the elasticity of substitution in production between the two inputs. If the technology is of the well known Cobb-Douglas type, the input-cost shares are unchanged.

For other technologies, the inputs shares will change, depending on the properties of the function. See Huffman (1996) for a review of long-term trends in the human agent's (labor's) cost share in U.S. Agriculture production.

We, however, can turn this issue on its head, reverse the process, and see the implications for the economic organization of production of setting the relative cost/price of unpaid labor "***too high***." ***The production of both outputs will be too intensive in Y, the marginal (and average) cost of both outputs will be too high, and the relative marginal cost of*** Q_1 ***will be too high compared to the marginal cost of*** Q_2.

Thus, setting the wage/price/cost of unpaid farm labor too low or "too high" distorts the story about the cost minimizing economic organization of agricultural production and the absolute and relative marginal cost of agricultural commodities. Hence, the only escape from inefficient distortions and misinformation about the cost of production is to set or get the relative inputs prices "right"--not "too high" and not "too low" -- even if this feat seems hard to accomplish!

Methods for Improving the Measurement of the Cost of Farm Labor

In this paper, labor is defined to be ***all*** of the time using productive activities of human beings. Farm labor is a subset of all labor, and a broad definition makes for a relatively homogenous input category over time, as specialization and change in the economic organization of our economy occur. Economic incentives faced by farmers affect the extent and degree to which purchased services are used as substitutes for more traditional unpaid hired farm labor. For example, the economic incentives in IRCA have created an incentive for farmers to use farm-labor contractors to acquire seasonal farm labor and subcontract their crop to intermediaries for harvesting. Thus, if farm labor is viewed too narrowly, labor services used in agriculture are underestimated significantly and a distorted picture of the magnitude of how they are changing over time is obtained.

Unpaid farm labor should be valued at its opportunity cost at nonfarming activities. Thus, for any individual doing unpaid farm labor during a period, there is only ***one*** price for his (her) time, irrespective of how that time is used in farming activities during that period. Furthermore, ***all*** of the farm labor and related services should be treated as ***variable (economic) cost***, irrespective of whether it is "hired" or "unpaid" farm labor. The primary reason is that all labor used in farming has immediate alternative or nonfarm uses, e.g., as leisure, household work, off-farm work, etc., and hence, it is a variable economic cost. Furthermore, the traditional calculation of return to (farm) management does not provide any meaningful or useful information and should be discontinued.

Quantity of Farm Labor

All of those purchased services that are highly substitutable for unpaid and hired farm labor should be included in the input class called "labor and related services." This would include ***all labor*** acquired through farm-labor contractors and all semi-skilled services used in farming, including mechanics, machinery and building repair services (labor only), information and management services, and bookkeepers. It would not include the services of highly skilled professionals, e.g., lawyers, tax accountants, and veterinarians.

Furthermore, the number-one priority for collecting data on the quantities of labor and related services should be obtaining accurate estimates of "whole annual farm uses" in hours. Counts of numbers of workers are not useful. Also, we believe that farm labor data based primarily upon input-output coefficients or labor-requirements per unit of output are very unsatisfactory for cost-return methods, and they should not be the primary source of information about farm labor use. Farm labor use should be based primarily on data obtained from surveying farmers.

Although some might be skeptical about the quality of the information obtained from surveys, the state of knowledge about how to conduct good surveys of time use are quite advanced (see Juster and Stafford 1991). Also, farmers can be expected to know or to be able to make reasonable estimates of the use of unpaid farm labor when the questions are asked appropriately. For example, fairly accurate information on ***hours*** of farm labor by a farm operator can be obtained by the following procedure. First, identify the farm operator (or farm operators) for a farm. Second, ask him(her) (or each of time) how many hours he(she) allocated to each of farm work (broadly defined), to off-farm work, to work around the house, and to all other activities during the last month (week). This type of question has the advantage of having a control total on hours allocated by a given individual to all uses of time during a day. Thus, an error in the estimate of one use of time causes an offsetting error in the opposite direction in other uses of time. Most individuals have a relatively good perception about how their time is allocated to major activities using this procedure.

Farmers can be expected to present much less reliable information about how they allocate their time to particular farming activities, or commodities. There are several reasons for this outcome. First, farmers are frequently engaged in a fairly wide range of activities during any day, week, month, or year. Human recall for small details is difficult for everyone (Juster and Stafford 1991). Second, farmers frequently use time that affects more than one commodity or enterprise. Thus, obtaining an estimate of exactly how much is to be allocated to each enterprise or commodity is arbitrary. We recommend that in the long term, cost-return methods move away form all methods of estimating labor use that require the application of highly subjective or arbitrary rules for allocating time among commodities.

It seems best to obtain an estimate from a farm operator of the total amount of labor (hired and unpaid) used in a farm business during some period, say a year (the "whole farm estimate"), then he (or she) be asked to allocate the share of each of the major types (or cost) of labor to each major commodity or enterprise. Again, it is important that information be collected in a way so that shares sum to one (or 100 percent).

In the long term, econometric fitting of cost or profit functions is recommended as a much better procedure for obtaining estimates of the marginal cost of particular commodities when joint production occurs. The conceptual framework for doing this was laid out in equations (24) and (25). Also, see Antle and Capalbo 1988, Ch. 2. The econometric approach has the major advantage of not requiring information on the specific allocation of inputs to jointly produced outputs. It does require that a particular function form be chosen, e.g., translog or generalized quadratic profit or cost function to represent the technology, but the data on inputs and outputs that are required are just "whole farm totals" on say an annual basis. Application of the above econometric approach would eliminate the need for subjective or arbitrary allocation of farm labor (or labor cost) among various commodities.

The Cost/Price of Labor

There are two main types of labor and associated services to be distinguished here, "paid" and "unpaid" ones. For hired (not family, partners or shareholders) labor and related purchased services, the cost should be measured as the ***cash-equivalent cost of total cost or compensation*** from the producer's point of view (wages and salaries; farm-trip charges; cash outlays on hiring, screening, documenting workers; cash and in-kind benefits, etc.). Although nonwage benefits are a smaller share of total compensation for farm labor than for nonfarm labor, the relative importance of the cost of benefits has been increasing and is most likely to continue to increase. For children of farm families that are paid a wage for farm work, the cost of this labor should be the actual wage paid, provided that it appears to be reasonable given their age and skill.

For unpaid farm labor, the cost, even in the short-run, should be set at a positive opportunity cost. For all operators, partners, and spouses, who are adults, the cost of their time for national cost-return methods should be the wage per hour for off-farm work. In particular, the predicted off-farm wage rate for individuals with a given gender and having particular attributes, e.g., schooling, potential labor market experience, is a good approximation to the opportunity cost of their farm labor for cost-returns methodology. This procedure has the advantage of moving its determination into the hands of relatively objective researchers. Data obtained from farmers on wages paid spouses, partners, and shareholds are viewed as unreliable and should not be used. For any particular farm, extension specialists can consider the value of a unit of time used for vacation, household, or other nonmarket uses as the appropriate opportunity cost, if it is higher that the off-farm wage for a similarly skill worker in the area. This value of human time in nonmarket uses, however, is not recommended for general cost-returns methodology use because of its extremely subjective nature and problems in soliciting meaningful information about its value from surveys.

For unpaid child labor, the value of their time is best set at the wage rate for hired farm labor if they are 16 years of age or older and set at the local minimum wage if they are less than age 16. Much greater work is required to obtain the opportunity wage for unpaid adult farm labor.

Methodology for Estimating the Opportunity Cost of Unpaid Farm Labor

Labor market information--wage rates and attributes of workers and locations--are major inputs for estimating the opportunity cost of unpaid farm labor by the off-farm wage rate paid for similarly skilled individuals. The procedure that is recommended for translating information on attributes into wage rates is an econometric one.

The Labor Market

The market for labor is abstract, not being so well defined in location as the Chicago Board of Trade or a community livestock auction. It, however, is a useful construct in which to define the context within which the buyers and sellers of labor come together to determine the wage and allocation of labor services (Elliott 1991, p. 4-5). The market for labor usually has a distinct geographical dimension, e.g, a single town or city, a region (county or state), or a country (United States). Typically labor economists are concerned with the labor market for a particular skill or occupation, location or region, and point in time.

Labor economists also find it useful to consider "the" market for labor. Although this level of abstraction ignores complexities and heterogeneities of labor, jobs, and locations, it acknowledges that through the process of mobility, i.e., promotions and investments in skills and moving geographically, each of the separate sublabor markets are interlinked (Elliott 1991, p. 47; Stigler 1962).

The labor services offered for sale in the labor market exhibit considerable degree of heterogeneity and tend to be exchanged in submarkets. Individuals differ in their formal education, type and amount of experience, physical and mental ability, motivation, aptitude for particular tasks or responsibilities, leadership potential, and ability to deal with uncertainty and to take risk. As indicated above, formal education and training create useful skills and generally raise a worker's productivity and can offer substantial financial rewards to workers. The two major types of skills, general and specific, have profound effects on labor compensation and allocation and decisions. As the skills become more specific, workers become more heterogeneous and their mobility decreases. Mobility--geographical and occupational--is what provides the linkages between different labor markets (Elliott 1991, p. 6; Rosen 1986; Huffman 1996).

Equalizing Wage Differentials. In labor markets where employers are primarily competitive firms or businesses and a significant share (need not be all) of the workers are mobile, the "theory of equalizing wage differentials" is "the fundamental long-run labor market equilibrating mechanism" (Elliott 1991, p. 313; Rosen 1986). The value to prospective workers (and the cost to employers) of the pecuniary and nonpecuniary aspects of jobs differ. The pecuniary aspects are the financial aspects, the wage or salary profile over time, paid vacations, employer contributions to retirement plans and health insurance and other directly costing benefits. Nonpecuniary aspects of jobs include (but are not limited to) flexibility, timing, and location of work; opportunities for training, promotion or advancement; and on the job working conditions--safety, comfortableness and pleasantness, compatibility and cooperative coworkers.

The theory of equalizing compensation differentials suggests that the evaluation by prospective employees and firms of pecuniary and nonpecuniary aspects of jobs are factored into their actions taken in the labor market, and at the margin the net advantage across heterogenous jobs or employees is approximately equalized. As indicated above, this theory is applicable when firms or employers are primarily, but need not be exclusively, motivated for profit. The implications are that when location of work and nonmonetary aspects of jobs are held constant, jobs that require larger investments in general skill or training pay wage rates that are higher than those requiring less skill or training. Furthermore, the wage differential is large enough to provide a competitive rate of return on investment to workers. Holding skill and location constant, jobs that have undesirable nonmonetary characteristics pay higher wage rates than those jobs that supply more desirable working conditions.

Prospective employees, however, tend to be heterogenous in their preferences and evaluation of nonmonetary aspects of jobs, so the size of the compensating differential depends on the distribution of preferences among workers, given the demand for labor and nonmonetary aspects of employment (Elliott 1991, Ch. 11; Becker 1971, p. 177-179; Rosen 1986). For example, the labor literature shows that the wage is higher for jobs that have a significantly higher probability of immediate work-related death, e.g., for skyscraper steel workers and aquanauts (Elliott 1991, p. 332; Rosen 1986).

Furthermore, the theory of equalized differentials predicts that if a firm offers benefits to its employees that a minority of the population of potential workers will use directly, it will pay a lower wage rate than otherwise and attract primarily workers that value this benefit highly. For example, competitive firms that offer "free child care services" to their employees will pay lower wage rates to their employees than they would otherwise pay, unless they charge the employees who uses the service for the cost of the child care. The theory of equalizing wage differentials is just another example of the economic metaphor that there is no such thing as a "free lunch."[4] A competitive firm places itself at a disadvantage when it pays both a higher wage rate and provides more costly benefits than other firms. The wage and benefit package offered by the government sector, however, does not need to meet the rigors of competition, and it can offer any package that taxpayers will pay for (Harberger 1971).

General Versus Specific Training or Information. A unit of general human capital, e.g., formal schooling, increases the productivity of a worker by approximately the same amount in a wide range of producing units or firms. In contrast, specific human capital increases an individual's productivity to only one firm, business, or farm and has approximately no effect on the individual's productivity in other firms or businesses. Each farmer has his own procedures or standards for many farm tasks, e.g., for planting corn, soybeans, cotton and other row crops, and employees who participate in these activities must learn them.

Farm operators or growers also obtain "farmland specific information" whenever they farm a particular parcel of land for several years, a type of specific human capital. Each piece of farmland is unique in its productive characteristics. The reason is that plant and animal biology is generally geoclimatic sensitive, and they interact with local soil, climate, cultural practices and management practices differently (see Griliches 1960; Evenson 1989; Acker and Cunningham 1991, p. 370-371; Barnes 1957). Thus, the land, technology, weather outcomes, and management all interact together to determine the particular agricultural production outcome.

Furthermore, the only way that a farmer, rancher, or grower can obtain this information is through actual experience farming the land, i.e., through an extended period of time spent observing and measuring the outcomes. When he (or she) moves to a new parcel of farmland, his (her) knowledge about the previously farmed land becomes obsolete and largely useless. Furthermore, this specificity of experience to a particular piece of farmland means that sons and daughters of farmers have a comparative advantage in learning about the productive aspects of the land operated by the family and help explain why farm businesses and farmland are passed from one generation to the next with much higher frequency than any other business or major occupation in the United States, making the occupation and control of the major asset for a business, the farmland, appear to be highly inheritable (Hoiberg and Huffman 1978, p. 8, 20).

The distinction between general and specific human capital is crucial to an understanding who pays the costs and receives the benefits from training or information and of the functioning of modern labor markets (Elliott 1991, p. 167; Becker 1975; Goldin 1990). Its importance arises from implications for who bears the cost (and receives the returns) from investments in these two types of human capital i.e., for understanding compensating differentials and effects on lay-off and quit rates. Furthermore, arrangements for sharing costs/returns between employees and employers generally involve implicit, rather than written, contracts (see Goldin 1991, p. 114-115; Elliott 1991, p. 256-262; Alchian and Demsetz 1972).

Except for unionized labor, there are very few written contracts dealing with terms of employment, sharing of hiring and training costs, and prerequisites for promotion because they are effectively unenforceable. It is very difficult to precisely define, monitor, and enforce the quantity and quality of labor of employees, and much of the information that exists is qualitative and internal to the employing firm (Elliott 1991, p. 167-168; Goldin 1990, p. 114-117). Employers have generally found it more efficient and effective to use implicit contracts and establish incentives for cooperative behavior and (or) company loyalty, e.g., piece-rate wage for workers in manufacturing and harvesting many fruit and vegetable crops, cash bonuses, profit sharing, and promotion to a "higher level position" or a higher wage or salary.

Hedonic Wage Equations

The concept of equalizing differentials due to employee and job (or employer) attributes has been given empirical content through "hedonic" wage or labor demand equations for labor services of individuals holding particular jobs. The "hedonic" or characteristic approach to explaining or determining the wage (or price of a good or service) is based upon the empirical hypothesis, or research strategy, which asserts that the multitude of skills or attributes of workers and jobs (or models and varieties of a particular commodity) can be comprehended in terms of a small number of characteristics or basic attributes (Griliches 1971, p. 4; Rosen 1974). By viewing the problem in this way, ***the magnitude of the number of truly "different" types of labor services, jobs, or submarkets available are greatly reduced because "new ones" are just viewed as a new combination of "basic" attributes that have been present for some time***.

In its parametric, or wage equation, version, the methodology asserts the existence of a reasonably good fitting empirical relationship between the hourly wage and an employee's skill and employer's various but not too numerous attributes. Labor economists have accumulated a large amount of evidence about (1) the relevant set of basic attributes for employees and jobs, (2) the algebraic form of the relationship between the wage and attributes, and (3) special problems of sample selectivity or non-representativeness of actual workforce participants relative to the population of potential participants (see Pencavel 1986). The relationship can be summarized as:

(37) $\ln W = \beta_o + X_1\underline{\beta}_1 + X_2\underline{\beta}_2 + \delta_3\lambda + \mu$

where W is the average (hourly) wage, X_1 is a vector of personal attributes that are exogenous to current workforce participation decisions (e.g., years of formal schooling, years of potential or actual post-school workforce experience, race), X_2 is a vector of job or employer associated attributes that are exogenous to current workforce participation decisions (e.g., geographical location of work, anticipated and unanticipated local labor market conditions, local cost of living indicators, and indicators of local amenities), λ is a variable that controls for sample selectivity of workforce participants from the pool of potential workforce participants, μ is a random zero mean disturbance term that represents the impact of many other factors that affect wage rates but that are individually of minor importance to the wage or labor demand facing an individual.

The hedonic wage equation (37) is a type of reduced-form equation, and its parameters (βs) need not be constant over time. Empirical studies by labor economists, however, have shown considerable stability over time and across similar but not exactly the same individuals. They, however, have found strong evidence for different wage equations for men and women, and the primary reason is greater within-gender homogeneity of particular attributes than across-gender homogeneity. See Gunderson (1989), Rosen (1986), Willis (1986), Goldin 1990; Smith and Ward 1984, 1989; Fuchs 1989; Juster and Stafford (1991), Pencavel (1986), and Killingsworth and Heckman (1986) and the discussion below of gender wage differences.

The Size and Density of Labor Markets. When some of the prospective workers and some of the jobs are tied to specific geographical areas--e.g., members of farm families tend to be tied to particular parcels of land, married adults are largely tied to each other, jobs are tied to particular geoclimatic aspects of the local environment or distance from large centers of consumption--aspects of local labor markets matter for labor market outcomes. Kenny and Denslow (1980), Adams (1985), Topel (1986), Tokle and Huffman (1992) and others have found state units to be adequate representations of local labor markets in the United States.

Fixed employment-related costs and density of demand for particular skills, frequently referred to as the size of the market, also have a major impact on the distribution of skills available in and the functioning of the labor market. Adam Smith (1776) noted more than 200 years ago that the extent of specialization that can be achieved (obtained or supported) in a market is proportional to the size of the market (also see Stigler 1951, 1962; Rosen

1983; and Becker 1989). Thus, only very large labor markets or urbanized areas can support extremely specialized human capital, e.g., specialized accountants, tax preparers, lawyers, medical doctors. The reason is the very large investment in skill that is required relative to the size of the demand by any one household, firm, or individual for these services (Rosen 1983). Modern communications and microcomputer systems have extended the accessibility to rural areas of some of these services.

In rural and some other areas where people are tied to particular areas due to the location of farm land and family relationships and fixed costs and other transaction costs are high, employees' skills (men and women) and jobs are most likely less perfectly matched than urban areas and can lead to employees being overqualified for the jobs that they hold. The relative degree of the mismatch and the frequency of significant mismatches are likely to be larger in rural areas and small towns than in large urban areas. The outcome of this mismatch is subject to several different interpretations. The issue of "thin" rural labor markets is a research topic that Briggs has examined (see Briggs 1981, 1986). In some areas of the United States, especially in the Great Plains and Mountain States, low density of people and jobs and high transactions costs seem likely to reduce the efficiency of the functioning of rural labor markets.

Gender Differences. Goldin concludes from her extensive U.S. historical review that significant gender wage differences did not exist before the turn of the centrury when labor markets were primarily spot markets. In these markets, workers were generally paid the value of their marginal product at each instant in time, e.g., daily or weekly exchanges of labor. If a job required skill learned on the job, the worker generally paid (Goldin 1990, p. 114-115).

Turning to recent years, Fuchs (1989), Smith and Ward (1989), Goldin (1990), Gunderson (1989) all conclude from their extensive research that although a small amount of labor market discrimination may exist against women, especially black women, differences in the quantity and quality of skills are the major factors in understanding gender wage differences in the United States. These differences exist because individuals have other sources of utility or satisfaction than their own job in the market and their own workforce earnings.

The Off-Farm Wage Equation

Two wage equations, one for adult males and one for adult females, are in principle needed in order to be able to predict the off-farm wage rates by gender, or opportunity cost of unpaid adult farm labor for male and female farm operators, partners, and shareholders doing farm work.

A somewhat arbitrary decision must be made on choice of the size of the relevant local labor market. Some researchers have experimented with "commuting areas," which are groups of counties that might go across state boundaries. Others have found local labor markets defined along state boundraies to be conceptually appealing and to work well empirically. State units get away from the sometimes bleak employment opportunities available in the nearest town and recognize that individuals living on farms currently commute relatively long distances on a daily basis for good jobs. Either definition might be used, but to make the following procedure concrete, local labor markets are defined along state boundaries.

For a given individual within a particular state (locality), labor market conditions are approximated by a perfectly elastic demand curve for his or her labor of a given type (see Figure 2). This is an approximation to the actual situation and follows a long tradition in ecometric labor economics (see Willis 1986; Pencavel 1986). The reason for not distinguishing between "part-time" and "full-time" wage rates is that workers decide whether to work full-time or part-time when both options are in principle available in the market. Hourly wage rates for part-time work are generally less than for full-time work because of a negative compensating differential. Each individual's potential labor supply represents a very small share of total labor services available in the state. This wage for full-time work, however, is a function of his/her attributes--schooling, experience, location--and local economic conditions. Individuals who possess larger quantities of market human capital on average face a higher wage, or perfectly elastic demand, for their labor than those having less market human capital.

Although the hedonic wage equations used by different researchers differ in their exact specifications, a specific example is instructive here. One particular empirical specification of the wage equation that has considerable promise is equation (38):

$$\begin{aligned}(38)\quad \ln WAGE_i^j = {} & \alpha_1^j + \alpha_2^j EXP_i + \alpha_3^j EXP_i^2 + \alpha_4^j ED_i + \alpha_5^j RACE_i + \alpha_6^j PJOBGR_i \\ & + \alpha_7^j PURATE_i + \alpha_9^j ESHOCK_i + \alpha_{10}^j RURATE_i + \alpha_{11}^j \ln PLAND_i \\ & + \alpha_{12}^j URBAN_i + \alpha_{13}^j JAN_i + \alpha_{14}^j JAN_i^2 + \alpha_{15}^j JULY_i \\ & + \alpha_{16}^j JULY_i^2 + \alpha_{17}^j NC_i + \alpha_{18}^j SOUTH_i + \alpha_{19}^j WEST_i \\ & + \alpha_{20}^j TIME_i + \alpha_{21}^j \lambda_i + \epsilon_i^j, \; i = 1, ..., n, \; j = M, F.\end{aligned}$$

where personal attributes include: years of schooling completed (ED), potential experience (EXP and EXP squared), and race (RACE). Potential experience is more exogenous to current wage and hours outcomes than actual work experience (Killingsworth and Heckman 1986). Also, almost all individuals are primarily involved in some time of work activity--housework, farmwork, wage work--during all post-schooling years until retirement. Although a year of experience in each type of work is not of equal quality for affecting market wage rates, it is difficult to judge exactly how to weigh them. Thus, potential experience can be considered a proxy for general human capital obtained from all post-school work-experience (also see Willis 1986; Pencavel 1986; Elliott 1991).

Attributes of the state of employment that affect the wage include variables that workers and employers can be expected to know or predict at planning time: predicted job growth (PJOBR), predicted rate of civilian unemployment rate (PURATE) and variables that neither firms nor households could be expected to know: local labor demand shocks (ESHOCK) and unanticipated local business cycle shocks (RURATE) that will occur during the year. Also, the price of land is a major part of the costs of housing-plus-access. This can be proxied by the state average land price from an earlier year (PLAND). An additional component to the price of home sites is associated with the extent of urbanization in a state. This can be proxied by the percentage of the population living in urban areas in a past year (URBAN). The simplest local amenity to measure is climate. Anticipated climate can be proxied by the 30-year normal average January (JAN, JAN squared) and July (JULY, JULY squared) temperatures. In additional, a wage equation fitted to annual data would include a variable for time trend (TIME).

In any given year, not all adults are observed to be working in the market. The ones who are (not) working are in this group because of a conscious decision or because of unanticipated events. If the decision in the workforce is largely under the control of the worker or the worker's household, we cannot assume that nonworkers have unmeasured characteristics that are equal to those who are working. This circumstance creates a potential problem with ***selectivity bias*** if the wage equation is fitted to data only for those individuals who are observed to be currently in the workforce. One route to alleviate the problem is to include a variable that controls for the probability that an individual is in the workforce during any particular year (see Killingsworth and Heckman 1986).

When the wage equation, corrected for selectivity, is fitted to data for workers, it can be used to predict the wage for both workers and nonworkers. Data on individuals that are available for fitting these wage equations are the USDA's Farm Operator Resource Survey and Census Bureau's Current Population Survey. The Farm Operator Resource Survey does collect data on annual off-farm earning and hours of off-farm work for all adults in the farm operator's household. The Farm Operator Resource Survey would need to collect gender specific information for individuals engaging in unpaid farm work. Farm households and its members face very strong incentive to specialize in skill acquisition, even holding years of formal schooling constant. Furthermore, these incentives have a strong gender specific component given the wide range of tasks that must be undertaken in a successful farm household.

The predicted hourly off-farm wage from an equation like (38) is a statistically consistent estimate of what individuals with given skills and location can expect to earn on average. This methodology is one that enables us to draw inferences about the opportunity cost or forgone wage per hour for ***all potential workers*** in a given year. When the attributes of a potential worker are inserted into the wage equation containing estimated coefficient, obtained from data for observed workers, and the coefficient of the sample-selection variable is ignored, the resulting predicted wage can be interpreted as an estimate of the average wage rate that the prospective worker could expect to receive, given employment. See Figures 3 and 4 for examples of what wage-age profiles might be expected to look like for adult married men and women who are in farm households. The profiles are derived using the wage equation reported in Appendix 1 (and in Tokle and Huffman 1992) and national means for attributes of adult farm men and women (see Table 3). The wage equations were fitted to data for married couples in the nonmetropolitan nonfarm population. In making the prediction of off-farm wage rates for husbands and wives that live on a farm and have farm income, we assume that the value of these attributes is not affected significantly by fitting the wage equation to individuals in the nonfarm population.[5] With the relatively high participation rates of farm husbands and wives in off-farm work, this assumption is not too bad (see Table 1 and Huffman 1991a).

As a practical matter, wage equations would not need to be fitted every year to data in order to obtain good forecasts of off-farm wage rates. Real wage rates for particular attributes are relatively stable over time. Better wage equations can be obtained by pooling data together for individuals in the 48 contiguous states than by fitting equations to observations for each state separately. Most likely, wage equations would need to be fitted at least once in five years. Provided high quality methodology was used, the fitting of wage equations could (but need not) be part of the research activity of ERS.

Conclusion

Farm labor seems best defined to labor and related services. Furthermore, these inputs should be treated as variable inputs and not fixed or overhead costs of agricultural production. Farmers should be surveyed for their estimate of the annual amount of labor used on their farm. In the short run, they should be asked to allocate the time among the commodities that they produce. In the long term, cost of production estimates should move away from all methods that require arbitrary allocation of labor to particular commodities. This could be achieved by using econometric estimates of cost or profit functions for multicommodity technology.

All purchased (from outside sources) be valued at producers' cost. All adult unpaid farm labor should be valued at its opportunity cost, defined to be the predicted off-farm wage rate. Methods are suggested for lightening the burden of this task and for helping to insure good predictions. In particular, except for children employed on the farm, reported payments to spouses of operators, partners, and shareholders for farm work should not be used in cost of production estimates.

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FOOTNOTES

1. Stigler (1966, p. 104) concludes that historic costs or costs measured only as cash outlays have powerful sway over untutored minds. For example, A lazy shopkeeper has identical goods available at two different prices, men (and women) incur additional losses trying to "get their money" out of a venture, and rent freezes are an effective way of making housing available to low-income households. These examples suggest a concept of cost that flies in the face of a basic principle of rational behavior, "By-gones are forever by-gones," or more to the point, there is no such thing as a "free lunch" even in France (Stigler 1966, p. 104 and 108).

2. Clearly, this assumption is introduced to reduce needless complexities. If the real interest rate were high, it might be important to incorporate the interest rate.

3. The market is a relatively objective and efficient evaluator of private resources.

4. A good analogy is that an individual can withdraw his (her) hand from a bucket of ice water, but the water level in the bucket will in fact drop. It is impossible to have the hand free of the water and the original water level, unless a handicap is used.

5. The farm operator households used by Tokle and Huffman (1991) are taken from the Current Population Survey. They were defined to be a household that had both a farm residence and (any) self-employment income from farming. Thus, these households do not include households living on farms but providing only hired farm labor or only off-farm work. The Census of Agriculture and Farm Costs and Returns Survey use a different definition. Some (more than 10 percent) of their farm operators have a nonfarm residence. Although these farm operator populations do not match perfectly, the behavior relationships are unlikely to be affected by small differences in the definition of a farm operator.