Transaction Costs and Institutional Innovations in Agricultural Labor Contracts

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Abstract. This paper develops and econometrically tests a model of labor contractual choice in developing countries, focusing on the choice between directly hiring labor on a spot market versus reliance on labor contractors. The theoretical model examines the role of market prices and factor endowments on contract choice and the role of labor contracting as an institutional innovation to reduce transactions costs associated with the use of hired labor. Econometric results confirm hypotheses that contracting becomes more profitable as farm size and collateral ownership increase, as family size decreases, and with tightening of the casual labor market.

Introduction

This paper develops and applies a framework to analyze the impacts of transactions costs on agricultural production and on employer choice between labor contracts. In particular, the paper focuses on employer choice between two types of labor arrangements: the direct hiring of labor via the casual market versus employing the services of an independent labor contractor who recruits and monitors the work team. The basic thesis is that employer choice of labor contracting is determined as the result of a tradeoff between two sets of costs attendant to hired labor contracts: the cost of working capital necessary for direct monetary payments to labor and employer time costs of labor recruitment and supervision. Hiring labor from the spot or "casual" labor market entails a number of transactions costs in terms of employer time to recruit the work force, negotiate contracts, coordinate the production process and monitor the quality and amount of labor effort supplied by hired hands. Casually hired labor is costly in terms of the opportunity cost of employer time, which must be diverted from directly productive activities to managerial ones. Use of contract labor involves greater monetary costs but requires less employer time than do casual labor. Employer choice of labor arrangement thus depends not only on market prices and technology, but also on employer endowments of working capital and available time.

The paper is organized as follows. In Part 1, following Sen (1981) and Eswaran and Kotwal (1986), two perturbations are introduced into a standard profit function. The availability and cost of credit depend on borrower ability to offer collateral and hiring labor on the spot market entails transactions costs in terms of employer time. Transactions costs impose a number of constraints on production and explain certain stylized facts in Indian agriculture. In Part 2, labor contracting is modeled as an institutional innovation that allows employers to economize on time costs. By substituting working capital for time, reliance on labor contractors allows employers to circumvent managerial diseconomies. In the model, contracting increases responsiveness of labor demand and output supply to market prices and increases labor demand on large farms. Labor contracting becomes more profitable as farm size and collateral ownership increase, as family size decreases, and with tightening of the casual labor market. Contracting is also more profitable for tasks that require the application of large amounts of labor over a short time horizon. In Part 3, an econometric model of contractual choice is developed to test hypotheses about contractual choice arising from the theoretical model. This model is estimated using data from a rice-growing village in semi-arid tropical India. The empirical findings, which prove consistent with predicted behavior, are compared with other studies of labor contracting systems in South and Southeast Asian agriculture. The conclusion summarizes main results.

Model specification

Each household is endowed with $\underline{A}$ units of a collateral asset – owned land for example – and $\underline{F}$ units of available family labor time. The amount of credit available to each household, B is an increasing function of the amount of owned land

(1) $$B = B(\underline{A});\ B' > 0.$$

The interest rate charged, i, is decreasing in a household's owned land.

(2) $$i = i(\underline{A}); \qquad i' < 0.$$

Larger landowners often have greater access to credit at more favorable rates than do smaller landowners [Bandhyopadyay; Bhende, 1986; Iqbal; Lipton, 1976].

Each farm household allocates available family labor time $\underline{F}$ between two sets of activities – direct cultivation F and managerial activities, t. The family time constraint is

(3) $$\underline{F} = F + t(N, u).$$

The function $t(N,u)$ represents managerial time spent by employers. These employer time costs represent recruitment, negotiation, and supervision costs. Each household may hire casual labor time N as required during the crop cycle at an exogenously given village wage rate, w. The parameter u represents factors such as unemployment, which influence the time cost of hiring casual labor. Negotiation, recruitment, and supervision costs are decreasing in u, implying that transactions costs are higher when labor markets are tight. This point merits some discussion. During periods of peak labor demand, there are congestion externalities as employers compete for a limited number of village workers, increasing recruitment costs. Employers may have to resort to recruiting labor outside the village or recruiting less reliable labor within the village. Reliance on less able or experienced workers or on workers whose abilities are unknown (migrants) requires employers to devote more time to direction and monitoring. We thus make the further specifications

(4) $$t_N > 0;\ t_{NN} > 0;\ t_u < 0;\ t_{nu} < 0$$

where subscripts denote first derivatives and double subscripts denote second derivatives. The transactions costs involved in employing casual labor places an upper bound on the number of workers a farm operator can recruit, instruct, and supervise in a given period.

In a given season, a farm operator's profits Π on a plot of size A are

(5) $$\Pi = pQ[A,L] - wN(1 + i(\underline{A}))$$

where Q is a concave production function and output price is p. The purchase of casual labor time is financed through borrowing at a rate of interest $i(\underline{A})$. The variable L is total labor input

(6) $$L = N + \underline{F} - t(N,u).$$

Use of hired labor diverts family time away from direct cultivation activities, F. These transactions costs are unavoidable (i.e. t is determined by the choice of N). Operated acreage A is assumed to be fixed in the short run. Most intermediate production activities are carried out after employers have chosen how much acreage to cultivate. The variable A may also be taken as a technological shift parameter.

Consider first an interior solution where neither the family time nor the credit constraints are binding and some casual labor is hired. The optimality condition

(7) $$pQ_L = [w\ (1 + i(\underline{A}))] / (1 - t_N)$$

implies that employers equate the marginal value product of aggregate labor input L to the effective marginal cost of hired labor. To employers, the marginal cost of casual labor has two components – a constant monetary cost component and an increasing cost in terms of employer time. Each additional casual laborer hired diverts family time away from direct cultivation activities. Although laborers receive a constant market wage w they are costly in terms of employer time. For this reason, a household will not simultaneously hire out family labor for agriculture and hire in labor from the casual labor market for the same period or task. The marginal cost of labor also depends on the farm operator's ownership of collateral assets, $\underline{A}$, which influence interest costs.

Roumasset and Smith have noted transaction costs in the labor market act as a progressive tax on hired labor use, preventing employers from equating the marginal value product of labor to its marginal monetary costs. This relationship is illustrated in Figure 1. The upper part of

Figure 1 shows the level of hired labor input that solves equation (7). The marginal cost of hired labor $[w\ (1 + i(\underline{A}))]\ /\ (1 - t_N)$ is shown by cc' while curve mm' represents the marginal value product of aggregate labor input, pQ_L.

The bottom portion of the graph shows the level of family labor devoted to direct production and to management as a function of hired labor *N*. Aggregate labor input *L* devoted to direct production is given by the distance *OB*, where *OA* is hired labor time and *AB* = *OF* represents family labor time. The amount of family labor time spent on management equals the distance $\underline{F}F$. If transactions costs were eliminated, total labor directly hired would increase to $OB^* > OB$. Transactions costs impose a constraint on employment and output on labor-hiring farms. Time costs have an effect analogous to an ad valorem tax on hired labor. The triangle *def* represents an analogous "deadweight loss" from transactions costs, implying that efficiency gains may be obtained by reducing these costs.

Inverting, Q_L the demand function for hired labor is

$$N^* = N^*\ (w/p,\ u,\ i(\underline{A}),\ \underline{F}). \quad (8)$$

The demand for hired labor depends not only on market prices and farm size, but also on household endowments of family labor time and collateral assets, as well as factors, *u*, affecting labor market transaction costs. Using N^* one can derive a supply function $Q^0(w/p, u, A, \underline{A}, \underline{F})$ and a profit function $\Pi^0(w/p, u, A, \underline{A}, \underline{F})$. Both production and profits depend on the distribution of productive assets, $\underline{A}$ and $\underline{F}$. A number of attempts to apply duality theory to more efficiently estimate parameters of profit, supply, and input demand equations have often yield disappointing results [e.g. Lau and Yotopolous, 1971; Junankar, 1978, 1980a, 1980b; Binswanger and Evenson, 1984]. Results have been disappointing in the sense that the null hypothesis of restricted profit maximization is frequently rejected, estimated parameters have the wrong signs, or both. Such problems may stem from biases created by omitting variables such as $\underline{A}$, $\underline{F}$, or u.

The results of comparative static exercises are presented in Table 1 (Detailed calculations are available upon request from the author). These results are consistent with Bardhan's (1984a) empirical finding that hired labor demand is related to both landholding and family labor availability. An increase in a household's collateral assets translates into lower credit costs, shifting the *cc*' curve downward. In the new equilibrium, more labor is hired and family members spend proportionally more time in management activities and will devote less time to direct cultivation. The model has important implications for the impact of internal migration the agriculture. The model predicts that out-migration from net hiring households will have a negative impact on local employment and output. If family labor availability $\underline{F}$ decreases because of out-migration, the *F(N)* curve shifts upward. In the new equilibrium, the household relies increasingly on hired labor (i.e. $dN / d\underline{F} < 0$). However, less family labor is available for direct production. Also, because more casual labor is hired, family labor must be reallocated from directly productive activities to managerial ones. Thus, the amount of directly productive labor employed declines (i.e. $dL / d\underline{F} < 0$) if $t_{NN} > 0$ as assumed. This result holds even if the agricultural labor supply curve is perfectly elastic with respect to the casual wage rate. Harriss (1982) has observed peasant farms that suffered economic losses because there were too few family members available to properly recruit and monitor labor. Lipton (1980) and Connell et al. (1976) also cited evidence suggesting that out-migration from employer households has a negative effect on local labor demand.

The results also have implications for inter-village labor mobility. If the parameter u is interpreted as a measure of mutual familiarity, migrant labor would entail greater transactions costs. Employers may prefer local labor even if newcomers offered to work at lower monetary wage rates. Conversely, laborers may be averse to seeking work in villages with higher prevailing market wages than their own because their probability of gaining employment, and expected earnings, hence would be lower than the observed market wage. This results is consistent with Rudra's (1984) empirical finding in West Bengal villages that laborers did not migrate to nearby villages where higher wage rates prevailed and employers did not hire labor from surrounding villages with lower prevailing wage rates. Rajaraman (1982) also found wide wage dispersions in contiguous villages in Karnataka.

An increase in operated acres *A* will cause the marginal productivity of labor curve *mm*' to shift upward, increasing demand for hired labor as well as the deadweight loss from transactions costs. The variable *A* may also be taken as a technological shift parameter representing tasks that have large labor requirements. Family labor constraints may thus constrain adoption of more labor-intensive crops or technologies.

Price responsiveness

Under the general specification employed thus far, it is not clear what the precise effect of transactions costs on the price sensitivity of output supply and labor demand will be. We have, however, derived, various elasticities for the special case of a Cobb-Douglas production function $Q = L^{\alpha}A^{\beta}$. The elasticity of labor demand with respect to output price ε_p is

(9) $$\varepsilon_p = [\ (1 - \alpha) + (L\ t_{NN}) / (1 - t_N)^2\ ]^{-1}$$

With no transaction costs, this elasticity is ε^0_p or

(10) $$\varepsilon^0_p = 1 / (1 - \alpha) > \varepsilon_p$$

The elasticity of output supply with respect to output price is $\eta_p = \alpha\ \varepsilon_p$. With no transaction costs, this elasticity is $\eta^0_p = \alpha / (1 - \alpha) > \eta_p$. Further, the elasticities η_p and ε_p will equal zero if either the family labor availability constraint or the credit constraint are binding. This would be true even under a general production function specification. The elasticity of labor demand with respect to the market wage rate ε_w is

$$\varepsilon_w = \{[\,(\alpha - 1\,)\,(1 - t_N)\,] - [(L\,t_{NN}) / (1 - t_N)^2\,]\,\}^{-1} \tag{11}$$

If hired labor use is high enough for t_N to tend toward one, then ε_w will tend toward zero. The value of ε_w will tend toward zero if the family labor constraint is binding. Without transaction costs, $\varepsilon_w = 1/(\alpha - 1)$. These results imply that with transactions costs and relatively high use of hired labor, the demand for hired labor may be highly inelastic. The computed elasticities for the special Cobb-Douglas case are consistent with evidence presented by Junankar (1978; 1980a; 1980b), Bardhan (1984a) and Binswanger and Evenson (1984), which suggests that the demand for labor in Indian agriculture is quite inelastic with respect to output price and the wage rate. The Binswanger and Evenson study, estimating labor demand functions from a number of regions, found price responsiveness to be smaller in areas where the ratio of hired to family labor use was highest. This is in concert with our theoretical results.

Implications of the Model

Model results have important implications in terms of policy and specification of economic relationships. Regarding economic modeling, a standard result of many household models is that allocative efficiency is independent of the distribution of endowments (Barnum and Squire; Singh, Squire, and Strauss). Transaction costs and differential credit costs imply that this result no longer holds. This occurs because interest rate dispersion and transactions costs systematically depend on asset distribution. This is particularly important because most agricultural production data sets do not include any measures of transaction costs or exact rates of interest paid. Our results suggest that in addition to average market prices, it is necessary to include endowment variables for family size and property ownership in input demand, output supply and profit functions of agricultural households.

The model also suggest that as hired labor use becomes great relative to family labor availability, output supply and labor demand become unresponsive to increases in output price. This suggests that there may be little scope for inducing increases in output or employment through price support policies. In the limiting case where the family labor constraint is binding, output price increases only direct income transfers to labor-constrained employers. Alternatively, reducing the scale of agricultural operations may reduce the deadweight loss from transaction costs. This occurs because the source of inefficiency is the use of hired labor. As A declines, family labor increasingly substitutes for hired labor. At the limit, the farm operates with only family labor and the deadweight loss is zero. Eswaran and Kotwal (1986) have demonstrated that given dual imperfections in the credit and labor markets, breaking down large net hiring farms into smaller operations may increase allocative efficiency as well as agricultural employment and output.

Adjustments through induced innovation in labor arrangements

Employers have an economic incentive to develop new labor arrangements that reduce transaction costs. Alternative labor arrangements to the casual market may be understood as institutional innovations designed to economize on employer time. Examples of time-saving innovations in labor markets include the creation of markets for managerial labor (Calvo and Wellisz) ant the development of incentive contracts such as piece rates (Roumasset and Uy), efficiency wages (Shapiro and Stiglitz; Bowles) and labor-tying arrangements (Eswaran and Kotwal, 1985a). An important feature of these alternatives to the casual market is that they allow employers to substitute working capital for employer time. They represent a shift from personal labor management, which is intensive in family member time, to contractual forms of labor management, which entail greater monetary cost, but economize on family member time. Contractual innovation may be explained in terms of a tradeoff between the opportunity cost of employer time necessary to manage labor and the cost of working capital necessary for monetary payments to hired labor. The induced demand for time-saving contracts will depend, therefore, on a household's endowment of available family labor and factors affecting labor requirements such as scale of operation and technology. In addition the relative monetary costs of different labor arrangements will also be important. The analysis of contracts in terms of tradeoffs between employer time and working capital has been carried out by Sen (1981) and Eswaran and Kotwal (1985b) who examined the choice between casual labor contracts and land rental contracts. Land rental contracts may not always substitute for different labor contracts. For example, there may be no market for land-rental once the crop production cycle has begun. Thus, once employers decide to operate a given holding, they will be constrained to choose from among different employment arrangements.

The theory of induced institutional innovation (Ruttan and Hayami) implies that there will be and economic incentive to develop contracts that substitute for missing or imperfect markets. In addition, contractual arrangements adjust in response to changes in technology and relative factor scarcities in a manner analogous to flexible prices in a Walrasian system, allowing economic agents to equate relative marginal factor costs to returns. Given transaction costs in labor markets and price distortions in rural credit markets, however, relative factor scarcity will be household specific as will relative factor costs. Small-holding peasant households are characterized by relatively large endowments of available family labor relative to owned land. For this group, working capital is scarce and smallholders will relay on labor arrangements that require fewer financial resources. For larger-scale farms, family labor availability for recruitment and supervision of labor may become the scarce and limiting factor of production. On such farms, there will be an induced demand for labor contracts that economize on family member time. Contractual choice, therefore, cannot be explained without consideration of the distribution of productive assets across agents.

The approach taken here extends earlier work on induced institutional innovation, which focused on the role of relative factor scarcity at a regional or village level. This limits one's ability to explain the existence of heterogeneous institutional structures in regions with homogeneous relative resource endowments. For example, Hayami and Kikuchi had difficulty explaining why, two different types of rice harvesting contracts were developed within a geographical contiguous and ecologically homogeneous area. They were led to explain differences in contractual choice in terms of the manner in which the distribution of assets in a region influenced the transactions costs of alternative contractual arrangements. This important insight, however, was not developed formally. Moreover, the main explanatory variable – transactions costs – was unobserved. However plausible and intuitive this approach may be in describing changes in contractual arrangements ex post, its reliance on unobserved explanatory variables severely limits the theory's verifiability and predictive power. In the following section, a model of endogenous institutional change is developed that may be viewed as an extension of earlier theories of induced institutional innovation.

The approach develops more formally its micro foundations, taking the household, rather than the region or village as the basic unit of analysis. The significant extensions may be summarized as follows. First, problems of imperfect information and collateral requirements imply that relative factor scarcities are household specific and incompletely revealed by average relative market prices. Thus, the structure and mix of contracts in a region depend not only on the aggregate level of endowments, but also on the distribution of those endowments across households. Second, transaction costs in labor markets may be evaluated in terms of employer time costs. It is hypothesized that these costs are systematically related to such readily observable factors as scale of operation, technology, labor force characteristics and local unemployment rates. The fact that major explanatory variables are observed (or potentially observed) makes the proposition of the model amenable to empirical verification.

In this section, employers are allowed the option of hiring the services of a labor contractor who recruits and organizes work-gang labor for specialized tasks. Employers can hire *C* hours of work-gang labor on a contract basis at a total cost of *Z*. The sum payment *Z*, is an increasing function of the number of laborers require to complete the task in the specified time, $Z = Z(C)$ and $Z'(C) > 0$. It is assumed that $Z(C)$ is a simple linear function of the form $Z = zC$, where *z* is a scalar constant. Examination of village level data revealed that, for a given season-task combination, the contract rate, z exceeded the casual hourly rate, *w*. The difference $z - w$ may be thought of as a per labor hour premium charged for contracting services. Contract labor is assumed to be self-recruiting, but to require some supervision time τ such that $\tau = \tau(C,u)$ where $\tau_C > 0$, $\tau_{CC} = 0$ and $\tau_u \leq 0$. It is also assumed that $\tau C < \tau N$ for any $C = N$. Time cost functions for casual and contract labor are shown in Figure 2. Contract labor economizes on employer time but involves higher per unit monetary costs. The introduction of contracting, however, places a ceiling on the effective marginal cost of hired labor. At sufficiently high levels of hired labor use (points to the right of *h**) the effective marginal cost of contract labor (which includes the opportunity cost of employer time) is less than that for casual labor. Transaction costs under contracting may be further reduced if the employer and contractor have a long-standing relationship. In such cases, the reputation of a contractor may ac as a substitute for gathering information about the quality of particular workers. This captures the tradeoff employers face between the opportunity cost of their time and the extra monetary cost of adopting labor contracting as a system of management.

An employer's optimization problem involves both a discrete and a continuous choice. The discrete choice is whether to adopt labor contracting or to directly hire and manage casual labor. Employers adopt labor contracting if it is more profitable to do so. Employers' optimization may be expressed as a sequential decision process:

Step 1: max Π with respect to N (holding $C = 0$) yielding a profit function Π^0

Step 2 max Π with respect to C (holding $N = 0$) yielding a profit function Π^1

Step 3: select max $[\Pi^0, \Pi^1]$.

It is assumed that employers only hire one type of labor for a specific task. This is consistent with observations from the study area. An employer's continuous choice is to determine the optimal size of the hired work force, along with contractual structure.

Properties of labor demand under labor contracting

If labor contracting is adopted the first order condition will be

(12) $$pQ_L\,[A, L^1\,] = [z\,(1 + i(\underline{A}))]\,/\,(1 - \tau_C)$$

where L^1 is the optimally chosen amount of production labor employed if contracting is adopted. By inverting Q_L, equation (12) can be expressed as an input demand function for contract labor of the form $C^* = C\,(z/p, u, A, i(\underline{A}), \underline{F})$. Further substitution yields a supply $Q^1(z/p, u, A, \underline{A}, \underline{F})$ and a profit function $\Pi^1(z/p, u, A, \underline{A}, \underline{F})$. Figure 3 compares the marginal cost of hired labor under each system and Figure 4 compares equilibrium solutions under the direct hire and contracting systems. Given the specification of the time cost functions t and τ, the marginal cost curve for hired labor under the direct-hire system cuts from below the marginal cost curve for hired labor under the contracting system (Figure 3). For operations, with sufficiently high labor requirements,

(13) $$(z / (1 - \tau_C(C^*, u))) < (w / (1 - t_N(N^*, u)))$$

where C^* and N^* are optimal levels of hired labor under each contractual regime. If contracting is introduced, total employment increases from *OB* to *OB**. Equilibrium values if contracting were adopted will differ from those under the direct hire system as follows:

(14) $$L^1 > L^0; \quad Q^1 > Q^0; \quad Q_A{}^1 > Q_A{}^0; \quad Q_L{}^1 < Q_L{}^0$$

Under contracting, labor demand and output supply will be more sensitive to changes in output price. In fact, assuming employer time cost function is linear under contracting, price elasticities under contracting are identical to those under zero transactions costs.

Determinants of Contractual Choice

Consider the discrete choice between contract versus casual labor. Let $\Lambda = \Pi^1 - \Pi^0$ represent the net return from adopting labor contracting over the direct-hire system. Employers adopt contracting if and only if $\Lambda \geq 0$. Some comparative static results are

(15) $d\,\Lambda / dA = Q_A{}^1 - Q_A{}^0 > 0$

(16) $d\,\Lambda / d\underline{F} = Q_L{}^1 - Q_L{}^0 < 0$

(17) $d\,\Lambda / du = -t_u\, Q_L{}^1 - (-\tau_u) Q_L{}^0 < 0$ if $|t_u| > |\tau_u|$

(18) $d\,\Lambda / dw/p = (1 + i(\underline{A}))N^* > 0$

(19) $d\,\Lambda / dz/p = -(1 + i(\underline{A}))Z^* < 0$

(20) $\mathrm{d}\,\Lambda / \mathrm{d}\underline{A} = -i'\,[\, z\, C^* - wN^* \,] > 0$

These results imply that the relative profitability of adopting labor contracting increases with an increase in the tightness of the casual labor market, represented as an increase in *w* or a decrease in *u*. This suggests that labor contracting will be more prevalent for operations performed at times of peak labor demand. Again, if *u* is a measure of mutual familiarity between employers and laborers, one would expect a higher incidence of contracting in areas relying more heavily on migrant labor. Contracting also becomes increasingly profitable as (a) the monetary cost of contract labor z/p decreases, (b) a household's endowment of family labor time $\underline{F}$ decreases, (c) plot size (or land productivity) A increases, and (d) as a household's ownership of collateral assets $\underline{A}$ increases.

On large farms, employers will tend to select contractual or indirect forms of management. Their advantageous position with respect to the credit market makes them better able to adopt more complex and costly management systems such as contracting. Small farms, alternatively, find credit less available and more costly to attain. For this group, labor-saving innovations such as contracting are less suited to their particular needs. Consequently, small farms may continue to capitalize on their advantage in the labor market, relying on family members to manage hired labor directly.

An iso-locus can be shown in endowment space that determines the critical combinations of land ownership and family labor endowments that separate adopters of labor contracting from non-adopters. Let $\underline{A}^*$ and $\underline{F}^*$ be those values of household specific endowments that satisfy the equation

(21) $$\Lambda(w/p, z/p, u, A, \underline{A}, \underline{F}) = 0.$$

Figure 5 depicts this locus of points. For given values of the exogenous parameters, a household on this locus will be indifferent between adopting labor contracting and directly hiring labor. From the comparative static results obtained above, it is clear that for all points above Λ^* the relative profitability of labor contracting is positive and conversely, it is negative for all points below Λ*.

The Λ* locus will shift in response to changes in *w/p, z/p, u*, and *A*. From the comparative static results, factors that increase the marginal product of labor will shift the curve out. Conversely, an increase in the relative cost of labor contracting through a decrease the unemployment rate or an increase in *z* relative to *w* will cause the locus to shift in. These results suggest that for a given level of endowments, households are more likely to adopt contracting in the context of higher labor productivity and tighter labor markets.

Econometric Model

For a given plot, a farmer may either employ contract work-gang labor or directly hire casual labor on the spot market. The profits on the *i*th plot of the *j*th employer directly hiring casual labor can be written as

$$\Pi_{ij}^{0} + e_{ij}^{0} \quad (22)$$

where Π_{ij}^{0} represents the determinate portion of the profit function and e_{ij}^{0} is a stochastic error term capturing unobserved factors that affect profits under the direct hire system. Alternatively, profits under the labor contracting system can be written as

$$\Pi_{ij}^{1} + e_{ij}^{1} \quad (23)$$

where e_{ij}^{1} represents unobserved factors that affect profits under labor contracting. Contract labor will be employed on a given plot *i* by employer *j* if

$$\Lambda_{ij} = [\Pi_{ij}^{1} - \Pi_{ij}^{0}] + [e_{ij}^{1} - e_{ij}^{0}] > 0 \quad (24)$$

where Λ_{ij} represents the net gain from adoption. It is further assumed that Λ_{ij} may be approximated by a first order Taylor series expansion around a point in ($w/p, z/p, u, A, \underline{A}, \underline{F}$) space. Expression (24) may then be written as

(25) $$\Lambda_{ij} = \beta' x_{ij} + \nu_{ij}$$

where x_{ij} +is a vector of exogenous explanatory variables and where $\nu_{ij} = e_{ij}^1 - e_{ij}^0$. If e_{ij}^1 and e_{ij}^0 are normally distributed, ν_{ij} will also be normally distributed. The dependent variable Λ_{ij} is, however, unobserved. Instead what is observed is the dichotomous contractual choice variable y defined by

(26) $$y = 1 \text{ if } \Lambda_{ij} > 0$$
$$y = \text{ otherwise}$$

Equation (25) may then be estimated as a probit regression equation where

(27) $$\beta' x_{ij} = \beta_0 + (w/p)\,\beta_1 + (z/p)\,\beta_2 + A\,\beta_3 + \underline{A}\,\beta_4 + \underline{F}\,\beta_5 + u\,\beta_6$$

the intercept term β_0 represents that part of the Taylor's series approximation involving only the point around which the expansion was made. If the expansion were around the sample means of the variables, then β_0 would represent information about the average observation. This interpretation allows us to test our hypotheses that the distribution of endowments at the householdd level affects contractual choice. This amounts to an imposition of the restriction $\beta_4 = \beta_5 = \beta_6 = 0$. on equation (27). The restricted model embodies the null hypothesis where the alternative hypothesis is one where contractual choice depends on household specific factor scarcity and unemployment.

Data and study setting

The econometric model was estimated using data from rice farms in the village of Aurepalle in south-central India. The data come from the village level studies of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) for the years 1981/2 – 1984/5. Data included information on contractual choice, plot size, household attributes as well as prevailing seasonal wage and unemployment rates operating in the study area. There were two types of contracting systems operating in the study area. The first is extra-village contracting. Here, labor contractors recruit local villagers for work outside the village such as public works jobs or agricultural operations in other areas. Villagers in dryland areas prove to be a cheap reserve of labor for recruiters from more heavily irrigated areas. Breman (1985) has discussed the importance of this type of extra-village contracting of migrant labor in the harvest of sugar cane in Gujarat. The other form of contracting is intra-village contracting. Here, local village contractors recruit members of small contract gangs to perform specialized tasks. Data were available only for this type of contracting. Intra-village labor contracting has been observed in other rice-growing regions of South India, Sri Lanka, and the Philippines. In Aurepalle, there were four female work-gangs specializing in two operations: transplanting and weeding of paddy rice. Each work-gang had between 15-30 members with one female group leader known as a *peddamanish*i. The group leader, accompanied by three or four work gang members visited rice growers to negotiate job contracts. Work-gangs were paid a collective piece rate based on the number of laborers required to complete the given task in a pre-specified period of time. The level of payment may also be partially determined by prevailing field conditions and task difficulty. The payment received by the work gang was shared equally among its members. In Aurepalle, the group leader did not receive additional payments for her services, but the group as a whole earned a higher wage than the casual rate. This equal sharing of contract payments has also been observed by Athreya et al. on rice farms in Tamil Nadu. Epstein (1973) and Hayami and Kikuchi, however, noted cases where the contract group leader was paid a premium above payments to other workers. The group leader's main function appeared to be bargaining with prospective employers and allocating contract work among members of the work-gang. Not all tasks require the full participation of all members at a given time. The group leader coordinatedthe timing and deployment of work-gang labor across different employers and fields. For a given job, the group leader and employer jointly determined the size of the labor force. The group leader is also responsible for settling any internal disputes among work-gang members. The effective cost per hour of contract labor is higher than the casual daily wage rate for female labor. Contract labor however is self-recruiting. In Aurepalle, the group leader was not responsible for supervision of the work-gang. Interviews with rice growers revealed that they felt that their personal supervision was necessary to guarantee work quality. Employers reported that the main reason for using contract labor was to economize on recruitment costs and to reduce risk of production delays.

Aurepalle experienced a tightening of its agricultural labor market since the 1970s. This has occurred despite continued population growth, lack of any significant technological change that might increase labor demand, and reduction in irrigated acreage as a consequence of recent drought and groundwater scarcity. Many factors acted to shift the supply curve for agricultural labor inward (ICRISAT, 1987). First, many formerly landless labor households received grants of previously government-held grazing land. Agricultural labor households diversified into other activities such as herding animals or tapping palm trees. There was also increased migration to Hyderabad 70 kilometers away to work in the urban informal sector as well as an expansion of alternative income-generating activities developed through Integrated Rural Development Programs (IRDPs) in the village. In addition, some agricultural labor households were able to purchase cropland outright. This combination of factors led to a secular decline in unemployment and increase in real agricultural wages (ICRISAT, 1987).

Data on employment of casual and contract labor by task for the South Indian village of Aurepalle were available for the crop years 1981/2 – 1984/5. During this period, contract labor employment was concentrated almost exclusively in paddy rice transplanting and weeding. Returns to task performance are sensitive to the speed and timeliness of task completion. Delays in transplanting seedlings from nursery beds to fields once they have reached maturity may severely reduce yields. Yields are also sensitive to the timing of fertilizer applications. Weeding, if necessary is performed between transplanting and fertilizer applications. Thus, both operations require that relatively large amount of labor be mobilized in a relatively short time horizon. These tasks represent cases where family labor time constraints are more likely to be binding and where marginal recruitment and monitoring costs are likely to be higher. It is not surprising that contract labor specializes in these tasks. Use of contract labor has been observed in other rice-growing areas of India (Athreya et al.; Epstein 1962, 1973), in the Philippines (Hayami and Kikuchi) and Indonesia (Hart, 1980). Problems of mobilizing sufficient labor are particularly acute for *rabi* season transplanting of paddy from late November to early December. This is a time when the villages major *kharif* season crops – sorghum, pearl millet, and castor – are harvested. This is usually a time when labor availability in the village is lowest and wage rates are highest (Ryan and Ghodake).

A total of 75 complete observations were available for plots on which weeding was performed and 164 observations were available for transplanting. The observations were for rice farmers choosing between casual and contract hired labor. One farm in one year that employed only family labor was excluded from the sample. Tables 1 and 2 compare adoption rates of labor contracting in the base and final years of observation. For transplanting, adoption rates between large and small-to- medium farms are compared. The year 1984 was a relatively dry year with lower than average agricultural employment. Weeding was almost exclusively carried out by the large farm group. Table 1 shows that large farms have a higher rate of adoption.

Estimation results

Tables 3 and 4 report results of regression estimation for weeding and transplanting. The variable *PMU* – the probability of market unemployment – is the ratio of days an agricultural laborer fails to find employment to the total number of days which she sought employment. The reference period is the month during which the given operation was performed. One would expect the incidence of contracting to be inversely related to this variable as a tighter labor market implies greater recruitment costs. The probability that contract labor is employed is greater for households with more owned land (*OWN*), on larger plots (*AREA)* and have lower levels of available family labor (*AVAIL*). The variable *AVAIL* includes both family members and regular farm servants employed annually by the household. Adoption of contracting is negatively associated with its monetary cost and positively associated with the casual wage rate, though only marginally for transplanting. The coefficient of the variable *PMU* meant to capture the effect of market unemployment on transaction costs has the expected negative sign in both equations, but is significant only for the transplanting equation. This result may be due to the fact that only monthly measures of unemployment were available for the village. Weeding operations are often performed in the end of January when the labor market has slackened. All the coefficients have the signs expected from the theoretical model. The hypothesis that contractual choice depends solely on technology / plot size, relative monetary prices and average relative factor scarcity ($\beta 4 = \beta 5 = \beta 6 = 0$) was rejected at the 2.5% significance level using a likelihood ratio test for weeding. The likelihood test statistic equaled 10.16 with 3 degrees of freedom. The same hypothesis was rejected at the 1% level for transplanting – the likelihood ratio statistic was 12.81 with 3 degrees of freedom. For weeding, the model correctly predicted contractual choice over 66% of the time, while the percentage correct for transplanting was 74%.

Comparison with other studies

The results are in line with observations made by Hart (1980) of Indonesian rice-growing areas who found nearly all recruitment and organization of transplanting operations were carried out by local female contractors. For weeding operations, the incidence of direct hiring was greater (as in this study) but "larger landowners delegated recruitment." The theoretical results of the model are also consistent with the observations of Rao (1984) of a Karnataka village originally studied by Epstein, 1973. Rao (1984) found a declining incidence of labor contracting in rice cultivation accompanying a general slackening of the agricultural labor market and a secular reduction in the numebr of households owning more than one acre or more of irrigated land.

Managerial innovations remove a number of constraints on the profitability of large-scale farming in Indian agriculture. It has been noted that Green Revolution technological packages often generated sharp peaks in labor demand (Ghodake, Ryan, and Sarin; Bardhan; Binswanger and Rosenzweig) The new technology requires large amounts of labor to perform certain tasks over a specific, short time horizon. Such technology may create labor bottlenecks by driving up the wage rates in times of short-term labor scarcity. Adoption of new labor-intensive technologies may be hindered by constraints on available family labor. Labor contracting, however, lowers the marginal cost of hired labor. We also notate that imperfect information may restrict inter-village labor mobility. Contractors, by acting as guarantors of the performance of their work-gang reduce the importance of mutual familiarity between employers and individual laborers. Thus, labor contracting complements the adoption of more labor intensive practices on large farms employing migrant labor. Labor contracting systems employing large amounts of migrant labor predominate in sugar growing regions of Gujarat (Breman; Attwood). The introduction of sugar growing in the area led to a high degree of labor intensification. Labor contracting with migrant labor has also been observed in areas of rapid adoption of Green Revolution technologies (Bhalla, 1976; Rao, 1975).

Both the theoretical and empirical results indicate that contracting appears to be more favored by larger farms. This observation has been made elsewhere with respect to sugar harvesting (Attwood; Roumasset and Uy) and rice cultivation (Athreya et al.; Hart) and more generally (Breman). Results also suggest that the incidence of labor contracting increases with a tightening of the rural labor market. Roumasset and Uy also found a positive correlation between agricultural wage rates and the use of contractors.

Conclusions

To summarize, the study explains labor contracting in agriculture as a means of overcoming constraints imposed by transaction costs. Information and other transaction costs implies that hired labor is an imperfect substitute for family labor, but small farms face higher credit costs, tighter credit constraints, or both. Larger-scale producers hold a cost advantage in the credit market, but small farms, relying predominantly on family labor, hold a cost advantage in the labor market.

Larger-scale production is constrained by family labor availability. A simple model was developed that characterizes use of labor contractors as an institutional innovation that allows larger-scale employers to substitute (relatively) cheaper working capital for scarce time. Econometric analysis yields results in general agreement with the theoretical model of labor contract choice. One implication of the results, beyond the scope of the present study, is that growth of labor contracting may facilitate the increase in the scale operation in Indian agriculture and agriculture elsewhere in the developing world.

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Table 1. Impact of exogenous parameter changes on employment, output, and profits

Variable Affected	Parameter changed $\underline{A}$	A	$\underline{F}$	w	u	p
F	–	–	+	+	?	–
N	+	+	–	–	?	+
L	+	+	+	–	+	+
Q	+	+	+	–	+	+
Π	+	+	+	–	+	+

Table 2. Comparison of labor contracting adoption rates for paddy rice transplanting

	1981/2	1984/5
Percent of plots using contracting	55	77
Large farms	71	92
Medium/small farms	15	40
Percent of labor hours employed under contracting	63	82
Large farms	70	95
Medium/small farms	27	49

Table 3. Comparison of labor contracting adoption rates for paddy rice weeding

	1981/2	1984/5
Percent of plots using contracting	41	62
Percent of labor hours employed under contracting	51	62

Table 4. Probit regression of factors affecting use of labor contracting for weeding operations on Aurepalle rice plots

Dependent variable y = 1 if contract labor employed (46 observations);
y = 0 otherwise (29 observations)

Variable	Estimated Coefficient	t ratio	Mean of Explanatory Variable	Standard Deviation
AREA	0.99635	* 2.07	1.146	0.646
OWN	0.10833	* 2.49	11.628	8.787
AVAIL	-0.32461	* -2.07	5.146	2/197
WWAGE	4.01340	** 1.77	0.481	0.121
WCON	-3.02430	** -1.77	0.622	0.177
PMU	-0.00933	-0.38	15.605	8.160
Constant	-0.12752	-0.11		

75 observations
Likelihood ratio test (zero slopes) 19.85 with 6 d.f.
Percent correctly predicted: 66.67
* significant at the 5% level; ** significant at the 10% level

Glossary of Variables

AREA	Size of plot in hectares
OWN	Owned land in hectares
AVAIL	Number of available family members
WWAGE	Average village casual real wage rate (female), weeding
WCON	Average village real contract rate (female), weeding
PMU	Probability of market unemployment for reference period – number of days laborers were unable to find work divided by the total number of days work was sought (multiplied by 100)

Table 5. Probit regression of factors affecting use of labor contracting for transplanting operations on Aurepalle rice plots

Dependent variable y = 1 if contract labor employed (108 observations);
y = 0 otherwise (56 observations)

Variable	Estimated Coefficient	t ratio	Mean of Explanatory Variable	Standard Deviation
AREA	0.99987	* 3.6157	1.088	0.583
OWN	0.04206	* 2.6762	11.898	8.851
AVAIL	-0.10393	**-2.4181	3.853	4.022
TWAGE	1.17080	1.1443	0.456	0.117
TCON	-2.32970	-1.5299	0.642	0.087
PMU	-0.04538	*-2.7711	16.490	7.867
Constant	1.02270	1.0077		

164 observations
Likelihood ratio test (zero slopes) 33.38 with 6 d.f.
Percent correctly predicted: 74.4
* significant at the 1% level; ** significant at the 5% level

Glossary of Variables

AREA	Size of plot in hectares
OWN	Owned land in hectares
AVAIL	Number of available family members
TWAGE	Average village casual real wage rate (female), transplanting
TCON	Average village real contract rate (female), transplanting
PMU	Probability of market unemployment for reference period – number of days laborers were unable to find work divided by the total number of days work was sought (multiplied by 100)

Figure 1. Impact of transaction costs on labor allocation

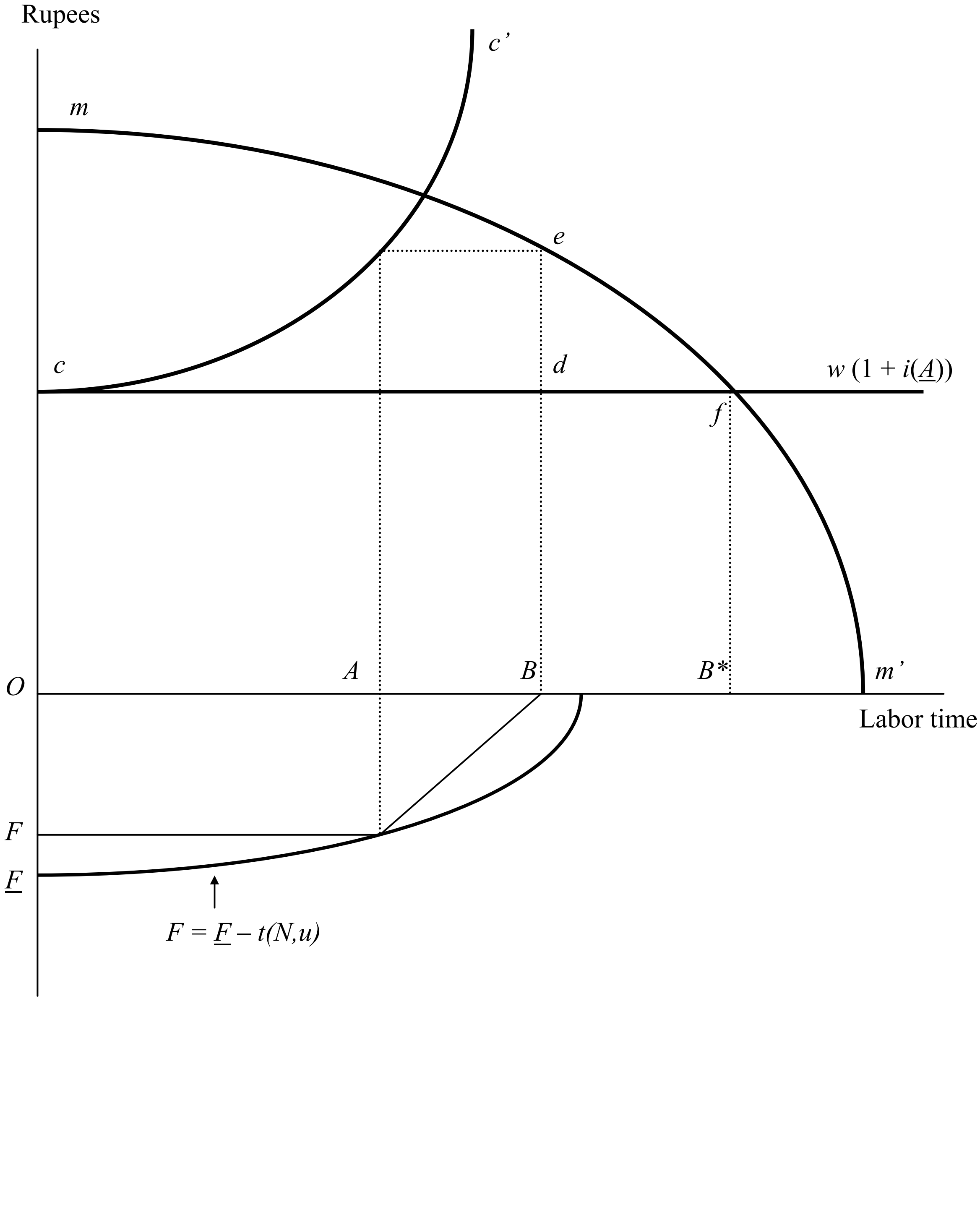

Figure 2. Employer time cost functions under labor contracting and direct hiring

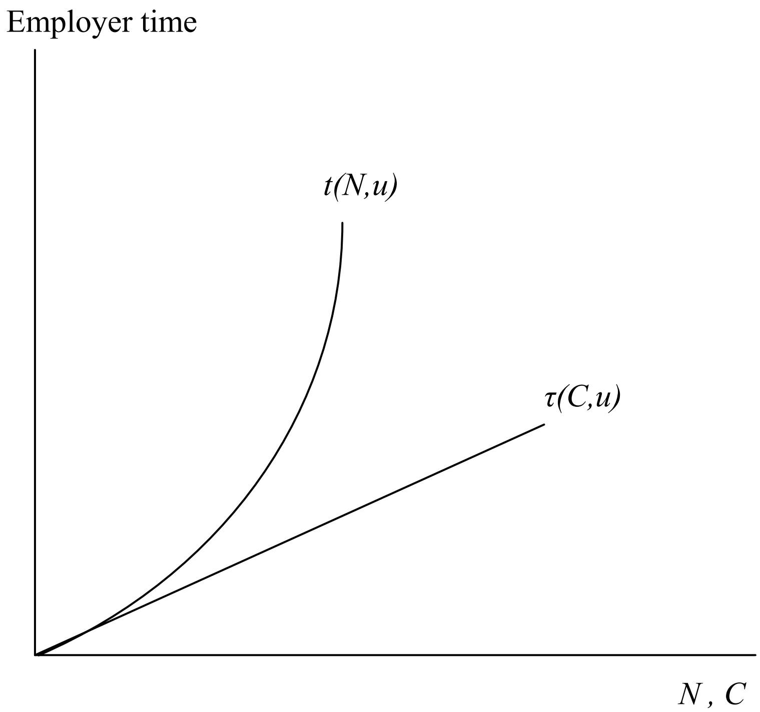

Figure 3. Marginal cost of hired labor under contracting and direct hiring

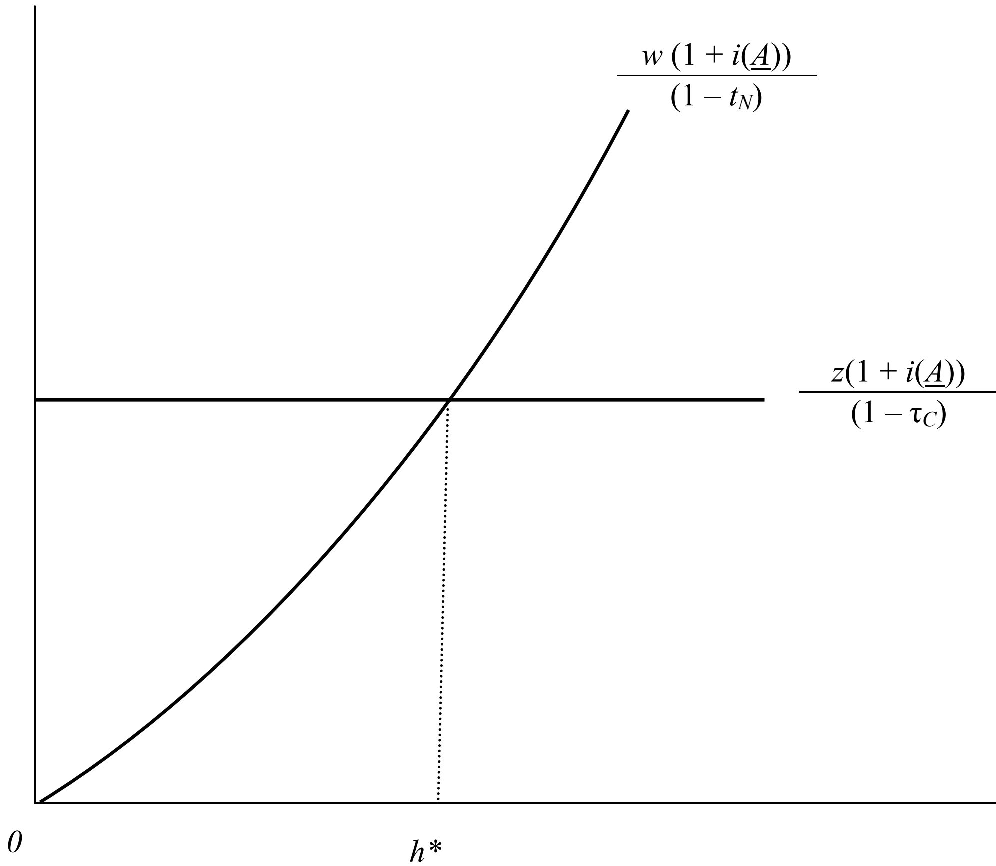

Figure 4. Impact labor contracting on transaction costs and labor allocation

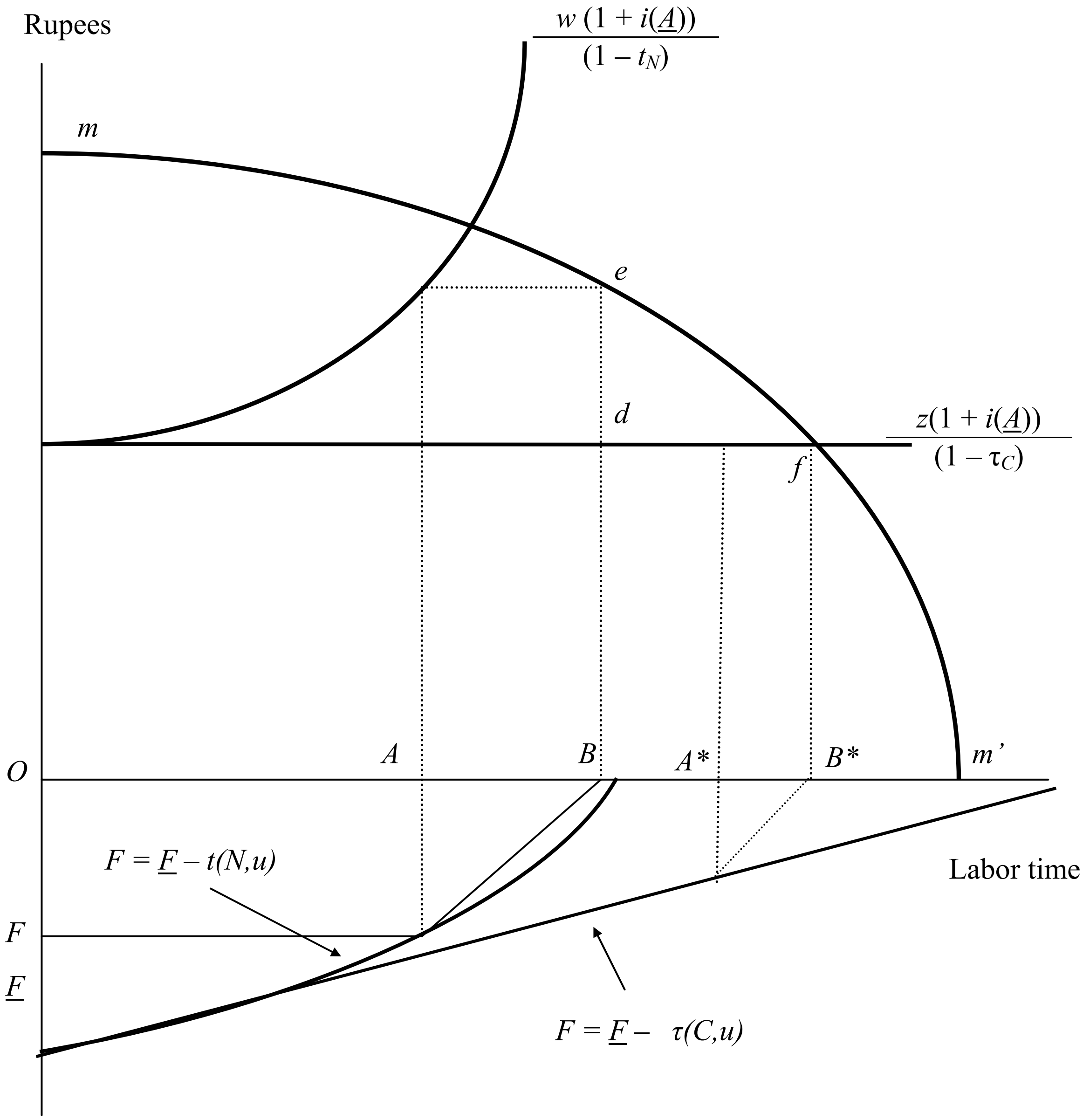

Figure 5. Choice of labor contract in endowment space