Labor Contracts, Incentives, and Food Security in Rural Myanmar *

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June 2004

Abstract

This paper develops an agency model of contract choice in hiring labor and estimates the determinants of the choice in rural Myanmar based on the model. As a salient feature relevant for the agricultural sector in a low income country like Myanmar, the agency model incorporates considerations for food security as well as incentive concerns. It is shown that when food security considerations are important for an employee, possibly due to poverty, a contract with wages paid in kind (food) is preferred to labor contracts paid in cash. At the same time, when output is more responsive to workers' efforts but efforts are private information to workers or not enforceable, a contract with piece-rate wages is preferred to labor contracts with hourly wages. The case of sharecropping can be understood as the combination of the two: piece-rate wages paid in kind. Implications of the theoretical model are tested using a cross section dataset collected in rural Myanmar through a sample household survey conducted in 2001 covering about 600 households with diverse agro-ecological environments. Estimation results are consistent with the theoretical implications: wages in kind are more likely to be adopted when workers have higher budget shares of food; piece-rate wages are more likely to be adopted when workers are male; fixed effects of crops and farming operations are jointly significant and more effort-oriented crops or operations are associated with piece-rate contracts.

Keywords: contract, incentive, selection, food security, Myanmar.

*Very preliminary. Please do not quote without the author's consent.

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1 Introduction

In both developed and developing countries, various kinds of compensation policy are observed when firms or farms employ workers. Under what context is a particular policy chosen and how does it affect the efficiency and equity of labor transactions? Because of theoretical interests in modeling this issue as well as its practical importance in designing optimal contracts/policies, the issue is discussed intensively in the theoretical literature in labor economics and development economics. Especially in development economics, the institution of sharecropping has been investigated heavily where a landlord transacts a land use right to a tenant in exchange for a land rent paid as a fixed share of output (see for example, Arimoto 2003, Kurosaki 2001, Agrawal 1999, Hayami and Otsuka 1993, Eswaran and Kotwal 1985). The sharecropping tenancy can be understood as a mechanism to control for the asymmetric information problems (moral hazard, adverse selection, enforcement/strategic default), and it may perform better than a fixed wage or a fixed rent contract under the conditions prevailing in developing countries, i.e., low income, high production risk, and less developed credit and insurance markets.

In contrast to the volume of the theoretical literature, empirical studies on the efficiency of resource allocation and the determinants of contract choice are limited, except for those analyzing sharecropping or natural gas (see the review by Chiappori and Salanie 2003). Empirical studies on the existence of different compensation policies for hired workers in developing countries are especially limited.[1] The main difficulty in examining the efficiency issue lies in the identification of selection (or matching) versus incentives. In other words, when a particular contract is found to be associated with low efficiency, it is not easy to judge the underlying causality: the low efficiency could be due to disincentive effects of the contract (workers choose low efforts due to the contract design) or it could reflect the selection mechanism (only less able workers are attracted to the contract).

This paper thus develops an agency model of contract choice in hiring agricultural labor and estimates the determinants of the choice in Myanmar (formerly Burma) based on the model. As a salient feature relevant for the agricultural sector in a low income country like Myanmar, the agency model incorporates considerations for food security as well as

[1] Among the few existing studies, Foster and Rosenzweig (1994) demonstrated that the level of moral hazard differs depending on labor contracts in rural India such as on-farm employment (family labor), piece-rate payment schemes, share-tenancy contracts, and time-wage payment schemes; Fukui (1995) investigated the efficiency of permanent labor contracts in the Philippines paid in piece-rate wages in kind.

incentive effects. The model is motivated by findings and data obtained from field surveys in rural Myanmar conducted in 2001 covering about 600 households with diverse agro-ecological environments (Kurosaki et al. 2004). Unique features of the dataset is that first, various kinds of compensation policy are observed, and second, information is collected on wages paid to agricultural workers (employees) and wages paid by farmers (employers). The first feature enables us to classify wage types into a complete list of time wages in cash, time wages in kind, piece-rate wages in cash, and piece-rate wages in kind. Thus both the contrast between cash or in-kind and that between time wage and piece rate can be analyzed. These contrasts also exist in the issue of sharecropping versus fixed wage/rental contracts but asymmetric information surrounding land makes it difficult to concentrate on these contrasts. By concentrating on labor contracts, more powerful assessment of agrarian contract theories could be possible. The second feature enables us to examine dyadic determinants of contract choice, although not to the full extent due to the lack of matching between the employer and the employee.

As far as the author knows, this paper is the first attempt to incorporate concerns for food security in modeling the role of compensation policy toward workers in an agency framework. When the income level is low and the food availability and price in the market are highly variable, due to the vulnerability of agricultural production to weather shocks and less-developed agricultural produce markets, rural dwellers in developing countries need to pay high attention to food security. As analyzed by Kurosaki and Fafchamps (2002), Kurosaki (1998), Fafchamps (1992), and Finkelshtain and Chalfant (1991), such concerns are likely to affect portfolio choice and input decision-making in agricultural production. Unlike a risk-averse firm under uncertainty without such concerns, a risk-averse farmer may increase the production of a more risky crop if the crop is a food crop that is important in his consumption. Adjustment in production choice are not the only way to improve food security, however. A similar strategy is possible through adjusting the compensation policy toward workers. Therefore, in investigating the determinants of contract choice in Myanmar, the effects of factors associated with food security (risk aversion, size of income risk, ability to cope with income risk, the importance of the basic food in budget, etc.) need to be analyzed as well as those related with moral hazard (ease of supervision, enforcement, importance of reputation, long-run relations, etc.).

The paper is organized as follows. Section 2 develops an agency model of wage contract choice. Section 3 describes the dataset and labor markets in the study region. It also gives

OLS estimation results of a production function, which show that the inefficiency of hired labor is not observed at the first glance. This does not necessarily mean that there is no moral hazard problems. Section 4 shows that this could be attributable to the selection into wage contracts, by estimating probit models for the determinants of wage types. Section 5 concludes the paper.

2 Theoretical Model

2.1 Setting

An agency model of wage contract choice is proposed in this section. The model focuses on incentive for workers to shirk, concerns for food security, and the optimal choice between the worker and the employer. To simplify the analysis, the trade-off between quality and quantity associated with piece rates, i.e., piece rates increase the productivity per labor hour if measured in terms of quantity of output but its quality may deteriorate, is assumed away.[2] Since the amount of labor hours is easily monitored, it is fixed in the following analysis. To reflect the context of low income developing countries, a commodity called "food" is introduced, which is the main output in production and the main item in consumption. To simplify the argument, there are only two consumption items: the food and "non-food," whose price is normalized at one.

A farmer (principal) is searching for a laborer (agent) to produce the food. The physical output (measured in kg) of a laborer is assumed to be a non-decreasing function of his effort e denoted by $f(e)$ with $f'() \geq 0, f''() \leq 0$, multiplied by a yield shock, θ, with its mean at one. Due to less-developed agricultural produce markets and possibly due to unpredictable interventions by the state in rural marketing, the price of the food, p, fluctuates with its mean at $\bar{p}$. Thus the output value from production is $p\theta f(e)$, measured in "Kyats" (Myanmar's currency). There are four types of wage contracts: [1] time wage in cash, [2] time wage in kind (paid by the food), [3] piece rates in cash, and [4] piece rates in kind. Let w_j, $j = 1, .., 4$ as the wage rate in each contract. They are all different in units: w_1 is measured by Kyats/day, w_2 by kg/day, w_3 by Kyats/kg, and w_4 by the share of the output. *Ex post*, the farmer's payment in Kyats to the laborer under contract j, W_j, is equivalent to

$$W_1 = w_1, \quad W_2 = pw_2, \quad W_3 = w_3\theta f(e), \quad W_4 = w_4 p\theta f(e), \tag{1}$$

[2]See Paarsch and Shearer (2000) for modeling the trade-off and its empirical importance for the case of tree industry in Canada.

The agent is a poor landless laborer. Making an effort brings him a direct disutility. Because of the limited opportunity to cope with risk *ex post* (Kurosaki and Fafchamps 2002), he behaves in a risk-averse way. Thus his *ex post* payoff is given by $v(y,p)-e$, where $v(y,p)$ is an indirect utility function where y is his consumption expenditure that is equal to W_j in this case. The following properties are assumed for the partial derivatives of the indirect utility function:

$$v_y > 0, \quad v_p < 0, \quad v_{yy} < 0, \quad v_{pp} < 0, \quad v_{yp} > 0, \quad v_{yyy} > 0. \tag{2}$$

The first two are required for a valid indirect utility function. The third one guarantees that the laborer is risk averse in the Arrow-Pratt sense. The fourth one implies that the welfare decreases when the food price variability increases with the income level held constant. This seems to be a natural property for a poor worker.[3] The condition $v_{yp} > 0$ implies that the welfare increases when the food price and income moves in the same direction when the income level, the price level, the income variance, and the food price variance are held constant. Since positive correlation of the food price and the income level means that real income is more stable, this assumption is also justifiable for a poor laborer in developing countries. The last assumption $v_{yyy} > 0$ corresponds to "risk prudence" (Kimball 1990). Since prudent risk preferences guarantee that the welfare cost of consumption fluctuation decreases with the level of expected consumption, the assumption is relevant for the analysis of this paper.

The reservation utility of the agent is exogenously given at u_0^A, which corresponds to a unit of labor without effort for which hourly wage w_0 (Kyats/day) is paid. Then, the agent's participation constraint for contract j is given by

$$u_j^A = E[v(W_j,p)] - e \geq u_0^A, \tag{3}$$

where $E[.]$ is an expectation operator.

The principal is a rich farmer who does not need to worry about price and yield risk. Thus his objective function u^P is given by

$$u_j^P = E[p\theta f(e) - W_j]. \tag{4}$$

Because of the existence of yield risk θ, the effort level e by the laborer is unobservable to or unenforceable by the principal. Therefore, to maximize u^P, the principal has to meet the

[3]However, $v_{pp} < 0$ is not always satisfied in popular utility functions used in the literature. For instance, when the utility is in Cobb-Douglas with constant relative risk aversion, i.e., $v(y,p) = (y/p^\beta)^{1-\psi}/(1-\psi)$, $\psi > 0$, the risk aversion should be sufficiently high, i.e., $\psi > 1 + 1/\beta$, for $v_{pp} < 0$.

participatory constraint (3) and the incentive compatibility constraint given by

$$\frac{\partial u_j^A}{\partial e_j} \leq 0, \quad e_j \geq 0, \quad e_j \frac{\partial u_j^A}{\partial e_j} = 0. \tag{5}$$

Solving this equation implicitly, the incentive constraint can be expressed as a reduced form $e_j^* \equiv e^*(w_j, u_0^A, \zeta)$ where ζ is a vector of parameters that characterizes the agent's preferences, technology, and the nature of price and yield risk.

2.2 Optimal Contract

Under contract [1] or contract [2], $\partial W_j/\partial e_j = 0$ so that $\partial u_j^A/\partial e_j < 0$, implying that the agent pays no effort ($e_j^* = 0, j = 1, 2$). Therefore, the principal chooses w_1^* and w_2^* to satisfy the participation constraint as equality. Thus $w_1^* = w_0$, the opportunity wage for the laborer. Between contract [1] and contract [2], the principal prefers the one with lower $E[W_j]$. Then what kind of parameters determine the relative attractiveness of contracts?

By applying the second order Taylor approximation of $v(y, p)$ to the relation $E[v(w_1^*, p)] = E[v(pw_2^*, p)]$,

$$E[v(w_1^*, p)] \approx v(w_1^*, \bar{p}) + \frac{1}{2}\bar{v}_{pp} Var(p), \tag{6}$$

$$E[v(pw_2^*, p)] \approx v(\bar{p}w_2^*, \bar{p}) + \frac{1}{2} Var(p) \left(\bar{v}_{yy}(w_2^*)^2 + 2\bar{v}_{yp} w_2^* + \bar{v}_{pp}\right). \tag{7}$$

Comparing the two, the sign of $E[W_1] - E[W_2] (= w_1^* - \bar{p}w_2^*)$ is the same as the sign of $\bar{v}_{yy}(w_2^*)^2 + 2\bar{v}_{yp}w_2^*$. This implies that when the laborer's concern for food security is high in the sense that v_{yp} is sufficiently positive, $E[W_1] - E[W_2] > 0$, so that the principal prefers contract [2] to contract [1]. This is intuitively plausible.

Following Fafchamps (1992) and Kurosaki and Fafchamps (2002), the size of v_{yp} can be investigated further using Roy's identity, resulting in

$$v_{yp} \approx -q_y v_y - q v_{yy} = \frac{v_y}{p} s(\psi - \eta), \tag{8}$$

(all evaluated at the mean of y and p), where q is the Marshallian demand for the food, q_y is its derivative with respect to income, s is the budget share of the food, ψ is the Arrow-Pratt measure of relative risk aversion, and η is the income elasticity of food demand. The assumption $v_{yp} > 0$ is thus equivalent to assume $\psi > \eta$ in this approximation, which is likely to be satisfied for low income households (Fafchamps 1992). As ψ increases, not only v_{yp} increases but also v_{yy} decreases, so that the direction of the change of expression (8) is ambiguous. In contrast, as s increases, expression (8) also increases, giving more favor to contract [2]

against contract [1]. Since s is measurable using household expenditure data, this leads to the following proposition, which is empirically verifiable:

Proposition 1. *An increase of the share of the food in family budget of the laborer will increase the probability for the employer to choose a contract with time wage in kind to a contract with time wage in cash.*

Although Proposition 1 focuses on the characteristics of the laborer, a related implication can be derived for the characteristics of the farmer-employer by assuming the same functional form for the payoff, except for the existence of effort costs. Then a farmer with a higher food share prefers contract [1] more than contract [2] than a farmer with a lower share. This is because $W_j, j = 1, 2$, enters negatively in y in the expected utility $v(y, p)$ for the principal. Thus an increase of the share of the food in family budget of the employer will increase the probability for him to choose a contract with time wage in cash to a contract with time wage in kind.

Under contract [3] or contract [4], $\partial W_j/\partial e_j$ has the same sign as $f'()$. Therefore, when $f'(e)$ is not large enough, the incentive compatibility constraint of (5) is characterized by a corner solution with $e_j^* = 0, j = 3, 4$. Even in such cases, the two contracts may bring different welfare results to the laborer due to the existence of yield risk θ. If θ is not stochastic but taking the value of one, contract [3] becomes equivalent to contract [1], and contract [4] becomes equivalent to contract [2]. If θ and p are independent (analogous to the small country assumption), contract [3] becomes inferior to contract [2] when the variability of θ is not too small compared to that of p because W_3 and p are not correlated while W_2 and p are positively correlated. Contract [4] is the least preferred because of its larger variance of W_4. If θ and p are negatively correlated, which is more likely in a closed economy, the attractiveness of [4] increases because the variance of W_4 is reduced. Therefore, when output is less responsive to efforts, the choice among the four contracts depends on parameters characterizing price and yield risk at the one hand, and parameters characterizing income risk and price risk aversion.

When $f'(e)$ is sufficiently large, the incentive compatibility constraint under contract [3] is associated with an interior solution. Then expression (5) is rewritten as

$$E[v_y w_3 \theta f'(e)] = 1, \tag{9}$$

and under contract [4], it is rewritten as

$$E[v_y w_4 p\theta f'(e)] = 1. \tag{10}$$

With the assumption $v_{yyy} > 0$, the marginal decline of v_y due to an increase in y is attenuating while a rise in wage rates increases $\partial W_j/\partial e_j$ linearly. Thus the agent's behavior is characterized by $\partial e_j^*/\partial w_j > 0$. Taking this relation into consideration, the principal chooses w_3^* and w_4^* to maximize u^P subject to the participation constraint. The participation constraint may not be binding, depending on the curvature of function $f(.)$.[4] Then the principal finally chooses the optimal contract that is associated with the lowest value among w_1, $\bar{p}w_2$, $w_3 f(e_3^*)$, and $w_4\bar{p}f(e_4^*)$. Similar to the corner solution cases, the optimal choice among the four contracts depends on parameters characterizing price and yield risk at the one hand, and parameters characterizing income risk and price risk aversion on the other hand. In addition to these parameters, parameters characterizing the output response to efforts should affect the contract choice.

To investigate the effects of the production technology parameters, consider the case when contracts [1] and [3] are indifferent to the principal and preferred to contracts [2] and [4]. Due to the assumption $v_{yyy} > 0$, a marginal increase in $f'(e)$ gives the agent to increase the effort marginally, leading to a marginal shift of the distribution of income for the laborer. Since the participation constraint is binding when contract [1] is optimal, this gives an opportunity for the principal to extract more surplus from the agent. Therefore, the marginal increase in $f'(e)$ leads to a situation where contract [3] is strictly preferred to the other three. From a similar reasoning, when contracts [2] and [4] are indifferent to the principal and preferred to contracts [1] and [3], the marginal increase in $f'(e)$ leads to a situation where contract [4] is strictly preferred to the other Thus the following proposition is obtained:

Proposition 2. *An increase of the effort elasticity of output will increase the probability for the employer to choose a contract paid in piece rates to a contract paid in time wages.*

The output is more effort elastic especially when the quickness in conducting the work is important. This has an empirically verifiable implication that a piece-rate contract is more likely to be adopted than a contract with time wage when the farming operation requires

[4]However, as far as numerical examples show (see the next subsection), the participation constraint is found to be always binding when smooth and concave production functions are used.

quick completion.

2.3 Numerical Examples

To have a concrete idea of how the optimal choice looks like, the agency model above is calibrated numerically in this subsection. The agent's indirect function is specified with the linear expenditure system

$$v(y,p) = \frac{1}{1-\phi}\left(\frac{y-p\gamma}{p^{\beta}}\right)^{1-\phi}, \tag{11}$$

where ϕ is a positive parameter determining the risk aversion,[5] γ is subsistence need for the food, and β is the marginal propensity to spend on the food after meeting the subsistence need. The linear expenditure system has an appealing property for this case that the number of parameters is small and it predicts a plausible response of poor households to evade starvation, i.e., a situation with y close to the value of the subsistence needs (Atkeson and Ogaki 1996, Kurosaki and Fafchamps 2002).

The principal's production function is specified as

$$f(e) = A(1+e)^{\rho}, \tag{12}$$

where A is a positive parameter to determine the productivity and ρ is a non-negative parameter that characterizes the effort elasticity of output ($1+e$ is interpreted as the total effort, 1 is the minimum effort, and e is the additional effort). In the simulation, γ and β are restricted to take the same value and parametrically changed in the range from 0.05 to 0.60. For each parameter value, the food budget share s was evaluated at the mean price under the reservation scenario.

Regarding the stochastic process, the uniform distribution is assumed for p and θ with their mean at unity and then approximated by a finite number of probability nodes.[6] The expected utility is then evaluated by taking a probability-weighted sum of utility under each pair of realized values of p and θ. For contracts [3] and [4], the optimal effort of the laborer given w_3 or w_4 is solved in the inner loop and then the optimal wage rate for the employer given that relation is solved in the next outer loop. In the last outer loop, the contract that brings the highest u_j^P is chosen.

Figure 1 plots the results when $\phi = 3$ and the standard deviation of θ is set at 40% of that of p. It is assumed that θ is distributed independently of p. A horizontal line extending

[5]The Arrow-Pratt coefficient of relative risk aversion is obtained as $\psi = \phi y/(y-p\gamma)$.

[6]Simulation results reported in this paper are based on the number of probability nodes at 21. The results were found insensitive to the number of nodes around this number.

from the vertical axis shows the indifference curve between contracts [1] and [2]. When the food share s is higher than this line, contract [2] (time wage in kind) is chosen as a better arrangement to improve the food security of the laborer than contract [1] (time wage in cash). The horizontal line moves downward when higher risk aversion (higher value of ϕ) is assumed in this case. Moving to the right when s is smaller than the horizontal line, the indifference curve between contracts [1] and [3] appears. When the effort elasticity of output ρ is greater than this curve, contract [3] (piece rate in cash) is preferred to time wage in cash. When s is larger than the horizontal line but not so large, as the effort elasticity ρ increases, the optimal contract is changed from time wage in kind to piece rate in cash. When s is very large (more than 0.7 in this case), the optimal contract changes from [2] to [4] (piece rate in kind) first, then changes to [3] (piece rate in cash). In other words, when both s and ρ take large numbers, piece rates in cash tend to dominate the other three.

When θ is set at unity without any variation, a similar figure was obtained. Because yield risk is eliminated, the four regimes intersect at the same point; in the southwest segment, contracts [1] and [3] are indifferent; and in the triangular region above the southwest segment, contracts [2] and [4] are indifferent. As in Figure 1, when both s and ρ take large numbers, piece rates in cash tend to dominate the other three.

Figure 2 plots the results when θ and p are correlated with their correlation coefficient at -1. As discussed in the analytical part, contract [4] becomes more attractive due to low variance of W_4. This is particularly true when both s and ρ take medium values. When both take large numbers, piece rates in cash become more attractive.

Both propositions are satisfied in these examples. A stronger version of Proposition 1, i.e., an increase in s of the laborer will increase the probability of a contract with in-kind wages against a contract with cash wages, is satisfied only in Figure 1. In Figure 2, there is a region where the indifference curve between contracts [3] and [4] is negatively sloped. Thus a kind of non-monotonic relationship is found between the optimal contract choice and parameter s. In Section 4, it is examined whether or not actual contracts in the real world are consistent with the pattern shown in these figures, through estimating reduced-form probit models taking care of the non-monotonicity using data collected in rural Myanmar.

3 Data

3.1 Myanmar's Economy and Agricultural Policies

Myanmar, whose population is close to 50 million, is in the transition from a planned to a market economy (Kurosaki et al 2004). The military government that has been in power since 1988 has deregulated various economic activities. Industrial development is under process, but currently the agricultural sector still remains dominant in the national economy and the income level is estimated at among the lowest in the world. Rice is the staple food in Myanmar, accounting for more than 20% of consumption expenditure of the nation (CSO 2002).

The government has given high priority to the expansion of paddy production, since it believes that a stable supply of rice is a prerequisite for political stability. To achieve the expansion, first, reforms in agricultural marketing have been introduced, where the state procures from farmers a limited and fixed amount of produce and allows them to sell the surplus freely in private markets. Since paddy prices in the market during the late 1980s and early 1990s were usually much higher than the government procurement price, the reform initially gave a substantial incentive to produce a surplus. This system is enforceable because of the system of state ownership of farmland. Farmers do not have the official right to exchange, transfer, lease, inherit, or mortgage their land, although children are usually given the right to cultivate their parents' land. To retain their tillage right for paddy fields, farmers are obliged to grow paddy crops and supply a designated amount of paddy to the government procurement system, regardless of the profitability of paddy crops.

Second, the government has been promoting the expansion of paddy areas through irrigation investment. Traditionally, the main paddy season in Myanmar was the monsoon season, which brings sufficient (and frequently too much) water to paddy crops in rainfed fields. Since the early 1990s, numerous dams have been constructed in some areas, while private investment in small scale diesel pumps has been promoted in others, in order to increase paddy cultivation in the dry season.

Because of these two measures, both the area under cultivation and paddy production in Myanmar rose remarkably in the early 1990s. However, as analyzed by Kurosaki et al. (2004) in detail, such policies have resulted in low income of farmers because the paddy production is not profitable in general and have not improved the stability of consumption of rural dwellers because of inconsistency and frequent changes in agricultural policies. Thus in spite

of increased production of rice, farmers in Myanmar still have a reason to be concerned with food security.

Another important characteristic of Myanmar's rural economy is the existence of a large pool of landless, non-farm households. The land tillage right is not distributed to all village residents equally but only to those who owned means of production such as bullocks at the time of land reforms in the 1950s. There has been little change in the unequal distribution of tillage rights and the share of landless, non-farm households in villages typically ranges from 20 to 50%. The majority of landless households depend on income earned as agricultural wages and their income and wealth level is substantially lower than that of landed households. Because of poverty and dependence on farmers, it is critically important for the landless to secure their subsistence needs in food.

3.2 Characteristics of Sample Villages and Households

Due to its isolation foreign policy, very few micro data are available in Myanmar on its rural economy. We thus conducted a survey of sample households belonging to eight selected villages in June-October 2001 (Kurosaki et al 2004).

The characteristics of the villages are shown in Table 1. The first two villages (DELTA1 and DELTA 2) are located in the delta regions of lower Myanmar and DRY1 is located in the Mandalay Basin, which has been one of Myanmar's centers of commercial crop production due to its long history of canal irrigation dating back to the dynastic period of Burma. In contrast, DRY2 and DRY3 represent villages relying on rainfed agriculture. Complicated crop mixtures of pulses and oilseed crops are observed in both villages. DRY2 is more typical as a dry zone village since only rainfed crops and no paddy crops are grown there. HILL1 and HILL2 represent villages relying on vegetable-based development in hilly regions. HILL1's agriculture includes small-scale vegetable growing on the floating plots of Inya Lake. Tomatoes from this region are famous throughout the country. HILL2 specializes more in vegetables grown on upland fields. Both villages sell their vegetables to major consumption centers such as Yangon and Mandalay, while their paddy cultivation is oriented towards subsistence. The last village of the study, COAST, lies in the coastal region of southern Myanmar, where tropical agro-forestry (rubber, fruits, cashew nuts, etc.) prevails. Peasant farmers run both small-scale rubber estates and paddy farms. Among the eight villages studied, COAST has the most active non-farm sector, which includes general shops, cycle taxis, and fish processing. The eight villages chosen are thus quite representative of the

diverse agro-ecosystems found in Myanmar.

The specific villages were chosen for this study to ascertain that they would be representative of each region. As far as can be judged by the statistics on cropping pattern and land distribution, this aim was achieved. Sample households were drawn from a complete list of households in each of the villages studied. While these households are not strictly a random sample, we used information obtained from village leaders and local administrations to eliminate discretionary elements, so that the sample households are as representative as possible in terms of the distribution of farmland and primary jobs. A total of 521 households were surveyed in the eight villages: 341 households denoted "farm" households" are those with the land tillage right and 180 households denoted "non-farm" households" are those without the right (Table 2).

A structured questionnaire was used for all households to establish household characteristics, such as the age, sex, education, working status, and earnings of each member; household assets, such as land, livestock, agricultural machinery, and transportation equipment; consumption; and debt and credit, including informal transactions. From the section on income sources, information is taken on agricultural wages earned by household members. The sample households included 2850 persons, implying that the average household size is 5.5 persons. From this part of the dataset, individual attributes that could affect labor contracts were taken. If households operated farmland, another part was added, asking about cropping patterns, the use of hired labor, the cost of production of major crops, and output disposal. From this part of the dataset, information is taken on agricultural wages paid by the farmer to laborers. Household heads or other relevant persons were interviewed by local research assistants and the information was cross-checked on the spot by the authors to ensure internal consistency and data quality.

Table 3 reports asset and income status of sample households. The average land holding size among farm households was 8.6 acres, which is large by South-East Asian standards.[7] Ownership of modern assets is in poor status: no households owned four-wheel tractors; bicycles are common among villagers but motorcycles and four-wheel vehicles for transportation are very rare; because the majority of villages in Myanmar are not electrified, TV or VCR owners (using batteries) are very rare. Livestock are the main source of assets. The majority

[7]The average land holding size among non-farm households is slightly positive because 14 out of 180 non-farm households cultivated a piece of land, which is officially registered under different households' names, through inter-vivo transfers or land tenancy contracts.

of sample farmers own draft animals and a number of sample households (both farm and non-farm households) keep pigs. Comparing different household types, total asset values were lower among non-farm households than among farm households.

Overall averages of household income were 184,000 Kyats per household and 36,000 Kyats per person per year. If these figures are converted at the market exchange rate of 650 Kyats/US$, average annual incomes were $283 per household and $55 per person. Incomes thus were indeed low, but not that different from the average village in rural Myanmar. If these incomes are converted using the price of rice in the Yangon market (56 Kyats/kg), they are equivalent to 3,300 kg of rice per household and 640 kg per person per year. Total household income was highest in COAST, followed by DRY1 and DRY2. DRY3 had the lowest income. The ranking is similar when per capita income is compared. Among the villages, COAST and DRY2 had the highest inequality. The two villages in the delta, the two in the hilly regions, and DRY3 showed the lowest inequality. Based on the poverty line adopted by Kurosaki et al. (2004),[8] the estimate for the poverty headcount index for the sample households was 42%. The village ranking of poverty incidence and the ranking of per capita income are not the same. Among the top three high-income villages (DRY1, DRY2, and COAST), only DRY1 and COAST had a poverty incidence lower than the overall average of 42%. In DRY2, because of high inequality, poverty incidence was also high despite the village's high average income. DRY3, the village with the lowest average income, had the highest poverty incidence. Other poverty measures such as the poverty gap index and the squared poverty gap index confirm this pattern (not shown). All of these income measures indicate that non-farm households are poorer than farm households.

3.3 Labor Contracts and Farm Productivity

It is important to distinguish two kinds of agricultural laborers in rural Myanmar. Casual laborers are hired for a day or several days to conduct a well-specified farm operation. In contrast, seasonally-hired laborers are employed for a cropping season and are responsible for various farm operations, just like family workers. Following the literature on rural institutions, they are called permanent laborers below. This implies that actual farm work is conducted by three kinds of labor: labor by unpaid family members of farm households,

[8]Kurosaki et al. (2004) set the poverty line at 400 kg of rice per person per year because there is no official poverty line in Myanmar and it is not feasible to apply the World Bank's poverty line of PPP$1/day due to multiple exchange rates and the non-availability of disaggregated household expenditure data. Assuming a per capita consumption of rice of 200 kg (and its equivalents) per person per year, the poverty line here implies that 50% of income is spent on basic food.

casual labor, and permanent labor.

Among all sample households, income from casual farm labor occupied 12.7% of the household earned income and income from permanent farm labor occupied 2.6% (Kurosaki et al. 2004, Table 8). If non-farm households are divided into the households whose main income source is agricultural wages and the households whose main income source is in non-agriculture, the share of casual farm labor rose to 62.4% and that of permanent farm labor rose to 19.3% for the former households. Farm households, who usually employ these laborers, sometimes send their family members to farm wage work as well. The share of casual farm labor in the income of farm households is 5.0% and that of permanent labor is 0.1%.

One of the hottest debate in rural development in Asia is the efficiency of hired labor. It is often argued that permanent labor in South Asia is inefficient than family labor so that the productivity of large farms is lower than that of small farms while such inefficiency is rarely found in South-East Asia (Hayami and Otsuka 1993, Fukui 1995). Such a regional contrast is not found clearly for casual labor since daily-hired workers are often assigned farming operation that does not require care and effort. Especially in South-East Asia, even small farms with surplus in family labor employ casual labor in harvesting, which is sometimes attributable to the norm of income sharing (Hayami and Kikuchi 1999).

To investigate this issue, production functions are estimated with the total labor (sum of family, casual, and permanent labor) as a production factor and hired labor shares as a productivity shifter. If three types of labor are perfect substitutes and there is no productivity difference among the three types, the hired labor shares should have zero coefficients. If the coefficients are significantly negative, the existence of inefficiency is suggested. From the field survey results, 518 cases of crop production details were obtained covering various crops and households. Since technology for paddy production is fundamentally different from technology for non-paddy crops, production functions are estimated separately for paddy and non-paddy crops. Village and crop fixed effects are introduced in the regression to control for difference in market and production environments.

OLS estimation results based on a Cobb-Douglas specification are reported in Table 4. Elasticity parameters for each production factors are in the reasonable range. The coefficient on the log of land is negative because the dependent variable is output per acre. Adding one to the reported coefficient, land elasticity of crop production is obtained. The major concern of this regression is the efficiency of hired labor. In none of the four models, the

permanent labor share or the casual labor share is significantly negative. On the contrary, the permanent labor share is significantly positive on paddy value-added, non-paddy output, and non-paddy value-added, and the casual labor share is significantly positive on paddy output and paddy value-added. Therefore, at the first glance, hired labor in rural Myanmar does not seem to be inefficient. But does this imply that workers have no moral hazard problems?

Needless to say, OLS estimates in Table 4 suffer from the endogeneity bias: contractual choice and the levels of factor inputs are endogenously determined; the possibility of omitted variables and misspecification cannot be ruled out. It is possible that the significantly positive coefficients on hired labor shares imply that a more productive farmer is able to hire outside labor more and the farmer's ability is not observed. One way to solve the endogeneity problem is to show that the endogeneity bias is not serious through the exogeneity test or to estimate the model using instruments (Chiappori and Salanie 2003). Both procedures require valid instruments, which are hard to be found from the current dataset.

Thus this paper concentrates on the first stage decision making process (i.e., the determinants of labor contracts). If it can be shown that contractual choice are consistent with self-selection stories, then the OLS estimates of no negative effects of labor contract on productivity do not contradict the existence of moral hazard.

From the field survey results, the following information is obtained on hired labor in agriculture: 60 cases of wage transactions for those employed as permanent laborer, approximately 1,700 cases for those employed as casual laborer, 164 cases for farmers employing permanent laborers, and approximately 1,400 cases for farmers employing casual laborers. The information includes details of farm work and the mode, conditions, and timing of wage payment.

The mode of wage varies substantially among casual labor transactions (Table 5). Wages fixed in cash per labor ("Kyats/day") were found most frequently, accounting for 79% of 3,100 cases. Regardless of the choice of weights, the modern mode of payment fixed as "Kyats/day" is the dominant one in Myanmar.

As shown in Section 2, the payment fixed in cash per day may put a heavy burden on laborers' welfare in terms of food security. When grain markets are not working efficiently, laborers are exposed to the risk of high price or non-availability of food in the market. If this is the case, cash wages are subject to the erosion of their purchasing power. In contrast, wages paid in kind, such as grains, are not subject to such risk. In the current case, time

wages in kind accounted for 2.5% out of 3,100 cases.

Another argument against the payment fixed in cash per day is that time wages may give workers incentive to shirk because the efforts in work are not observable to the employer and the wage is insensitive to the efforts (Section 2). Piece-rate contracts should be superior if shirking is potentially a problem and the farm operation requires quick completion. Table 4 shows that such transactions accounted for 15% out of 3,100 cases. There are varieties in this category. Contracts with the payment in kyats fixed per acre of farming operation are observed in every stage of farming, beginning from land preparation to harvesting. Contracts with the payment in kyats fixed per unit of farm work, such as the amount of seedlings/weeds taken, are also observed in various farming operations.

The fourth category combines the piece-rate system with in-kind payment, such as a fixed proportion of harvested output paid to the laborers (sharecropping). These cases accounted for 1.8% out of 3,100 cases.

To correct for the difference of importance of each case in the rural economy, the share of each mode in the total was calculated using two sets of weights: total mandays and total kyats.[9] Interestingly, the share of time wages in cash is larger when mandays are used as weights than when the money metric is used as weights, while the share of other three groups of wage modes is smaller when the weight is mandays than when the weight is in Kyats. This implies that workers are paid more per day when wages are paid in kind or as piece rates. Higher productivity of workers under piece rates is consistent with the theoretical argument in Section 2. Higher payment to workers under in-kind wage systems could be due to incentive effects or a result of the custom of income sharing discussed by Hayami and Kikuchi (1999) where farmers redistribute their income to poor laborers through employing more harvesting workers even when the farmers have surplus family labor.

There are other dimensions of variation in wages paid to casual laborers. For instance, the number of meals per day served to hired laborers differed from zero to three. Approximately two thirds of the casual labor transactions were without meals. A little less than one third were with one meal. Two or three meals per day accounted for the rest. The quality of meals also differed. When the payment was in cash such as Kyats/day (time wage) or Kyats/acre (piece rate), some workers were paid in advance of a month or two. In such cases, the wage

[9]Both weights have to be estimated for some observations, using fixed coefficients for each village based on field observation. When piece rates are adopted, farmers usually don't remember the exact number of days worked by laborers. When the wage is paid in kind, the employer and the employee only remember the quantity, which has to be converted into Kyats using village prices.

rate was often reduced by 20 to 33%. Such a large discount suggests the severeness of credit constraints faced by the poor laborers.[10]

The wage level, the mode of wage payment, and the number of meals per day differed across villages, crops, and farming operations. At the same time, different modes were observed within a village for the same crop and the same operation. For this reason, the analysis in the next section focus more on within-village variation of labor contracts, which could be systematically attributable to the variation in characteristics of workers and employers, after controlling for fixed effects of villages, crops, and farming operations.

4 Determinants of Contract Choice

4.1 Empirical Strategy

In the empirical analyses, determinants of contract choice among the four alternatives are investigated. Let I_{ji} be an indicator function taking the value of 1 when the contract adopted in observation i is j and 0 other wise (j=1: time wage in cash, j=2: time wage in kind, j=3: piece rates in cash, and j=4: piece rates in kind). It is assumed that there exists a latent variable I^*_{ji} such that

$$I_{ji} = 1 \quad if \quad I^*_{ji} = g(Z_i) + \epsilon_{ji} > 0, \tag{13}$$

and 0 otherwise, where $g(.)$ is a function determining the latent variable and Z_i are variables in the function. Ideally, a multinomial probit model covering the four exclusive regimes ($j = 1, 2, 3, 4$) should be estimated.

However, in this paper, estimating multinomial models is left for future task and single-equation probit models are estimated instead. There are two reasons for this. The first is the functional form of $g(.)$. When the four exclusive regimes are treated separately, the numerical examples in Section 2 have shown that the probability of choosing a contract other than $j = 1$ can be a non-monotonic function of ρ (effort elasticity of output) and s (the food share in family consumption). For instance, when s is raised with ρ held constant at a relatively low value, the probability of choosing contract [2] increases first, replacing contract [1], then decreases, being replaced by contract [4]. Because of this non-monotonicity, approximating $g(.)$ linearly may not be relevant if all of the four exclusive regimes are analyzed in a multinomial framework. Therefore, in the first model, contracts [3] and [4] are merged to make a

[10]The interest rates in the study regions are in the following range: around 10% per month in the informal credit market without collateral, 3 to 5% per month charged by private pawn shops, and 1.25% per month charged on agricultural production loans provided by the state.

new dummy variable for piece rates (*Cont_piece*), and in the second model, contracts [2] and [4] are merged to make a new dummy variable for in-kind wages (*Cont_kind*). Looking at Figures 1 and 2, the probability of choosing [3] or [4] is monotonically increasing with s and ρ; the probability of choosing [2] or [4] are almost monotonically increasing with s. Then it is safe to estimate a probit model with a linear functional form for the latent variable, namely,

$$Prob[Cont\_piece_i = 1] = \Phi(\beta_{pr} Z_i), \tag{14}$$

where β_{pr} is a vector of coefficients to estimate. A similar model for *Cont_kind* is estimated separately with parameter β_{kd} .

The second reason for adopting this specification is the unbalanced distribution of regimes in the current dataset. As shown in Table 5, the frequency of contract [4] is low. By merging contract [4] with contract [2] or [3], maximum likelihood estimation of a probit model is expected to be well-behaved.

Three types of explanatory variables are included in Z_i. In the first type, attributes of the employee (laborer) are included. As discussed in Section 2, the employee's attributes, such as food security concerns, risk aversion, and ability to make efforts, should affect the contract choice. Note that some of the employee's attributes are individual characteristics such as age, education, and sex, while others are household characteristics such as consumption allocation, asset holding, and household size. The second type in vector Z_i includes attributes of the employer (farmer). Individual and household characteristics of the employer, such as those listed for the employee, may affect the contract choice. The third type controls for fixed effects of villages, crops, and farming operations. Because the mode of wage payment tends to be similar within a village for a specific crop doing a particular work, it is better to control for these effects to obtain reliable estimates for the effects of individual and household attributes on the optimal contract choice.

Thus the main empirical test in this paper is to investigate whether individual/household characteristics that are proxy for s and ρ affect the contract choice in a way predicted by the theory in Section 2. In addition, the fitted values of the fixed effects are examined to investigate whether piece rates are more likely to be adopted for crops and farm operation that require high efforts and whether in-kind wages are more likely to be adopted for crops and farm operation that are closely related with the subsistence food need.

The observations for probit estimation are taken from employees' and employers' data.

In the current dataset, employees and employers are not matched. Therefore, one way to estimate model (14) is to run regressions using either employees' or employers' data separately. However, since village-, crop-, and operation fixed effects in model (14) should be the same regardless of using employees' or employers' data, an efficiency gain can be expected from pooling the data. Thus results using pooled data are reported mainly.

4.2 Estimation Results

As individual and household characteristics, the following variables were attempted for both employees and employers: sex, age, relation within the households (such as household head, son, etc.), education, and main occupation, as individual characteristics; size of landholding, size of labor force, household income, share of rice consumption in household income, household size, family type (such as extended vs. nuclear family), age, sex, education of the household head, and main source of income, as household characteristics. Variables that were found insignificant robustly were deleted from the results reported in this paper. Thus the results reported in Table 7 were obtained (see table 6 for the definition and statistics of the empirical variables).

First, which factors affect the probability of choosing piece rate contracts? Regression results show that female or more educated workers are more likely to be offered time wages rather than piece rates. This could be interpreted in two ways: efforts of such workers may not be productive in farming, possibly due to their weaker physical power than other workers; or such workers are more disciplined so that it is not necessary to give them effort-based incentives. The variable *S_labor*, the value of the annual amount of rice consumed at home divided by the annual household income, is included as a main proxy for s in the theoretical model. It has a significantly positive coefficient, consistent with predictions in Figures 1 and 2. In the study region, higher food concern for a worker is accommodated by being offered a piece rate contract so that he or she can earn more by paying efforts more.

Among the employer's attributes, age and education increase the probability of choosing piece rate contracts. This could be interpreted in two ways: their opportunity cost for monitoring labor is higher because of high age or non-agricultural work opportunities for the educated; or aged and educated farmers tend to adopt technologies that require more efforts of workers.

Crop fixed effects on the determinants of *Cont_piece* show that monsoon paddy (reference) tends to be cultivated under piece rates more than pulses, oilseeds, and vegetables. This is

consistent with the claim in the literature that paddy cultivation requires more efforts than other crops (Hayami and Otsuka 1993, Hayami and Kikuchi 1999). In growing pulses and oilseeds, less efforts may be optimal. In the case of vegetable growing, the interpretation could be more subtle: vegetables require careful labor, which may not be available through a piece-rate arrangement because of the quality-quantity trade-off (Paarsch and Shearer 2000). A similar reasoning can explain the negative coefficient on *Middle* of operation fixed effects: weeding and fertilizing require careful labor with high quality. In contrast, quick completion is important in planting and harvesting so that piece rates are likely to be chosen.

Second, which factors affect the probability of choosing labor contracts paid in kind? Regression results show that a worker from a household with smaller farmland and a larger rice share in family budget are more likely to be offered in-kind wages. This is exactly what was predicted theoretically when there are concerns for food security (see Figures 1 and 2 in Section 2). A worker with higher *S_labor* (proxy for s) tends to work under in-kind payment schemes more because the food consumption is more important for him than a worker with lower *S_labor*. At the same time, with the same level of *S_labor*, having more farmland under command reduces the food security concern of the worker because food can be produced on his farm without going to the market. It is found that none of the attributes of the employee is significant in explaining *Cont_kind*.

Crop fixed effects show that monsoon paddy (reference) and upland paddy tend to be cultivated by in-kind wages more than other crops. Operation fixed effects show that payment is more common in harvesting than in planting operations. These are as expected because these two types of paddy are grown mainly for consumption while other crops are grown mainly as cash crops so that the harvest of these crops can readily be paid to harvesting workers on the spot.

In Table 8, regression results under alternative estimation procedures are presented to check the robustness of the findings above. In the first and second groups of rows, weighted regressions were attempted. In the last portion, model (14) was estimated using either employees' data or employers' data separately, without restricting the fixed effects to be the same between employees' and employers' side. Estimated coefficients on fixed effects were very similar to those reported in Table 7 so that they are not reported. Among the employee's characteristics, the negative effect of being female on *Cont_piece* and the positive effect of having a higher rice share in family budget on *Cont_kind* are most robust. The employee's landholding variable consistently shows a negative coefficient on *Cont_kind* but

their significant levels are lower in weighted regressions. The positive effect of *S_labor* on *Cont_piece* is not robustly found with statistical significance. Among the employer's characteristics, the positive effects of age and education on *Cont_kind* are very robust. For education, land, and *S_labor*, different definitions were also attempted.[11] Results from these models are qualitatively the same as those reported in this paper.

Overall, regression results for *Cont_piece* and *Cont_kind* are consistent with the theoretical prediction of this paper focusing on effort elasticities, incentives, and food security. Therefore, one of the reasons for finding no inefficiency effects of casual labor on farm productivity (Table 4) could be attributable to careful selection of contracts for each worker in each farm operation, which reduces the moral hazard cost and rewards the food security concern of workers. If this interpretation is correct, the OLS estimates of no negative effects of hired labor shares on productivity do not contradict the existence of moral hazard.

One caveat of the contract choice analysis above is that endogenous matching is not controlled for. If model in (14) is correctly specified, each variable is measured correctly, and there is no inherent heterogeneity that determines the contract choice (so-called "exogenous or random matching" in the literature), then the probit regression gives consistent estimates for β_{pr} and β_{kd}. Instead, if some of the variables are omitted or there exists inherent, unobservable heterogeneity ("endogenous matching"), then the estimates for β are inconsistent. To avoid this bias through instrumental variables (Ackerberg and Botticini 2002), variables that affect the matching equation but do not affect the contractual choice are necessary. This extension is left for further analysis.

5 Conclusions

This paper developed an agency model of contract choice in hiring labor and estimated the determinants of the choice in rural Myanmar based on the model. As a salient feature relevant for the agricultural sector in a low income country like Myanmar, the agency model incorporates considerations for food security as well as incentive concerns. It was shown that when food security considerations are important for an employee, possibly due to poverty, a contract with wages paid in kind (food) is preferred to labor contracts paid in cash. At the same time, when output is more responsive to workers' efforts but efforts are private

[11] In defining education variables, instead of combining schooling years of formal and monastery schools, years at formal schools only were attempted. For land, instead of using the total size, only paddy fields or non-paddy fields aggregated with smaller weights were attempted. *S_labor* was redefined using the estimate for the total rice requirement for the family based on their demographic composition.

information to workers or not enforceable, a contract with piece-rate wages is preferred to labor contracts with hourly wages. The case of sharecropping can be understood as the combination of the two: piece-rate wages paid in kind. Numerical examples indicate a possibly non-monotonic relationship between the optimal contract choice and parameters determining the food security and moral hazard concerns.

Implications of the theoretical model were tested using a cross section dataset collected from a sample household survey conducted in 2001 covering about 600 households with diverse agro-ecological environments in Myanmar. Estimation results showed that in-kind wages are more likely to be adopted when workers have higher budget shares of food and less farmland under their management, both are characteristics of poverty in the study region and increase the food security concern. Piece-rate wages are more likely to be adopted when workers are male and uneducated, possibly a sign of their comparative advantage in physical work that requires more efforts and quick completion. Fixed effects of crops and farming operations are jointly significant and more effort-oriented crops or operations are associated with piece-rate contracts. These results seem consistent with the theoretical implications. Selection into contracts thus could be one of the reasons for finding no inefficiency effects of casual labor on farm productivity when production functions was estimated using the same dataset.

To tackle the possibly non-monotonic relationship of optimal contract choice and also due to the small number of cases with piece rates in kind, this paper estimated single-equation probit models, pooling piece rates in kind with either piece rates in cash or hourly wages in kind. Estimating the full model with the four exclusive regimes is left for further study. Simulation-based econometrics, in which the structural model of optimization is modeled as such, may be required to incorporate such non-linearity in a rigorous way.[12] Another issue that was not examined in this paper is the contract selection for permanent labor. The production function estimates showed no adverse effects of permanent labor on farm productivity as well. The speculation of this paper is that the contract choice based on kinship and reputation reduces the incentive for permanent laborer to shirk in Myanmar. Testing this speculation and then re-estimatng the production function controlling for the endogeneity of contract choice are also left for further research.

[12]See for example Fafchamps (1993) and Fafchamps and Soderbom (2002) for attempts of structural estimation based on the primal optimization model.

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Table 1: Survey Villages

Name in the paper	Division/State	Township	Topology	Irrigation	Major crops
DELTA1	Ayeyarwady D.	Myaungmya	Deltaic agric.	Pump	Paddy
DELTA2	Bago D.	Waw	Deltaic agric.	Rainfed+Canal	Paddy, pulses
DRY1	Mandalay D.	Kyaukse	Dry zone	Canal	Paddy, vegetables
DRY2	Magway D.	Magway	Dry zone	Rainfed	Upland crops
DRY3	Magway D.	Taungdwingyi	Dry zone	Rainfed+Tank	Upland crops, paddy
HILL1	Shan State	Nyaungshwe	Hilly region	Rainfed	Vegetables, paddy, sugarcane
HILL2	Shan State	Kalaw	Hilly region	Rainfed	Vegetables, paddy
COAST	Tanintharyi D.	Myeik	Coastal agric.	Rainfed	Paddy, rubber

Table 2: Sample Households

	Number of sample households			Number of household members included in the sample households		
Village	Farm households	Non-farm hhs	Total	Farm households	Non-farm hhs	Total
DELTA1	67	33	100	352	158	510
DELTA2	60	40	100	345	217	562
DRY1	65	37	102	307	171	478
DRY2	24	16	40	123	89	212
DRY3	24	16	40	152	74	226
HILL1	26	12	38	170	58	228
HILL2	34	6	40	192	31	223
COAST	41	20	61	273	138	411
Total	341	180	521	1914	936	2850

Table 3: Average Asset and Income of Sample Households

	Farmland (acres)	Livestock (number)			Transportation equipment (number)		Total current value of production assets* (1000 Kyats)	Total household income		Per-capita household income	
		Cattle	Pigs	Chicken and ducks	Bullock cart	Bicycle		Average (Kyats)	Gini coefficient	Average (Kyats/ person)	Headcount poverty measures
By village											
DELTA1	5.97	1.45	0.78	16.9	0.12	0.22	218.2	134,535	0.398	30,065	0.508
DELTA2	7.17	3.78	1.02	14.2	0.60	0.21	207.8	155,423	0.335	29,745	0.294
DRY1	3.32	0.95	0.67	4.9	0.32	1.08	232.7	209,661	0.440	49,378	0.326
DRY2	6.13	1.65	0.30	3.2	1.18	0.50	282.0	216,482	0.563	43,975	0.539
DRY3	6.06	2.90	0.78	8.8	0.65	0.55	188.5	87,591	0.395	17,084	0.677
HILL1	7.06	0.53	0.03	2.9	0.24	0.87	225.7	194,807	0.389	36,447	0.411
HILL2	3.92	1.45	0.63	0.1	0.50	0.25	172.9	169,477	0.388	32,147	0.475
COAST	5.81	1.70	0.62	15.6	0.13	0.15	579.0	314,478	0.535	44,547	0.371
By household type											
Farm households	8.56	2.52	0.76	11.3	0.62	0.60	378.6	207,981	0.461	39,337	0.391
Non-farm households	0.01	0.14	0.43	5.9	0.01	0.02	38.1	138,819	0.372	30,191	0.483
Total	5.62	1.70	0.64	9.5	0.41	0.47	261.0	184,086	0.460	36,177	0.421

Notes:

* The sum of the values of livestock, agricultural equipment and machinery, and transportation equipment, including items not listed in this table.

Household income is defined as the sum of wage/salary receipts including the imputed value of in-kind payment such as meals and rice, non-agricultural self-employment earnings (gross revenue minus actually paid costs), agricultural self-employment earnings (sum of the value of output minus actually paid costs), and net receipts of non-earned income. Median market prices within each village were used to impute the value of non-cash transactions such as the paddy produced by farmers and consumed by themselves and in-kind payment to workers.

Table 4: Efficiency of Hired Labor (Cobb-Douglas Production Function Estimates)

	Log of paddy output value per acre		Log of paddy value-added per acre		Log of non-paddy output value per acre		Log of non-paddy value-added per acre	
Log of production factors								
Land under the crop	-0.042	(0.035)	-0.083 *	(0.049)	-0.208 **	(0.083)	-0.248 **	(0.108)
Labor in mandays	0.036	(0.065)	0.055	(0.080)	0.117 **	(0.056)	0.218 ***	(0.077)
Animal in days	0.029	(0.032)	0.038	(0.046)	-0.036	(0.082)	-0.028	(0.097)
Machinery in hours	0.009	(0.029)	0.004	(0.037)	0.198 ***	(0.054)	0.293 ***	(0.069)
Current input in kyats	0.236 ***	(0.050)			0.335 ***	(0.065)		
Hired labor share								
Permanent labor	0.016	(0.242)	0.482 ***	(0.174)	1.391 ***	(0.426)	1.984 ***	(0.529)
Casual labor	0.163 *	(0.092)	0.306 **	(0.127)	-0.214	(0.252)	-0.367	(0.397)
Crop fixed effect								
Summer paddy	0.153 **	(0.073)	0.123	(0.094)				
Upland paddy	-0.463 *	(0.258)	-1.609 ***	(0.305)				
Pulses					-0.378	(0.276)	-0.413	(0.397)
Oilseed					0.299	(0.265)	0.572 *	(0.337)
Industrial crops					1.310 ***	(0.375)	1.810 ***	(0.424)
Rubber					0.474	(0.550)	1.535 ***	(0.536)
Vegetables					1.038 ***	(0.333)	1.798 ***	(0.426)
Other crops					1.286 ***	(0.423)	1.315 ***	(0.415)
Village fixed effect								
Delta1	-0.032	(0.190)	-0.188	(0.245)				
Hill2	-0.424	(0.273)	-0.249	(0.280)	0.497 *	(0.292)	0.402	(0.423)
Dry1	0.253	(0.195)	0.230	(0.246)	0.436	(0.292)	0.201	(0.364)
Dry2					0.766 ***	(0.280)	1.002 ***	(0.361)
Dry3	-0.753 **	(0.338)	-0.452	(0.361)	0.376	(0.308)	0.445	(0.405)
Delta2	0.007	(0.225)	-0.055	(0.279)	1.212 ***	(0.342)	1.547 ***	(0.475)
Coast	0.341 *	(0.205)	0.292	(0.271)	0.307	(0.457)	-0.811 **	(0.394)
Intercept	7.634 ***	(0.520)	9.268 ***	(0.424)	6.120 ***	(0.559)	7.942 ***	(0.422)
Number of observations	316		303		198		190	
F stat for zero slope	23.42 ***		9.94 ***		24.52 ***		13.46 ***	
R-squared	0.526		0.349		0.724		0.536	

Notes:
(1) Estimated by OLS with Huber-White heteroscedastic robust standard errors (in parentheses). Significant at 1% (***), 5% (**), and 10% (*).
(2) Reference for fixed effects: Hill1 and Monsoon paddy or Hill1 and Cereals. No paddy crops in DRY2. No non-paddy crops in DELTA1.
(3) When observations with zero or negative output were excluded from the analysis.

Table 5: Mode of Wage Payment to Casual Labor

	No. of observations	Share to the total (%)		
		Un-weighted	Weighted by mandays	Weighted by kyats
(1) Time wage in cash				
Kyats/day	2437	78.61	81.36	77.68
Other	71	2.29	2.25	1.01
Subtotal	2508	80.90	83.61	78.69
(2) Time wage in kind				
Cleaned rice/day	65	2.10	1.11	1.99
Unhusked paddy/day	12	0.39	0.41	1.02
Subtotal	77	2.49	1.52	3.01
(3) Piece-rate wage in cash				
Kyats/acre	154	4.97	5.83	6.94
Kyats for the whole operation	100	3.23	2.53	2.73
Kyats/unit of farm work	152	4.90	3.21	4.19
Kyats/unit of crop output	52	1.68	1.68	1.74
Subtotal	458	14.78	13.25	15.60
(4) Piece-rate wage in kind				
Sharecropping	4	0.13	0.06	0.15
Crop output/acre	21	0.68	0.82	1.18
Crop output for the whole operation	30	0.97	0.71	1.33
Other	2	0.06	0.02	0.03
Subtotal	57	1.84	1.61	2.69
Total	3100	100.00	100.00	100.00

Table 6: Variables Used for the Determinants of Contract Choice

Variable	Definition		Mean	Std. Dev.	Min	Max
Dependent variables						
Cont_piece	Dummy for choosing piece-rate contracts (contract type [3] and [4])		0.166			
Cont_kind	Dummy for choosing wage contracts in kind (contract type [2] and [4])		0.043			
Explanatory variables						
Female_labor	Female dummy for the employee		0.292			
Educ_labor	Completed years of education of the employee at formal schools. When the employee attended monastery schools, the value of 2 years was assigned.		2.818	2.360	0	10
Land_labor	Size of farmland holding in acres managed by the household of the employee		1.835	3.518	0	22
S_labor	Importance of rice in the family budget. Defined as "the value of the annual amount of rice consumed at home" divided by "the annual household income". When it is larger than unity, the value was truncated at one.		0.285	0.204	0.026	1.000
Age_farmer	Age of the employer (=farmer)		43.871	12.193	21	85
Educ_farmer	Completed years of education of the employer (=farmer) at formal schools. When the employee attended monastery schools, the value of 2 years was assigned.		3.619	3.395	0	16
Village fixed effects						
DELTA1		#	0.210			
DELTA2			0.133			
DRY1			0.208			
DRY2			0.116			
DRY3			0.110			
HILL1			0.119			
HILL2			0.065			
COAST			0.039			
Crop fixed effects						
Monsoon paddy	Including late monsoon variety	#	0.369			
Summer paddy	Grown during the dry season		0.184			
Upland paddy	Including paddy grown under shifting cultivation		0.007			
Cereals	Cereal crops other than paddy		0.018			
Pulses	Pulses such as green gram, black gram, pigeon pea		0.083			
Oilseed	Oilseed crops such as sesame, groundnut, sunflower		0.151			
Industrial crops	Industrial crops such as sugarcane		0.024			
Rubber	Rubber		0.011			
Vegetables	Vegetables including cabbage, green chili, tomato		0.138			
Other crops	Other crops		0.015			
Operation fixed effects						
Planting	Operations before and during the planting stage, such as land preparation, transplanting, planting		0.349			
Middle	Operations during the middle stage, such as irrigation, fertilizing, weeding		0.192			
Harvest	Operations during the harvesting stage, such as harvesting, winnowing, threshing		0.416			
Other operation	All other operations and operations covering different	#	0.043			

Notes: (1) The total number of observations is 3100, of which 1701 are employees' data and 1399 are employers' data.
(2) When the variable is a dummy, the percentage of those observations taking one is reported.
These dummy variables are used as reference in the regression analysis.

Table 7: Determinants of Contract Choices (Probit Estimation Results)

Dep.variable=	Cont_piece (piece rates)			Cont_kind (in-kind wages)		
	Coeff	Std. Err	dF/dx	Coeff	Std. Err	dF/dx
Individual and household attriutes						
Female_labor	-0.2173 *	(0.127)	-0.0373	0.1062	(0.274)	0.0017
Educ_labor	-0.0504 **	(0.022)	-0.0095	-0.0205	(0.043)	-0.0003
Land_labor	0.0122	(0.015)	0.0023	-0.0868 *	(0.047)	-0.0013
S_labor	0.6005 **	(0.279)	0.1131	1.2326 ***	(0.462)	0.0183
Age_farmer	0.0101 ***	(0.002)	0.0019	0.0054	(0.004)	0.0001
Educ_farmer	0.0315 ***	(0.012)	0.0059	-0.0020	(0.029)	0.0000
Village fixed effects						
DELTA2	0.4359 ***	(0.099)	0.0987	-2.7910 ***	(0.359)	-0.0361
DRY1	0.8006 ***	(0.094)	0.1952	-0.4917 **	(0.233)	-0.0055
DRY2	0.6392 ***	(0.160)	0.1577	-1.2065	(0.795)	-0.0082
DRY3	0.3661 ***	(0.136)	0.0814	-2.6684 ***	(0.433)	-0.0156
HILL1	-0.3775 **	(0.164)	-0.0593	-0.3885	(0.298)	-0.0040
HILL2	-0.0994	(0.208)	-0.0177	-0.2381	(0.295)	-0.0027
COAST	0.2956	(0.187)	0.0652		#	
Crop fixed effects						
Summer paddy	0.0025	(0.078)	0.0005	-0.4890 ***	(0.169)	-0.0052
Upland paddy	-0.4621	(0.561)	-0.0648	0.9005 ***	(0.349)	0.0422
Cereals	-0.3347	(0.293)	-0.0513		#	
Pulses	-0.2960 **	(0.143)	-0.0477	-1.4815 *	(0.800)	-0.0089
Oilseed	-0.4971 ***	(0.128)	-0.0753	-2.2048 ***	(0.305)	-0.0176
Industrial crops	-0.0724	(0.270)	-0.0131		#	
Rubber	0.0917	(0.361)	0.0182		#	
Vegetables	-0.7020 ***	(0.124)	-0.0960		#	
Other crops	-0.3541	(0.370)	-0.0535		#	
Operation fixed effects						
Planting	0.2680	(0.215)	0.0531	-1.2671 ***	(0.400)	-0.0207
Middle	-0.4801 **	(0.227)	-0.0752		#	
Harvest	0.1758	(0.216)	0.0337	0.5176	(0.381)	0.0077
Intercept	-1.4454 ***	(0.247)		-0.2503	(0.484)	
Wald chi2stat for zero slope	380.0 ***			321.3 ***		
Pseudo R2	0.203			0.496		
Log likelihood	-1111.0			-224.4		

Notes:

(1) Estimated by a probit model with Huber-White heteroscedastic robust standard errors (in parentheses). Significant at 1% (***), 5% (**), and 10% (*).

(2) Reference for fixed effects: DELTA1, Monsoon paddy, and Other operations. See Table 6 for the list of dummy variables.

(3) The number of observations used was 3100 in the left model. In the second model, fixed effects with # predicted "failure" (dependent variable=0) perfectly so that these dummy variables and associated observations were deleted. Therefore, the effective number of observations for the right model was 1438.

Table 8: Determinants of Contract Choices (Robustness Check to Estimation Procedure)

Dep.variable=	Cont_piece (piece rates)			Cont_kind (in-kind wages)		
	Coeff	Std. Err	dF/dx	Coeff	Std. Err	dF/dx
Weighted regression using "Mandays"						
Female_labor	-0.5297 ***	(0.146)	-0.0684	0.0923	(0.337)	0.0006
Educ_labor	-0.0510 *	(0.028)	-0.0082	0.0121	(0.057)	0.0001
Land_labor	0.0274	(0.015)	0.0044	-0.0966 *	(0.057)	-0.0005
S_labor	0.5863	(0.426)	0.0938	0.8071 *	(0.478)	0.0044
Age_farmer	0.0118 ***	(0.003)	0.0019	0.0038	(0.006)	0.0000
Educ_farmer	0.0420 **	(0.018)	0.0067	-0.0501	(0.036)	-0.0003
Weighted regression using "Kyats"						
Female_labor	-0.5367 ***	(0.151)	-0.0868	0.3210	(0.317)	0.0081
Educ_labor	-0.0611 **	(0.030)	-0.0123	0.0143	(0.058)	0.0003
Land_labor	0.0331 *	(0.018)	0.0064	-0.0733	(0.057)	-0.0014
S_labor	0.1469	(0.526)	0.0295	0.7686 *	(0.455)	0.0147
Age_farmer	0.0149 ***	(0.004)	0.0030	0.0039	(0.006)	0.0001
Educ_farmer	0.0461 **	(0.017)	0.0092	-0.0275	(0.040)	-0.0005
Regression using only employees' data						
Female_labor	-0.1859 *	(0.109)	-0.0173	0.0464	(0.240)	0.0007
Educ_labor	-0.0026	(0.024)	-0.0003	0.0060	(0.044)	0.0001
Land_labor	0.0016	(0.015)	0.0002	-0.0877 **	(0.043)	-0.0012
S_labor	0.0989	(0.268)	0.0098	1.3323 ***	(0.415)	0.0186
Regression using only employers' data						
Age_farmer	0.0053 *	(0.004)	0.0017	0.0007	(0.008)	0.0002
Educ_farmer	0.0250 *	(0.014)	0.0080	-0.0160	(0.045)	-0.0037

Note: Only results for individual and household attributes are reported in this table. All specifications included village, crop, and operation fixed effects as in Table 7 and they were jointly significant at 1%.

Figure 1: Optimal Contract Choice (phi=3, theta stochastic and iid)

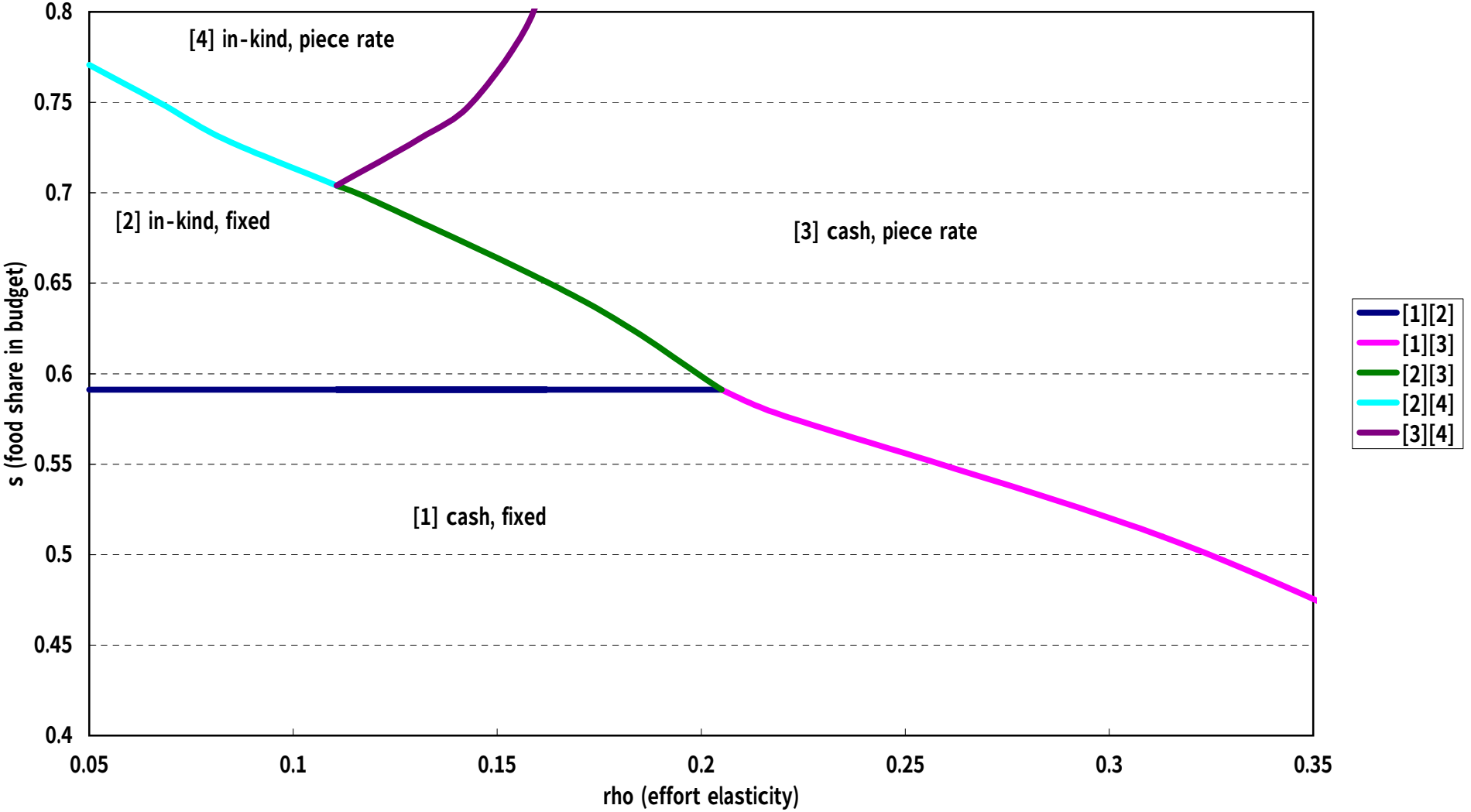

Figure 2: Optimal Contract Choice (phi=3, theta and p completely negatively correlated)