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

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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 and labor monitoring is more costly, 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. These predictions of the theoretical model are tested using a cross section dataset collected in rural Myanmar through a sample household survey conducted in 2001, covering diverse agro-ecological environments. The estimation results are consistent with the theoretical predictions: wages in kind are more likely to be adopted when workers have higher budget shares of staple food and smaller farmland to produce food themselves; piece-rate wages are more likely to be adopted when work efforts are more difficult to monitor; 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.

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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, a contract in which a landlord transacts a land-use right to a tenant in exchange for land rent paid as a fixed share of output, has been investigated in detail (see, for example, Arimoto 2005, 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, and strategic default), and it may perform better than a fixed wage or a fixed rent contract under the conditions prevailing in developing countries such as low income, high production risk, and less developed markets for credit and insurance.

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 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 incentive effects. The model is motivated by findings and data obtained from field surveys in rural Myanmar conducted in 2001 covering diverse agro-ecological environments. Unique features of the dataset is that first, various kinds of compensation policy are observed, and second,

[1] Among the few existing studies, Foster and Rosenzweig (1994) demonstrated that in rural India, the level of moral hazard differs depending on labor contracts 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 that were paid in piece-rate wages in kind; Datta et al. (2004) investigated the choice between cash and kind wages in rural India.

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. Therefore, both the contrast between cash and in-kind wages, and the contrast between time and piece-rate wages can be analyzed. These contrasts also exist in the issue of sharecropping versus fixed wage/rental contracts but asymmetric information surrounding farmland makes it difficult to concentrate on these contrasts. By focusing on contracts of casual labor, 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 because the data matching between the employer and the employee is incomplete.

As far as the author knows, this paper is the first attempt to combine considerations for food security with concerns for incentive provision 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 exposure 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 farmers' 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 is not the only way to improve food security, however. A similar strategy is possible through adjusting the compensation policy toward workers. A recent paper by Datta et al. (2004) also examined the theoretical mechanism underlying the contractual mix between cash and kind wages of casual workers. This paper is distinguished from theirs in that the role of food price risk aversion is correctly incorporated and another important concerns in employing casual workers (preventing workers' shirking) is combined with food security considerations. Therefore, the contribution of this paper is in investigating the determinants of contract choice in a more comprehensive way, incorporating both the 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.) and those related with moral hazard (ease of supervision and enforcement, importance of reputation and long-run relations, etc.).

The paper is organized as follows. Section 2 describes the background and the dataset. It also gives the estimation results of a production function, which show that the inefficiency of hired labor is not observed at the first glance in our dataset. This does not necessarily mean

that there is no moral hazard problems. The production function estimation results may indicate that institutional arrangements in labor markets in the study region are effective in preventing moral hazard to occur. Section 3 thus develops an agency model of wage contract choice to explain the institutional arrangements. Based on the agency model, Section 4 analyzes the selection into wage contracts, by estimating reduced-form models for the determinants of wage types. Section 5 concludes the paper.

2 Background and Data

2.1 Myanmar's Economy and Agricultural Policies

Myanmar, whose population is close to 50 million, is in transition from a planned to a market economy (Myat Thein 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. The estimated income level is 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 this expansion, first, the government has introduced various reforms in agricultural marketing since the late 1980s. Under the marketing regime that was in force until fiscal year 2003/04, the state procured from farmers a limited and fixed amount of paddy and allowed 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-fixed procurement price, the reform initially gave a substantial incentive to produce a surplus. In addition, the government has been promoting the expansion of paddy areas through irrigation investment. Throughout the 1990s, numerous dams were constructed in some areas, while private investment in small scale diesel pumps was promoted in others, in order to increase paddy cultivation in the dry season.

As a result of these two measures, both the area under cultivation and paddy production in Myanmar rose remarkably in the early 1990s. However, such policies resulted in low incomes for farmers because the production of paddy was not profitable due to repressed domestic prices for paddy resulting from the government monopoly of rice export (Kurosaki et al. 2004) and the instability of consumption of rural dwellers remained at a high level because of inconsistency and frequent changes in agricultural policies. Thus in spite of increased production of rice, farmers in Myanmar still have reasons 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. At the time of land reforms in the 1950s, the land tillage right was distributed to village residents who owned means of production such as bullocks. There has been little change in the unequal distribution of tillage rights since then. 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, the landless may face a threat of not being able to secure their subsistence needs in food. Therefore, food security is a real and urgent concern for landless workers in rural Myanmar.

2.2 Characteristics of Sample Villages and Households

As a result of the country's isolationist foreign policy, the availability of micro data on Myanmar's rural economy is limited. We therefore conducted a survey of sample households belonging to eight selected villages[2] in June-October 2001 (Kurosaki et al. 2004).

The characteristics of the villages are shown in Table 2. 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 is one of Myanmar's centers of commercial crop production due to its long history of canal irrigation dating back to Burma's dynastic period. In contrast, DRY2 and DRY3 represent villages relying on rainfed agriculture. DRY2 is more typical of a dry zone village since only rainfed crops and no paddy crops are grown here. HILL1 and HILL2 represent villages relying on vegetable-based development in hilly regions. Both villages sell their vegetables to major consumption centers such as Yangon and Mandalay, while their paddy cultivation is oriented toward 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 carefully chosen to ensure that they would be representative of each region. As far as can be judged by the statistics on cropping patterns 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

[2]The smallest administrative unit in Myanmar is the "village tract," which usually consists of several hamlets or natural villages. While Table 1 refers to "village tracts," in the text and the following tables, they are simply referred to as "villages" for convenience's sake.

to eliminate discretionary elements, so that the sample households were 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 (Table 2): the 341 households denoted as "Farm" are households with land tillage rights, while the 180 households denoted as "Non-farm" have no tillage rights.

A structured questionnaire was used for all households to establish household characteristics, household assets, income, consumption, and debt and credit. The part of the dataset on income sources provides the information on agricultural wages earned by household members. The sample households include 2,850 persons, implying that the average household size is 5.5 persons. This part of the dataset provides the individual attributes that are used in the analysis of labor contracts. If households operated farmland, they were asked to fill in an additional questionnaire on farm management. This part of the dataset provides the information 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 to ensure internal consistency and data quality.

Table 3 reports the asset and income status of the sample households. The average land holding size among the farm households was 8.6 acres, which is large by South-East Asian standards. 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. Comparing different household types, the total asset values were lower among the non-farm households than among the farm households.

Overall average incomes 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$ prevailing during the study period, they are equivalent to $283 per household and $55 per person per year. Incomes in the sample villages 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) prevailing during the study period, they are equivalent to 3,300 kg of rice per household and 640 kg per person per year. The average income level was also lower among the non-farm households than among the farm households, although the income disparity was not as large as the asset disparity.

2.3 Labor Contracts and Farm Productivity

It is important to distinguish two kinds of agricultural laborers in rural Myanmar (Takahashi 2000). *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. Thus the total farm labor can be decomposed into three: labor by unpaid family members of farm households, casual labor, and permanent labor.

Among all sample households, the income from casual farm labor occupied 12.7% of the households' earned income and the income from permanent farm labor occupied 2.6% (Table 3). 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 debates 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 a 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, i.e., farmers redistribute their income to poor laborers through employing more harvesting workers (Hayami and Kikuchi 1999).

To investigate whether or not hired labor is inefficient in our dataset, production functions are estimated with the total labor (sum of family, casual, and permanent labor in mandays) 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 farm-level production details were obtained for various crops. Since the production technology of paddy crops is fundamentally different from that of 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 differences in market and production environments.

The ordinary least squares (OLS) estimation results are reported in Table 4, based on a Cobb-Douglas specification. Elasticity parameters for production factors are in the reasonable range. The coefficient on the log of land is negative because the dependent variable is output per acre. By adding one to the reported coefficient, we can obtain land elasticity of crop production. Various measures of farmer's human capital were tried as productivity shifters, among which, the head's education was found to be positive with statistical significance.

In none of the four models, the coefficient on the permanent labor share or the casual labor share is negative and statistically significant. On the contrary, the coefficient on the permanent labor share is positive and statistically significant in regressions of paddy value-added, non-paddy output, and non-paddy value-added, and the coefficient on the casual labor share is significantly positive in regressions of 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 farmers face no moral hazard problems in hiring labor from outside?

Needless to say, the OLS estimates in Table 4 suffer from the endogeneity bias: contractual choice and the levels of factor inputs are determined endogenously and 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.

This paper instead concentrates on the first stage decision making process (i.e., the determinants of labor contracts). If it can be shown that contractual choice is consistent with the story of self-selection, the OLS estimates of no negative effects of hired labor on productivity do not contradict the existence of moral hazard. The results of no negative effects may imply that hired laborers' opportunistic behavior is successfully suppressed by contract designs.

From the field survey results, the following information is obtained on hired labor in agriculture: 60 cases of wage transactions for those employed as a permanent laborer, approximately 1,700 cases for those employed as a 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 payment varies substantially among casual labor transactions (Table 5).[3] Wages fixed in cash per labor ("Kyats/day") were found most frequently, accounting

[3]There are other dimensions of variation in wages paid to casual laborers (Kurosaki 2004). For instance, the number of meals per day served to hired laborers was observed in the range 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 rate was often reduced by 20 to 33%. Such a large discount suggests the severeness of credit constraints faced by the poor laborers (the interest rates in the study regions were 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 public sector).

for 79% of 3,100 cases. The modern mode of payment fixed as "Kyats/day" is thus the dominant one in Myanmar.

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 an incentive to shirk because the efforts in work may not be observable to the employer and the wage is insensitive to the efforts. Piece-rate contracts should be superior if shirking is potentially a problem and the farm operation requires quick completion. Table 5 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 in the importance of each case in the rural economy, the share of each mode in the total was re-calculated using two sets of weights: total mandays and total Kyats.[4] 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 Kyats. This implies that workers earn more per day on average when wages are paid in kind or in piece rates.

In all villages, at least two categories of the four wage modes were observed. Time wages in cash and piece rates in cash were found in all eight villages. In-kind wages were observed in seven villages excluding DELTA1. When a certain farm operation was conducted by a *group* of casual laborers hired by a farmer, they were paid under the same mode. In other words, we observed no instance of several casual laborers who were hired on the same plot doing the same work together, but paid differently. However, we often observed instances

[4]Both weights have to be estimated for the following cases, using fixed coefficients for each village based on our field observations. First, when piece rates are adopted, farmers usually do not remember the exact number of days laborers actually worked. Second, 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.

in which casual laborers working separately in different plots were paid in different ways, although they were doing the same farm work for the same crop in the same village.

3 Theoretical Model

3.1 Setting

To guide the econometric investigation of wage contract choice in rural Myanmar thus described, an agency model is proposed in this section. The model focuses on the cost of monitoring workers against shirking, 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 output quantity per labor hour but the average quality of output under piece-rate contracts may deteriorate, is assumed away.[5] 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." The price of "non-food" 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 product of $f(e)$ and θ, where $f(e)$ is a production function with $f'(.) \geq 0$ and $f''(.) \leq 0$ (e is the agent's effort), and θ is a yield shock 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). To reflect the variation in wage contracts observed in the study region, it is assumed that 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 (paid by the food). Let w_j, $j = 1, .., 4$, as the wage rate in each contract. It should be noted that their units are different: 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*, W_j, the gross value of the farmer's payment to the laborer under contract j, is equivalent to

$$W_1 = w_1, \quad W_2 = w_2 p, \quad W_3 = w_3 \theta f(e), \quad W_4 = w_4 p \theta f(e), \tag{1}$$

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 ante* payoff is given by $E[v(y, p)] - g(e)$, where

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

$E[.]$ is an expectation operator, $v(y,p)$ is an indirect utility function from consumption, and $g(e)$ is a disutility function from efforts with $g'(.) \geq 0$ and $g(0) = 0$. For simplicity, it is assumed that the laborer has no other income sources so that his consumption expenditure y is equal to W_j. 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.[6] The condition $v_{yp} > 0$ implies that the welfare increases when the correlation between food price and income becomes more positive, with the income mean, the price mean, the income variance, and the food price variance being 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

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

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

[6] However, $v_{pp} < 0$ is not always satisfied in popular utility functions used in the literature. For instance, when the utility function is 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 ($\psi > 1+1/\beta$), for $v_{pp} < 0$. In their analysis of contract choice between cash and kind wages in low income economies, Datta et al. (2004) adopted a constant elasticity of substitution (CES) utility function, which nests Cobb-Douglas as a special case. Because they assumed a relatively low value for ψ, their analysis turned out to be a case with $v_{pp} > 0$. In other words, they implicitly assumed that the worker's welfare increases when the food price becomes more variable. Since we think that this is not relevant for modeling poor workers' behavior, this paper adopts a utility function that is associated with $v_{pp} < 0$.

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 $e_j^* \equiv e_j^*(w_j, u_0^A, \zeta)$ where ζ is a vector of parameters that characterize the preference of the agent, farming technology, and the nature of price and yield risk.

3.2 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 minimal 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 the two contracts?

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

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

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

Comparing the two, the sign of $E[W_1] - E[W_2] (= w_1^* - w_2^* \bar{p})$ 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

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

(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 $E[W_1] - E[W_2]$ is ambiguous. In contrast, as s increases, expression (8) 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 against a contract with time wage in cash.*

Although Proposition 1 focuses on the characteristics of the laborer, a related prediction can be derived for the characteristics of the farmer-employer by assuming the same functional form for the payoff of the farmer, 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 against a contract with time wage in kind.

Under contract [3] or contract [4], $\partial W_j/\partial e_j$ has the same sign as $f'(e)$. 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 and p are independent, 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. The case of independent θ and p corresponds to the small country assumption in which farmers face idiosyncratic yield risk only and the sources of price fluctuation are from the demand side only. 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 the stochastic distribution of price and yield at the one hand, and parameters characterizing preferences toward income risk and price risk.

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

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

Similarly, under contract [4], it is rewritten as

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

Let e_3^* and e_4^* be the agent's solution satisfying each of these equations.

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 $f(.)$.[7] Then the principal finally chooses the optimal contract that is associated with the highest value among $E[p\theta]f(0) - w_1$, $E[p\theta]f(0) - \bar{p}w_2$, $E[p\theta]f(e_3^*) - w_3 f(e_3^*)$, and $E[p\theta]f(e_4^*) - w_4 f(e_4^*)E[p\theta]$. 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 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 $f'(e)$ due to exogenous factors 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 three. 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 against 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 quick completion. When the effort is observable and enforceable by the employer, such premium for piece-rate contracts disappears.

3.3 Numerical Examples

To have a concrete idea of how the optimal choice looks like, the agency model above is calibrated numerically. See Appendix for the details of specification and calibration parameters actually adopted. The indirect utility function in the agent's payoff function is specified

[7] However, as far as numerical examples show (see the next subsection), the participation constraint is found to be always binding.

with a risk-averse linear expenditure system (LES). The LES 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). LES utility functions require smaller values of risk aversion to assure $v_{pp} < 0$ than Cobb-Douglas or CES utility functions. The welfare cost of effort for the worker, $g(e)$, is specified as a linear function. The principal's production function is specified as iso-elastic with respect to $1 + e$ (the total effort), where 1 is the minimum effort and e is the additional effort. Regarding the stochastic process, a discrete distribution of price and yield risk is assumed so that the expected utility can be evaluated by taking a probability-weighted sum of utility under each pair of realized values of p and θ.

Figure 1 plots the results when ϕ (the relative risk aversion parameter with respect to the income after meeting subsistence needs) is set at 3 and the standard deviation of yield risk θ is set at 40% of that of p. It is assumed that θ is distributed independently of p (no common yield shocks). A horizontal line extending 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 0.73 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 ρ becomes very large, piece rates in cash tend to dominate the other three.

Figure 2 plots the results when θ and p are negatively correlated with a correlation coefficient of $-\sqrt{2}/2$. This corresponds to the case in which farm-level yields are subject to common and idiosyncratic shocks with the same size of variances and the only source of price fluctuation is the common yield shocks. As discussed in the analytical part, contract [4] becomes more attractive due to the low variance of W_4. Figure 2 shows that the area under contract [4] expands in two regions. First, between contract [1] and contract [2], there is a horizontal belt in which contract [4] is chosen. This is a case associated with the corner solution $e_4^* = 0$. Although the expected output is the same among the four contracts, contract [4] is the most preferred because the negative correlation between θ and p gives an

advantage of income risk hedge to contract [4]. When s becomes larger, this advantage is dominated by the advantage of contract [2] so that contract [2] becomes the most preferred one. Another region where contract [4] becomes more attractive is for medium values of ρ. When θ and p are independent, contract [3] was the most preferred one, while contract [4] becomes more attractive when θ and p are negatively correlated because the negative correlation gives an advantage of income risk hedge to contract [4]. When ρ becomes very large, piece rates in cash become the most attractive one as is the case of Figure 1.

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 not satisfied because 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, leading to non-convexity in the parameter space (s, ρ) for contract [3] or [4].

4 Determinants of Contract Choice

4.1 Empirical Strategy

Based on the theoretical model above, determinants of contract choice among the four alternatives are empirically investigated in this section. 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

$$I_{ji} = 1 \quad if \quad I^*_{ji} = h(Z_i) + \epsilon_{ji} > 0, \tag{11}$$

and 0 otherwise, where $h(.)$ is a function determining the latent variable and Z_i are variables in the function. The function $h(.)$ can be derived implicitly from the optimization problem described in the previous section. In this sense, the empirical exercises in this paper are based on a reduced-form approach.

Two specifications are attempted in this paper to characterize the reduced-form function $h(.)$. First, a multinomial logit model covering the four exclusive regimes ($j = 1, 2, 3, 4$) is estimated. The multinomial logit model is specified as

$$Prob(I_{ji} = 1) = \frac{\exp(Z_i\beta_j)}{\sum_{k=2,3,4} \exp(Z_i\beta_k)}, \quad j = 2, 3, 4, \tag{12}$$

where β_j is a vector of coefficients to be estimated, associated with wage contract choice j.[8]

[8] Alternative specifications may include adopting a multinomial probit framework or modeling sequential decision making in which the two parties first choose between in-kind versus cash wages and then choose between time versus incentive wages. Robustness of the estimation results under these specifications is left for a future investigation.

When a coefficient in vector β_j on a particular variable Z^k is positive (negative), it implies that the logarithm of the odds ratio of choosing j over the default contract [1] (time wage in cash) increases (decreases) with Z^k.

Second, as an alternative specification, single-equation probit models are estimated by merging contracts [2] and [4] into a new dummy variable for in-kind wages, and by merging contracts [3] and [4] into a new dummy variable for piece-rate contracts. The probit model is specified as

$$Prob(I_{2i} = 1 \ or \ I_{4i} = 1) = \Phi(Z_i\beta_{kd}), \tag{13}$$

$$Prob(I_{3i} = 1 \ or \ I_{4i} = 1) = \Phi(Z_i\beta_{pr}), \tag{14}$$

where $\Phi(.)$ is the distribution function of a standard normal variable and β are vectors of coefficients to be estimated. Each of the probit models is estimated separately. There are two reasons for attempting the second specification. The first is the functional form of $h(.)$. When the four exclusive regimes are treated simultaneously, the numerical examples in Section 3 have shown that the probability of choosing a contract other than $j = 1$ may be a non-monotonic function of s (the food share in family consumption). Because of this non-convexity, approximating $h(.)$ linearly may not be relevant when all of the four exclusive regimes are analyzed in a multinomial framework. By merging contracts [3] and [4] or contracts [2] and [4], the optimal contract regions shown in Figures 1 and 2 become less non-convex. Another reason for adopting the probit 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 multinomial logit and the single-equation probit models. The first type includes variables characterizing the employee (laborer). As discussed in Section 3, 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 preferences, asset holding, and household size. The second type in vector Z_i includes variables characterizing 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 the 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. In other words, within-village variation of wage contracts

observed for the same crop and for the same farming operation is mainly utilized to identify the model. Since our dataset is incomplete in matching employees' and employers' data, both the employees' and the employers' characteristics are measured as deviation from their village-level means and then the employees' data and the employers' data are pooled. In effect, this brings in an efficiency gain in estimation by imposing the restriction that village, crop, and operation fixed effects are the same regardless of using employees' or employers' data. As a robustness check, the estimation results using employees' data only will be reported additionally.

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 theoretical model. 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 quick completion 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.

4.2 Estimation Results

In order to examine the effect of individual and household characteristics on the wage contract choice, the following variables were tried initially: (1) farmland size (the size of lowland fields managed by the household, the size of upland fields managed by the household, the irrigation status of the land); (2) demographic variables (the size and composition of household members, the sex and age of the household head, main occupation, family type such as extended or nuclear family); (3) education (schooling years of the household head, a dummy representing whether or not the head was educated in a monastery school, the highest education status in schooling years among adult household members); (4) household food security concerns (importance of rice in the family budget,[9] a dummy variable for having had to borrow rice from neighbors for household consumption); and (5) assets (total value of household assets, value of major asset groups, number of major agricultural machines). Since several of these variables were found to be robustly insignificant, they were excluded from the results reported in this paper. See Table 6 for the definition and summary statistics of the retained empirical variables.

The estimation results for the multinomial logit model are reported in Table 7. First, which factors affect the probability of choosing labor contracts paid in fixed amount of food

[9]To control for the endogeneity of s (the food budget share) in the theoretical model, the empirical model employs the value of the annual amount of rice consumption required (age-sex specific rice consumption coefficients times the vector of demographic composition) divided by the expected household income (asset-specific income coefficients times the vector of asset holding) as a proxy for the importance of rice in the family budget. The empirical variable is more exogenous to households' short-run decision making than the observed value of the food budget share.

(contract [2]) against time wages in cash (contract [1])? 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 3). 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 own farm without going to the market. It is found that none of the attributes of the employee is significant in explaining the probability of choosing contract [2] against contract [1].

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

Second, which factors affect the probability of choosing contract [3] (piece rates in cash) against contract [1]? The regression results show that female or more educated workers are more likely to be offered time cash wages rather than piece rates in cash. 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 or tend to work under closer supervision by the farmer so that it is not necessary to give them effort-based incentives.[10] The variable *S_labor* has a significantly negative coefficient. Numerical examples in the theoretical section showed that the direction of the effects of s on the probability of choosing contract [3] is indeterminate, depending on the functional form of $g(e)$ (the welfare cost of effort for the worker). The estimation results show that the effect is negative. This could be due to the fact that piece rates in cash do not contribute much to the improvement of household food security when the food market is highly volatile.

Among the employer's characteristics, 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 contract [3] show that monsoon paddy (refer-

[10]Takahashi (2000) reported that in rural Myanmar, female laborers are tend to work in field plots closer to the farmer's residence while male laborers are tend to work far away from the residence so that more effort-based incentives are required for male laborers.

ence) tends to be cultivated under piece rates more than 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 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). Among operation fixed effects, the coefficient on *Middle* is negative and statistically significant. This seems to imply that 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.

Third, variables representing individual characteristics are not statistically significant in explaining contract [4] (piece rates in kind, or, sharecropping arrangements) against contract [1]. This could be due to the smaller number of observations falling under contract [4]. As a whole, fixed effects in the multinomial logit model were jointly significant at the 1% level.

Because of this indeterminacy for contract [4], the alternative specification of single-equation probit models were estimated and their results are reported in Table 8. The sign and the statistical significance of individual characteristics for the probit model explaining in-kind wages are qualitatively the same as those for the multinomial logit model explaining contract [2]. The worker's landholding decreases the probability of choosing in-kind wages and the worker's food budget share increases the probability of choosing in-kind wages. Similarly, the sign and the statistical significance of individual characteristics for the probit model explaining piece-rate contracts are qualitatively the same as those for the multinomial logit model explaining contract [3]. Workers who are female, educated, and having higher food budget shares are less likely to work under piece-rate contracts while employers who are aged and educated are more likely to employ workers under piece-rate contracts. Fixed effects in both probit models were jointly significant at the 1% level.

In Table 9, 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, the multinomial logit or the probit model was re-estimated using employees' data only, 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 Tables 7 and 8 so that they are not reported. The sign and the statistical significance of individual characteristics are overall consistent with those reported in Tables 7 and 8. In none of the cases, the same variable has statistically significant coefficients with the opposite sign. However, depending on the specification, the positive effect of having a higher rice share in family budget and the negative effect of land assets on

choosing in-kind wages are not statistically significant in several cases. In contrast, the determinants of piece-rate contracts are more robustly estimated, especially the positive effects of the employer's age and education on choosing piece-rate contracts. For education and land, different definitions were also attempted.[11] Results from these models are qualitatively the same as those reported in this paper.

As a different strategy to check the robustness of results regarding the determinants of in-kind contracts, household-level regressions were also attempted. As shown in the theoretical model, whether or not in-kind contracts are adopted depends on household characteristics such as risk aversion and the importance of rice consumption in the family budget. Since the food security should be evaluated at the household level, not at the individual contract level, it could be more meaningful to examine the determinants of the relative importance of in-kind labor at the household level. In other words, the household-level regressions could be a better way to assess the importance of food security concerns in contract choice if we allow for mixed strategy. For these reasons, the manday share of in-kind labor in the total household casual farm labor is regressed on household characteristics and village fixed effects. The main variables of interests are household characteristics corresponding to those adopted in Tables 7-9. In addition to them, demographic characteristics and non-land asset values were included to control for differences in preferences. Crop and operation fixed effects are now dropped since they are endogenous at the household level after aggregating individual contracts defined on one crop and one operation.

Estimation results are reported in Table 10. In the upper portion, the OLS estimation results with robust standard errors are reported, while in the lower portion, the tobit estimation results are reported taking into account of the double censoring at zero and one because the dependent variable is a share. Both the negative effect of land holding and the positive effect of the rice consumption importance are statistically significant in all six specifications. The tobit results indicate that conditional on being strictly positive, the share of in-kind contracts increases with the share of rice consumption with the elasticity of 0.7 to 0.9. In the OLS results, the coefficients are much smaller because of a large number of left censored observations, but their statistical significance levels are similar to those of the tobit results. In the tobit results, the dummy variable for female headed households becomes significantly positive. This can be interpreted as another (although weak) evidence that households' food security concerns affect contract choices because females are usually responsible for family food management in rural Myanmar. Therefore, the household-level regressions give another support for the importance of food security concerns when laborer households choose how

[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.

much labor to sell under each type of wage contracts.

Overall, the regression results are consistent with the theoretical prediction of this paper focusing on effort enforcement, incentives, and food security. Therefore, one of the reasons for finding no inefficiency of casual labor in crop production (Table 4) could be attributable to the 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 problems.

One caveat of the contract choice analysis above is that endogenous matching is not controlled for. If the multinomial logit or the probit model 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 regression gives consistent estimates for β_j, β_{pr}, or β_{kd}. Instead, if some of the variables that determine the matching are omitted or there exists inherent, unobservable heterogeneity (endogenous matching), then the estimates for β are inconsistent. To avoid the bias due to endogenous matching through the instrumental variables estimation (Ackerberg and Botticini 2002), variables that affect the matching equation but do not affect the contract choice are necessary. Unfortunately, our dataset does not contain instruments that satisfy this condition.

5 Conclusion

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 (agent), possibly due to poverty, and food markets are thin, the employer (principal) prefers a contract with wages paid in kind (food) to labor contracts paid in cash. At the same time, when output is more responsive to workers' efforts and the employer has less ability to enforce workers' efforts, the employer prefers a contract with piece-rate wages 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 indicated a possibly non-monotonic relationship between the optimal contract choice and parameters determining the food security and moral hazard concerns.

These predictions of the theoretical model were tested using a cross section dataset collected from a sample household survey conducted in 2001 covering diverse agro-ecological environments in Myanmar. The estimation results of multinomial logit and probit models

at the individual contract level and OLS and tobit models at the household level 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 of which are characteristics of poverty in the study region and associated with higher food security concern. Piece-rate wages are more likely to be adopted when workers are male and uneducated, who are more likely to work under conditions where the enforcement of efforts is difficult and who are more likely to have comparative advantage in physical work that requires quick completion. Piece-rate wages are more likely to be adopted when employers are aged and educated as well. 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 predictions. Selection into contracts thus could be one of the reasons for finding no adverse effects of casual labor on farm productivity when production functions were estimated using the same dataset.

The regression results reported in this paper are based on a reduced-form approach, so that the non-monotonic relationship of the optimal contract choice is not well incorporated. Simulation-based econometrics, in which the structural model of optimization is re-produced numerically and their structural parameters are estimated, may be required to incorporate such non-linearity in a rigorous way.[12] As a further extension, intra-household interaction among family members and among work opportunities need to be incorporated in the theoretical model, since the interaction *de facto* allows the contract mix. Another issue that was not examined in this paper is the contract selection for permanent labor. The production function estimates showed no adverse effect (or favorable effect if any) of permanent labor on farm productivity. The speculation of this paper is that the contract choice based on kinship and reputation increases the production incentive for permanent laborers in Myanmar. Testing this speculation and then re-estimatng the production function controlling for the endogeneity of contract choice are interesting research agendas. These are 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.

Appendix: Detail of the Numerical Model

The principal's production function is specified as

$$f(e) = A(1+e)^{\rho}, \tag{15}$$

where A (a positive parameter determining the productivity) is set at 5 and ρ (a non-negative parameter that characterizes the effort elasticity of output) is parametrically changed in the range from zero to 0.50. $1+e$ is interpreted as the total effort, 1 is the minimum effort, and e is the additional effort.

The distribution of food price p is assumed to be a symmetric binomial[13] with eleven nodes,[14] mean of one, and the coefficient of variation of 0.25. The distribution of output risk θ is also assumed to be a symmetric binomial with eleven nodes, mean of one, and the coefficient of variation of 0.10. The correlation between p and θ is parametrically changed. We first simulate the case when p and θ are independent (no common yield shocks so that the price fluctuates due to demand side shocks only). Then we simulate the case when p and θ are completely negatively correlated (no idiosyncratic yield shocks and the only source of price fluctuation is from the supply side). By taking the weighted average of the two, we can simulate plausible cases in the context of developing countries, where both idiosyncratic and common yield shocks are important. When the weight is 0.5, we can simulate a case in which farm-level yields are subject to common and idiosyncratic shocks with the same size of variances and the only source of price fluctuation is the common yield shocks. The correlation coefficient for this case is $-\sqrt{2}/2$ (Figure 2).

The indirect utility function in the agent's payoff function is specified with the linear expenditure system

$$v(y,p) = \frac{1}{1-\phi}\left(\frac{y-p\gamma}{p^{\beta}}\right)^{1-\phi}, \tag{16}$$

where ϕ is a positive parameter determining the risk aversion,[15] γ is a subsistence need for the food, and β is the marginal propensity to spend on the food after meeting the subsistence need. For simplicity, the subsistence need for the non-food is set at zero. In the simulation, ϕ is parametrically changed in the range from 1.1 and 4,[16] β is assumed to be the same as γ to reduce the dimension of the space of parameter changes, and γ is parametrically changed

[13] Note that binomial distribution can be interpreted as an approximation of normal distribution.

[14] To avoid extreme values of the food price that leads to a case in which the subsistence food value is larger than the worker's income, the number of nodes cannot be large as long as a binomial distribution is adopted. The simulation results reported in this paper were found insensitive when we decline the number of nodes, when we change the probability values of each node marginally, or when we replace the symmetric binomial distribution by a triangle distribution.

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

[16] This range assures $v_{pp} < 0$ for all values of γ used in the simulation.

in the range from 0.05 to 0.60. For each value of γ, s (the budget share of the food) is calculated as $s = 2\gamma - \gamma^2$ when it is evaluated at the mean price under contract [1].

Finally, the welfare cost of effort for the worker, $g(e)$ is specified as $g(e) = \gamma e$. The linear form is adopted for simplicity. Since we parametrically change the values of γ and β, function g needs to be measured in a unit comparable to these values. If $g(e) = e$, we implicitly reduce the welfare cost of effort when we parametrically increase γ, giving undue advantage of contract [3] over [1]. The indifference curve between contract [1] and [3] in Figure 1 becomes highly negatively sloped when $g(e) = e$, which is the opposite of the regression result that the probability of choosing contract [3] is negatively correlated with a proxy for s. To avoid the highly negative slope between s and the indifference curve between contracts [1] and [3], we adopt the specification $g(e) = \gamma e$.

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 the inner loop is solved in the next outer loop. This part is solved by MINOS non-linear optimization solver in GAMS.[17] In the last outer loop, the contract that brings the highest u_j^P is chosen.

[17]The GAMS program file is available on request. GAMS software is available at http://www.gams.com/.

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Table 1: Survey Villages

Name	Division (D.)/ State (S.)	Township	Village tract	Topology	Irrigation	Major crops
DELTA1	Ayeyarwady D.	Myaungmya	Kyonethout	Deltaic agric.	Pump	Paddy
DELTA2	Bago D.	Waw	Acarick	Deltaic agric.	Rainfed, Canal	Paddy, pulses
DRY1	Mandalay D.	Kyaukse	Pyiban	Dry zone	Canal	Paddy, vegetables
DRY2	Magway D.	Magway	Kanpyar	Dry zone	Rainfed	Upland crops
DRY3	Magway D.	Taungdwingyi	Wetkathay	Dry zone	Rainfed, Tank	Upland crops, paddy
HILL1	Shan S.	Nyaungshwe	Linkin	Hilly region	Rainfed	Vegetables, paddy, sugarcane
HILL2	Shan S.	Kalaw	Myinmahti	Hilly region	Rainfed	Vegetables, paddy
COAST	Tanintharyi D.	Myeik	Engamaw	Coastal agric.	Rainfed	Paddy, rubber

Source: Authors' survey (ibid. for the tables below).

Table 2: Sample Households

Village	Number of sample households			Number of household members included in the sample households		
	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)	Total current value of production assets* (1000 Kyats)	Household income (Kyats)		Composition of income sources (%)			
			Average of total household income	Average of per-capita household income	Self-employment income from agriculture	Agricultural wage income (casual)	Agricultural wage income (permanent)	Non-agricultural income
By village								
DELTA1	5.97	218.2	134,535	30,065	61.5	12.6	2.3	23.6
DELTA2	7.17	207.8	155,423	29,745	57.3	14.0	10.7	18.0
DRY1	3.32	232.7	209,661	49,378	61.3	11.1	0.8	26.8
DRY2	6.13	282.0	216,482	43,975	69.0	10.4	0.0	20.6
DRY3	6.06	188.5	87,591	17,084	60.5	25.9	3.4	10.2
HILL1	7.06	225.7	194,807	36,447	53.9	22.7	0.0	23.4
HILL2	3.92	172.9	169,477	32,147	70.2	11.7	0.0	18.1
COAST	5.81	579.0	314,478	44,547	33.8	8.6	1.1	56.4
By household type								
Farm households	8.56	378.6	207,981	39,337	73.6	5.0	0.1	21.2
Non-farm households	0.01	38.1	138,819	30,191	5.6	34.4	9.5	50.4
Total	5.62	261.0	184,086	36,177	55.9	12.7	2.6	28.8

Notes:

* The sum of the values of livestock, agricultural equipment and machinery, and transportation equipment. Among livestock, cattle is the most important whose average number per household is 1.70. Among transportation equipment, bullock cart and bicycle are the most important (the average number is 0.41 and 0.47, respectively).

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	-0.048	(0.035)	-0.094 *	(0.049)	-0.230 ***	(0.087)	-0.284 **	(0.113)
Labor in mandays	0.039	(0.063)	0.063	(0.077)	0.136 **	(0.058)	0.242 ***	(0.078)
Animal in days	0.028	(0.032)	0.036	(0.045)	-0.024	(0.075)	0.001	(0.088)
Machinery in hours	0.008	(0.029)	0.001	(0.037)	0.181 ***	(0.058)	0.257 ***	(0.075)
Current input in kyats	0.235 ***	(0.049)			0.326 ***	(0.063)		
Household head's schooling y	0.020 *	(0.011)	0.041 ***	(0.012)	0.067 ***	(0.024)	0.120 ***	(0.037)
Hired labor share								
Permanent labor	0.013	(0.244)	0.475 ***	(0.172)	0.993 ***	(0.375)	1.256 **	(0.514)
Casual labor	0.139	(0.091)	0.252 **	(0.127)	-0.283	(0.244)	-0.452	(0.364)
Crop fixed effect								
Summer paddy	0.143 **	(0.072)	0.100	(0.093)				
Upland paddy	-0.456 *	(0.258)	-1.601 ***	(0.294)				
Pulses					-0.334	(0.261)	-0.335	(0.385)
Oilseed					0.288	(0.249)	0.522	(0.324)
Industrial crops					1.251 ***	(0.363)	1.676 ***	(0.426)
Rubber					0.500	(0.577)	1.529 ***	(0.558)
Vegetables					0.966 ***	(0.324)	1.629 ***	(0.440)
Other crops					1.204 ***	(0.405)	1.177 ***	(0.390)
Village fixed effect								
DELTA1	-0.063	(0.189)	-0.251	(0.251)				
DELTA2	-0.049	(0.223)	-0.172	(0.278)	1.070 ***	(0.341)	1.287 ***	(0.478)
DRY1	0.190	(0.194)	0.103	(0.251)	0.215	(0.287)	-0.172	(0.381)
DRY2					0.618 **	(0.274)	0.737 **	(0.371)
DRY3	-0.853 ***	(0.325)	-0.634 *	(0.356)	0.104	(0.304)	-0.026	(0.424)
HILL2	-0.476 *	(0.275)	-0.313	(0.282)	0.206	(0.310)	-0.104	(0.493)
COAST	0.268	(0.204)	0.142	(0.277)	0.149	(0.466)	-0.998 ***	(0.352)
Intercept	7.634 ***	(0.515)	9.249 ***	(0.415)	6.087 ***	(0.523)	7.757 ***	(0.434)
Number of observations	316		303		198		190	
F stat for zero slope	23.56		10.49		24.66		14.28	
R-squared	0.531		0.367		0.739		0.574	

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: Explanatory Variables Used for the Determinants of Contract Choice

Variable	Definition		Mean	Std. Dev.	Min	Max
Individual and household characteristics						
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 consumption required (age-sex specific rice consumption coefficients times the vector of demographic composition)" divided by "the expected household income (asset-specific income coefficients times the vector of asset holding)". When it is larger than unity, the value was truncated at one.		0.463	0.221	0.073	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 including those overlapping different stages.	#	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 (Multinomial Logit Estimation Results)

Reference= [1] Time wage in cash	[2] Time wage in kind		[3] Piece rate in cash		[4] Piece rate in kind	
	Coeff	Std. Err	Coeff	Std. Err	Coeff	Std. Err
Individual and household characteristics#						
Female_labor	-0.1824	(0.498)	-0.5405 *	(0.284)	0.0045	(1.260)
Educ_labor	-0.0029	(0.084)	-0.0920 **	(0.042)	-0.1359	(0.191)
Land_labor	-0.1266 *	(0.077)	0.0224	(0.029)	-0.1064	(0.219)
S_labor	1.5135 *	(0.855)	-1.4830 ***	(0.482)	-0.1148	(1.983)
Age_farmer	0.0058	(0.011)	0.0123 ***	(0.005)	0.0257	(0.017)
Educ_farmer	0.0159	(0.074)	0.0475 **	(0.021)	0.0104	(0.090)
Village fixed effects						
DELTA1	-33.4590 ***	(0.970)	-0.8493 ***	(0.178)	-14.4234 ***	(1.531)
DRY1	3.9348 ***	(1.013)	0.1161	(0.195)	23.8845 ***	(1.603)
DRY2	3.8094	(2.622)	-0.0336	(0.301)	22.3602 ***	(1.762)
DRY3	1.1924	(1.420)	-0.4798 *	(0.259)	-12.6052 ***	(1.780)
HILL1	4.5500 ***	(1.072)	-1.9606 ***	(0.361)	22.4905 ***	(2.189)
HILL2	5.2942 ***	(1.070)	-1.3390 ***	(0.405)	-12.2369 ***	(1.808)
COAST	5.0412 ***	(1.056)	-0.9354 **	(0.457)	23.5516 ***	(1.618)
Crop fixed effects						
Summer paddy	-0.5101	(0.376)	0.1824	(0.136)	-1.1881 **	(0.459)
Upland paddy	1.4412 **	(0.641)	-0.0977	(1.223)	-15.5435	.
Cereals	-36.0312 ***	(0.481)	-0.2895	(0.570)	-33.9780 ***	(0.875)
Pulses	-2.9662	(2.011)	-0.3292	(0.274)	-33.9907 ***	(0.546)
Oilseed	-4.0068 ***	(0.780)	-0.7141 ***	(0.230)	-35.0729 ***	(0.369)
Industrial crops	-35.7458 ***	(0.441)	0.1756	(0.544)	-34.9096 ***	(0.654)
Rubber	-35.9595 ***	(0.757)	0.9623	(0.760)	-35.3865 ***	(0.851)
Vegetables	-35.6362 ***	(0.327)	-1.1159 ***	(0.251)	-35.0691 ***	(0.429)
Other crops	-35.9684 ***	(0.479)	-0.1909	(0.812)	-34.7374 ***	(0.680)
Operation fixed effects						
Planting	-2.0923 **	(0.923)	0.8040 *	(0.441)	-2.8543 *	(1.468)
Middle	-34.5102 ***	(0.940)	-0.6823	(0.466)	-32.9904 ***	(1.043)
Harvest	0.3034	(0.851)	0.3791	(0.442)	2.0539 **	(1.035)
Intercept	-4.9351 ***	(1.249)	-1.8342 ***	(0.477)	-25.8261	.
Pseudo R2	0.324					
Log likelihood	-1298.6					

Notes: # Deviations from the village means were employed in the regression.
(1) Estimated by a multinomial logit model with Huber-White heteroscedastic robust standard errors (in parentheses). Significant at 1% (***), 5% (**), and 10% (*).
(2) Reference for fixed effects: DELTA2, Monsoon paddy, and Other operations. See Table 6 for the list of dummy variables.
(3) The number of observations used was 3100.

Table 8: Determinants of Contract Choices (Probit Estimation Results)

	[2] or [4] (in-kind wages)			[3] or [4] (piece-rate wages)		
	Coeff	Std. Err	dF/dx	Coeff	Std. Err	dF/dx
Individual and household characteristics						
Female_labor	0.1087	(0.272)	0.0016	-0.2238 *	(0.128)	-0.0420
Educ_labor	-0.0309	(0.043)	-0.0005	-0.0444 **	(0.022)	-0.0083
Land_labor	-0.0744 *	(0.045)	-0.0011	0.0093	(0.014)	0.0017
S_labor	0.9363 **	(0.453)	0.0141	-0.6213 ***	(0.228)	-0.1167
Age_farmer	0.0065	(0.005)	0.0001	0.0084 ***	(0.002)	0.0016
Educ_farmer	0.0022	(0.030)	0.0000	0.0273 **	(0.012)	0.0051
Village fixed effects						
DELTA1		#		-0.4507 ***	(0.099)	-0.0720
DRY1	2.3072 ***	(0.320)	0.2108	0.2637 **	(0.105)	0.0543
DRY2	1.8537 *	(0.979)	0.1638	0.1355	(0.159)	0.0271
DRY3	0.3538	(0.510)	0.0074	-0.1878	(0.138)	-0.0322
HILL1	2.4145 ***	(0.389)	0.3490	-0.8232 ***	(0.171)	-0.1039
HILL2	2.5145 ***	(0.386)	0.4346	-0.5862 ***	(0.203)	-0.0792
COAST	2.8013 ***	(0.359)	0.5385	-0.1344	(0.193)	-0.0234
Crop fixed effects						
Summer paddy	-0.4884 ***	(0.168)	-0.0053	0.0036	(0.078)	0.0007
Upland paddy	0.9205 ***	(0.353)	0.0446	-0.4927	(0.559)	-0.0674
Cereals		#		-0.3243	(0.295)	-0.0498
Pulses	-1.4906 *	(0.810)	-0.0090	-0.2964 **	(0.143)	-0.0476
Oilseed	-2.2095 ***	(0.302)	-0.0182	-0.4987 ***	(0.129)	-0.0752
Industrial crops		#		-0.0786	(0.268)	-0.0141
Rubber		#		0.0983	(0.360)	0.0196
Vegetables		#		-0.7002 ***	(0.125)	-0.0955
Other crops		#		-0.3336	(0.370)	-0.0509
Operation fixed effects						
Planting	-1.2576 ***	(0.401)	-0.0209	0.2714	(0.214)	0.0536
Middle		#		-0.4766 **	(0.227)	-0.0745
Harvest	0.5302	(0.383)	0.0081	0.1794	(0.215)	0.0343
Intercept	-2.6446	(0.501)		-0.8529 ***	(0.236)	
Wald chi2stat for zero slope	327.2 ***			375.1 ***		
Pseudo R2	0.495			0.204		
Log likelihood	-225.3			-1109.4		

Notes: See Table 7.

The number of observations used was 3100 in the second model for the piece-rate wages. In the first model for the in-kind wages, 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 1445.

Table 9: Determinants of Contract Choices (robustness check)

Multinomial logit estimation	[2] Time wage in kind		[3] Piece rate in cash		[4] Piece rate in kind	
	Coeff	Std. Err	Coeff	Std. Err	Coeff	Std. Err
Weighted regression using "Mandays"						
Female_labor	0.1921	(0.513)	-1.0712 ***	(0.344)	-4.3749 **	(2.159)
Educ_labor	-0.0257	(0.110)	-0.1296 **	(0.051)	0.3845 *	(0.217)
Land_labor	-0.1693 *	(0.092)	0.0573	(0.036)	-0.8995	(0.945)
S_labor	1.6820 *	(1.008)	-1.5505 *	(0.789)	-7.9269 **	(3.766)
Age_farmer	0.0017	(0.014)	0.0159 **	(0.007)	0.0024	(0.022)
Educ_farmer	-0.0803	(0.110)	0.0602 *	(0.033)	-0.1163	(0.092)
Weighted regression using "Kyats"						
Female_labor	0.3223	(0.527)	-0.9465 **	(0.405)	-2.0130	(2.259)
Educ_labor	0.0318	(0.107)	-0.1523 ***	(0.057)	0.1502	(0.276)
Land_labor	-0.1209	(0.090)	0.0739 *	(0.038)	-0.4270	(0.388)
S_labor	1.2118	(0.983)	-0.4422	(0.990)	-4.2599	(4.064)
Age_farmer	-0.0016	(0.015)	0.0221 ***	(0.008)	0.0121	(0.021)
Educ_farmer	-0.0140	(0.115)	0.0758 **	(0.033)	-0.0675	(0.087)
Regression using only employees' data						
Female_labor	0.0425	(0.484)	-0.4599	(0.291)	-0.7677	(1.382)
Educ_labor	0.0040	(0.086)	-0.0160	(0.049)	0.0081	(0.247)
Land_labor	-0.1159	(0.074)	0.0098	(0.031)	-0.2342	(0.173)
S_labor	1.8266 **	(0.881)	-0.4976	(0.601)	3.2966	(2.261)

Probit estimation	[2] or [4] (in-kind wages)			[3] or [4] (piece-rate wages)		
	Coeff	Std. Err	dF/dx	Coeff	Std. Err	dF/dx
Weighted regression using "Mandays"						
Female_labor	0.0822	(0.339)	0.0004	-0.5291 ***	(0.147)	-0.0841
Educ_labor	0.0098	(0.057)	0.0001	-0.0432	(0.027)	-0.0069
Land_labor	-0.0859	(0.056)	-0.0005	0.0247	(0.019)	0.0039
S_labor	0.5223	(0.602)	0.0028	-0.7277 **	(0.359)	-0.1156
Age_farmer	0.0042	(0.007)	0.0000	0.0095 ***	(0.004)	0.0015
Educ_farmer	-0.0483	(0.038)	-0.0003	0.0366 **	(0.018)	0.0058
Weighted regression using "Kyats"						
Female_labor	0.3062	(0.319)	0.0059	-0.5144 ***	(0.164)	-0.1032
Educ_labor	0.0118	(0.059)	0.0002	-0.0615 **	(0.030)	-0.0123
Land_labor	-0.0647	(0.055)	-0.0012	0.0356 *	(0.020)	0.0072
S_labor	0.4684	(0.582)	0.0090	-0.1979	(0.428)	-0.0397
Age_farmer	0.0041	(0.007)	0.0001	0.0130 ***	(0.004)	0.0026
Educ_farmer	-0.0263	(0.041)	-0.0005	0.0419 **	(0.018)	0.0084
Regression using only employees' data						
Female_labor	0.0616	(0.241)	0.0002	-0.1883 *	(0.107)	-0.0186
Educ_labor	-0.0025	(0.044)	-0.0001	-0.0029	(0.024)	-0.0003
Land_labor	-0.0750 *	(0.040)	-0.0002	0.0011	(0.015)	0.0001
S_labor	1.1518 ***	(0.454)	0.0038	-0.1300	(0.256)	-0.0129

Note: Only results for individual and household attributes are reported in this table. All specifications included village, crop, and operation fixed effects as in Tables 7-8 and they were jointly significant at 1%.

Table 10: Determinants of the Manday Share of In-Kind Labor in the Total Household Casual Farm Labor

	Weighted by the number of contracts per		Weighted by the working mandays per household		Weighted by the earning in kyats per household	
	Coeff	Std. Err	Coeff	Std. Err	Coeff	Std. Err
Estimated by OLS						
Household characteristics corresponding to Tables 7-9 #						
Female_labor ##	-0.0006	(0.013)	0.0041	(0.023)	0.0006	(0.014)
Educ_labor ##	0.0019	(0.002)	0.0040	(0.003)	0.0023	(0.002)
Land_labor	-0.0029 **	(0.001)	-0.0029 **	(0.001)	-0.0020 *	(0.001)
S_labor	0.0923 **	(0.037)	0.1474 **	(0.058)	0.1007 **	(0.041)
Additional household characteristics #						
No. of male children	0.0010	(0.006)	0.0087	(0.007)	0.0018	(0.006)
No. of male adults	-0.0039	(0.008)	-0.0149 *	(0.009)	-0.0075	(0.008)
No. of female children	-0.0076	(0.006)	-0.0142 *	(0.008)	-0.0100	(0.007)
No. of female adults	0.0101	(0.008)	0.0136	(0.009)	0.0120	(0.009)
Non-land household assets (in million kyats)	0.1348	(0.107)	0.2377	(0.192)	0.1747	(0.119)
Age of head	0.0002	(0.000)	0.0002	(0.001)	-0.0001	(0.000)
Village fixed effects						
DRY1	0.0408 ***	(0.014)	0.0650 ***	(0.019)	0.0235 **	(0.010)
DRY2	0.0005	(0.009)	0.0082	(0.014)	0.0030	(0.010)
DRY3	0.0004	(0.007)	-0.0024	(0.008)	-0.0023	(0.006)
HILL1	0.0479 ***	(0.016)	0.0519 ***	(0.019)	0.0434 ***	(0.017)
HILL2	0.0762 ***	(0.022)	0.1151 ***	(0.037)	0.1039 ***	(0.036)
COAST	0.1305 **	(0.059)	0.1247 **	(0.057)	0.1254 **	(0.059)
Intercept	0.0038	(0.005)	0.0034	(0.005)	0.0033	(0.004)
F(16,202)	2.78 ***		2.53 ***		2.20 ***	
R-squared	0.175		0.204		0.181	
Estimated by Double Censored Tobit						
Household characteristics corresponding to Tables 7-9 #						
Female_labor ##	0.4080 **	(0.173)	0.5029 **	(0.202)	0.4270 **	(0.176)
Educ_labor ##	0.0064	(0.015)	0.0114	(0.017)	0.0071	(0.015)
Land_labor	-0.0851 ***	(0.027)	-0.0968 ***	(0.031)	-0.0802 ***	(0.026)
S_labor	0.7249 **	(0.342)	0.9372 **	(0.394)	0.7351 **	(0.342)
Additional household characteristics #						
No. of male children	-0.0121	(0.047)	0.0012	(0.055)	-0.0070	(0.047)
No. of male adults	0.0107	(0.057)	-0.0187	(0.067)	-0.0020	(0.057)
No. of female children	-0.0382	(0.042)	-0.0572	(0.049)	-0.0397	(0.042)
No. of female adults	0.0493	(0.045)	0.0606	(0.052)	0.0592	(0.045)
Non-land hh. assets	0.6670	(0.687)	0.9473	(0.788)	0.7185	(0.685)
Age of head	-0.0012	(0.005)	-0.0014	(0.006)	-0.0021	(0.005)
Village fixed effects (not reported: individually and jointly significant with the same signs as the OLS results)						
chi2(16)	72.70 ***		76.97 ***		73.31 ***	
Pseudo R2	0.391		0.388		0.398	
Log likelihood	-56.73		-60.71		-55.51	

Notes: # Deviations from the village means were employed in the regression.
In Tables 7-9, they were characteristics of the worker involved while these variables in this table are characteristics of the head of the laborer household.
(1) The number of observations used was 219 (sample households in village DELTA1were not included since no in-kind wage was observed). Out of 219, 184 are left censored at zero and 4 are right censored at one.

Figure 1: Optimal Contract Choice (phi=3, theta and p independent)

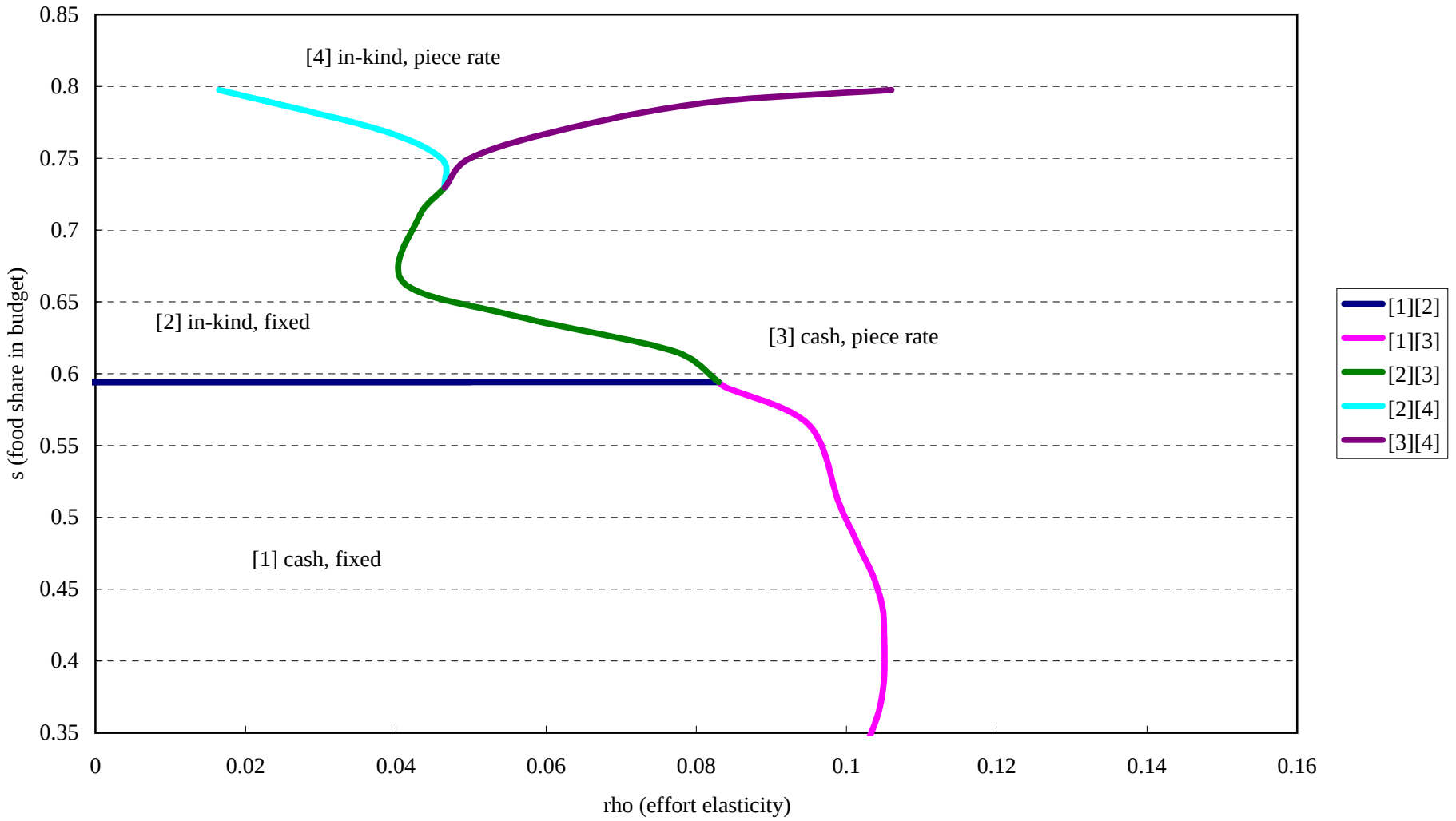

Figure 2: Optimal Contract Choice (phi=3, theta and p are negatively correlated with -1/sqrt(2) correlation coeff)