Discussion Paper Series

No.134

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January 2006

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A 21st-Century COE Program

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Abstract

This paper develops an agency model of contract choice in the hiring of labor and then uses the model to estimate the determinants of contract choice in rural Myanmar. As a salient feature relevant for the agricultural sector in a low income country such as Myanmar, the agency model incorporates considerations of food security and incentive effects. It is shown that when, possibly due to poverty, food considerations are important for employees, employers will prefer a labor contract with wages paid in kind (food) to one with wages paid in cash. At the same time, when output is responsive to workers' effort and labor monitoring is costly, employers will prefer a contract with piece-rate wages to one with hourly wages. The case of sharecropping can be understood as a combination of the two: a labor contract with piece-rate wages paid in kind. The predictions of the theoretical model are tested using a cross-section dataset collected in rural Myanmar through a sample household survey which was conducted in 2001 and covers diverse agro-ecological environments. The estimation results are consistent with the theoretical predictions: wages are more likely to be paid in kind when the share of staple food in workers' budget is higher and the farmland on which they produce food themselves is smaller; piece-rate wages are more likely to be adopted when work effort is more difficult to monitor and the farming operation requires quick completion.

JEL classification codes: J33, Q12, O12.

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

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*The author is grateful to Sonia Laszlo, Yasu Sawada, Kei Kajisa, Akio Takahashi, Yutaka Arimoto, Tomohiro Machikita, and other seminar participants at the Northeast Universities Development Consortium Conference, the Japanese Economic Association Annual Meeting, the Japan Agricultural Economics Association General Meeting, the microeconomics research seminar at the University of Tokyo, and the economics research seminar at Hitotsubashi University for useful comments on earlier versions of this paper.

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1 Introduction

Both in developed and developing countries, firms and farms rely on a variety of compensation policies when employing workers. But what determines which policy is chosen and how does the choice of compensation policy affect the efficiency and equity of labor transactions? This is a question that has been discussed intensively in the fields of labor economics and development economics, both because of the theoretical interest in modeling this issue and because of its practical importance for designing optimal contracts. Especially in development economics, the practice of sharecropping, a contract in which landlords transfer land-use rights to tenants in exchange for land rent paid as a fixed share of output, has been investigated in detail (see, for example, Arimoto, 2005; Agrawal, 1999; Hayami and Otsuka, 1993; Eswaran and Kotwal, 1985). Sharecropping tenancy can be understood as a mechanism to control for 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 where incomes are low, production risks high, and markets for credit and insurance underdeveloped.

Yet, while the theoretical literature is vast, the number of empirical studies on the efficiency of resource allocation and the determinants of contract choice is small (see the review by Chiappori and Salanie, 2003). The number of empirical studies on the existence of different compensation policies for hired workers in developing countries is especially small.[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 the disincentive effects of the contract (workers choose a low effort due to the contract design) or it could reflect the selection mechanism (only less able workers are attracted to the contract).

This paper therefore develops an agency model of contract choice in the hiring of agricultural labor and then uses the model to estimate the determinants of the choice, considering the case of Myanmar (formerly Burma). As a salient feature relevant for the agricultural sector in a low income country such as Myanmar, the agency model incorporates considerations of food security as well as incentive effects. The model is motivated by findings and data obtained from field surveys in rural Myanmar that were conducted in 2001 and cover diverse

[1] Among the few existing studies, Foster and Rosenzweig (1994) demonstrated that in rural India, the level of moral hazard differed depending on the type of labor contract, i.e. whether it consisted of on-farm employment (family labor), a piece-rate payment scheme, a share-tenancy contract, or a time-wage payment scheme; Fukui (1995) investigated the efficiency of permanent labor contracts in the Philippines where compensation consisted of piece-rate wages paid in kind. Datta et al. (2004) investigated the mechanisms responsible for the co-existence of both cash and in-kind wages in rural India.

agro-ecological environments. Unique features of the dataset are, first, that various kinds of compensation policies are observed, and second, that 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 range of categories including 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 as well as the contrast between time and piece-rate wages can be analyzed. The second feature of the dataset enables us to examine the dyadic determinants of contract choice.

This paper is the first attempt to provide a model of worker compensation that takes both food security and incentive structures into account. The incorporation of food security considerations is important because in a low-income country like Myanmar, rural dwellers' food security is greatly affected by fluctuations in the availability and prices of food as a result of underdeveloped produce markets and the susceptibility of agricultural production to weather shocks. As shown by Kurosaki and Fafchamps (2002), Kurosaki (1998), Fafchamps (1992), and Finkelshtain and Chalfant (1991), food security considerations are likely to affect farmers' portfolio choice and input decisions in agricultural production. Unlike firms, which do not have such considerations, risk-averse farmers may increase the production of a more risky crop if the crop yields food that is important in their consumption. Adjustments in production choices are not the only way to improve food security, however. Another possibility to achieve food security is through adjustments in the way workers' are compensated. The purpose of this paper is thus to provide a comprehensive analysis of the determinants of contract choice, incorporating both food security issues (such as risk aversion, the variability of income, the ability to cope with income risk, and the importance of the basic food in budgets) and moral hazard issues (such as the ease of supervision and enforcement).

The paper is organized as follows. Section 2 provides some background information on Myanmar's economy and agricultural policies and describes the dataset used in this study. The section also estimates a production function and the results produce no evidence suggesting that hired labor is inefficient. This result does not necessarily mean that there are no moral hazard problems; instead, it may indicate that institutional arrangements in labor markets in the study region are effective in preventing moral hazard from occurring. In order to show that the institutional arrangements can serve such a role, Section 3 develops an agency model of wage contract choice. Based on the agency model, Section 4 analyzes the determinants of wage types by estimating reduced-form models. Section 5 concludes.

2 Background and Data

2.1 Myanmar's Economy and Agricultural Policies

Myanmar, which has a population close to 50 million, is in transition from a planned to a market economy (Thein, 2004). The military government that has been in power since 1988 has deregulated various economic activities. Industrial development is in progress, but 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 national consumption expenditure (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, 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 investment in irrigation. 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 led to low incomes for farmers in the late 1990s and the early 2000s because the production of paddy became non-profitable due to repressed domestic prices for paddy resulting from the government monopoly of rice export (Kurosaki, 2005). Furthermore, rural dwellers, especially in rice-deficit regions, continued to suffer from unstable supplies because of inconsistencies and frequent changes in agricultural policies. Thus, in spite of increased rice production at the national level, low income farmers or farmers in rice-deficit regions still have reason to be concerned about 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 the land reforms in the 1950s, land tillage rights were 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 agricultural wages for their income, and their income and wealth are substantially lower than those of landed households. Because of their poverty and dependence on farmers, the landless may from time to time be unable to secure sufficient food for subsistence. Therefore, food security is a real and urgent concern for landless workers in rural Myanmar.

2.2 Characteristics of Sample Villages and Households

Micro data on Myanmar's rural economy are scarce. We therefore conducted a survey of sample households in eight selected villages in June-October 2001 (Map 1). The characteristics of the villages are shown in Table 1.[2]

The first two villages (DELTA1 and DELTA 2) are located in the delta regions of lower Myanmar, which produces surplus rice for export, 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 whose economy relies on growing vegetables for market. 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 are representative of each region. As far as can be judged by the statistics on cropping patterns and land distribution, this aim was achieved. The sample households were drawn from a complete list of households in each of the villages studied. While the selected households are not strictly a random sample, we used information obtained from village leaders and local administrations to eliminate discretionary elements, so that the sample households 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 and their distribution is shown in Table 2. The 341 households denoted in the table as "Farm" households had land tillage rights, while the 180 denoted as "Non-farm" households had no tillage rights.

A structured questionnaire was used for all households to establish household character-

[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 brevity.

istics, household assets, income, consumption, and debt and credit. The sample households include 2,850 persons, implying that the average household size was 5.5 persons. If households operated farmland, they were asked additional questions 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 size of farm households' land holding was 8.6 acres, which is large by South-East Asian standards. Ownership of modern assets was not widespread: none of the households owned a four-wheel tractor; bicycles were common among villagers but motorcycles and four-wheel vehicles for transportation were very rare; TVs or VCRs were also very rare. Livestock represented the main form of assets. Comparing different household types, non-farm households had fewer total assets than 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

In rural Myanmar, two kinds of agricultural laborers can be found and they play different roles (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 like family workers are responsible for various farm operations. Following the literature on rural institutions, they will be labeled *permanent laborers* below. Thus, total farm labor can be decomposed into three categories: labor by unpaid family members of farm households, casual labor, and permanent labor.

The average share of income from casual farm labor in the earned income of all sample households is 12.7%, while the share of income from permanent farm labor is 2.6% (Table 3). Farm households which usually employ casual and permanent laborers sometimes also send family members to farm wage work. The share of casual farm labor in the income of farm households is 5.0% and that of permanent labor is 0.1%. In contrast, the income share of farm wages is higher among non-farm households: 34.4% (casual labor) and 9.5% (permanent labor).

In studies on rural development in Asia, it is often argued that in South Asia, hired labor is less efficient than family labor so that the productivity of large farms is lower than that of small farms. On the other hand, such inefficiency is rarely found in South-East Asia (Hayami and Otsuka, 1993; Fukui, 1995). Especially in South-East Asia, even small farms with surplus family labor employ casual labor for harvesting. This phenomenon is interpreted as income sharing, i.e., farmers redistribute their income to poor laborers through employing more harvesting workers (Hayami and Kikuchi, 1999). The absence of inefficiency regarding hired labor in South-East Asia could be attributable to this norm of income sharing. In Myanmar, some of the rural institutions are similar to those in South Asia, while others are more similar to those in South-East Asia (Takahashi, 2000). Evidence on the efficiency of hired labor in rural Myanmar is, however, lacking.

To investigate whether our dataset contains evidence that hired labor is inefficient, production functions are estimated. As one of the production factors, total labor (the sum of family, casual, and permanent labor in man-days) is included. As productivity shifters, the share of casual labor in total labor and the share of permanent labor in total labor are added. If the three types of labor are perfect substitutes and there is no productivity difference among them, the share of casual (permanent) labor should have a zero coefficient. On the other hand, if the coefficient turns out to be significantly negative, this would be an indication of inefficiency. From the field survey results, 518 observations of farm-level production were obtained for various crops. Since the farming techniques for paddy crops are fundamentally different from those for non-paddy crops, separate production functions are estimated for paddy and non-paddy crops. Village and crop fixed effects are introduced into the regression to control for differences in market and production environments.

The ordinary least squares (OLS) estimation results based on a Cobb-Douglas specification are reported in Table 4. The elasticity parameters for production factors are in a reasonable range. Since the dependent variable is output per acre, we can obtain the land elasticity of crop production by adding one to the reported coefficient on the land variable. Various measures of farmers' human capital were tried as productivity shifters and it was found that the level of education of the household head had a significantly positive effect.

In none of the four models, the coefficient on the permanent labor share or the casual labor share is negative with statistical significance. The coefficient on the permanent labor share is positive with statistical significance (at the 1 to 5% level) in the regressions for paddy value-added, non-paddy output, and non-paddy value-added. The coefficient on the casual labor share is positive with statistical significance in one out of the four regressions. Therefore, at 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?

Needless to say, the OLS estimates in Table 4 suffer from endogeneity bias: contractual choice and factor input levels 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 more productive farmers are better able to hire outside labor and their ability is not observed. One potential way to solve the endogeneity problem would be to show the absence of any endogeneity bias in a statistical sense using the exogeneity test; another would be to estimate the model using instrumental variables (Chiappori and Salanie, 2003). Both procedures require valid instruments, which are hard to find in the current dataset.

Instead of trying instrumental variables estimations, this paper concentrates on the first stage decision making process (i.e., the determinants of labor contracts). If it can be shown that contractual choice is consistent with self-selection, the results of the OLS estimation suggesting that hired labor has no negative effect on productivity do not contradict the existence of moral hazard. The absence of a negative effect may instead imply that any opportunistic behavior by hired workers is successfully suppressed by the way contracts are designed.

To investigate the way contracts are designed, the following observations on hired labor in agriculture are compiled from the primary data: 60 cases of wage transactions for those employed as permanent laborers, approximately 1,700 cases for those employed as casual laborers, 164 cases for farmers employing permanent laborers, and approximately 1,400 cases for farmers employing casual laborers. These observations include detailed information on farm work and the mode, conditions, and timing of wage payments.

Casual labor transactions display a considerable variation in terms of the mode of wage payments. There are four broad categories, each of which includes several sub-categories (Table 5).[3] First, wages fixed in money terms and paid per labor hour ("Kyats/day") were found most frequently, accounting for 79% of the 3,100 observations of hired labor

[3]In addition to those shown in the table, there are other dimensions in which the wages paid to casual laborers varied (Kurosaki, 2004). For instance, the number of meals per day served to hired laborers ranged from zero to three. Approximately two thirds of casual labor transactions were without meals, while a little less than one third were with one meal. The remaining transactions involved two or three meals per day. 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 a month or two in advance. In such cases, the wage rate was often reduced by 20 to 33%. Such a large discount suggests the severity of credit constraints faced by poor laborers (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).

(1,700+1,400). The modern mode of payment fixed as "Kyats/day" is thus the dominant one in Myanmar.

The payment of wages 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 prices or the non-availability of food in the market. If this is the case, cash wages are subject to the erosion of purchasing power. In contrast, wages paid in kind, such as grains, are not subject to such risk. We therefore expect that wages are more likely to be paid in kind when food security concerns are important. In the current case, time wages in kind accounted for 2.5% out of the 3,100 cases. This is the second category of the mode of wage payments.

Another situation in which wages may not be paid in Kyats/day is when time wages provide workers with an incentive to shirk because their work effort may not be observable to the employer and the wage is insensitive to workers' effort. The third category, 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 the 3,100 cases. Within the broad category of piece-rate wages in cash, there are several varieties. For example, contracts with the payment fixed in Kyats per acre of farming operation are observed in every stage of farming from land preparation to harvesting. Contracts with the payment fixed in Kyats 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 laborers (sharecropping). These cases accounted for 1.8% out of the 3,100 cases.

To correct for differences in the importance of each category of compensation policy in the rural economy, the share of each mode in the total was re-calculated using two sets of weights: total man-days and total Kyats.[4] Interestingly, the share of time wages in cash is larger when man-days are used as weights than when the money metric is used as a weight, while the share of the other three groups of wage modes is smaller when the weight is man-days 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 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 all villages with the exception of DELTA1. When a certain farm operation was conducted by

[4]In the following cases, both weights have to be estimated using fixed coefficients for each village based on our field observations: first, when piece rates are adopted, since farmers usually do not remember the exact number of days laborers actually worked; second, when the wage is paid in kind, as the employer and the employee only remember the quantity, which has to be converted into Kyats using village prices.

a *group* of casual laborers hired by a farmer, the group was paid in the same way. In other words, we observed no instance where several casual laborers were hired to work on the same plot and did the same work together but were paid differently. However, we often observed instances in which casual laborers working separately on different plots were paid in different ways, although they were doing the same farm work on the same crop in the same village.

3 Theoretical Model

3.1 Setting

This section develops an agency model to guide the econometric investigation of wage contract choice in rural Myanmar. The model incorporates three elements that are important in wage contract choice: the potential benefit and cost of monitoring workers to prevent shirking, laborers' consideration of food security, and the process in which the optimal contract is chosen. To simplify the analysis, any potential trade-off between the output quantity per labor hour and the quality of output in the case of piece-rate contracts is assumed away.[5] Since the number of labor hours is easily monitored, it is fixed in the following analysis. To reflect the conditions of low income developing countries, the commodity "food," which is the main output in production and the main item in consumption, is introduced into the model. To simplify the model, there are only two consumption items: food and "non-food." The price of "non-food" is normalized at one.

A farmer (principal) is searching for a laborer (agent) to produce food. The physical output (measured in kg) produced by 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 a mean of one. Due to underdeveloped agricultural produce markets and possibly due to unpredictable interventions by the state in rural marketing, the price of food, p, fluctuates; its mean is $\bar{p}$. It follows that 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 wages in cash, [2] time wages in kind (paid in food), [3] piece rates in cash, and [4] piece rates in kind (paid in food). Let the wage rate in each contract be expressed as w_j ($j = 1, .., 4$). It should be noted that the units of the wage rates are different: w_1 is measured in Kyats/day, w_2 in kg/day, and w_3 in Kyats/kg. The wage rate w_4 is the share of the output retained by the worker. *Ex post*, W_j, the gross value of the farmer's payment to the laborer

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

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 manner. Thus, his *ex ante* payoff is given by $E[v(y,p)] - g(e)$, where $E[.]$ is an expectation operator, $v(y,p)$ is an indirect utility function from consumption, and $g(e)$ is a disutility function from effort 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. This setting implies that piece-rate wages ([3] or [4]) have the advantage of providing the worker with a greater incentive to make an effort at the expense of the loss in utility captured by $g(e)$. 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 properties are required for a valid indirect utility function. The third guarantees that the laborer is risk-averse in the Arrow-Pratt sense, and the fourth implies that, for a given income level, the laborer's welfare decreases when the food price variability increases. The fourth property is especially appropriate for a poor worker in a developing country who is vulnerable to food insecurity.[6] The condition $v_{yp} > 0$ implies that the laborer's welfare increases when the correlation between the 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 a 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 a developing country. The last assumption, $v_{yyy} > 0$, corresponds to "risk prudence" (Kimball, 1990). Since prudent risk preferences guarantee that the welfare cost of consumption fluctuations decreases with the level of expected consumption, the assumption is appropriate 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 the hourly wage w_0 (Kyats/day) is paid. Then, 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 $v_{pp} < 0$. Datta et al. (2004) in their analysis of contract choice between cash and kind wages in low income economies 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 this is not appropriate for modeling poor workers' behavior, this paper adopts a utility function that is associated with $v_{pp} < 0$.

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 risks. 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 and unenforceable by the principal. Therefore, to maximize u^P, the principal has to meet the 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 risks.

3.2 Optimal Contract

Under contract [1] and contract [2], $\partial W_j/\partial e_j = 0$ so that $\partial u_j^A/\partial e_j < 0$, implying that the agent makes a minimal effort ($e_j^* = 0, j = 1, 2$). The principal therefore chooses w_1^* and w_2^* at the level where the participation constraint is satisfied as an equality with the condition that $e_j^* = 0, j = 1, 2$. Thus, w_1^* equals the worker's opportunity wage, i.e., $w_1^* = w_0$. Between contract [1] and contract [2], the principal prefers the one with the 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 $E[v(w_1^*, p)] = E[v(pw_2^*, p)]$, we obtain

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

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

Comparing the two, the sign of $E[W_1] - E[W_2] (= w_1^* - w_2^* \bar{p})$ is the same as that of $\bar{v}_{yy}(w_2^*)^2 + 2\bar{v}_{yp} w_2^*$. This implies that when the laborer is highly concerned about food security 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 means of y and p), where q is the Marshallian demand for food, q_y is its derivative with respect to income, s is the budget share of food, ψ is the Arrow-Pratt measure of relative risk aversion, and η is the income elasticity of food demand. The assumption of $v_{yp} > 0$ is thus equivalent to the assumption of $\psi > \eta$ in this approximation, which is likely to be satisfied for low income households (Fafchamps, 1992). As ψ increases, not only does v_{yp} increase, but v_{yy} also 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, meaning that contract [2] becomes more attractive to the employer than contract [1]. Since s can be measured using household expenditure data, we can derive the following proposition, which is empirically verifiable:

Proposition 1. *An increase in the share of food in the laborer's family budget will increase the probability for the employer to offer a contract with time wages in kind against a contract with time wages in cash.*

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 sufficiently large, 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 for the laborer due to the existence of yield risk θ. If θ and p are independent, contract [3] is likely to be inferior to contract [2],[7] 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 in which θ and p are independent corresponds to the assumption that farmers face idiosyncratic yield risks only and the sources of price fluctuations are from the demand side only. If θ and p are negatively correlated, which is more likely in a closed village economy, the attractiveness of [4] increases because the variance of W_4 is reduced. Therefore, when output is less responsive to effort, the choice among the four contracts depends on the parameters characterizing the stochastic distribution of prices and yields on the one hand, and the parameters characterizing preferences toward income risk and price risk on the other.

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

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

[7] Contract [3] is inferior to contract [2] when the variability of θ is not too small compared to that of p. The exact threshold values of the variability of θ and p for this relation to hold are available on request.

Similarly, under contract [4], it should be 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 $f(.)$.[8] In the last phase of the decision making process, the principal 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 $E[p\theta]f(e_4^*) - w_4 f(e_4^*)E[p\theta]$ and offers it to the agent. Since the agent's participation constraint is satisfied by construction, the agent accepts the offer. Similar to the corner solution cases, the optimal choice among the four contracts depends on the parameters characterizing price and yield risks on the one hand, and parameters characterizing risk aversion on the other. In addition to these parameters, the parameters characterizing the output response to effort affect the contract choice.

To investigate the effects of the production technology parameters, we now consider the case when the principal is indifferent between contracts [1] and [3] but prefers these to contracts [2] and [4]. Due to the assumption of $v_{yyy} > 0$, a marginal increase in $f'(e)$ due to exogenous factors leads the agent to marginally increase his effort. With the increased effort, the income of the laborer marginally increases. Since the participation constraint is binding when contract [1] is optimal, the increased income of the laborer provides an opportunity for the principal to extract a greater 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. Following similar reasoning, when the principal is indifferent between contracts [2] and [4] but prefers these 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 in the effort elasticity of output will increase the probability for the employer to offer a contract paid in piece rates against a contract paid in time wages.*

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

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

completion. When the effort is observable and enforceable by the employer, such a premium for piece-rate contracts disappears.

3.3 Numerical Examples

To gain a concrete idea of what the optimal choice looks like, the agency model above is calibrated numerically. See the Appendix for details of the specification and calibration parameters actually adopted. The indirect utility function in the agent's payoff function is specified with a risk-averse linear expenditure system (LES). The LES has the appealing property that the number of parameters is small and it provides a plausible prediction of poor households' response to avoid starvation. With the LES specification, the situation of starvation is described as income (y) being so low that it is close to the total value of the subsistence needs in consumption (Atkeson and Ogaki, 1996; Kurosaki and Fafchamps, 2002). LES utility functions require smaller values of risk aversion to assure that $v_{pp} < 0$ than Cobb-Douglas or CES utility functions. The welfare cost of effort to 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 risks is assumed so that the expected utility can be evaluated by taking the probability-weighted sum of the 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 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). The 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 (a higher value of ϕ) is assumed in this case. When we move to the right in the figure (i.e., we increase the effort elasticity of output, ρ), starting from a point where s is smaller than the horizontal line, we find contract [1] as the optimal contract initially, but then we reach the indifference curve between contracts [1] and [3]. After we cross the indifference curve, we find contract [3] (piece rate in cash) as the optimal contract. When we start from a point where s is slightly larger than the horizontal line, we find contract [2] as the initial optimal contract, but then we reach the indifference curve between contracts [2] and [3], beyond which contract [3] becomes the optimal contract. When s is very large (greater than 0.73 in this case), the optimal contract changes from [2] to [4] (piece rate in kind) first and then to [3] (piece rate in cash). In other words, when ρ becomes very large, a piece-rate-in-cash contract tends to dominate the other three types of contracts.

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, the variances of the common and idiosyncratic shocks are the same, and the only source of price fluctuations is the common yield shocks. As discussed in the previous subsection, 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 the case associated with the corner solution $e_4^* = 0$. Although the expected output is the same under all of the four contracts, contract [4] is the most preferred because the negative correlation between θ and p has the advantage of providing an income risk hedge. When s becomes larger, this advantage is dominated by the advantage of contract [2] so that contract [2] becomes the most preferred. Another region where contract [4] becomes more attractive is for medium values of ρ. When θ and p are independent, contract [3] is the most preferred one, while contract [4] becomes more attractive when θ and p are negatively correlated because the negative correlation means that contract [4] offers the advantage of providing an income risk hedge. When ρ becomes very large, the piece-rate-in-cash contract becomes the most attractive one, as is the case of Figure 1.

Both propositions stipulated above are satisfied in these examples. A stronger version of Proposition 1, i.e., that an increase in the share of food in the laborer's household budget 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 in Figure 2 and the indifference curve between contracts [3] and [2] is negatively sloped in Figure 1. A kind of non-monotonic relationship is thus found between the optimal contract choice and parameter s, leading to non-convexity in the parameter space (s, ρ) for contracts [3] or [4].

4 The Determinants of Contract Choice

4.1 Empirical Strategy

Based on the theoretical model above, this section empirically investigates the determinants of the choice of contract among the four alternatives. Let I_{ji} be an indicator function taking the value of 1 when the contract adopted in observation i is j and 0 otherwise (j=1: time wage in cash, j=2: time wage in kind, j=3: piece rate in cash, and j=4: piece rate 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 $I_{ji} = 0$ 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, which characterize the wage contract choice j.[9] When a coefficient in vector β_j on a particular variable Z^k is positive (negative), this implies that the logarithm of the odds ratio of choosing j over default contract [1] (time wage in cash) increases (decreases) with Z^k.

The second specification is a single-equation probit model, estimated by merging contracts [2] and [4] into a new dummy variable for in-kind wage contracts, and 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 the βs are vectors of coefficients to be estimated. Each of the probit models is estimated separately. There are two reasons for trying the second specification. The first is to incorporate the non-monotonicity of the functional form of $h(.)$. The numerical examples in Section 3 have shown that when the four exclusive regimes are treated simultaneously, 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 appropriate 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 contracts [2] or [3], the maximum likelihood estimation of the probit model is expected to be well-behaved.

[9] Alternative approaches would be to adopt a multinomial probit framework or to model sequential decision making in which the two parties first choose between in-kind and cash wages and then between time and incentive wages. An examination of the robustness of the estimation results under these specifications is left for a future study.

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, employee characteristics such as food security concerns, risk aversion, and the willingness to make an effort, should affect the contract choice. Note that some of the employee characteristics are individual attributes such as age, education, and sex, while others are household attributes such as consumption preferences, asset holdings, and household size. The second type of explanatory variables in vector Z_i include variables characterizing the employer (farmer). Individual and household characteristics of the employer similar to those listed for the employee may affect the contract choice. The third type of explanatory variables control for the fixed effects of villages, crops, and farming operations. Because the mode of wage payments tends to be similar within a village for a specific crop and a particular job, it is better to control for these effects to obtain reliable estimates for the effects of individual and household characteristics on the choice of contract. In other words, the within-village variation of wage contracts observed for the same crop and for the same farming operation is utilized to identify the model. Since it is not possible to completely match employee and employer data, both the employee and the employer characteristics are measured as deviations from their village-level means and then the employee data and the employer data are pooled. This approach entails an efficiency gain in estimation since it imposes the restriction that village, crop, and operation fixed effects are the same no matter whether employee or employer data are used. In addition, in order to provide a robustness check, the results for the estimation using employee data only will be reported.

Thus, the main empirical test concerns whether individual/household characteristics that are proxies for s and ρ affect the contract choice in a way predicted by the theoretical model. An additional task is to examine the fitted values of the fixed effects and thereby to investigate whether piece rate contracts 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 subsistence food requirements.

In order to examine the effect of individual and household characteristics on the contract choice, the following variables, both for workers and for employers, are included (see Table 6 for a detailed list of the variables).[10] First, as demographic controls, sex and age are included. The sex dummy of the employer is, however, deleted from the final model since the majority of employers are male. Second, to represent human capital, the level of education (in terms of schooling years) is included. Third, the size of the farmland workers and employers possess is included. For workers, this provides an indication of the extent to which they can secure food from their own farmland. Therefore, if it is found that the worker's farmland reduces

[10]All empirical variables used in the regression analysis are available on request for verification.

the probability of contract [2] and [4], such a finding is consistent with the food security concern modeled in the previous section. For employers, the farmland size controls for their farming assets. Fourth, non-land asset values such as livestock, transportation equipment, etc., are included. This variable controls for liquidity effects. When workers have few assets and as a result are more likely to be liquidity constrained, they prefer cash wages to increase their liquidity. Similarly, when employers have few assets and hence are more likely to be liquidity constrained, they prefer to pay in-kind wages to preserve their liquidity. Fifth, as a direct control for household food security concerns, the relative importance of rice in the family budget is included.[11]

4.2 Main Estimation Results

The estimation results for the multinomial logit model are reported in Table 7. First, which factors affect the probability that labor contracts paid in fixed amounts of food (contract [2]) against time wages in cash (contract [1]) are chosen? The regression results show that the smaller a worker's farmland and the larger the rice share in his family budget, the more likely he is to be paid in kind. This is exactly what the theoretical model predicted for the case when food security concerns were present (see Figures 1 and 2 in Section 3). A worker with a higher value for *S_labor* (the proxy for s) is more likely to work under in-kind payment schemes because food consumption is more important for him than for a worker with a lower value for *S_labor*. At the same time, for a given level of *S_labor*, the more farmland a worker possesses/controls, the greater is his food security because he can produce food on his own farm and does not have to rely on the market. The coefficients on the other worker characteristic variables are insignificant. Turning to employer characteristics, *Land_farmer* and *S_farmer* raise the probability that contract [2] is chosen over contract [1]. The reason for a farmer with more farmland to adopt contract [2] could be the saving of wage payments through the adoption of in-kind wages: the abundance of food on his farm implies that the shadow price of the food for the farmer is likely to be lower than its shadow price for the laborer. It turns out that the effect of *S_farmer* on the likelihood of contract [2] being chosen over contract [1] is not robust.

The coefficients on the crop fixed effects show that it is more likely that paddy crops, including monsoon paddy (the reference crop), are cultivated under the in-kind wage arrangement. The coefficients on the operation fixed effects show that wages fixed in kind are

[11]To control for the endogeneity of s (the food budget share in the theoretical model), the empirical model uses the value of the annual amount of rice consumption required (age-sex specific rice consumption coefficients times the vector of the demographic composition of household members) divided by the expected household income (asset-specific income coefficients times the vector of asset holdings) 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.

more common in harvesting than in other operations. These results are as expected because paddy crops are grown mainly for consumption so that the harvest of these crops can be readily paid to harvesting workers on the spot, while other crops are grown mainly as cash crops.

Second, which factors affect the probability of contract [3] (piece rate in cash) being chosen over contract [1]? The regression results show that female or more educated workers are more likely to be offered time wages in cash rather than piece rates in cash. This suggests that such workers are more disciplined or tend to work under closer supervision by the farmer so that it is not necessary to provide them with effort-based incentives.[12] The variable *S_labor* has a significant negative coefficient. Numerical examples in the theoretical section showed that the direction of the effects of s on the probability of contract [3] being chosen is indeterminate and depends on the functional form of $g(e)$ (the welfare cost of effort to 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 characteristics, education and landholding increase the probability of piece rate contracts being chosen. The effect of education could be interpreted in two ways: the opportunity cost for an educated farmer to monitor labor is higher because of non-agricultural work opportunities for the educated; or educated farmers tend to adopt technologies that require more effort of workers. The positive effect of landholding implies that farmers with larger farms are disadvantaged in completing farming operations in time so that they adopt piece rates to speed up the completion.

The coefficients on the crop fixed effects in determining contract [3] show that it is more likely that monsoon paddy (the reference crop) and summer paddy are cultivated under the piece-rate arrangement than oilseeds and vegetables. This is consistent with the claim in the literature that paddy cultivation requires more effort than other crops (Hayami and Otsuka, 1993; Hayami and Kikuchi, 1999). To grow oilseeds, the optimal effort level may be less than the optimal level required for other crops. In the case of vegetable cultivation, 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 the operation fixed effects variables, *Planting* has a significant positive coefficient. This suggests that planting requires quick completion so that piece rates are likely to be chosen.

Third, turning to what variables determine if contract [4] (piece rate in kind, i.e., share-

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

cropping arrangements) is chosen against contract [1], the value of workers' assets and farmers' age have positive and significant coefficients. The former variable indicates that workers with fewer assets prefer being paid in cash, i.e., they seek liquidity. Note that the coefficient on *Asset_labor* in determining contract [2] is also positive, though only marginally significant at the 20% level. The latter effect of farmers' age may capture the effect of history, since contract [4] is the oldest form of wage mode in the survey villages. As a whole, few of the variables in the estimation for contract [4] are statistically significant. This could be due to the smaller number of observations falling under contract [4].

Because of this indeterminacy for contract [4], the alternative specification consisting of single-equation probit models was estimated and the results are reported in Table 8. In the middle columns of Table 8, the determinants for the adoption of in-kind wages are shown. The signs on the coefficient for individual characteristics are very similar to those in the multinomial logit model explaining contract [2], and when the coefficient is statistically significant, the signs are exactly the same. Employee landholdings decrease the probability of in-kind wages being chosen and a larger food share in the laborer's budget is associated with a higher probability of in-kind wages being chosen. The level of statistical significance is improved for these two variables. The effect of the value of workers' assets now becomes significantly positive and that of employers' assets now becomes significantly negative. This pattern is consistent with the explanation based on liquidity constraints.

Comparing the probit model for piece-rate contracts and the logit model for contract [3], the results are again qualitatively similar in terms of the signs and the statistical significance of individual characteristics. Female workers, educated workers, and those with a high food budget share are less likely to work under piece-rate contracts, while educated employers and employers with more farmland are more likely to employ workers under piece-rate contracts. In addition to the effect of farmers' education, the effect of farmers' age now becomes statistically significant. The age effect can be interpreted in two ways: the opportunity cost for an elderly farmer to monitor labor is higher because of high age; or elderly farmers tend to adopt technologies that require more effort of workers. In both probit models, the fixed effects were jointly significant at the 1% level.

4.3 Robustness of the Estimation Results

In Table 9, regression results under alternative estimation procedures are presented to check the robustness of the findings above. The estimated coefficients on the fixed effects are very similar to those reported in Tables 7 and 8 so that they are not reported in this table. In Part A, contract [4] is merged with contract [2] or contract [3] and multinomial logit models with three choices are estimated. This specification allows a more direct comparison between the multinomial logit results and the probit results. When contract [4] is merged with contract [2], the level of significance of the effects of *land_labor* and *S_labor* deteriorates to 20%. However, the signs are the same as before and their estimated marginal effects on the probability are comparable to the results from the other specifications in which the coefficients were more significant. Otherwise, the results reported in Part A are qualitatively similar to those in Table 8.

In Part B of Table 9, the multinomial logit or the probit model is re-estimated using employee data only. The signs and the levels of significance of individual characteristics overall are consistent with those reported in Tables 7 and 8. In none of the cases has the same variable a statistically significant coefficient with the opposite sign. However, individual determinants for contract [3] (multinomial logit) or contracts [3] and [4] (probit) become statistically insignificant. In contrast, the negative effect of *land_labor* and the positive effect of *S_labor* on contract [2] or in-kind wages are more robust.

In Part C of Table 9, more parsimonious models are estimated, where variables that were statistically insignificant in all specifications are deleted from the list of explanatory variables. The positive effect of *S_labor* and the negative effect of *land_labor* on in-kind wages, and the positive effect of *Age_farmer* and *Educ_farmer* as well as the negative effect of *Female_labor*, *Age_labor*, and *S_labor* on piece-rate wages are strengthened in these specifications. In addition to the results reported in Table 9, different definitions are also attempted for education and land,[13] the asset value variable is disaggregated into each source of assets, and models are re-estimated using weighted regression with total man-days or total Kyats as weights to correct for the difference in the importance of each wage mode in the rural economy. The results from these models are qualitatively the same as those reported in this paper.

As an alternative strategy to check the robustness of the results regarding the determinants of in-kind contracts, household-level regressions are also attempted. As shown in the theoretical model, whether in-kind contracts are adopted depends on household characteristics such as risk aversion and the importance of rice consumption in the family budget. Since food security should be evaluated at the household level, not at the individual contract level, it might be more meaningful to examine the determinants of the relative importance of in-kind labor at the household level. In other words, household-level regressions could be a better way to assess the importance of food security concerns with regard to contract choice, since the worker can mix different types of contracts. For this reason, the man-day share of in-kind labor in total household casual farm labor is regressed on household characteristics

[13]Instead of defining education as the sum of years of formal and monastic schooling, only years at formal schools are counted; instead of using the total size of farmland (i.e., the simple sum of the acreage of paddy and non-paddy fields), farmsize is calculated as the weighted sum of the acreage of paddy and non-paddy fields with a smaller weight on the latter.

and village fixed effects. The main variables of interest are the household characteristics corresponding to those adopted in Tables 7 to 9. In addition to these variables, demographic characteristics are included to control for other differences in preferences. The crop and operation fixed effects are now dropped since the composition of crops/operations is endogenous at the household level after aggregating individual contracts.

The estimation results are reported in Table 10. In the upper portion, the OLS estimation results with robust standard errors are reported. To take into account the double censoring at zero and one because the dependent variable is a share, a tobit model is also estimated and the results are reported in the lower portion. Both the negative effect of land holding and the positive effect of the importance of rice consumption are statistically significant in all six specifications. The tobit results indicate that conditional on it being strictly positive, the share of in-kind contracts increases as the share of rice consumption increases, with an elasticity of 0.7 to 0.9. In the OLS results, the coefficients are much smaller because of the large number of left-censored observations, but the 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) piece of evidence that households' food security concerns affect contract choice because in rural Myanmar females are usually responsible for family food management. Therefore, the household-level regression provides further evidence of the important role food security concerns play when laborer households decide how to allocate their work to different types of wage contracts.

Overall, the regression results are consistent with the theoretical prediction of this paper: a farmer carefully chooses and offers to a worker a wage payment mode that is optimal for the farmer in subtracting most of the economic surplus from the labor transaction, considering the characteristics of the worker and the farm operation. This mechanism reduces the opportunity for the worker to shirk and meets the food security concern of the worker. In Subsection 2.3, it was found that casual labor in crop production was as efficient as family labor (Table 4). That finding could be interpreted as a result of the choice of the wage contract type and should not be interpreted as any evidence of the non-existence of moral hazard possibilities in rural Myanmar.

One caveat with regard to the analysis of contract choice 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), then the regression gives consistent estimates for β_j, β_{pr}, or β_{kd}. If, however, 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 such bias due to endogenous matching, an instrumental variable estimation employing variables that affect the matching equation but not the choice of contract would be necessary (Ackerberg and Botticini, 2002). Unfortunately, our dataset does not contain instruments that satisfy this condition.

5 Conclusion

This paper developed an agency model of contract choice in the hiring of 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 such as Myanmar, the agency model incorporates considerations of food security as well as incentive issues. 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 one with wages paid in cash. At the same time, when output is more responsive to workers' effort and the employer is less able to enforce workers' effort levels, the employer prefers a contract with piece-rate wages to one with hourly wages. The case of sharecropping can be understood as a combination of the two: piece-rate wages paid in kind. Numerical examples indicated the possibility of a non-monotonic relationship between the optimal contract choice and the parameters determining food security and moral hazard.

These predictions of the theoretical model were tested using a cross-section dataset based on a sample household survey conducted in 2001 that covers 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 the higher the share of food in workers' budget and the less farmland they had under management; both factors are characteristics of poverty in the study region and associated with greater concerns for food security. Piece-rate wages are more likely to be adopted when workers are male and uneducated. Such workers are more likely to work under conditions where the enforcement of effort is difficult. Piece-rate wages are more likely to be adopted when employers are older and more educated. The fixed effects of crops and farming operations are jointly significant and crops or operations requiring greater effort 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 the structural parameters of the model are estimated, may be required to rigorously incorporate such non-linearity.[14] As a further extension, intra-household interactions among family members need to be incorporated into the theoretical model, since such interaction *de facto* allows a mix of different contracts. Another issue that has remained unexamined 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. This could be due to a mechanism in which contract choice based on kinship and reputation increases the production incentive for permanent laborers in Myanmar. Testing this hypothesis and then re-estimating the production function controlling for the endogeneity of contract choice are interesting topics for future research.

[14]See, for example, Fafchamps (1993) and Fafchamps and Soderbom (2002) for attempts at structural estimation based on a primal optimization model.

Appendix: Details 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[15] with eleven nodes,[16] a mean of one, and a coefficient of variation of 0.25. The distribution of output risk θ is also assumed to be a symmetric binomial with eleven nodes, a mean of one, and a 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, i.e., no common yield shocks so that the price fluctuates due to demand-side shocks only (Figure 1). The second simulation is for the case when p and θ are completely negatively correlated (no idiosyncratic yield shocks and the only source of price fluctuations 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, the simulation corresponds to the case in which farm-level yields are subject to common and idiosyncratic shocks whose variances are of the same magnitude and the only source of price fluctuations is the common yield shock. 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,[17] γ is the subsistence food requirement and β is the marginal propensity to spend on food after meeting subsistence needs. For simplicity, the non-food subsistence requirement is set at zero. In the simulation, ϕ is parametrically changed in the range from 1.1 to 4,[18] β is assumed to be the same as γ

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

[16]To avoid extreme values for the food price that lead to the 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 to be insensitive to a reduction in the number of nodes, marginal changes in the probability values of each node, or replacement of the symmetric binomial distribution with a triangle distribution.

[17]Under this specification, the Arrow-Pratt coefficient of relative risk aversion, ψ, is defined as $\psi = \phi y/(y-p\gamma)$.

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

to reduce the dimension of the space of parameter changes, and γ is parametrically changed in the range from 0.05 to 0.60. For each value of γ, s (the budget share of food) is evaluated at the mean price under contract [1] ($s = 2\gamma - \gamma^2$).

Finally, the welfare cost of effort to the worker, $g(e)$, is specified as $g(e) = \gamma e$. A 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 an undue advantage to contract [3] over contract [1]. The indifference curve between contracts [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 contract [3] being chosen 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 the probability-weighted sum of the 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 the MINOS non-linear optimization solver in GAMS.[19] In the last outer loop, the contract that brings the highest u_j^P is chosen.

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

Table 2: Sample Households

Village	Number of sample households			Number of household members included in the sample households		
	Farm households	Non-farm households	Total	Farm households	Non-farm households	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 Assets and Income of Sample Households

	Farmland (acres)	Total current value of production assets* (1000 Kyats)	Household income (Kyats)		Composition of income sources (%)			
			Average total household income	Average 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. As for livestock, cattle is the most important and the average number of heads of cattle per household is 1.70. With respect to transportation equipment, bullock carts and bicycles are the most important (the average numbers per household are 0.41 and 0.47, respectively).

Household income is defined as the sum of wage/salary receipts including the imputed value of in-kind payments such as meals and rice, non-agricultural self-employment earnings (gross revenue minus actually paid costs), agricultural self-employment earnings (the 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 payments 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 man-days	0.039	(0.063)	0.063	(0.077)	0.136 **	(0.058)	0.242 ***	(0.078)
Animal labor 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 years	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)
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)
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)
Oilseeds					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)
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) Observations with zero or negative output were excluded from the analysis.

Table 5: Mode of Wage Payment to Casual Labor

	No. of observations	Share in the total (%)		
		Unweighted	Weighted by man-days	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 as Determinants of Contract Choice

Variable	Definition		Mean	Std. Dev.	Min	Max
Individual and household characteristics						
Female_labor	A dummy variable indicating if the employee is female.		0.292			
Age_labor	Age of the employee.		34.225	11.382	11	69
Educ_labor	Completed years of formal school education of the employee. When the employee attended a monastic school, a value of 2 years was assigned.		2.818	2.360	0	10
Land_labor	Size of farmland holding in acres managed by the employee's household.		1.835	3.518	0	22
S_labor	Indicates the importance of rice in the family budget. Defined as "the value of the annual amount of rice required (age-sex specific rice consumption coefficients times the vector of the demographic composition)" divided by "the expected household income (asset-specific income coefficients times the vector of asset holding)". When the value was greater than unity, it was truncated at one.		0.463	0.221	0.073	1.000
Assets_labor	Total amount of assets (non-land: transportation equipment, livestock, agricultural machinery, etc.) owned by the employee (million Kyats).		0.064	0.127	0.000	0.924
Age_farmer	Age of the employer (=farmer).		43.871	12.193	21	85
Educ_farmer	Completed years of formal school education of the employer (=farmer). When the employer attended a monastic school, a value of 2 years was assigned.		3.619	3.395	0	16
Land_farmer	Size of farmland holding in acres managed by the household of the employer.		8.741	6.102	0.4	37.0633
S_farmer	Importance of rice in the employer's family budget (similarly defined as S_labor).		0.417	0.302	0.0523	1
Assets_farmer	Total amount of assets owned by the employer (similarly defined as Assets_labor).		0.343	0.433	0	3.62824
Crop fixed effects						
Monsoon paddy	Including the 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 peas.		0.083			
Oilseeds	Oilseed crops such as sesame, groundnuts, sunflowers.		0.151			
Industrial crops	Industrial crops such as sugarcane.		0.024			
Rubber	Rubber.		0.011			
Vegetables	Vegetables including cabbage, green chilies, tomatoes.		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 operations	All other operations including those overlapping different stages.	#	0.043			

Notes: (1) The total number of observations is 3100, of which 1701 are employee data and 1399 are employer data.
(2) When the variable is a dummy, the percentage of observations taking one is reported.
(3) In addition to these variables, village fixed effects are also included: DELTA1 (0.210), DELTA2# (0.133), DRY1 (0.208), DRY2 (0.116), DRY3 (0.110), HILL1 (0.119), HILL2 (0.065), and COAST (0.039) (the mean of each dummy variable is shown in the parentheses).
These dummy variables are used as reference in the regression analysis.

Table 7: Determinants of Contract Choice (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.	dF/dx	Coeff.	Std. Err.	dF/dx	Coeff.	Std. Err.	dF/dx
Individual and household characteristics#									
Female_labor	-0.3056	(0.386)	-0.0039	-0.4820 *	(0.285)	-0.0494	-3.7499	(2.939)	-0.0662
Age_labor	-0.0071	(0.016)	-0.0001	-0.0042	(0.008)	-0.0005	-0.0162	(0.039)	-0.0003
Educ_labor	-0.0010	(0.085)	0.0006	-0.0747 *	(0.044)	-0.0076	-0.6796	(0.437)	-0.0121
Land_labor	-0.1223 *	(0.069)	-0.0032	0.0566	(0.037)	0.0075	0.0234	(0.145)	0.0003
S_labor	1.5159 *	(0.820)	0.0401	-1.1736 **	(0.532)	-0.1588	2.0243	(1.431)	0.0390
Assets_labor	1.3851	(2.023)	0.0360	-1.4042	(1.471)	-0.1979	5.8948 **	(2.956)	0.1096
Age_farmer	-0.0048	(0.013)	-0.0002	0.0079	(0.005)	0.0009	0.0322 **	(0.016)	0.0006
Educ_farmer	-0.0307	(0.062)	-0.0010	0.0600 **	(0.024)	0.0076	0.0261	(0.054)	0.0003
Land_farmer	0.0639 **	(0.032)	0.0015	0.0265 *	(0.014)	0.0031	-0.0065	(0.051)	-0.0002
S_farmer	1.0020 *	(0.580)	0.0231	0.3022	(0.229)	0.0342	0.0665	(0.553)	-0.0001
Assets_farmer	-1.8700	(1.160)	-0.0430	-0.4590 **	(0.196)	-0.0472	-1.3712	(0.879)	-0.0226
Village fixed effects									
DELTA1	(dropped)			-0.8326 ***	(0.192)	-0.1048	(dropped)		
DRY1	4.2700 ***	(1.045)	0.1025	-0.0310	(0.195)	-0.0258	2.3028 ***	(0.703)	0.0397
DRY2	3.1516	(2.236)	0.0771	-0.2091	(0.301)	-0.0379	(dropped)		
DRY3	2.6336 *	(1.551)	0.0656	-0.4924 *	(0.268)	-0.0717	(dropped)		
HILL1	4.4241 ***	(1.030)	0.1144	-2.1157 ***	(0.372)	-0.2858	1.1803	(0.863)	0.0250
HILL2	5.5934 ***	(1.086)	0.1409	-1.4632 ***	(0.408)	-0.2048	(dropped)		
COAST	6.2406 ***	(1.093)	0.1555	-1.1964 ***	(0.442)	-0.1735	(dropped)		
Crop fixed effects									
Summer paddy	1.1756 ***	(0.365)	0.0274	0.2934 **	(0.135)	0.0326	-0.0049	(0.403)	-0.0014
Upland paddy	2.3469 ***	(0.483)	0.0570	-0.0476	(1.216)	-0.0146	(dropped)		
Cereals	(dropped)			0.0068	(0.575)	0.0009	(dropped)		
Pulses	-0.6781	(1.665)	-0.0158	-0.1761	(0.273)	-0.0197	(dropped)		
Oilseeds	-1.9451 **	(0.803)	-0.0456	-0.4154 *	(0.230)	-0.0452	(dropped)		
Industrial crops	(dropped)			0.3570	(0.579)	0.0449	(dropped)		
Rubber	(dropped)			1.4507 **	(0.694)	0.1827	(dropped)		
Vegetables	(dropped)			-0.8085 ***	(0.260)	-0.1018	(dropped)		
Other crops	(dropped)			0.1659	(0.777)	0.0209	(dropped)		
Operation fixed effects									
Planting	(dropped)			0.9537 **	(0.439)	0.1201	(dropped)		
Middle	(dropped)			-0.5684	(0.463)	-0.0716	(dropped)		
Harvest	2.5889 ***	(0.334)	0.0591	0.4596	(0.440)	0.0369	4.2261 ***	(0.758)	0.0738
Intercept	-9.3775 ***	(1.277)		-1.9475 ***	(0.526)		-10.0883 ***	(2.015)	
Pseudo R2	0.267								
Log likelihood	-1407.1								

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 a list of the dummy variables.

(3) The number of observations used is 3,100.

(4) dF/dX shows the marginal effect of the explanatory variable (in the case of dummy variables, the discrete effect from changing the dummy from zero to one) on the probability of choosing the contract, evaluated at the sample mean.

(5) "(dropped)" means that the fixed-effect is constrained to be zero to avoid the situation that the multinomial logit estimation result suffers from a perfect prediction problem when the variation of wage modes is insufficient for some crops and some villages.

Table 8: Determinants of Contract Choice (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	0.1321		(0.267)	0.0016	-0.2048	*	(0.125)	-0.0384
Age_labor	-0.0044		(0.009)	-0.0001	-0.0020		(0.004)	-0.0004
Educ_labor	-0.0491		(0.046)	-0.0006	-0.0384	*	(0.022)	-0.0072
Land_labor	-0.1015	**	(0.046)	-0.0012	0.0202		(0.019)	0.0038
S_labor	1.0195	**	(0.482)	0.0125	-0.5136	**	(0.247)	-0.0963
Assets_labor	1.5812	*	(0.945)	0.0194	-0.4294		(0.617)	-0.0805
Age_farmer	0.0051		(0.006)	0.0001	0.0066	**	(0.003)	0.0012
Educ_farmer	0.0006		(0.032)	0.0000	0.0347	***	(0.013)	0.0065
Land_farmer	0.0627	***	(0.020)	0.0008	0.0132	*	(0.008)	0.0025
S_farmer	-0.4287		(0.292)	-0.0052	0.0893		(0.129)	0.0167
Assets_farmer	-1.5712	***	(0.476)	-0.0192	-0.2792		(0.113)	-0.0524
Village fixed effects								
DELTA1	(dropped)				-0.4597	***	(0.103)	-0.0731
DRY1	2.3550	***	(0.339)	0.2003	0.2357	**	(0.108)	0.0481
DRY2	1.5976		(1.064)	0.1006	0.1090		(0.158)	0.0215
DRY3	0.3659		(0.505)	0.0063	-0.1684		(0.139)	-0.0291
HILL1	2.4904	***	(0.405)	0.3463	-0.8311	***	(0.172)	-0.1044
HILL2	2.4916	***	(0.385)	0.3961	-0.5908	***	(0.205)	-0.0795
COAST	3.0330	***	(0.382)	0.5952	-0.1265		(0.194)	-0.0221
Crop fixed effects								
Summer paddy	-0.4661	***	(0.178)	-0.0041	0.0108		(0.078)	0.0020
Upland paddy	1.1765	***	(0.348)	0.0663	-0.5005		(0.564)	-0.0681
Cereals	(dropped)				-0.3025		(0.292)	-0.0471
Pulses	-1.3342		(0.885)	-0.0068	-0.2937	**	(0.144)	-0.0472
Oilseeds	-2.1961	***	(0.315)	-0.0155	-0.4766	***	(0.130)	-0.0725
Industrial crops	(dropped)				-0.1111		(0.277)	-0.0195
Rubber	(dropped)				0.0233		(0.364)	0.0044
Vegetables	(dropped)				-0.6706	***	(0.124)	-0.0926
Other crops	(dropped)				-0.3397		(0.370)	-0.0516
Operation fixed effects								
Planting	(dropped)				0.2624		(0.214)	0.0517
Middle	(dropped)				-0.4895	**	(0.227)	-0.0761
Harvest	1.6847	***	(0.146)	0.0316	0.1658		(0.214)	0.0317
Intercept	-4.0203	***	(0.474)		-0.8371	***	(0.260)	
Wald chi2stat for zero slope	284.0	***			386.3	***		
Pseudo R2	0.504				0.208			
Log likelihood	-222.3				-1104.7			

Notes: See Table 7.

The number of observations used is 3100.

Table 9: Determinants of Contract Choice (Robustness Check)

A. Multinomial logit with three choices									
	[2] or [4] (in-kind wages)			[3] (piece-rate in cash)					
	Coeff.	Std. Err.	dF/dx	Coeff.	Std. Err.	dF/dx			
Female_labor	-0.5705	(0.395)	-0.0205	-0.4817 *	(0.286)	-0.0570			
Age_labor	-0.0088	(0.016)	-0.0003	-0.0042	(0.008)	-0.0005			
Educ_labor	-0.0498	(0.077)	-0.0016	-0.0742 *	(0.044)	-0.0090			
Land_labor	-0.0677	(0.064)	-0.0032	0.0570	(0.037)	0.0076			
S_labor	1.0582	(0.868)	0.0512	-1.1705 **	(0.532)	-0.1541			
Assets_labor	0.5850	(1.855)	0.0331	-1.4008	(1.463)	-0.1801			
Age_farmer	0.0126	(0.011)	0.0005	0.0078	(0.005)	0.0009			
Educ_farmer	-0.0064	(0.046)	-0.0006	0.0589 **	(0.024)	0.0075			
Land_farmer	0.0269	(0.032)	0.0009	0.0274 **	(0.014)	0.0033			
S_farmer	0.5912	(0.490)	0.0226	0.2977	(0.228)	0.0337			
Assets_farmer	-1.6767 **	(0.805)	-0.0664	-0.4646 **	(0.197)	-0.0478			
	[2] (time wage in cash)			[3] or [4] (piece-rate wages)					
	Coeff.	Std. Err.	dF/dx	Coeff.	Std. Err.	dF/dx			
Female_labor	-0.2845	(0.387)	-0.0048	-0.5094 *	(0.274)	-0.0694			
Age_labor	-0.0073	(0.017)	-0.0002	-0.0025	(0.008)	-0.0003			
Educ_labor	0.0047	(0.086)	0.0005	-0.0815 *	(0.043)	-0.0113			
Land_labor	-0.1164 *	(0.068)	-0.0030	0.0416	(0.038)	0.0062			
S_labor	1.4747 *	(0.827)	0.0403	-1.1000 **	(0.518)	-0.1585			
Assets_labor	1.0855	(2.034)	0.0291	-0.6861	(1.310)	-0.0995			
Age_farmer	-0.0051	(0.013)	-0.0002	0.0110 **	(0.005)	0.0015			
Educ_farmer	-0.0277	(0.061)	-0.0009	0.0602 **	(0.024)	0.0085			
Land_farmer	0.0646 **	(0.032)	0.0015	0.0259 *	(0.014)	0.0033			
S_farmer	1.0171 *	(0.576)	0.0239	0.1754	(0.224)	0.0201			
Assets_farmer	-1.8017	(1.157)	-0.0415	-0.5283 **	(0.200)	-0.0658			
B. Estimation using only employee data									
Multinomial logit	[2] Time wage in kind			[3] Piece rate in cash			[4] Piece rate in kind		
	Coeff.	Std. Err.	dF/dx	Coeff.	Std. Err.	dF/dx	Coeff.	Std. Err.	dF/dx
Female_labor	-0.1015	(0.385)	-0.0005	-0.4193	(0.288)	-0.0499	-0.9213	(1.528)	-0.0154
Age_labor	0.0007	(0.018)	-0.0001	0.0118	(0.010)	0.0012	0.0984 ***	(0.032)	0.0017
Educ_labor	0.0302	(0.093)	0.0007	-0.0078	(0.047)	-0.0015	0.1408	(0.348)	0.0025
Land_labor	-0.1158 *	(0.069)	-0.0027	0.0320	(0.039)	0.0057	-0.4449	(0.343)	-0.0081
S_labor	1.3909 *	(0.869)	0.0344	-0.4982	(0.597)	-0.0743	2.3865	(1.952)	0.0438
Assets_labor	1.3112	(2.081)	0.0300	-0.8118	(1.346)	-0.1350	10.2937 **	(4.668)	0.1874
Probit	[2] or [4] (in-kind wages)			[3] or [4] (piece-rate wages)					
	Coeff.	Std. Err.	dF/dx	Coeff.	Std. Err.	dF/dx			
Female_labor	0.0324	(0.236)	0.0005	-0.1666	(0.123)	-0.0165			
Age_labor	0.0037	(0.009)	0.0001	0.0054	(0.005)	0.0005			
Educ_labor	-0.0102	(0.048)	-0.0001	0.0009	(0.024)	0.0001			
Land_labor	-0.1173 **	(0.046)	-0.0017	0.0041	(0.021)	0.0004			
S_labor	1.1766 ***	(0.454)	0.0172	-0.1172	(0.253)	-0.0116			
Assets_labor	1.8350 *	(0.915)	0.0268	-0.0564	(0.593)	-0.0056			
C. Estimation based on parsimonious specification#									
Multinomial logit	[2] Time wage in kind			[3] Piece rate in cash			[4] Piece rate in kind		
	Coeff.	Std. Err.	dF/dx	Coeff.	Std. Err.	dF/dx	Coeff.	Std. Err.	dF/dx
Female_labor	-0.1824	(0.498)	-0.0024	-0.5405 *	(0.284)	-0.0674	0.0045	(1.260)	0.0016
Educ_labor	-0.0029	(0.084)	0.0003	-0.0920 **	(0.042)	-0.0112	-0.1359	(0.191)	-0.0022
Land_labor	-0.1266 *	(0.077)	-0.0031	0.0224	(0.029)	0.0036	-0.1064	(0.219)	-0.0019
S_labor	1.5135 *	(0.855)	0.0422	-1.4830 ***	(0.482)	-0.1920	-0.1148	(1.983)	0.0013
Age_farmer	0.0058	(0.011)	0.0001	0.0123 ***	(0.005)	0.0015	0.0257	(0.017)	0.0004
Educ_farmer	0.0159	(0.074)	0.0002	0.0475 **	(0.021)	0.0059	0.0104	(0.090)	0.0001
Probit	[2] or [4] (in-kind wages)			[3] or [4] (piece-rate wages)					
	Coeff.	Std. Err.	dF/dx	Coeff.	Std. Err.	dF/dx			
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			

Notes: In Parts A and B, all specifications include the same explanatory variables as in Tables 7 and 8. In Part C, out of the individual and household attributes in Tables 7 and 8, Age_labor and other non-significant village-, crop-, and operation-fixed effects were deleted from the model since they were not robustly significant. In Part C, only statistically significant coefficients are reported.

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

	Weighted by the number of contracts per household			Weighted by man-days worked per household			Weighted by earning in Kyats per household		
	Coeff.		Std. Err.	Coeff.		Std. Err.	Coeff.		Std. Err.
Estimated by OLS									
Household characteristics similar to those in Tables 7 to 9 #									
Female_labor ##	-0.0006		(0.013)	0.0041		(0.023)	0.0006		(0.014)
Age_labor ##	0.0002		(0.000)	0.0002		(0.001)	-0.0001		(0.000)
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)
Assets_labor	0.1348		(0.107)	0.2377		(0.192)	0.1747		(0.119)
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)
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 similar to those in Tables 7 to 9 #									
Female_labor ##	0.4080	**	(0.173)	0.5029	**	(0.202)	0.4270	**	(0.176)
Age_labor ##	-0.0012		(0.005)	-0.0014		(0.006)	-0.0021		(0.005)
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)
Assets_labor	0.6670		(0.687)	0.9473		(0.788)	0.7185		(0.685)
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									
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.

These variables are characteristics of the head of the household.

(1) The number of observations used is 219 (no sample households from village DELTA1 were included since no incidence of in-kind wage was observed). Out of the 219 observations, 184 are left-censored at zero and 4 are right-censored at one.

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

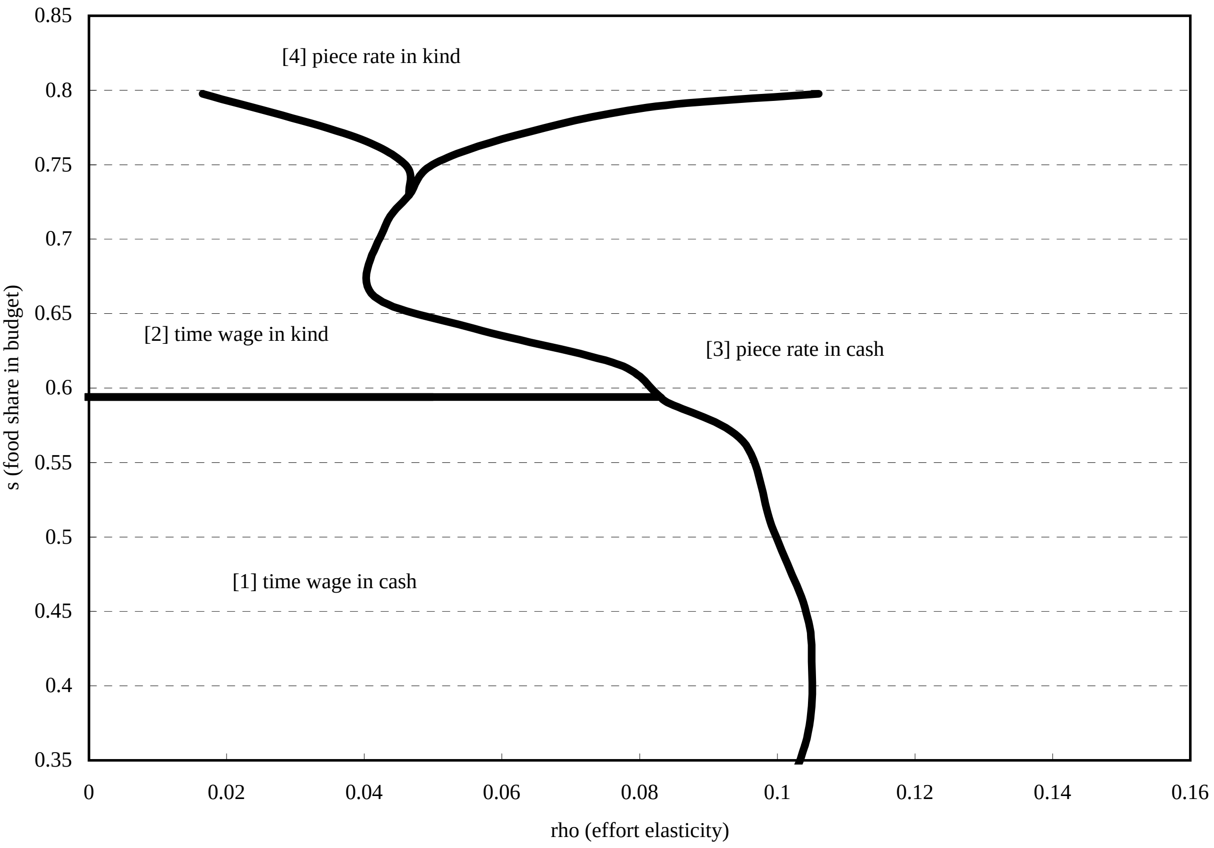
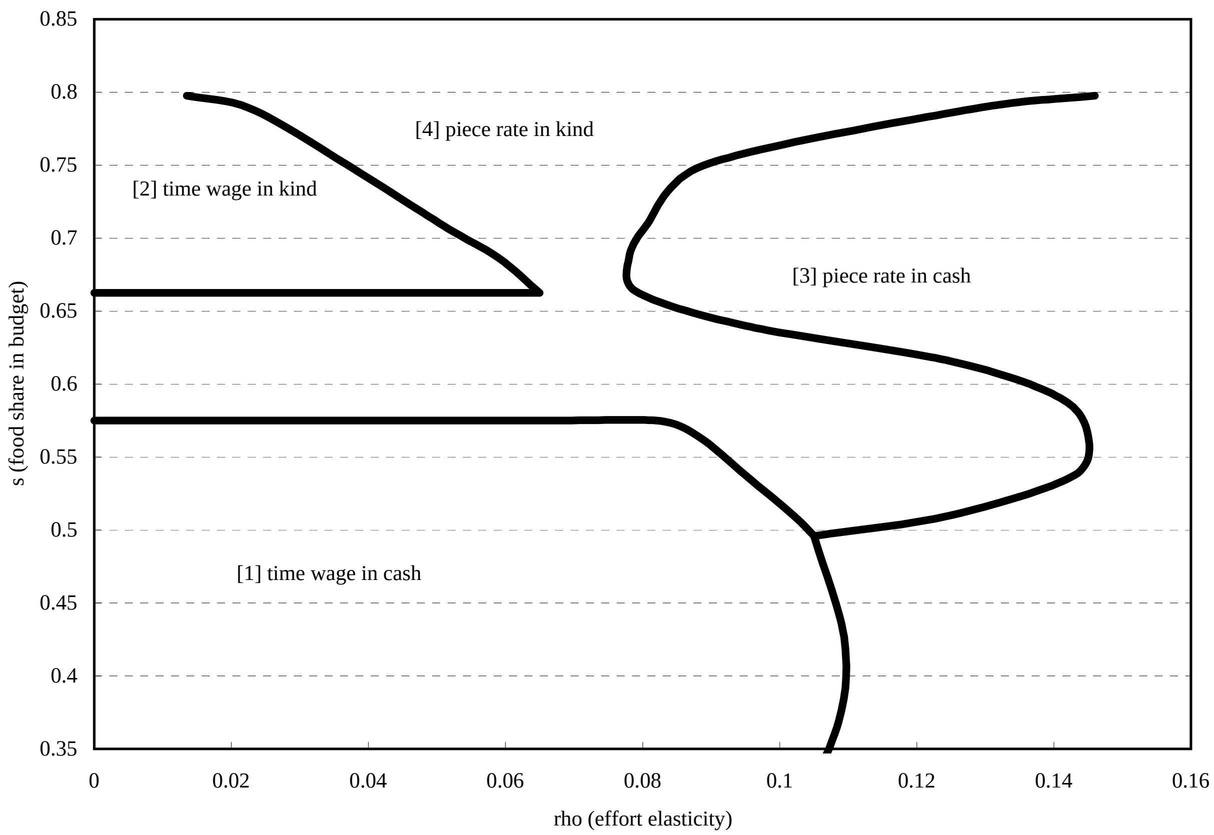


Figure 2: Optimal Contract Choice
(phi=3, theta and p are negatively correlated with -1/sqrt(2) correlation coeff.)



Map 1: Location of Survey Villages