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Reputation, Policy Risk, and Land Use

A Study of China's 'Grain for Green' Programme

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Abstract

Since 1999, China has spent RMB 50 billion (about US$7 billion) to implement the 'Grain for Green' programme, the largest land retirement programme in the developing world. From 1999 to 2003, over 7.2 million hectares of agricultural land were retired under the programme. However, many farmers report that they did not receive the compensation promised under the programme in exchange for planting trees on their agricultural land. This paper examines the impacts of subsidy payment shortfalls, delayed payments and programme uncertainty on farmers' participation in the Grain for Green programme. A stylized reputation game is used to explain how village-level corruption (subsidy underpayment), along with uncertainty regarding the likely longevity of the programme, discourage farmers' participation in the programme. Panel data are used to estimate the impact of previous payment shortfalls on subsequent …

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land conversion. A strong negative impact is found. Village level payment information is used to identify the impact on programme participation of both corruption and uncertainty regarding the programme's longevity. Further investigation reveals that variation in both payment receipt and programme participation appear to be driven by household specific characteristics, such as being a Communist Party member or working for the local government. These results provide useful guidance on how to make conservation efforts in developing countries more efficient and cost effective.

Figures and tables are at the end of the study.

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1 Introduction

Investors' future expectations are based upon previous experiences. Thus the reputations of participants in a contractual arrangement greatly influences their willingness to engage in possibly risky investments. If the legal infrastructure is incomplete or imperfect, as is often the case in developing countries, government agencies usually have more control on contract enforcement. Individuals holding contracts with the government sometimes find that the government does not honour them. In this situation, the reputation of the institutions administering government contracts can have a large impact on contract outcomes.

It is difficult to measure people's perceptions of their government's reputation, so there is relatively little direct evidence on the quantitative impact of government reputation on the success of public project implementation in developing countries. This paper examines the effect of reputation, in terms of both village level corruption and central policy design, using China's 'Grain for Green' programme as a case study. More specifically, this study examines the following questions: (1) Do previous government payment shortfalls discourage subsequent conversion of farm land into forest under this programme? (2) Does future uncertainty about whether the programme will be extended help explain changes in farmers' participation behaviour over time? And (3) how are the programme benefits distributed across different social groups, and how does the distribution of the subsidy affect farmers' participation?

The rest of this paper is organized as follows. The next section describes the Grain for Green programme and reviews some recent literature on that programme. Section 3 lays out a theoretical model of the reputation formation process to explain how village-level corruption (subsidy underpayment), along with uncertainty regarding the likely longevity of the programme, jointly discourage farmers' participation in the programme. Section 4 describes the GFG household survey data and presents some descriptive evidence that strongly suggests a link between previous subsidy underpayment and subsequent programme participation. Section 5 presents the empirical analysis, and the final section summarizes the results and presents suggestions for future research.

2 China's 'Grain for Green' Programme

In general, land use policy affects both environmental quality and economic development in rural areas of developing countries (Deacon 1995; Deininger and Minten 1999). Yet development and conservation goals are often in conflict, and China demonstrates this dilemma. China became the world's fastest growing economy after economic reforms were introduced in the early 1980s. However, this tremendous economic development has been accompanied by both significant environmental degradation and persistent pockets of rural poverty.

China's increasing population, and its growing disposable income, have increased its demand for grain, which exerts pressure on all natural resources, especially land. In addition to deforestation, intensive cultivation practices on agricultural land have increased soil erosion, often due to applying too much fertilizer on land that is only marginally suitable for cultivation. Soil erosion in China occurs mostly in its western provinces, which are the source of both the Yellow and the Yangtze Rivers. One year after devastating floods along the Yangtze River, China's central government initiated a land set-aside programme, known as 'Sloping Land Conservation Programme' or 'Grain for Green' (GFG) Programme.

To encourage local farmers to participate in the programme, China's government implemented an incentive scheme that gives farmers grain, cash payments and tree seedlings for converting their cropland to forest land. The grain subsidy varies from 1,500 to 2,250 kilograms per annum for each hectare of converted farmland, which has a market value of RMB2100 (US$260) to RMB3150 (US$390). The annual cash subsidy is RMB300 (US$40) for each hectare of converted farmland. On average, the total value of the compensation is over RMB3000 per year (Uchida et al. 2005). In addition to grain and cash payments, free tree seedlings are provided to participating households. The duration of the subsidies is as follows: eight years for converting farmland into ecologically protected forest;[1] five years for conversion of farmland into economic forest;[2] and two years for converting farmland into grassland. During these periods farmers must continue their reforestation efforts, under the leadership of their local government (village, county, or township).

Besides the direct environmental and ecological benefits, the GFG programme was designed to reduce rural poverty. China has more than six million hectares of farmland with a slope of over 25 degrees. The project was designed to convert cultivated land on slopes of 25 degrees or more to forestland in order to reduce cultivation of steeply sloped land. Sloped cropland usually has a limited water supply and low fertility, and high rates of soil erosion lead to low, unstable grain yields. The upstream area along the Yangtze is known for its underdeveloped economy and fragile environment, so the programme should have been attractive to most farmers in that area.

Although many programmes attempt to combine economic development with conservation goals, conservation projects in developing countries have had less impact than expected. Problems with China's 'Grain for Green' programme include inconsistent and unstable policy planning, and inadequate and irregular compensation payments. The policy clearly states that people who convert their croplands should plant trees, and those who manage the forests should benefit, but there have been several problems regarding compensation.

Several studies report that the GFG compensation payments either failed to materialize or were only partially paid. Xu and Cao (2001) examined a group of 1,026 participating households from the Shannxi, Gansu, and Sichuan provinces and found that 49.5 per cent had received only partial compensation. Among these partial payment recipients, 8.5 per cent had received only the grain subsidy, and 17.6 per cent had received no compensation at all up to the time of the survey (in 1999). Furthermore, grain payments have often involved poor quality grain. Xu et al. (2010) document that significant compensation shortfalls were still occurring in 2003. On average, only about 49 per cent of the grain subsidy and 23 per cent of the cash subsidy had been received by the programme participants. Moreover, Xu et al. point out that the shortfalls do not appear to be the result of programme lag time or sanctions due to poor implementation; some counties that had the maximum average subsidy shortfall also had the highest average tree seedling survival rates in the sample (the tree seedling survival rate is the main qualifying criteria for receiving subsidies). They also discuss possible reasons for

1 Growing these types of the trees is done mainly to reduce soil erosion.

2 These trees have economic values, such as fruit trees, timber, etc.

payment shortfalls, including local government reallocation of subsidies for other uses, and delays in payments due to insufficient implementation capability.

Grosjean and Kontoleon (2007) use different data (from Ningxia and Guizhou provinces) to analyse farmers' contingent post-programme land and labour decisions. Their empirical analysis includes a dummy variable, 'subsidy assurance', that measures whether households receive the programme subsidies in a timely and consistent manner. Their results reveal that the likelihood of re-enrollment is affected not just by the subsidy amount but also by the implementation assurances offered to farmers. In particular, they found that the subsidy assurance affects participation more in geographic areas where farmers have fewer off-farm opportunities.

China's GFG programme is a typical 'government payments for environmental services' programme (Wunder et al. 2008).[3] For historical reasons, as well as current land policies such as tenure insecurity and frequent government land redistribution efforts, farmers fear that there will be changes to the GFG programme. For example, according to one internal government report (China Forest Department report 2005), there was a sudden reduction in the size of the programme target in 2003 and 2004, which led to a large number of unpaid subsidies. Whether the programme will be continued and expanded nationwide depends on the success of the current pilot programme, which has been implemented only on a small scale. The data used for this study were taken from the three provinces—Shannxi, Gansu, Sichuan—that participated in the initial pilot programme.

As discussed in Bennett and Xu (2008) and Zuo (2001), both the land retirement and subsidy distribution processes of the GFG programme have been conducted using a top-down approach, where the central government distributes funds to the provinces, which then funnel funds and grain to counties, townships, and finally to villages. This process makes it easy for corrupt government officials at several administrative levels to divert GFG funds to other purposes, and it also implies that farmers may have difficulties making long-term land use decisions because of delays in the programme's implementation. Xu et al. (2010) explain that one reason for the delays is that the programme expanded so fast that local government agencies have not been able to check whether the converted land satisfies programme requirements (such as tree survival rates). Delays in certifying converted plots at the village level leads to reporting delays to the next level of administration, which resulted in top-level mistargetting and inconsistent programme planning. If previously converted land is not certified by spring, when farmers have to make their planting decisions, they will be more reluctant to participate.

Corruption and rent-seeking behaviour occurs not only in environment related projects (Barbier et al. 2005; Bulte et al. 2007), but also in other public programmes in developing countries. Reinikka and Svensson (2004) examined public expenditure on education in Uganda; they found that, on average, local schools received only 13 per cent of the grants that had been awarded, with most schools receiving nothing. This paper not only measures the magnitude of 'local capture,' but also measures for China's GFG programme the impact of local capture on the land conversion rate, a direct programme objective.

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[3] Government-financed programmes often start as pilot programmes, followed by an expansion. Thereafter the size of these programmes tends to change with annual budget allocations, which cause policy inconsistency and payment uncertainty.

3 The model

This section presents a model of the GFG programme based on the reputation model of Kreps and Wilson (1982). The model analyses the strategic interactions between governments and farmers in a dynamic setting. Two features are added to the original model: (i) a partial payment parameter that separates participants, to show that favoured groups are more likely to participate in the programme; and (ii) a probability factor that measures the future longevity of the programme, to assess whether policy uncertainty discourages farmer's participation.

Consider a simple model with two players: a farmer (F) and a local government (G). In each period, the farmer chooses whether to participate in the programme and the local government decides whether to issue subsidy payments. Local governments can be 'honest' (H-type) or 'opportunistic' (O-type). Farmers update beliefs about the local government, based on previous payment history, and then decide whether to participate. The timing of the model is as follows:

(1) In Period 0, nature determines player G's type i, which can be either H or O. Player F has an initial probability distribution over player G's type: $pr(\text{i} = \text{H}) = \beta_1$; $pr(\text{i} = \text{O}) = 1- \beta_1$.

(2) In each period (t=1, 2, ...T), player F decides whether to participate. Let q_t be the probability that player F participates in period t. If player F chooses 'participate', then player G decides whether to pay the full announced programme compensation (C) for participation. Let $\gamma_{i,t}$ be the probability of 'pay' at time t for type i. If player G chooses $\gamma_{i,t} = 1$, the full subsidy S is issued. If $\gamma_{i,t} = 0$, player G pays only part of the subsidy, δS, with $0 \le \delta < 1$ and keeps the rest for itself. If player F declines to participate, she receives the agricultural production payoff, π_a.

(3) At the end of each period, by observing player G's choice, $\gamma_{i,t}$, player F updates her belief, β_{t+1}.

(4) The game has two variants. In one, the game ends at period T, and both players know this. In the other, the game ends at period T with probability α and at period T+1 with probability $1\text{-}\alpha$. The matrix below shows the payoffs corresponding to each strategy for the two types of player G:

	F G	pay	cheat
Honest	participate	S,C	$\delta S,-C$
	not participate	$\pi_a,0$	$\pi_a,0$

	F G	pay	cheat
Opportunistic	participate	S,C	$\delta S,(1-\delta)S$
	not participate	$\pi_a,0$	$\pi_a,0$

Player G's payoff consists of a monetary part, the direct economic benefit from implementing the programme, and a non-monetary part related to local farmers' public trust and to evaluation of player G's institutional performance by the upper level administration. Assume that both types of player G receive both the monetary and non-monetary parts as their payoffs. The distinction between the H-type and the O-type is the difference in local government preferences over the monetary and non-monetary parts. An H-type truly cares about farmers and/or is punished for breaking promises; in either case the non-monetary part is more important for the H-type. An O-type, on the other hand, puts more or all of the weight on the monetary part and captures as much as it can from the project for its own pocket. Therefore, the payoffs for both types to play the 'cheat' strategy are weighted sums of these two parts.

The model assumes that both player G types get a positive C if they follow the rules and pay the full subsidy to player F, although the meaning of getting that benefit may differ for them. Also, both player Gs suffer a cost, $-C$, of a lower reputation if they play a 'cheat' strategy, in exchange for an immediate benefit of $(1-\delta)S$. Again, H-types care only about reputation and ignore everything else, so the payoff for H-types from cheating is simply $-C$. In contrast, O-types will get $(1-\delta)S$ by cheating, because they value only the monetary benefit.

The model also assumes that $\delta\pi \leq \pi_a \leq S$; in a full information world, where farmers know the type of local government they are dealing with, a farmer who plays with an H-type will choose 'participate', and a farmer who plays with an O-type will choose 'not participate'. Moreover, if $0 < C \leq (1-\delta)S$, then an O-type prefers to cheat and an H-type prefers a 'pay' strategy.

3.1 The case without uncertainty about programme length

To begin, consider the situation without uncertainty regarding the longevity of the programme, which means that both players know that the game will end at period T.

Proposition 1: *Given* $0 < C < (1-\delta)S$ *, if player F's prior belief is that* $\beta_1 \geq \frac{\frac{\pi_a}{S}-\delta}{1-\delta}$ *, there exists a pure-strategy pooling Perfect Bayesian Equilibrium (PBE),*[4] *which consists of the following:*

i) for t=1,...,T-1, player G's strategies are $\gamma_{H,t} = \gamma_{O,t} = 1$;

ii) player F's belief function is updated as follows: $\beta_{t+1}(\gamma_{H,t} = \gamma_{O,t} = 1) = \beta_t > 0$*; otherwise* $\beta_{t+1}=0$*;*

iii) player F's strategy is the following: $q_t(\beta_t > 0) = 1$*; and* $q_t(\beta_t = 0) = 0$ *for t=1,..., T;*

iv) a separating strategy at period T is: $\gamma_{H,T} = 1$ *and* $\gamma_{O,T} = 0$.

In other words, if $\beta_1 \geq \frac{\frac{\pi_a}{S}-\delta}{1-\delta}$, then an O-type player G can mimic H-types and play $\gamma_{O,t} = \gamma_{H,t} = 1$ until period T and play $\gamma_{O,t} = 0$ to get maximize the payoff (since player F will play $q_T = 1$ if $\beta_T = \beta_1$).

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4 Kreps and Wilson (1982)

Now consider what happens if the prior belief is not high enough to guarantee participation in the last period. With $\beta_1 < \frac{\frac{\pi_a}{S}-\delta}{1-\delta}$, if the O-type does not do something to enhance player F's belief, so that $\beta_T = \beta_1$, then player F will not participate in period T and O-type will lose the chance to play 'cheat' in the last period. Intuitively, playing with skeptical player Fs, an O-type has to play more strategically to convince player F to participate.

Proposition 2: If $\beta_1 < \frac{\frac{\pi_a}{S}-\delta}{1-\delta}$, *there exists a mixed strategy (hybrid) PBE that an O-type chooses, with* $\gamma_{O,t} = 1$, if t<T *and* $\beta_t \geq \left(\frac{\frac{\pi_a}{S}-\delta}{1-\delta}\right)^{T-t}$; $\gamma_{O,t} = \frac{\beta_t(1-(\frac{\frac{\pi_a}{S}-\delta}{1-\delta})^{T-t})}{(1-\beta_t)(\frac{\frac{\pi_a}{S}-\delta}{1-\delta})^{T-t}}$, *if t<T and* $\beta_t < \left(\frac{\frac{\pi_a}{S}-\delta}{1-\delta}\right)^{T-t}$;

and $\gamma_{O,T} = 0$ *if t=T. Player F plays* $q_t = 0,$ *when* $\beta_t < \left(\frac{\frac{\pi_a}{S}-\delta}{1-\delta}\right)^{T-t+1}$; plays *a mixed strategy with* $q_t = 1 - \frac{C}{(1-\delta)S}$, *when* $\beta_t = \left(\frac{\frac{\pi_a}{S}-\delta}{1-\delta}\right)^{T-t+1}$, and plays $q_t = 1$ *when* $\beta_t > \left(\frac{\frac{\pi_a}{S}-\delta}{1-\delta}\right)^{T-t+1}$.

Proof: both proofs of proposition 1 and 2 are straightforward and directly from Kreps and Wilson (1982).

In short, the probability that player F believes that player G is an H-type is a function of how the game has been played up to period t, (i.e. $\beta_{t+1}(\gamma_t)$). Farmers then decide whether to participate, depending upon the expected payoff, as determined by the updated belief (i.e. $q_{t+1}(\beta_{t+1})$).

The partial payment parameter, δ_t, accounts for exogenous factors that determine how much an O-type government would pay of the total contract amount. For example, farmers who have close ties to the local administration may be paid more than others. Farmers' responses will depend on how they have been treated previously, and their view of the probability that the government will pay. Note that both the mixed strategy probability and the threshold of playing 'participate' depend on δ. Simple calculation shows that the participation probability is a decreasing function of δ. Thus if player G chooses to pay more to a specific group than to others (i.e. $\delta_1 > \delta_2$), the threshold probability for this favoured group will be lower. Therefore, the favoured group is more likely to participate in the programme.

3.2 The case with uncertainty about programme length

In the standard reputation model the players know when the game will end. In reality, however, this is not always true. For the 'Grain for Green' programme, the central government periodically changes the size of the programme, which typically reflects the annual government budget. Moreover, the GFG programme started in 1999 as a pilot (experimental) project. In 2003 the central government debated whether to expand the programme to the whole country or end it. The decision was based on programme evaluations conducted during the pilot phase. Thus, during this phase neither the local government nor the individual farmers knew whether the programme would be extended, which created uncertainty about the end date of the programme.

To account for this uncertainty about the programme's end date in a relatively simple way, the original reputation model can be extended by assuming that there are either two or three periods. There are two variations of the model depending on the timing of the announcement of whether there will be a third period. In one variant this announcement is made before player F decides whether to participate in period 3. In the other, the announcement is made after player F makes that participation decision. While the likelihood of having a third period determines player F's participation threshold, the equilibria under 'early announcement' are similar to the previous (no uncertainty) case. Thus the focus will be on the second variation (delayed announcement).

Delayed announcement

Let α^D be the probability that the programme has only two periods, and 1 - α^D be the probability that it will be extended to a third period. Also assume that $(1 - \alpha^D)S \geq \pi_a \geq \delta S \geq (1 - \alpha^D)\delta S$, otherwise the payoffs and the rules of the game are the same as in the previous case. The announcement about whether the game will continue to a third period is made after player F decides whether to participate in period 3. If there is no third period, the game ends after player F's move with zero payoffs for both players in period 3. If there is a third period, then after the announcement, player G will decide to 'pay' or 'cheat'. The payoffs and rules of the game remain the same, except that the notation has a superscript 'D': α^D, β_t^D, [illegible]$^{D}_{O,t}$ and q_t^D.

Whether a pure-strategy pooling PBE (where player G pooled on 'pay' for the first two periods and separate in the last period) exists depends on player F's prior belief of the likelihood of having a third period. The condition for player F to choose 'participate' in period 3 is:
$(1 - \alpha^D)(S\beta_3^D + \delta S(1 - \beta_3^D)) > \pi_a$. Assuming that the farmer will participate in period 3, the condition for an O-type government to choose 'pay' at the second period is: $C + (1 - \alpha^D)(1 - \delta)S > (1 - \delta)S$.

Once all the payoffs and the probability meet the pooling equilibrium conditions, the structure and details of the pooling PBE are similar to Proposition 1. Therefore, focus on a more interesting situation where the prior belief is not high enough to guarantee that player F will participate at the beginning of the third period, (i.e. $\beta_1^D < \frac{\frac{\pi_a}{S(1-\alpha^D)} - \delta}{1-\delta}$).

Proposition 3: *If player F's prior belief,* $\beta_1^D < \frac{\frac{\pi_a}{S(1-\alpha^D)} - \delta}{1-\delta}$*, and the probability of having a third period is sufficiently high* $1-\alpha^D > 1-\frac{C}{(1-\delta)S}$*, there exists a mixed-strategy (hybrid) PBE.*

Proof: (for the details and the proof, see Appendix 1)

Consider how the uncertainty factor α^D plays a role in the equilibrium with a 'delayed announcement'. First, the minimum belief required for player F to play 'participate' in each period, β_t^{D*}, for t=1, 2, 3, are all decreasing functions of $1-\alpha^D$. This implies that the higher the probability of having a third period, the lower the belief threshold required for player F to enter the game, and the later she switches to a mixed strategy. Because both players know α^D and β_t^{D*}, with a higher $1-\alpha^D$ and lower β_t^{D*}, the farmer knows that it will be less likely for the O-type government to play 'cheat' and therefore, the farmer will play pure strategy 'participate' longer.

Second, the mixed-strategy probabilities for the O-type to pay in both periods 1 and 2 are increasing functions of $1-\alpha^D$. This means that if the expectation of having a third period is low, an O-type player G is more likely to pay in the earlier periods. In particular, for $\gamma_{O,2}^{D*}$, when $\alpha^D = 0$, the result converts to the standard reputation model without uncertainty that has been discussed in the first part for T=3 (Similarly for α^D = 1, it will be the same with just two periods).

From the farmers' perspective, both the uncertainty factor, 1 - α^D, and the partial payment factor, δ, will raise the participation belief threshold and influence the equilibrium in a similar fashion that discourages their incentive to participate. However, from an O-type player G's point of view, these two factors can have opposite effects. An O-type government will benefit from a higher $1-\delta$, but will suffer from a higher α^D in the same way as player F will. In other words, player G does not have any control on α^D, which explains why the uncertainty factor enters in the O-type's mixed-strategy probability.

In sum, in a world that has both uncertain information regarding the type of the player G and the future of the programme, to participate in the programme, player F needs a sufficiently high belief to overcome three types of risks: 1) the risk of facing an O-type player; 2) the risk of losing the reservation income 'π_a' due to the 'delayed announcement'; and 3) the risk that an O-type player G will cheat even earlier due to the fear that the game will end too soon, so that he or she is unable to cheat in the future.

3.3 Discussion

The above model attempts to capture two different issues that could discourage farmers' participation in the programme. The first is village-level corruption, where the local government does not pay farmers all that they are entitled. The second issue is problematic programme planning where the central government may cancel or re-target the programme. Both will cause farmers to be under-subsidized, but through different mechanisms.

Note that the current model assumes that farmers pay no additional cost to reconvert forest land back to agricultural use if they decide to drop out of the programme in later periods. In reality, however, farmers must pay various costs for reconversion, such as the extra labour costs of cutting down trees, cleaning up, ploughing and sowing land to prepare for raising crops in the next growing season. If player F incurs a cost to return land to cultivation, his or her actual payoff from choosing to participate but then being cheated will be less than δS. In other words, the payoff to player F from initially choosing not to participate is higher than π_a. Given the above discussion, the probability that player F will enter must be adjusted in such a way that, the higher the switching cost is, the earlier player F will switch to the mixed-strategy and the less likely he or she chooses 'participate' in later periods. The model also simplifies the costs that farmers pay to participate in the programme, such as purchases of tree seedlings, the labour cost of planting trees, and the cost of technical support to improve seedlings' survival rate. All these costs will further reduce farmers' incentive to participate.

In sum, modifying the reputation model to allow for both heterogeneity in programme participants and future uncertainty yields the following predictions: (1) Previous subsidy shortfall reduce current programme participation. (2) If an O-type government discriminates among farmers based on their specific characteristics, the favoured group should have a relatively high participation rate.[5] (3) Greater uncertainty about the end date of the programme reduces farmers' participation.

4 Data and descriptive analysis

The data used for the empirical analysis in this paper are from a two year panel data set collected in China in 2003 and 2005 by the Center for Chinese Agricultural Policy, the Institute of Geographical Sciences and the Chinese Academy of Sciences. During the second round of data collection in 2005, the survey included questions to collect recall information for the year 1999. The data were obtained from a stratified random sample of households in rural areas of China where the 'Grain for Green' programme had been implemented. The final data set has 348 households, of which 266 participated in the programme, from 40 randomly selected villages in 18 townships, 6 counties and 3 provinces: Shaanxi, Gansu and Sichuan (Uchida et al. 2005).

The household questionnaire was similar to those of the World Bank's Living Standard Measurement Study surveys, with detailed questions on many household characteristics and activities, including land transactions, agricultural production, and household members' demographic in-formation. The survey also asked participants and non-participants their perceptions of the programme, the sizes of plots they converted, the compensation amounts listed on the contract, actual compensation received, and the future plans of participating farmers after the programme ended.

4.1 Data construction

'Underpayment amount' is the most important variable used in the regression analysis. It is defined, for each year after a farmer converted land, as the difference between the subsidy the farmers actually received and the subsidy the farmer was entitled to receive as specified by the formula set by the central government. Villages have different payment schedules that depend on several factors, including the date when the local government received programme payments from higher levels of government, the timing of the certification process, and local government efficiency. In some villages, farmers received the subsidy the same year they converted land, while in others farmers had to wait until the following year.

However, this definition of underpayment suffers from a potentially serious shortcoming: it does not distinguish between underpayment and delayed payment. The difference in any given year between the payment received and the contractual amount could include both receipt of a delayed payment due in a previous year and shortfall in the current payment. Unfortunately, the data available do not distinguish between delayed payments and payments

5 However, farmers could have different perspectives, which could reflect the same characteristics that determine their payment priority. For example, the farmers who are favoured by the local government, and so get paid more, may also have more information or confidence about the future of the programme. In this case, the game could be more complicated, because an O-type G could take advantage of the group's future confidence by paying them less without losing this group's participation and pay more to the other farmers to raise their participation. In this sense, the parameter δ could be endogenously determined by the O-type government depending on the sizes of these two effects and the relative proportion of the two groups. While this could be an interesting extension of the model, due to limited empirical data, we defer this issue to future research.

of current obligations. Since both delayed payment and underpayment may affect farmers' behaviour, the impact of the underpayment variable is, in effect, a weighted average of the impacts of these two phenomena.

The first task in calculating underpayment was to construct a variable that measures the contract payment amount, the cash and/or grain payments that the contract specifies to be delivered to the household, based on the amount of the land converted from crop land to forest or grassland. Each household reported both payments stipulated by the contract and 'realized' payments for 2003 and 2004, but for earlier years only the 'realized payment' was collected. Therefore, to calculate the underpayment from 1999 to 2002 one must infer the contract amount. For each year, the data include the amount of land converted to ecological forest, economic forest or grassland, which allows one to calculate the subsidy payment based on programme rules, which were announced by the central government.[6] The annual programme underpayment is then calculated as the 'contract payment amount' minus the 'realized payment'.[7]

To check this approximation, Table 1 shows the correlation between the constructed 'contract amount' and the self-reported 'contract amount' as well as the correlation between constructed and self-reported underpayment for 2003 and 2004. Except for the grain subsidy in 2004, the correlation between the approximation and the survey data ranges from 0.44 to 0.80. Since the self-reported data may also be measurement with error, the constructed underpayment variable appears to be a reasonable approximation of the true value.

Table 2 shows the number of households that were underpaid (positive underpayment amount) and the number that were overpaid (negative underpayment amount) in each year of the panel. It is very unlikely that the government would overpay the participants, so the only explanation is that the previous subsidy payment was delayed, which led to the 'overpayment' in subsequent years. Thus observation of overpayments indicates previously promised, but delayed, payments. It is not surprising that the percentage of overpaid households rises over time, from 1 per cent in 1999 to 30 per cent in 2004, in Table 2.[8]

This information can also be used to construct 'accumulated underpayment amount', the accumulated sum of the difference between payment stipulated by the contract and the realized payment over time, to better measure the effect of underpayment. If observed underpayments reflect both delayed payments that are repaid in later years underpayments that are never repaid, the accumulated underpayment variable will increasingly reflect only the latter as time passes. Thus the empirical analysis in the next section examines not only the effect of the 'annual underpayment amount' but also the effect of the 'accumulated underpayment amount', since the latter is less influenced by delayed payments as time passes.

6 See Uchida et al. (2005)

7 Delayed payments imply that the underpayment amounts could be negative if last year's payment is paid this year.

8 Some villages started the programme earlier than 1999 which causes the overpayment in 1999.

4.2 Descriptive evidence

This subsection presents basic descriptive statistics relevant to the analyses presented in the following subsections. Figure 1 shows newly converted land as a percentage of households' total convertible agricultural land (excluding land converted in previous years). On average, about 10-15 per cent of current convertible land is converted each year, and this percentage decreases over time. This decreasing trend is consistent with the model's prediction that the probability of a farmer's participation declines over time. However, there are two other possible reasons for this decreasing trend: 1) farmers are likely to first convert their lowest quality land, and will stop participating when they reach the point where the remaining eligible land is more profitable to retain as cultivated land; and 2) due to frequent redistributions of agricultural land in rural areas (Jacoby et al. 2002), the total land area cultivated by each household changes over time, and a decrease in land conversion could be due lower availability of crop land resulting from a recent land redistribution.

Figure 2 plots households' average annual underpayment, as a percent of the payment specified in their contracts, from 1999 to 2004.[9] There is a clear upward trend in the first four years and a downward trend in the last two years. As discussed earlier, around 2002 and 2003 was the end of the five-year pilot phase (experimental period) of the programme. Treating the time period around 2002 and 2003 as a hypothetical ending point, that is the end of period 2 in the reputation game discussed above, the data in Figures 1 and 2 match the game theoretic prediction: the likelihood of cheating behaviour generally increases, and the likelihood of participation decreases, toward the end of the game. In other words, the more uncertainty about the future, the less likely that farmers continue to participate in the programme.

Figure 3 shows grain underpayment and cash underpayment separately. Overall, there was an upward trend from 1999 to 2002 and a downward trend after that. Interestingly, in 2004 the (average) grain underpayment was negative, so that farmers' grain payments were overpaid. There are two explanations for this: 1) farmers received delayed grain payments in addition to their current grain payments in 2004; or (2) cash payments were replaced by the grain payments. Both are consistent with previous studies (e.g. Xu et al. 2010) that suggest that grain subsidies are paid more often than cash subsidies.

To further investigate the payment inequality issue, we use the data that collected separately at the village level, mostly from the village accountant records to calculate the payment that village received from the next higher level government. Figure 4 is a plot of village underpaid cash amount overlaid with the household underpaid cash amount. One finds that the underpaid cash subsidy at the household level is almost 10 percent higher than the village level underpaid proportion. Although this could due to either side of the faulty recording or reporting, if the individual household sample is truly randomly selected, the gap between village and household should motivate further exploration on the way the subsidy is being distributed within each village.

Table 3 provides information on subsidy payments that compare 'elite' households with other farmers. Elite households are defined as households with at least one member who either works for the local administration or is a communist party member. This 'elite group' is, in general, less likely to be underpaid its cash payments. In particular, the difference of cash

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9 The total value of the subsidy is calculated by adding the cash payment to the monetary value of the grain payment. The value of the grain payment is calculated using separate market prices for different types of grains.

payments between these two groups increases significantly in 2002 and almost doubles in 2004. The difference of the total underpayment between these two groups is similar to the underpayment in cash amount for 1999 and 2002, but not for 2004.[10] A simple t-test of the difference between these two groups' means indicates that they are significantly different from each other (10 percent level).

Next, consider whether farmers change their perception of the programme based on subsidy shortfalls, and whether this becomes a major determinant of their future participation. The answer, summarized from the survey questions regarding participants' and non-participants' perspectives on the programme, shows that, in both 2002 and 2004, the number of payment-related negative comments accounted for 37 per cent to 44 per cent of all other negative comments regarding issues, such as technical support levels, programme extensions, and management issues. The survey also asked non-participants why they did not participate in the programme. The survey shows increasing worry among non-participants about payment shortfalls, delayed payment, and unequal payment distribution, based on observing participating households. This suggests that observing past government performance does affect farmers' decisions about whether to participate in the programme, as has been mentioned in the previous literature.[11]

5 Empirical identification and estimation

This section presents estimates of the determinants of which households are underpaid, and the impact of underpayment on household participation decisions,

5.1 Who is underpaid? The evidence from households

Recall the assumption in the theoretical model that the local government may pay different farmers different subsidy amounts. Recall also that the probability of a farmer's participation in each period is partly determined by how much he or she has been paid previously, and that an O-type government decides when to play a mixed strategy by comparing the farmer's updated posterior belief with the probability threshold in each period. Thus farmers' characteristics determine, in part, how much they are paid. Appendix 3 provides the summary statistics for the variables used in the empirical analysis.

Let U_{ijt} denote the subsidy underpayment for household i in village j at time t. The explanatory variables include household i's characteristics, denoted by Z_{ijt}, and characteristics of the household's land, denoted by L_{ijt}. Finally, let v_j be unobserved village-specific characteristics and ε_{ijt} be household-specific unobserved characteristics. The model to be estimated is:

$$U_{ijt} = \alpha Z_{ijt} + \sigma L_{ijt} + v_j + \varepsilon_{ijt}$$

10 The reasons for focusing on cash underpayments are: (1) the cash subsidy has a relatively clear standard: RMB300 per hectare per year, but grain payments depend on area; (2) in general, farmers value cash payments more than grain payments; and (3) to partially account for the fact that some cash payments are replaced by the grain payments.

11 See Grosjean and Kontoleon (2007).

To explore the richness of the data on land conversion and subsidy payments, both cross-sectional results for 2003 and 2004, as well as panel results are presented.

2003 and 2004 cross-sectional results

The first set of regression results uses the 2003 and 2004 recall data, which were collected in 2005. This is done separately for six dependent variables: farmers' self-reported underpayment amounts in cash and grain, their percentage amounts, and the sum of these two variables and its percentage amount.[12] The results are presented in Table 4.

Overall, the estimates that have grain payments as the dependent variable yield coefficients that have lower statistical significance than those for the other dependent variables. This may reflect the fact that some local governments replace cash subsidies with grain payments to extract additional monetary profits. If this is the case, the coefficients estimates from regressions with either cash or grain as the dependent variable could be biased, but in an opposite direction, due to the correlation between measurement error and any of the explanatory variables, which is very likely. Furthermore, if cash payments are replaced by the grain payments in some villages, and villages' propensity to do so is unrelated to the explanatory variables, this would produce random measurement error in the dependent variable, and so lead to less precise estimates. In contrast, the results for cash and total value of underpayment yield similar, and statistically significant, findings.

All regressions in Table 4 use a village level fixed-effects specification. The results show that households with steeply sloped land are more likely to receive their payments, which is not surprising because the programme gives priority to steeply sloped land. Interestingly, households with communist party members are significantly less likely to be underpaid. A household with one more communist party member receives RMB358 (US$31) more in cash payment and RMB 442 (US$63) more in total subsidy value. However, except for one grain payment regression there is no significant effect of having a family member working in the local administration.

1999-2004 results with constructed underpayment variables

Several additional features of the underpayment variables in these regressions are worth noting. For each of the three variables (underpaid in cash, in grain or total value), about half of the observations equal zero. Moreover, for households who experienced payment shortfalls, those shortfalls vary widely. To check the robustness of the results, several transformations of the dependent variable were used. Of those, the log(U) transformation (or -log(-U), if $U < 0$, or 0 if $U = 0$) best fits the data.

As a robustness check, and to confirm the findings from Table 4, Tables 5a and 5b report results from both an OLS and a village level fixed-effect model that use five years of data with the constructed underpayment amount as the dependent variable[13]. Table 5a uses the log of annual underpayment value as the dependent variable, while Table 5b uses the log of *accumulated* underpayment as the dependent variable. Using the accumulated underpayment variable should reduce the impact of short-term delays in payments, so this variable focuses on underpayments that will probably never be paid.

12 The grain payment is monetized by multiplying the grain amount by the market price for that type of grain.

13 The correlation between constructed underpayment and self-reported underpayment in 2003 and 2004 is 40-60 per cent.

The log annual underpayment results in Table 5a use both OLS (columns 1 and 2) and village fixed-effects (columns 3, 4 and 5) specifications. In general, the results in Table 5a are similar to those in Table 4. Columns 1 and 3 exclude the effect of having household members working for the village, focusing on the effect of having a Communistic Party member. Results suggest that, with or without the effect of having village administration workers in the household, there is a strong negative effect of the number of household members who are Communist Party members on households' payment shortfalls. Yet the results from columns 2, 4 and 5 suggest that having household members work for the local government has little effect on subsidy receipt.

The results in Table 5a also show a strong positive effect of household non-agricultural income on underpayment, which may reflect a distributive priority that some villages follow: households with lower income get paid more, or at least have a shorter delay. This priority may also explain why households with more educated heads receive smaller payments, but this is significant only for the two OLS specifications. The coefficient estimates on 'slope land' variables support the results in Table 4 that having more sloped land decreases a household's subsidy underpayment.

The dependent variable used in Table 5b, log accumulated underpayment, focuses more on real subsidy shortfalls rather than on short-term payment delays. Results are consistent across all specifications in Table 5b. Both 'education of head' and 'total land owned' have significant negative impacts on subsidy receipt. Again, the significant impact of 'having a communist party member' suggests that such households, who seem to have special status in the community, not only get their subsidies on time but are also more likely to eventually get their subsidies.

The young labourer variable represents households' alternative economic opportunities. Not surprisingly, having more economic alternatives reduces the probability that a household receives its subsidy, perhaps due to a village's distributional rule. Interestingly, the percentage of land in either category 2 or 3 does not affect a household's accumulated underpayment. Thus the steepness of a household's land may have a large effect on whether payments are delayed (Table 5a) but is not a major determinant of permanent subsidy shortfalls.

5.2 The reputation effect

The reputation game between farmers and the local administration generated three testable implications regarding programme participation and local governments' payment behaviour conditional on farmers' participation choices. First, if future uncertainty is assumed to increase over time (i.e. α_t is a decreasing function of $T - t$), then over time farmers would start to randomize the 'participate and 'not participate' strategies and eventually will drop out of the programme toward the end of the game. This is because the threshold belief for farmers to participate in the programme is an increasing function of future uncertainty, which is predicted by a mixed-strategy PBE. Second, if the government's reputation is based on the past experiences of farmers' concerning their subsidy payment, one should expect a negative relationship between the amount of land currently converted and past underpayment. Third, if some farmers are paid more than others, the favoured group should have more incentive to participate in the programme.

Recall that the theoretical model implies that the equation for the probability of a farmer's participation in the programme can be written as:

$$P_t > P_t^* = F(\pi_{at,}, (1 - \delta_{t-1})S, \alpha(T - t))$$

where π_{at} is the opportunity cost to participate in the programme and a negative coefficient should be expected; $(1 - \delta_{t-1})S$ is the lagged underpayment amount with an individual specific partial payment parameter, δ_{t-1}; and the uncertainty parameter α, which is a function of $(T - t)$. A linearized specification of the amount of land currently converted, as a function of the household's previous underpayments, household and village specific characteristics, and a time effect, is:

$$P'_{ijt} = \beta_1 X_{ijt} + \beta_2 U_{ij,t-1} + \beta_3(T - t) + \theta_{ij} + v_j + \varepsilon_{ijt}$$

where P'_{ijt} is the proportion of household i's land in village j that is newly converted at time t; X_{ijt} is a vector of exogenous explanatory variables that describe household i's economic, political and social status, such as household income, number of household members who are party members, and number of household members who work for the local government; and $U_{ij,t-1} = (1 - \delta_{ij,t-1})S$ is the proportion of the subsidy payment that household i did not receive at t-1. Assuming that future uncertainty increases over time, participation is a function of timing, which is the years remaining before the end of the experimental period (in 2003), so the regression equation includes a time variable, 2003-t. Finally, $\theta_{ij} + v_j + \varepsilon_{ijt}$ is a composite error term, where θ_{ij} is a time-invariant fixed effect on programme participation for household i who lives in village j, v_j is a village fixed effect that captures local government characteristics,[14] and ε_{ijt} represents household-specific time varying unobserved characteristics.

The previous underpayment, $U_{ij,t-1}$, is the main variable of interest. Recall that the theoretical model shows that there are two distinct factors, corruption and poor programme planning, that can reduce farmers' incentive to participate. Unfortunately, the available survey data do not provide sufficient information to separately identify the impacts of corruption and of policy design and implementation, both of which lead to the policy uncertainty regarding programme longevity.

There are two estimation problems that can lead to inconsistent estimates. First, unobserved household characteristics (θ_{ij}), such as differences in land converting preferences, risk aversion and discounting, are likely to be correlated with the regressors, such as underpayment, total crop land and other household income. A household fixed effects specification is used to address this problem. The regression also includes year effects to capture the average impact of changes in national policies that may have affect all households similarly in a given year.

The second estimation problem is that, even after controlling for time invariant household fixed effects, some time-varying household characteristics, such as a household's ability to be involved in local government decision making, or efforts households make to lobby local administrators, may jointly affect both payment shortfalls and programme participation. More specifically, consistent estimation using a fixed-effects specification requires that neither (X_{ijt}

14 The village-level fixed-effects are irrelevant once household fixed effects are used.

- $\overline{X}_{ij}$) nor (U_{ijt} - $\overline{U}_{ij}$) is correlated with (ε_{ijt} - $\overline{\varepsilon}_{ij}$). But this is unlikely to be true. In particular, village officials change from time to time (they are either newly elected by villagers or appointed by the upper level government), and joining the Party or getting more of one's subsidy payment may depend on special connections that some households have with specific village officials. Thus the empirical analysis combines a household-fixed effect specification with instrumental variables.

Turn next to the instrumental variables. The first is the average survival rate of the tree seedlings the household planted, to instrument the underpayment variable over time. The idea is that the GFG programme has a system to monitor newly planted trees, and their survival rate should exceed a certain level; if not, the subsidy payment will be either reduced or not paid. Note that the local forest department, not the village government, conducts this monitoring so any 'special relationship' between the village government and some farmers should not play a role in this monitoring. One may argue that the survival rate is also endogenous in that household effort, or its 'talent' for growing trees, may be correlated with other regressors. Yet most types of the trees planted under the programme require less skill and less maintenance, so the survival rate depends more on exogenous growing conditions such as temperature and rainfall. Therefore the household average tree seedling survival rate is correlated with the underpayment variable, but should not otherwise be related to the land conversion rate in the next time period.

To further explore the household underpayment variable, lagged village underpayment is used as the second (excluded) instrumental variable. Recall the delayed announcement case of the theoretical model; the impact of corruption is combined with the impact of policy uncertainty due to bad programme planning. Yet the household survey data provide information only on household underpayment history without further explanations of the underpayment. Since delayed announcement could cause some earlier converted land to become ineligible for the subsidy, this type of the ineligible early conversion may not be counted in the current programme budget which implies this part of the subsidy should not be received by the village administration as well. Thus village level underpayment[15] was more likely due to programme planning issues rather than corruption. In particular, if corruption does not exist, all of the subsidy received by the village should be used for farmers' subsidy payments. Therefore the lagged village underpayment variable should be closely correlated with household underpayment, but does not otherwise affect household programme participation. Still, one could argue that village underpayments may be correlated with some unobserved village characteristics that eventually directly affect farmers' land conversion behaviour. For this reason, further tests are needed.

Tables 6a and 6b report several estimates of Equation (2) using 'proportion of converted land' as the dependent variable. Those in Table 6a use 'lag proportion of annual underpayment' and those in Table 6b use 'lag accumulated proportion of underpayment' as explanatory variables to distinguish the impact of delayed payments from that of

15 Village-level underpayment amount is calculated the same way as the household's underpayment: taking the difference between the total amount of the subsidy that a village is entitled (based on the total amount of the land converted at village level) and the amount actually received from the next higher level government.

underpayment.[16] In both tables, all regressions include household fixed effects, and the last columns also use instrumental variables.

In Table 6a, the first column tests the hypothesis that farmers converted less land toward the hypothetical end of the programme (around 2003). The estimated coefficient on the '2003-t' variable shows a significant negative impact on the percentage of newly converted land, which is consistent with the theory. Yet other interpretations could explain this negative time trend. For example, farmers may worry that their land may be redistributed if they do not participate early on in the programme. If these concerns involve only household time invariant characteristics, the fixed-effects specification implies that the coefficient on '2003-year' should reflect an average overall farmers' time preference for land conversion; only unobservable household characteristics that determine farmers' conversion behaviour and vary over time lead to bias. Another interpretation is that the land belonging to each household, in particular its sloped land that meets the GFG programme's standard is limited, and therefore less and less land will be converted over time. Also, farmers may first convert relatively low productivity land, and once all poor quality land is enrolled, they stop adding new plots to the programme, preferring to cultivate only the good land to maximize their profits.[17]

To further investigate these possibilities, the regressions add two explanatory variables, 'Total Converted Area', the accumulated sum of land converted since 1999, and 'Total Available Agricultural Land', the total crop land that a household controls (excluding converted land) to examine whether the participation is limited by the total amount of land in the household.[18] The results for these two variables in Table 6a indicate that: (1) The more a household has converted land in previous years, the more it converts in the current year; and(2) the more land the household controls, the less land it converts (0.5-0.7 per cent for every 10 mu more land controlled). These results may reflect households preferences for land conversion and crop production; some households may have less interest in crop production, so they continue converting their land every year, while other households have more household labour and crop production expertise and so prefer cultivating, and usually have more land than others. If households are limited by their total land holdings, after adding these two variables the coefficient on the time trend ('2003-t') should have no significant effect on land conversion. However, that is significantly positive in all regressions.

The regressions in columns 5, 6 and 7 add variables indicating the percentage of remaining land that is steeply sloped (category 2 or 3).[19] The results indicate that conversion is more likely when a household's remaining land is more steeply sloped. Most importantly, the coefficient on the variable '2003-t' remains positive and significant, which implies that the alternative interpretation that households' land constraints discourages them from converting land is, at least, not the only explanation.

16 Regressions were also run including both 'lag underpayment' and 'lag accumulated underpayment'. Although the signs of the coefficients do not change, all estimates become insignificant. This is probably due to these two variables' high correlation.

17 'Good land' refers to land that can produce an economic benefit similar to or higher than the GFG subsidy payment.

18 As households convert new land every year, these two variables will vary over time.

19 This variable differs from those in Tables 4, 5a and 5b, in that it excludes the plots that were previously converted.

The regressions in columns 5, 6 and 7 control for households' crop income, non-agricultural employment and number of young labourers to control for economic activities that could affect households' preferences to convert land, but none of these factors significantly affects land conversion[20].

The estimation results in Table 6b are consistent with those in Table 6a, although the coefficients on 'lag accumulated proportion of underpayment' focus more on the impact of real payment shortfalls rather than a payment delay. All coefficient estimates, using either annual underpayment or accumulated underpayment, are negative and highly significant. Thus the larger the subsidy shortfall that a household experienced, the less likely that it would convert more land in later years. Moreover, since estimates based on the annual accumulated underpayment data are less likely to be influenced by delayed payments, the coefficient estimates of accumulated underpayment should be a better measure of the impact of real underpayment. In fact, the underpayment coefficient estimates from annual underpayments are larger than those for accumulated underpayments. This suggests that delayed payments also discourage farmers.

Columns FE(2) - FE(5) in both tables show regressions that include two noteworthy variables: (1) the number of party members in the household; and (2) the number of household members who work for the local government.[21] After controlling for other factors, having party members has a significant positive effect on the amount of newly converted land, and this effect is consistent across all four columns. Each party member increases the land conversion rate by 0.13, to 0.17. In contrast, the coefficients on household members working for village government do not have significant effects on land conversion. Also, the absolute values of the reputation estimates, 'lag underpayment' and 'lag accumulated underpayment', do not change and remain significant.

To overcome the second identification problem, that changes in 'underpayment' over time may be correlated with some unobservable, time-varying household characteristics, the last columns in Tables 6a and 6b show regressions in which the underpayment variable is instrumented. Recalling the discussion in the previous section, the two instruments are 'average tree seedling survival rate' and 'village-level underpayment'. While it may seem unusual to have village level underpayment be an instrument variable for a household level variable in a fixed-effect specification, note that the village annual payment shortfall does change over time.

For these 'IV FE' estimates, the impacts of underpayment remain negative, although the estimate using accumulated underpayment (Table 6b) loses statistical significance. The coefficient on the Party member variable shows an even stronger positive impact on programme participation: households with a Party member convert 20 per cent to 30 per cent more agricultural land into forest land. In addition, having someone who works for the village also has a significant positive effect on land conversion in both regressions. Note finally that

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[20] There may have been other policy changes in these areas at the same time. For example, the land reform/tenure policy that was introduced around 2004 could provide an incentive for households to keep their land for more profitable future purposes rather than convert to the GFG programme. Unfortunately, the data used here contain no information on this programme, so this possibility cannot be tested.

[21] Note that a fixed-effects model removes all the information that does not vary across different time periods. In the sample, there are 30 households who have either increased or decreased the number of party members from 1999 to 2004, and about 20 households that report a change in the number working for the local government. Only five households have both types of changes.

a Hausman test indicates that the IV estimates are preferred,[22] and an overidentification test does not reject the assumption that the instruments are uncorrelated with the error term.[23] One a more negative note, a weak instruments test indicates that weak instruments may be a serious problem for the estimates in Table 6a, but this is less of a problem in Table 6b.[24]

5.3 Privilege versus information

Summarizing the results from Tables 6a and 6b, having at least one party member in the household raises the probability of getting the full subsidy. This is consistent with the result that such households have a strong interest in participating in the programme. It is also consistent with the theoretical model: if the local government can treat households differently, based on δ, (the partial payment parameter), households with a higher δ or closer connections to the local government will tend to participate more. In other words, if political influence assures the favoured group's payment, those groups will have more faith that the government is trustworthy and, therefore, have a higher probability of participating. Although the theoretical model did not address this point, an alternative interpretation of Party members' particular interest in programme participation could be due to α, a parameter representing households' expectations about the future of the programme. If uncertainty about the future has less effect on the favoured groups, or they do not expect the programme to end soon, then they should have higher participation rates the rest of the population.

However, it is almost impossible to measure people's expectations directly. Although the empirical analysis has shown that an 'elite group' is more likely to receive full payment, one can distinguish between these two possibilities by running a similar regression with a smaller sample: the households living in villages that gave no payments to anyone in the last time period from 1999 to 2004. If the elite group in these villages is still more likely to participate in the programme, the only explanation is that they have a different expectation regarding the future of the programme.

Table 7 presents estimates that attempt to separate the 'party member' effect from the 'working in local government' effect. Despite the small sample size, all other coefficients are similar in terms of both sign and significance to those in Table 6a. In particular, the negative sign of the village level underpayment coefficient indicates that as the village payment shortfall (from upper level government, such as town, city or province) increases, less land is converted. However, neither the 'Party member' nor the 'working for local government' variables have a significant influence. This does not support the hypothesis that an 'elite group' has a different perspective, or private information regarding the programme's continuation. Or in other words, without the advantage of securing payments, the 'elite group' behaves just as the rest of the households and chooses not to participate. Therefore, the alternative hypothesis is that the 'elite group' is more likely to participate in the programme because its political power provides it higher subsidy payments than those received by other households.

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[22] The p-values from Hausman tests for both 'lag percentage of underpayment' and 'lag percentage of accumulated underpayment' are significant at the 1 percent level (p-value=0.0004 for 'lag percentage of underpayment' and p-value=0.0000 for 'lag percentage of accumulated underpayment').

[23] The over-identification test results: the chi-square statistic (p-value=0.352 for 'Lag percentage of underpayment' and p-value=0.196 for 'lag percentage of accumulated underpayment').

[24] The weak IV test results: f-statistic from regression 'lag percentage underpayment' and 'lag percentage of accumulated underpayment' on the excluded instruments are 1.72 and 5.12, respectively.

6 Conclusions

This paper looks for evidence that reputation regarding previous subsidy payments plays an important role in determining farmers' participation in China's 'Grain for Green' land conservation programme. A game theoretic model of the strategic interaction between households and local governments was used to explore the causal relationship between programme payment shortfalls and subsequent land conversion under the programme. Although one cannot directly observe how people make use of reputation, the empirical evidence supports the view that reputation or prior experience affects household participation in the programme. On average, every 10 percent payment shortfall in a previous time period leads to a loss of 0.6 per cent to 1.7 per cent in agricultural land being converted to forest. Moreover, uncertainty over the programme's continuation reinforces the impact of programme payment shortfalls, further reducing the participation rate.

The main contribution of the theoretical part in this paper is the extension of the reputation game to incorporate uncertainty about the game's end date, which addresses a policy planning issue concerning the 'Grain for Green' programme. With this environment, farmers will face an additional risk that comes from the local government's behaviour change regarding the future uncertainty. Supported by this theoretic implication, one empirical strategy combined instrumental variable estimation with panel data, instrumenting household underpayment with tree seedling survival rate and village-level payment information, which reflects the upper level governments' periodic targeting to separately identify the impact of corruption from the impact of policy uncertainty regarding programme longevity. The regression results showed a strong negative relationship between previous payment shortfalls and subsequent land conversion. Moreover, after controlling for variables such as 'previous total converted land' and 'total available cropland owned by households', a negative effect of the amount of time left before the end of the programme's pilot phase suggests that farmers are more cautious or less willing to convert land over time, which is consistent with the theoretical model.

Household characteristics also affect programme participation. Empirical estimates indicate a significantly positive effect of Communist Party membership on the land conversion rate. The empirical analysis also investigates the motivation of this 'elite' group to participate in the programme. After ruling out the possibility of having different expectations regarding the programme's long term continuation, the evidence favours the hypothesis that subsidy payment security or priority due to their political position is a likely reason for their high participation rates.

Reputation-building is often complicated, so it is reasonable to ask whether people actually behave in this way.[25] Assumptions underlying theories of reputation building are hard to verify. Yet these results, which are supported by both theory and empirical evidence, provide a partial explanation of farmers' decision-making on land conversion. In general, this paper provides insights into how policy design and implementation affect conservation programme outcomes. From a policy perspective, finding a relationship between payment shortfalls and land conversion rates suggests that improving programme implementation could reduce payment shortfalls, delayed payments and payment inequalities, then more agricultural land could be converted to forest under this conservation programme. In other words, the

25 See the discussion in Camerer (2003: section 9.2).

programme goal of converting 8 million hectares of cropland could have been achieved with a much smaller government budget. Therefore, a better understanding of this system will allow policy makers to improve the programme to better attain its economic and environmental objectives. This case study provides an example of how to estimate the effect of the reputation mechanism on the effectiveness of conservation programmes in developing countries. It also suggests that rooting out corruption and strengthening the legal enforcement of government contracts are keys to achieving effective conservation efforts in developing countries.

To our knowledge, there are few experiments on reputation formation in trust games, and even fewer empirical studies of the effect on public trustworthiness of previous individual experiences in real life situations. While the evidence cannot directly substantiate the process, the fact that reputation is important for the outcomes of the GFG programme suggests that it may also be important for other public projects. Combining other data sets and looking for evidence on the impact of what people have experienced on how they behave in other public projects will shed further light on the causal relationship. Future studies should also investigate spillover effects from programme participants to non-participants. Descriptive statistics show that payment-related issues are noticed not only by programme participants, but also by non-participants. If these concerns lead other farmers to avoid participation, the reputation effect on the programme outcome could be larger than those estimated in this study.

Policy makers should understand the impact of inconsistent programme planning and targeting, and of delays in the process due to the complicated top-down programme administration. More creative and non-traditional methods should be considered as the alternatives, such as educating local communities about carbon markets, providing opportunities for partnerships between local farmers and foreign firms, seeking carbon offsets or creating space for non-governmental organizations to work with local communities to enhance conservation outcomes and monitor local administrators' conservation efforts.

Table 1: Correlation between 'self-reported amount' and 'constructed amount'

	Contract Amount*, %		Underpayment Amount, %	
	2003	2004	2003	2004
Cash Subsidy	45	60	44	63
Grain Subsidy	67	26	69	26
Total**	80	69	60	51

Note: *The constructed contract amount is calculated based on the formula set by that the programme. **The total value is calculated by adding both cash amount and grain amount in kg*1.4 (China's government uses a conversion rate of 1kg of grain=RMB 1.4, Uchida et al. 2005.

Source: Calculated by the authors using GFG data (2003, 2005).

Table 2: Underpaid households versus overpaid households

Year	Number of underpaid HHs	%	Number of overpaid HHs	%
1999	79	30	3	1
2000	167	63	3	1
2001	203	77	21	8
2002	239	91	22	8
2003	195	85	28	12
2004	160	70	68	30

Data source: Calculated by the authors using GFG data (2003, 2005).

Table 3: Percentage of underpaid households: elite group versus the rest

	HHs were underpaid in cash, %		HHs were underpaid in total value*, %	
	'Elite group'	The others	'Elite group'	The others
1999	21.4	21.5	19.6	22.4
2002	63.2	68.9	64.5	67.1
2004	16.5	31.5	41.8	51.9

Note: *The total value of subsidy underpaid amount is calculated by adding both cash amount and grain amount in kg*1.4 (China's government uses a conversion rate of 1kg of grain=RMB 1.4, Uchida et al. 2005). **The demographic information is only available for year 1999, 2002 and 2004.

Data source: Calculated by the author using GFG household survey data (2003, 2005).

Table 4: Who is underpaid? The evidence from households: village fixed-effect (village dummy), dependent variable: self-reported underpaid subsidy (2003 and 2004)

	Cash	Cash (%)	Grain	Grain (%)	Total value	Total value (%)
Head age	-0.009**	-0.017	-0.001	0.003	-0.011**	0.002
	(0.004)	(0.011)	(0.002)	(0.004)	(0.005)	(0.005)
Head education	0.015	-0.028	0.001	0.011	0.016	0.048
	(0.015)	(0.059)	(0.006)	(0.017)	(0.018)	(0.033)
Party member	-0.358**	-0.434*	-0.060	0.093	-0.442**	-0.399*
	(0.143)	(0.213)	(0.060)	(0.168)	(0.173)	(0.212)
Village admin workers	0.194	0.900	-0.145*	-0.224	-0.009	0.788
	(0.210)	(0.702)	(0.079)	(0.181)	(0.256)	(0.824)
Crop income	0.005	0.071	-0.004	-0.012	-0.001	-0.005
(1000 rmb)	(0.017)	(0.044)	(0.007)	(0.022)	(0.020)	(0.057)
Non-agricultural income	0.001	0.004	0.000	-0.025**	0.001	0.000
(1000 rmb)	(0.002)	(0.004)	(0.001)	(0.011)	(0.003)	(0.003)
Young labourer	-0.073	-0.022	0.005	-0.107**	-0.065	0.005
	(0.057)	(0.112)	(0.016)	(0.042)	(0.061)	(0.144)
Total agri. land	0.032***	0.018	0.017*	0.016	0.056***	0.020*
(hectare)	(0.012)	(0.017)	(0.010)	(0.012)	(0.020)	(0.011)
Land in slope land category 2 (%)	-0.095***	-0.080**	-0.027*	-0.016	-0.133***	-0.057*
	(0.036)	(0.038)	(0.015)	(0.017)	(0.043)	(0.041)
Land in slope land category 3 (%)	-0.015	-0.046**	-0.020	0.002	-0.044*	-0.032
	(0.014)	(0.022)	(0.013)	(0.014)	(0.026)	(0.018)
Constant	0.503	1.144	0.060	0.310	0.588**	-0.312
	(0.244)	(0.873)	(0.089)	(0.268)	(0.285)	(0.510)
Observations	263	222	264	94	263	233
R-squared	0.154	-0.022	0.065	0.133	0.149	-0.028

Note: Robust standard errors in parentheses. *significant at 10%; **significant at 5%; ***significant at 1%. Slope land category 2: steepness is between 25 degree to 35 degree: category 3: steepness is greater than 35 degree; and the omitted slope category is below 25%.

Source: Estimated by the authors using GFG data (2003, 2005)

Table 5a: Who is underpaid? The evidence from households (2): OLS versus village fixed-effect, dependent variable: constructed underpayment (1999-2004) with log transformation

	OLS 1	OLS 2	FE 1	FE 2	FE 3
Head age	0.011	0.012	-0.013	-0.019	-0.011
	(0.014)	(0.014)	(0.015)	(0.014)	(0.015)
Head education	0.106**	0.104**	0.047	0.023	0.041
	(0.048)	(0.048)	(0.054)	(0.053)	(0.054)
Party members	-0.993*	-1.061**	-1.314***		-1.471***
	(0.520)	(0.526)	(0.496)		(0.501)
Village admin. workers		0.274		0.338	0.796
		(0.722)		(0.689)	(0.682)
Young labourer	0.162	0.162	0.103	0.085	0.098
	(0.124)	(0.125)	(0.129)	(0.128)	(0.129)
Crop income	-0.017	-0.017	-0.002	-0.001	-0.002
	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)
Non-agricultural income	0.005**	0.005**	0.005**	0.004*	0.005**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Total agri. land	0.107	0.106	0.183**	0.180**	0.180**
	(0.072)	(0.073)	(0.081)	(0.082)	(0.081)
Previous converted land	-0.086	-0.084	-0.204**	-0.191**	-0.198**
	(0.088)	(0.088)	(0.097)	(0.096)	(0.097)
% land in slope land category 2	-3.209*	-3.247*	-4.003**	-4.083**	-4.120**
	(1.729)	(1.716)	(1.753)	(1.682)	(1.729)
% land in slope land category 3	-1.976	-1.994	-2.436*	-2.474*	-2.481*
	(1.326)	(1.325)	(1.449)	(1.430)	(1.442)
Constant	-0.096	-0.131	1.225	1.443*	1.111
	(0.817)	(0.821)	(0.895)	(0.847)	(0.893)
Observations	734	734	734	736	734
R-squared	0.202	0.201	0.222	0.216	0.223

Note: Robust standard errors in parentheses. *significant at 10%; **significant at 5%; ***significant at 1%. Slope land category 2: steepness is between 25 degree to 35 degree: category 3: steepness is greater than 35 degree; and the omitted slope category is below 25%.

Source: Estimated by the authors using GFG data (2003, 2005).

Table 5b: Who is underpaid? The evidence from households (2): OLS versus village fixed effects, dependent variable: constructed accumulated underpayment (1999-2004) with log transformation

	OLS 1	OLS 2	FE 1	FE 2	FE 3
Head age	0.001	0.003	0.004	0.005	0.006
	(0.013)	(0.013)	(0.014)	(0.015)	(0.014)
Head education	0.091**	0.087**	0.094*	0.087*	0.088*
	(0.041)	(0.041)	(0.048)	(0.050)	(0.049)
Party members	-1.053**	-1.218**	-1.393***		-1.556***
	(0.483)	(0.506)	(0.449)		(0.453)
Village admin. workers		0.642		0.269	0.752
		(0.552)		(0.581)	(0.580)
Young labourer	0.238**	0.236**	0.230**	0.244**	0.224**
	(0.115)	(0.115)	(0.109)	(0.111)	(0.109)
Crop income	-0.088	-0.089	-0.102	-0.067	-0.097
	(0.100)	(0.101)	(0.106)	(0.103)	(0.105)
Non-agricultural income	0.008	0.007	0.002	0.000	0.000
	(0.019)	(0.019)	(0.017)	(0.016)	(0.016)
Total agri. land	0.078	0.077	0.135**	0.129**	0.133**
	(0.050)	(0.050)	(0.055)	(0.054)	(0.054)
Previous converted land	0.077*	0.082*	-0.039	-0.009	-0.034
	(0.044)	(0.044)	(0.049)	(0.050)	(0.049)
% land in slope land category 2	0.469	0.380	0.619	-0.184	0.509
	(1.309)	(1.313)	(1.373)	(1.421)	(1.375)
% land in slope land category 3	0.193	0.155	-0.262	-0.472	-0.309
	(0.693)	(0.691)	(0.800)	(0.773)	(0.793)
Constant	0.848	0.775	0.701	0.450	0.602
	(0.770)	(0.765)	(0.812)	(0.888)	(0.813)
Observations	754	754	754	756	754
R-squared	0.258	0.259	0.279	0.263	0.280

Note: Robust standard errors in parentheses. *significant at 10%; **significant at 5%; ***significant at 1%. Slope land category 2: steepness is between 25 degree to 35 degree: category 3: steepness is greater than 35 degree; and the omitted slope category is below 25%.

Source: Estimated by the authors using GFG data (2003, 2005).

Table 6a: Reputation effect (HH FE versus IV-FE) with ‘lag % of HH underpayment’

	Time Effect	FE 1	FE 2	FE 3	FE 4	FE 5	FE IV
Last year converted area	-0.200***	-0.136***	0.004	-0.136***	-0.004	-0.029	0.112
	(0.019)	(0.019)	(0.062)	(0.019)	(0.061)	(0.061)	(0.116)
Total converted area	0.317***	0.444***	0.165***	0.444***	0.247***	0.273***	0.522
	(0.023)	(0.022)	(0.059)	(0.022)	(0.072)	(0.073)	(0.423)
Total available agricultural land	-0.020*	-0.053***	-0.076***	-0.053***	-0.070***	-0.070***	-0.158**
	(0.012)	(0.019)	(0.027)	(0.019)	(0.027)	(0.026)	(0.076)
2003-year	0.056***	0.052***	0.029***	0.052***	0.021*	0.022*	-0.018
	(0.004)	(0.004)	(0.008)	(0.004)	(0.012)	(0.012)	(0.024)
Lag % of underpayment* (1)		-0.110***	-0.149***	-0.110***	-0.172***	-0.175***	-0.270**
		(0.008)	(0.013)	(0.008)	(0.014)	(0.014)	(0.131)
HH party member (2)			0.135**	0.013*	0.132***	0.153***	0.225***
			(0.058)	(0.007)	(0.044)	(0.047)	(0.086)
HH members works for village administration (3)				0.007	0.053	-0.083	0.191*
				(0.036)	(0.054)	(0.077)	(0.106)
(1)*(2)						-0.055	
						(0.070)	
(1)*(3)						0.262**	
						(0.103)	
Crop income					0.003	0.003	0.030**
					(0.006)	(0.006)	(0.015)
Non-agri. income					0.001	0.001	-0.002
					(0.001)	(0.001)	(0.004)
% land left in slope category 2[(1)]					-0.138*	-0.149*	-0.336**
					(0.079)	(0.078)	(0.168)
% land left in slope category 3					0.060*	0.064*	0.124
					(0.034)	(0.034)	(0.081)
Observations	1261	1198	485	485	482	482	364

Notes: Dependent variable: HH annual percentage of newly converted land. Robust standard errors are in parentheses, *significant at 10%; **significant at 5%; ***significant at 1%. The excluded IV for * include average HH’s survival rate of tree seedlings and lagged village underpayment. [(1)]This percentage excludes the land that has been already enrolled in the SLCP programme. All the regressions also control for ‘non-agri. employment’ and ‘number of young labourer’, but the estimators are not significant.

Source: Estimated by the authors using GFG data (2003, 2005).

Table 6b: Reputation effect (HH FE versus IV-FE) with 'lag % of HH accumulated underpayment'

	FE 1	FE 2	FE 3	FE 4	FE 5	FE IV
Last year converted area	-0.278***	-0.129*	-0.277***	-0.113*	-0.119*	0.097
	(0.017)	(0.068)	(0.017)	(0.066)	(0.068)	(0.197)
Total converted area	0.500***	0.350***	0.503***	0.310***	0.356***	0.169
	(0.022)	(0.069)	(0.022)	(0.080)	(0.083)	(0.493)
Total available agricultural land	-0.015	-0.026	-0.016	-0.020	-0.020	-0.016
	(0.010)	(0.017)	(0.010)	(0.016)	(0.016)	(0.030)
2003-year	0.041***	0.023**	0.041***	0.030**	0.028**	0.019
	(0.004)	(0.009)	(0.004)	(0.012)	(0.012)	(0.021)
Lag percentage of accumulated underpayment* (1)	-0.061***	-0.054***	-0.061***	-0.067***	-0.077***	-0.089
	(0.003)	(0.006)	(0.003)	(0.007)	(0.008)	(0.077)
HH party member (2)		0.171***	0.031*	0.175***	0.158***	0.371***
		(0.063)	(0.016)	(0.047)	(0.050)	(0.121)
HH members works for village administration (3)			-0.018	-0.008	0.045	0.219*
			(0.035)	(0.058)	(0.080)	(0.132)
(1)*(2)					0.017**	
					(0.008)	
(1)*(3)					-0.022	
					(0.020)	
Crop income				0.000	0.001	-0.001
				(0.006)	(0.006)	(0.012)
Non-agri. income				0.003**	0.003*	0.006
				(0.002)	(0.002)	(0.007)
% land left in slope category 2				-0.100	-0.091	-0.133
				(0.069)	(0.069)	(0.123)
% land left in slope category 3				0.066**	0.057*	0.138
				(0.032)	(0.032)	(0.121)
Observations	1261	494	494	491	491	370

Notes: Dependent variable: HH annual percentage of newly converted land. Robust standard errors in parentheses. *significant at 10%; **significant at 5%; ***significant at 1%. The excluded IV for * include average HH's survival rate of tree seedlings and lagged village underpayment.

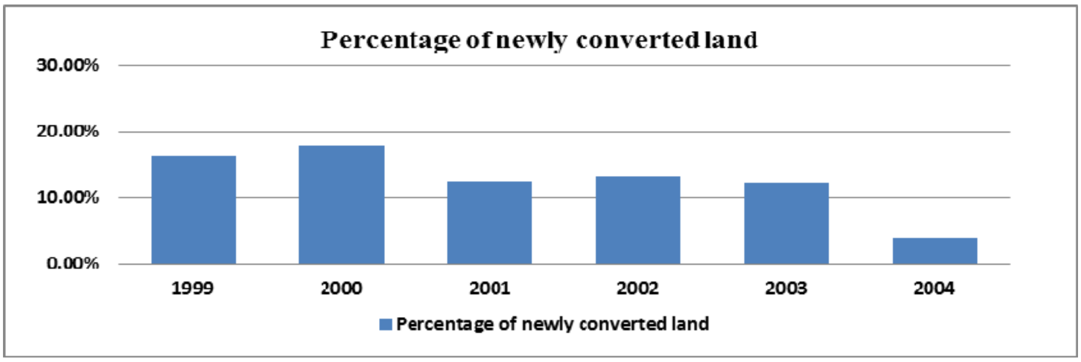
Source: Estimated by the authors using GFG data (2003, 2005).

Table 7: Privilege or information, sample: villages without any subsidy payment in t-1, dependent variable: proportion of converted land (pooled cross section OLS with village dummy)

Variable	1	2	3	4
Last year converted area	-0.12	-0.12	-0.12	-0.12
	(0.073)	(0.075)	(0.072)	(0.073)
Total converted area	0.52***	0.53***	0.53***	0.52***
	(0.14)	(0.15)	(0.14)	(0.15)
Total available land	-0.2	-0.2	-0.2	-0.2
	(0.16)	(0.16)	(0.16)	(0.16)
2003-year	0.006	0.005	0.007	0.005
	(0.012)	(0.013)	(0.012)	(0.013)
HH Lag underpayment (1)	-0.13***	-0.13***	-0.13***	-0.13***
	(0.045)	(0.047)	(0.045)	(0.046)
Village Lag underpayment (3)	-0.002	-0.002***	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
HH party member (2)	-0.016	-0.014		
	(0.051)	(0.086)		
(2)*(1)		0.031		
		(0.048)		
(2)*(3)		-0.000		
		(0.000)		
HH members working for village admin. (4)				-0.23
				(0.35)
(4)*(1)				-0.14
				(0.11)
(4)*(3)				-0.002
				(0.002)
N	335	335	335	335

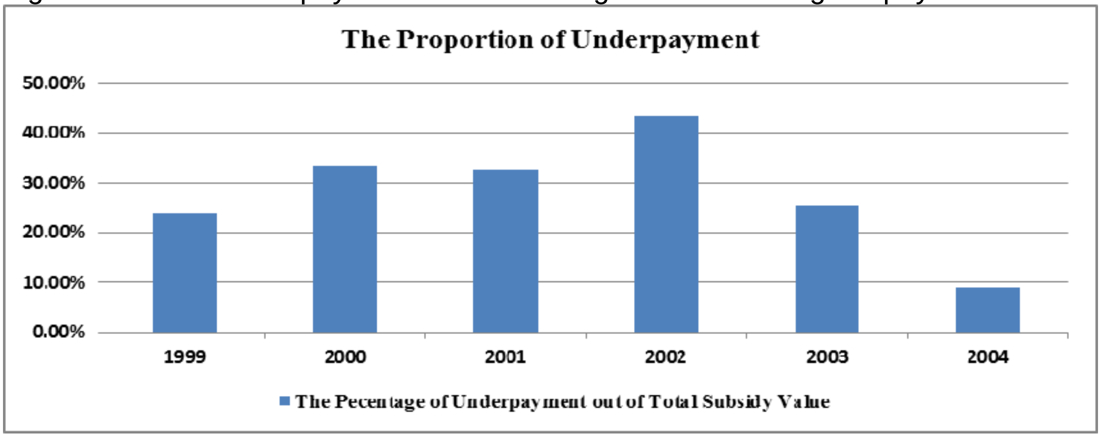
Note: Robust standard errors in parentheses. *significant at 10%; **significant at 5%; ***significant at 1%.
Source: Estimated by the authors using GFG data (2003, 2005).

Figure 1: Annual average conversion rate (1999-2004)



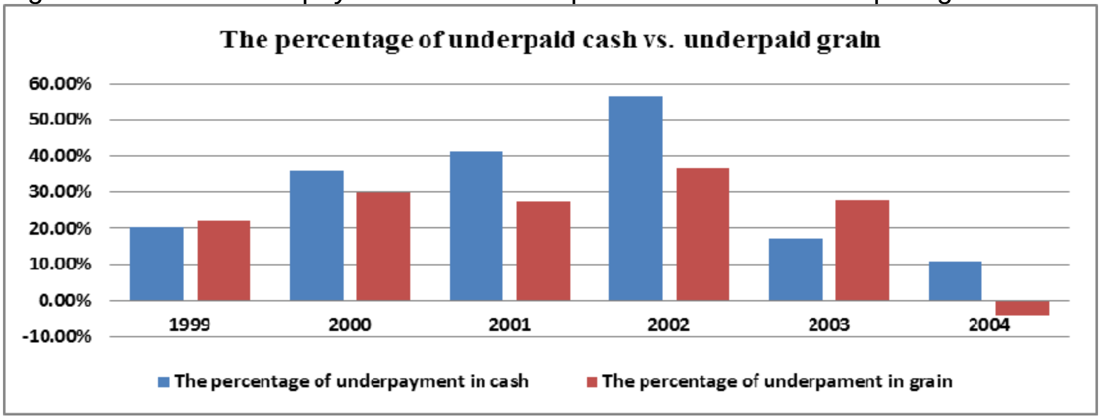
Source: Calculated by the authors using GFG data (2003, 2005).

Figure 2: Annual underpayment ratio: including both cash and grain payments



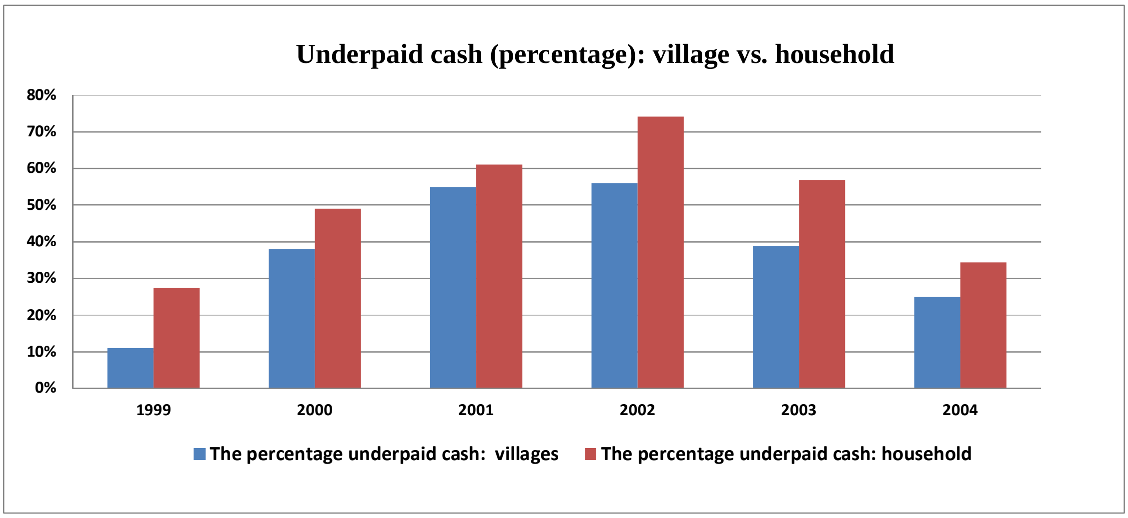
Source: Calculated by the authors using GFG data (2003, 2005).

Figure 3: Annual underpayment ratio: underpaid cash versus underpaid grain



Source: Calculated by the authors using GFG data (2003, 2005).

Figure 4: Annual average underpaid cash in percentage: village versus household



Source: Calculated by the authors using GFG data (2003, 2005).

Appendix 1

Proof for proposition 3

The proof will verify the ‘Sequential Rationality’ and ‘Bayesian Beliefs’ under the definition of PBE.

(1) Player F

(1.1) In period 1, choosing $q_1^D = 1$ if $\beta_1^D \geq \beta_1^{D*}$; otherwise $q_2^D = 0$.
For $\beta_1^D > \beta_2^{D*} \geq \beta_1^{D*}$ [26], the O-type chooses $\gamma_{O,1}^D = 1$ since $\beta_1^D > \beta_2^{D*}$, so does H-type. The best response for farmer is: $q_1^D = 1$, ‘participate’.

For $\beta_2^{D*} > \beta_1^D \geq \beta_1^{D*}$, following the same logic in the previous propositions, that the probability for player F to be fully paid is $\beta_1^D \frac{(1-\delta)^2}{\left(\frac{\pi_a}{(1-\alpha^D)S}-\delta\right)\left(\frac{\pi_a}{S}-\delta\right)}$ with $\gamma_{O,1}^D = \gamma_{O,1}^{D*} = \frac{\beta_1^D[(1-\delta)^2+(\delta-\frac{\pi_a}{S})(\frac{\pi_a}{(1-\alpha^D)S}-\delta]}{(1-\beta_1^D)\left(\frac{\pi_a}{(1-\alpha^D)S}-\delta\right)\left(\frac{\pi_a}{S}-\delta\right)}$. Therefore, the expected payoff of choosing ‘participate’ is: $EV_1^F(participate) = S * \beta_1^D \frac{(1-\delta)^2}{\left(\frac{\pi_a}{(1-\alpha^D)S}-\delta\right)\left(\frac{\pi_a}{S}-\delta\right)} + \delta S * (1 - \beta_1^D \frac{(1-\delta)^2}{\left(\frac{\pi_a}{(1-\alpha^D)S}-\delta\right)\left(\frac{\pi_a}{S}-\delta\right)})$.

Since $\beta_1^D \geq$ $\beta_1^{D*} = \frac{(\frac{\frac{\pi_a}{S}}{1-\alpha^D}-\delta)(\frac{\pi_a}{S}-\delta)^2}{(1-\delta)^3}$), the expected payoff of choosing $q_1^D = 1$ is greater than π_a, which is the payoff of $q_1^D = 0$ strategy. Hence $q_1^D = 1$ is the best response in this case. In particular, if $\beta_1^D = \beta_1^{D*}$, player F is indifferent between ‘participate’ or ‘no participate’, anything is the best response including $q_1^D = 1$.

Similarly, when $\beta_1^D < \beta_1^{D*}$, the expected payoff from ‘participate’ is: $EV_1^F(participate) < \pi_a$. Thus, the best response for player F is: $q_1^D = 0$, ‘No participation’ in this case.

(1.2) In period 2, choosing $q_2^D = 1$ if $\beta_2^D > \beta_2^{D*}$; $q_2^D = 1 - \frac{C}{(1-\delta)S}$ if $\beta_2^D = \beta_2^{D*}$; and $q_2^D = 0$ if $\beta_2^D < \beta_2^{D*}$.

For $\beta_2^D > \beta_3^{D*} \geq \beta_2^{D*}$ [27], both O-type and H-type will play $\gamma_{i,2}^D = 1, i \in O,H$ follows the equilibrium strategy profile above. Therefore, the best response for player F is to participate: $q_2^D = 1$.

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26 It is easy to show that $\beta_2^{''*} \geq \beta_1^{''*}$ with $0 < \frac{\pi_a}{S} - \delta < 1$.

27 It is easy to show that $\beta_3^{''*} \geq \beta_2^{''*}$ under the parameter assumptions.

For $\beta_3^{D*} > \beta_2^D > \beta_2^{D*}$, the probability for player F to get fully paid is $\beta_2^D \frac{1-\delta}{(\frac{\pi_a}{(1-\alpha^D)S}-\delta)}$ (with $\gamma_{O,2}^D = \frac{\beta_2^D[(1-\frac{\pi_a}{(1-\alpha^D)S}]}{(1-\beta_2^D)[\frac{\pi_a}{(1-\alpha^D)S}-\delta]}$). The expected payoff from 'participate' is: $EV_2^F(participate) = S*\beta_2^D \frac{1-\delta}{(\frac{\pi_a}{(1-\alpha^D)S}-\delta)} + \delta S*(1-\beta_2^D \frac{1-\delta}{(\frac{\pi_a}{(1-\alpha^D)S}-\delta)}) > (<)\pi_a$ with $\beta_2^D > (<)\beta_2^{D*} = \frac{(\frac{\frac{\pi_a}{S}}{1-\alpha^D}-\delta)(\frac{\pi_a}{S}-\delta)}{(1-\delta)^2}$. Therefore the best response is: '$q_2^D = 1$ if $\beta_2^D > \beta_2^{D*}$; and $q_2^D = 0$ if $\beta_2^D < \beta_2^{D*}$ '. In particular, $\beta_2^D = \beta_2^{D*} = \frac{(\frac{\frac{\pi_a}{S}}{1-\alpha^D}-\delta)(\frac{\pi_a}{S}-\delta)}{(1-\delta)^2}$ leads to the expected payoff of participation to be exactly equal to π_a. This means the player F is indifferent between 'participate' and 'no participate'. Anything is a best response, including $q_2^D = 1 - \frac{C}{(1-\delta)S}$.

(1.3) In period three, choosing '$q_3^D = 1$ if the updated belief $\beta_3^D > \beta_3^{D*}$; $q_3^{D*} = \frac{(1-\delta)S-C}{(1-\alpha^D)(1-\delta)S}$ if $\beta_3^D = \beta_3^{D*}$; and $q_3^D = 0$ if $\beta_3^D < \beta_3^{D*}$.'

As this is the last period, knowing O-type will play 'cheat' and H-type will pay, the expected payoff which takes into account of the possibility that the game may end after it entered is:

$$(1-\alpha^D)[S*\beta_3^D + \delta S*(1-\beta_3^D)] = (1-\alpha^D)\delta S + (1-\alpha^D)(1-\delta)S*\beta_3^D > or < \pi_a$$

when $\beta_3^D > or < \beta_3^{D*}$. In particular, when $\beta_3^D = \beta_3^{D*}$, player F is indifferent between 'participate' and 'no participate', anything is a best response, including '$q_3^{D*} = \frac{(1-\delta)S-C}{(1-\alpha^D)(1-\delta)S}$ '.

The above strategy plan, therefore, is player F's best response.

(2) Player G

For player G, note all the payoffs and the mixed-strategy probabilities for player F to participate in period 2 and 3 are exactly same as in the 'early announcement' case. In fact, changing the timing of the announcement does not affect player Gs' situation, therefore, the proof remains same as the proof of player G's equilibrium strategies in proposition (4).

We have shown that both players' strategies are best responses in all three periods given their beliefs, and that beliefs are updated with Bayes' Rule. Therefore these strategies constitute a PBE. (QED)

Appendix 2

Descriptive statistics: comparison of household characteristics between participating households and non-participating households

Sample	Participants		Non-Participants	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Demographic variables:				
Head age	46.82	11.50	47.35	12.16
Head education	4.73	3.36	4.63	3.70
Household size	4.90	1.71	4.58	1.43
No. of communist party members	0.16	0.40	0.24	0.47
No. of village administration workers	0.08	0.28	0.06	0.24
Income sources: (RMB)				
Crop income	854.94	1705.56	1451.33	3979.85
Non-agriculture income	2152.91	9339.81	2810.90	6706.94
Household labour:				
No. of young labourer	2.28	1.25	2.09	1.08
No. of agricultural workers	1.06	0.92	0.99	0.92
Land information:				
Total agricultural land (Mu)	14.4	12.5	10.9	12.0
Average distance from home (meter)	924.5	668.4	668.4	603.6
Average distance from road	770.7	964.7	687.7	1193.5
Average distance from ditch	862.5	1674.0	540.8	1144.7
Percentage of irrigated land	14.5%	29.7%	19.7%	35.1%
Percentage of paddy land	9.6%	25.1%	9.6%	25.0%
Percentage of land with low productivity	41.8%	31.7%	39.1%	32.2%
Percentage land in slope category 2	15.2%	22.1%	17.2%	26.3%
Percentage land in slope category 3	46.2%	34.9%	35.1%	37.5%

Note: *The total number of participating households is 266 for 3 years, therefore N=798. The total number of non-participating households is 86.

Source: Calculated by the authors using GFG household survey data (1999, 2003, 2005).

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