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FOR ECONOMIC RESEARCH

Relative Performance Contracts versus Group Contracts with Hidden Savings

by

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March 2022

Discussion Paper

No. 176

Relative Performance Contracts versus Group Contracts with Hidden Savings*

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March 15, 2022

Abstract

This paper studies the effects of hidden savings on the relative benefits of two optimal incentive contracts, namely, relative performance contracts and group contracts. As an analysis framework, this paper develops a dynamic moral hazard model in which agents can secretly save. The results from the model suggest that hidden savings affect relative performance contracts more than they affect group contracts. In addition, under group contracts, agents rely more on risk-sharing networks and less on own savings than they do under relative performance contracts. To test the model's predictions, this paper uses a unique data set with detailed information on households' characteristics, their choices of loans, and their responses to liquidity shocks. The empirical results confirm that, in the areas where hidden savings problem is likely to be more severe, households are more likely to choose group loans. In addition, the results also show that households with group loans rely more on networks to prevent themselves from future liquidity shocks.

Keywords: Incentive contracts; Unobserved savings; Relative performance; Group lending; Microfinance

JEL classification: D86; G21; G51

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*I am very grateful to Douglas W. Diamond, William Fuchs, and particularly Robert M. Townsend for their helpful comments and encouragement. The views in this paper are those of the author and not necessarily those of the Puey Ungphakorn Institute for Economic Research or the Bank of Thailand.

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1 Introduction

Previous studies on dynamic moral hazard problems usually assume that agents can neither secretly save nor secretly borrow. For instance, Rogerson (1985) shows that agents are "saving-constrained" when facing optimal contracts under the assumption of such conditions. However, these assumptions are unrealistic in the real world—in particular, the assumption that agents cannot secretly save—because agents can simply keep their savings at home.

This paper investigates the effects of unobserved savings on the relative benefits of two incentive contracts, namely, relative performance contracts and group contracts. Under relative performance contracts, an agent is punished more severely for a bad outcome if an outcome of the other agent is good. In other words, agents are evaluated against each other and, therefore, have incentive to put more effort into the project. In contrast, under group contracts, agents are allowed, or even encouraged, to coordinate their effort levels and share their consumption. Therefore, group contracts provide agents with better insurance against future uncertainties.

As an analysis framework, this paper develops a dynamic moral hazard model in which agents can secretly save. The model provides two testable predictions. First, group contracts are more likely to be preferred in the economies where the hidden savings problem is more severe. Second, under group contracts, agents rely more on their risk-sharing network and less on their own savings to protect themselves against future liquidity shocks than they do under relative performance contracts. Using a unique data set with detailed information on households characteristics, their choices of loans, and their responses to liquidity shocks, this paper finds empirical evidence that supports the model's predictions. More specifically, in the villages where the hidden savings problem is likely to be more severe, households are more likely to choose group loans. Also, households with group loans rely more on networks and less on own savings when facing liquidity shocks.

The intuition behind these results is that, in the model, agents' unobserved savings arise from precautionary motives. Since group contracts provide agents with better insurance against future consumption uncertainty, agents have less incentive to save. In addition, when agents can secretly save, the ability of a principal to punish agents for bad outcomes under relative performance contracts is limited. Therefore, relative performance contracts are more affected by hidden savings than group contracts.

The contribution of this paper is twofold. First, it is related to the literature on optimal incentive contracts. Earlier works find that agents' access to a credit market can significantly influence the outcome of the moral hazard problem. For example, Chiappori et al. (1994) and Park (2004) show that if agents' access to the credit market is unobservable to a principal, then it is impossible to construct renegotiation-proof contracts that implement a high effort level. This paper shows that if agents can secretly save but cannot secretly borrow, a principal can design renegotiation-proof contracts that incentivize agents to maintain a high effort level.

Several studies in this literature focus on optimal incentive contracts with multiple agents, including Holmström (1979), Mookherjee (1984), Holmström and Milgrom (1990), Ramakrishnan and Thakor (1991), Itoh (1993), Che and Yoo (2001), Prescott and Townsend (2002), and Madeira and Townsend (2008). This paper contributes to this literature by comparing the relative benefits of optimal incentive contracts with hidden savings. To the best of my knowledge, this is the first paper that evaluates optimal incentive contracts with multiple agents when agents can secretly save.

Second, this paper is also related to the literature on microfinance in developing economies. Previous studies have attempted to identify the mechanisms through which joint-liability loans have advantage over individual loans. These mechanisms include social collateral (Besley and Coate, 1995), peer selection (Ghatak, 1999; Laffont, 2003), or peer monitoring (Che, 2002). The contribution of this paper is providing an alternative explanation why joint-liability loans may be preferred over individual loans. In this paper, when savings are unobserved, group loans are preferred over individual loans because the risk sharing within group lowers agents' incentive to secretly save.

The remainder of the paper is organized as follows. Section 2 describes the model. Section 3 characterizes optimal incentive contracts with hidden savings. Section 4 summarizes the data used and reports the empirical evidence. Section 5 concludes.

2 The Model

Consider a two-period economy with one risk-neutral principal and two risk-averse agents, indexed by i. The principal has two projects, each of which will be assigned to an agent. In period 2, agents work on their projects[1] and choose whether they exert effort or not: $e_i \in \{0, 1\}$. The output from each project can be either low or high: $y_i \in \{L, H\}$. Let $\mathbf{e}$ and $\mathbf{y}$ denote the pair of effort levels of both agents, (e_1, e_2), and the pair of output levels from both projects, (y_1, y_2), respectively.

The production technology is characterized by the joint probability distribution. Let $\pi(y_1, y_2|e_1, e_2)$ denote the probability of output levels from both projects that is conditional on the effort levels of both agents. This paper assumes that the probability that the output of agent i's project is high increases with agent i's effort level.

The preference of agent i takes the form

$$U\left(c_i^1, c_i^2, e_i\right) = u\left(c_i^1\right) + \beta u\left(c_i^2\right) - \beta e_i, \tag{1}$$

where c_i^t denotes agent i's consumption in period t, and β denotes the discount factor. The function $u(\cdot)$ is strictly increasing and strictly concave. Agents have zero initial wealth, can secretly save but cannot secretly borrow, and receive a rate of return r on their savings.

The principal's objective is to maximize the expected profit. Since agents' savings and effort levels are unobservable, contracts must be incentive compatible. In other words, contracts must be structured such that agents are willing to choose savings and effort levels desirable to the principal. To make the problem non-trivial, this paper assumes that it is profitable for the principal to create incentives for agents to choose high effort level. A contract, $C \equiv (e_i, w_i^1, w_i^2(\mathbf{y}), s_i)$, for agent i specifies the recommended effort level in period 2, e_i, the payment of consumption goods in period 1, w_i^1, the payment of consumption goods in period 2 that is conditional on the outputs of both projects, $w_i^2(\mathbf{y})$, and the recommended savings in period 1, s_i. If agents reject the principal's offer, they can receive utility level $\overline{U}_i$ from their outside option. Therefore, the principal must offer

[1] Making the project require an agents effort in both periods is straightforward and does not change the results.

the contract under which agent i's utility is at least equal to $\overline{U}_i$.

The timeline of the economic activity is as follows. At the beginning of period 1, the principal makes an offer to agents. Agents accept the offer if their expected utility under the contract is not less than their outside option and reject the offer otherwise. At the end of period 1, agents choose their consumption and savings levels. At the beginning of period 2, the principal can renegotiate the terms of the contracts (i.e., the payment of consumption goods in period 2), and agents again choose their effort levels, which leads to the realization of the output. At the end of period 2, agents consume the consumption goods they receive in period 2 plus their savings from period 1.

3 Principal-Agent Problems

This study considers two types of incentive contracts: relative performance contracts and group contracts. Under a relative performance contract, the principal can prevent agents from colluding. Therefore, such contracts provide stronger incentives for agents. However, under group contracts, agents can observe the effort level of each other and can share their consumption goods. Therefore, such contracts allow for better risk sharing among agents[2].

If agents can observe the effort level of each other and the principal can also prevent collusion, the principal's expected profit might be even further increased. Ma (1988) considers a static model in which agents can observe the effort levels of other agents. After agents choose their effort levels, but before outputs are realized, the principal will demand that one agent reports—and another agent verifies—the effort level. Ma (1988) argues that this mechanism can lead to the first-best allocation. However, Itoh (1993) shows that if agents' reports are mutually observable and agents can write side contracts based on these reports, no coalition-proof mechanism is available to increase the principal's expected profit. Following Itoh (1993), this study assumes that agents can write side contracts based on all mutually observable information, including their reports, and that no coalition-proof mechanism is available to the principal.

[2]With the presence of adverse selection, group contracts can also benefit the principal through the peer selection effect. See Ghatak (1999, 2000), for example.

3.1 Relative Performance Contracts

Under relative performance contracts, the principal can prevent agents from coordinating effort levels or sharing consumption goods with each other. The principal may be able to do so by placing agents in different locations. As discussed by Fafchamps and Gubert (2007), geographic proximity is important for the formation of a risk-sharing network. However, when they are placed in different locations, agents are not able to observe the effort levels of the other agents.

Because agents' savings and effort levels are unobservable to the principal, contracts must be incentive compatible. In other words, agent i's utility level from following the recommended actions, $(e_i, w_i^1, w_i^2(\mathbf{y}), s_i)$, must be no less than the utility level from any other deviation, i.e.,

$$\begin{aligned} & u(w_1^1 - s_1) + \beta \sum_{\mathbf{y}} \pi(\mathbf{y}|e_1, e_2) u\big(w_1^2(\mathbf{y}) + (1+r)s_1\big) - \beta e_1 \\ & \quad \geq u(w_1^1 - \hat{s}_1) + \beta \sum_{\mathbf{y}} \pi(\mathbf{y}|\hat{e}_1, e_2) u\big(w_1^2(\mathbf{y}) + (1+r)\hat{s}_1\big) - \beta \hat{e}_1, \quad \forall \hat{s}_1 \geq 0, \forall \hat{e}_1 \in \{0,1\}, \end{aligned} \tag{2}$$

and

$$\begin{aligned} & u(w_2^1 - s_2) + \beta \sum_{\mathbf{y}} \pi(\mathbf{y}|e_1, e_2) u\big(w_2^2(\mathbf{y}) + (1+r)s_2\big) - \beta e_2 \\ & \quad \geq u(w_2^1 - \hat{s}_2) + \beta \sum_{\mathbf{y}} \pi(\mathbf{y}|e_1, \hat{e}_2) u\big(w_2^2(\mathbf{y}) + (1+r)\hat{s}_2\big) - \beta \hat{e}_2, \quad \forall \hat{s}_2 \geq 0, \forall \hat{e}_2 \in \{0,1\}. \end{aligned} \tag{3}$$

Moreover, agents will receive utility $\overline{U}_i$ from their outside option if they decline the principal's offer in period 1. Therefore, the principal must offer a contract that gives agents at least $\overline{U}_i$, i.e.,

$$u(w_i^1 - s_i) + \beta \sum_{\mathbf{y}} \pi(\mathbf{y}|e_1, e_2) u\big(w_i^2(\mathbf{y}) + (1+r)s_i\big) - \beta e_i \geq \overline{U}_i, \quad \forall i. \tag{4}$$

The principal's objective is to design a contract that maximizes the expected profit,

$$\max_{e_i, w_i^1, w_i^2(\mathbf{y}), s_i} \sum_i \left[-w_i^1 + \frac{1}{1+r} \sum_{\mathbf{y}} \pi(\mathbf{y}|e_1, e_2)\big(y_i - w_i^2(\mathbf{y})\big) \right] \tag{5}$$

subject to the incentive constraints (2) and (3) and the participation constraint (4).

3.2 Group Contracts

Group contracts represent situations in which agents work closely together and the principal cannot prevent them from sharing consumption goods with each other. Agents can also observe the effort level of the other agent. Consequently, the principal can utilize this information when designing the optimal contract[3].

Under group contracts, both agents can commit to maximizing their group's utility, which is defined as the weighted average of the utility levels of both agents: $U_G \equiv \sum_i \mu_i U_i$. Pareto weights, μ_i, represent the relative importance of agents within the group and are endogenously determined by agents' outside options. An agent with a better outside option will have a greater Pareto weight and will exert greater influence on the group's decisions. Together, agents decide how much to save in period 1, effort levels in period 2, and how to share the consumption goods received from the principal. Both agents are forward-looking and consider the consequences of their group's savings on their utility in period 2 when they make their saving decision in period 1.

Suppose that a group has saved s in period 1 and given its Pareto weights, μ_i, its decision problem in period 2 is

$$\max_{e_i, c_i^2(\mathbf{y})} \sum_i \mu_i \left[\sum_{\mathbf{y}} \pi(\mathbf{y}|e_1, e_2) u\big(c_i^2(\mathbf{y})\big) - e_i \right] \tag{6}$$

subject to the feasibility constraint

$$\sum_i c_i^2(\mathbf{y}) = \sum_i w_i^2(\mathbf{y}) + (1+r)s, \quad \forall y_i \in \{y_h, y_l\}. \tag{7}$$

Given Pareto weights (μ_1, μ_2), let $V_i(s|\mu_1, \mu_2)$ denote the period-2 utility that agent i will receive from a group's decision if it saves s in period 1. Then, in period 1, both agents

[3]As discussed in Holmström and Milgrom (1990) and Itoh (1993), allowing side contracting between agents never benefits the principal if agents have no information advantage over the principal.

choose the levels of consumption and savings that maximize their group's utility

$$\max_{c_i^1, s} \sum_i \mu_i \left[u(c_i^1) + \beta V_i \left(s|\mu_1, \mu_2\right)\right] \tag{8}$$

subject to the feasibility constraint

$$\sum_i c_i^1 + s = \sum_i w_i^1 \tag{9}$$

and the no-borrowing constraint

$$s \geq 0. \tag{10}$$

Since the principal can observe neither savings nor effort levels, the contract must be incentive compatible, i.e.,

$$(w_1^1, w_2^1, s) = \underset{c_1^1, c_2^1, \hat{s}}{\arg\max} \sum_i \mu_i \Big[u(c_i^1) + \beta V_i(\hat{s}|\mu_1, \mu_2)\Big] \tag{11}$$

subject to the feasibility constraint (9) and the no-borrowing constraint (10), and

$$\big(e_1, e_2, w_1^2(\mathbf{y}), w_2^2(\mathbf{y})\big) = \underset{\hat{e}_1, \hat{e}_2, c_1^2(\mathbf{y}), c_2^2(\mathbf{y})}{\arg\max} \sum_i \mu_i \left[\sum_y \pi(\mathbf{y}|\hat{e}_1, \hat{e}_2) u\big(c_i^2(\mathbf{y})\big) - \hat{e}_i\right], \forall \hat{e}_i \in \{0, 1\} \tag{12}$$

subject to the feasibility constraint

$$\sum_i c_i^2(\mathbf{y}) = \sum_i w_i^2(\mathbf{y}), \quad \forall y_i \in \{y_h, y_l\}. \tag{13}$$

The principal's problem is to design a contract that maximizes the expected profit,

$$\max_{\mu_i, w_i^1, w_i^2(\mathbf{y})} \sum_i \left[-w_i^1 + \frac{1}{1+r} \sum_{\mathbf{y}} \pi(\mathbf{y}|1, 1)\big(y_i - w_i^2(\mathbf{y})\big)\right] \tag{14}$$

subject to the participation constraint (4) and the incentive constraints (11) and (12).

3.3 A Numerical Example

In this section, I will compare the relative benefits of optimal incentive contracts with hidden savings through a numerical example of the model developed in this paper. The utility function of agent i takes the form[4]

$$u(c) = 2\sqrt{c} - 2. \tag{15}$$

The discount factor, β, and the interest rate, r, are both equal to one. The set of possible output levels is $\{0, 70\}$.

The technology is described by the conditional probability distribution in Table 1. The parameter ϵ captures the degree of correlation between the realizations of outputs. When $\epsilon = 0$, the outputs of both projects are independent. Therefore, the realization of the output of one agent's project provides no information regarding the effort level of another agent. When $\epsilon > 0$, the outputs of both projects are positively correlated and the realization of the output of one agent's project also contains some information about the effort level of another agent. As ϵ increases, the principal can extract more and more information about the effort levels of both agents.

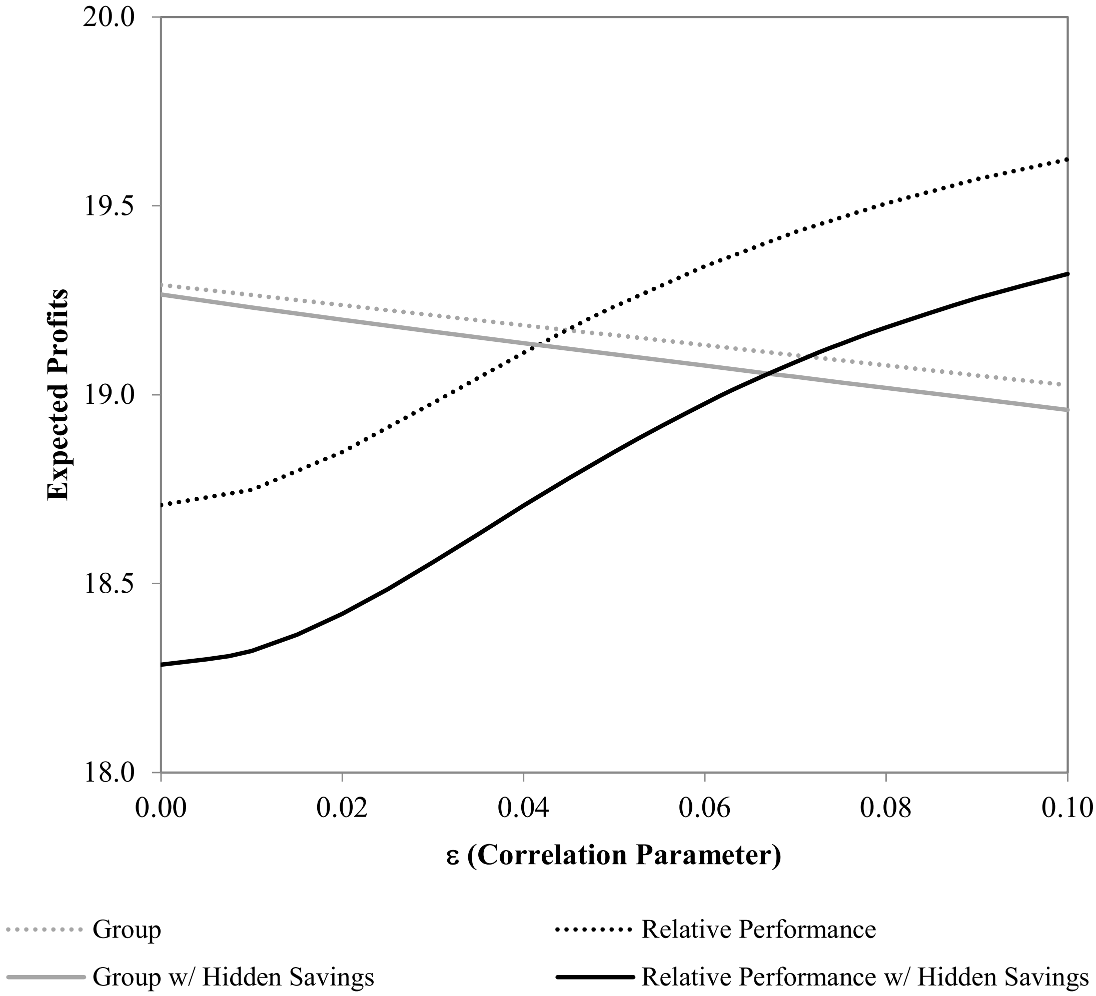
Table 1: Probability distribution of outcomes

$\mathbf{y} = (y_1, y_2)$	$\pi(\mathbf{y}\|1,1)$	$\pi(\mathbf{y}\|1,0)$	$\pi(\mathbf{y}\|0,1)$	$\pi(\mathbf{y}\|0,0)$
$\mathbf{y} = (70, 70)$	$0.49 + \epsilon$	$0.28 - \epsilon$	$0.28 - \epsilon$	$0.16 + \epsilon$
$\mathbf{y} = (70, 0)$	$0.21 - \epsilon$	$0.42 + \epsilon$	$0.12 + \epsilon$	$0.24 - \epsilon$
$\mathbf{y} = (0, 70)$	$0.21 - \epsilon$	$0.12 + \epsilon$	$0.42 + \epsilon$	$0.24 - \epsilon$
$\mathbf{y} = (0, 0)$	$0.09 + \epsilon$	$0.18 - \epsilon$	$0.18 - \epsilon$	$0.36 + \epsilon$

Figure 1 shows how the correlation between the outputs of both projects affects the principal's expected profit. In this example, the outside option of agent 1 is 10, and the outside option of agent 2 is 15. As a benchmark, consider first the dotted lines, which represent the principal's expected profits in the absence of hidden savings. When $\epsilon = 0$,

[4] To check the robustness of the result, I also consider the exponential utility function and the constant relative risk aversion (CRRA) utility function at different values of the coefficient of relative risk aversion. The results are similar and available upon request.

Figure 1: Expected profits



the principal receives a higher expected profit under group contracts than under relative performance contracts. When the outputs are uncorrelated, the realization of the output of agent 1's project does not provide any information about the effort level of agent 2, and vice versa. Therefore, optimal relative performance contracts simply become individual contracts. In addition, as shown by Itoh (1993), group contracts perform better than individual contracts when outputs are uncorrelated. Moreover, the correlation between outputs increases the principal's expected profit under relative performance contracts but decreases the principal's expected profit under group contracts. Furthermore, there is a cut-off correlation level below which group contracts are preferred; above this level, relative performance contracts are preferred.

Next, consider the solid lines, which represent the expected profits under optimal contracts with hidden savings. Hidden savings decrease the expected profits of both relative performance evaluation contracts and group evaluation contracts. However, hidden savings have a stronger effect on the former as can be seen from the higher cut-off correlation level.

Figure 2: Relative benefits of optimal contracts

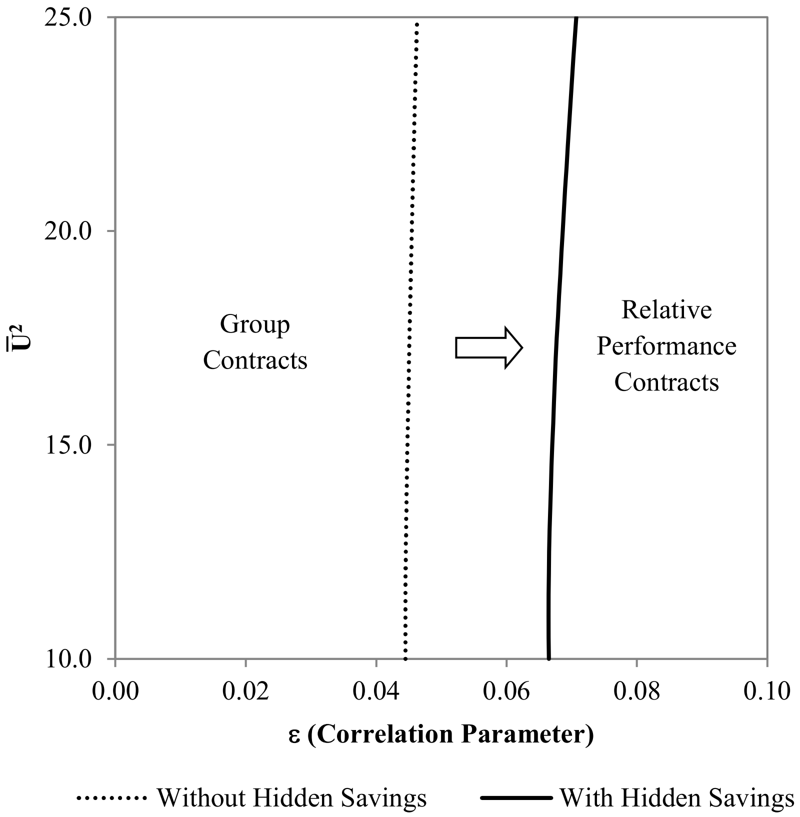


Figure 2 summarizes the results of this example by showing how the relative benefits of optimal contracts varies across the levels of correlation between outputs and the levels of inequality between agents. The outside option of agent 1 is fixed at ten, whereas the outside option of agent 2 is varied; these values are shown along the vertical axis. Moving up the vertical axis increases the inequality between both agents. The dotted line in the middle represents the result of the case without hidden savings. The dotted line separates the region in which group evaluation contracts are preferred from the region in which relative performance evaluation contracts are preferred. Group evaluation contracts are preferred when the correlation between outputs is low, whereas relative performance evaluation contracts are preferred when this correlation is high. In addition, the former performs better when inequality between agents is high.

The solid line in Figure 2 summarizes the result with hidden savings. Because hidden savings affect group contracts less than relative performance contracts, the line separating the two regions shifts to the right. The line shifts further at the top of Figure 2 than it does at the bottom, suggesting that group evaluation contracts are affected by hidden savings relatively less when inequality between agents is high.

Further, group contracts are less affected by hidden savings because such savings in this model arise from precautionary motives. The benefit of relative performance contracts is that they create strong incentives for agents to exert high effort levels by evaluating agents against each other. However, such contracts also make agents uncertain about their future consumption levels, which encourages agents to save. Hidden savings also limit the principals ability to punish an agent for low output. Therefore, hidden savings reduce the benefit of relative performance contracts. By contrast, under group contracts, agents can share their consumption and are thus better insured against uncertain future outputs. As a result, agents have less incentive to save, and therefore, group contracts are less affected by hidden savings.

The results also suggest that, compared with the case without hidden savings, group contracts yield better performance when inequality between agents is high. Under group contracts, the groups savings benefit all the agents equally when these agents have the same outside options. By contrast, when agents have different outside options, the agent who has the better outside option gains less, or even loses, if the group decides to save and deviate from the recommended effort levels. However, this agent has a higher Pareto weight and thus more influence on the groups decisions, including those regarding savings. Therefore, hidden savings affect group contracts less when inequality between agents is high.

4 Empirical Evidence

4.1 Data

This paper uses the household data from the baseline survey of the Townsend Thai project. Conducted in 1997, the survey covers households in 192 villages from two Central provinces (Chachoengsao and Lop Buri) and two Northeastern provinces (Buri Ram and Si Sa Ket). The data include household composition, education levels and occupations of household members, household assets, household income, and household expenditures. In addition, the data also include the information of all existing loans and all loans that were fully repaid in the last 12 months prior to the survey.

The model developed in Section 3 considers two types of incentive contracts, namely, relative performance contracts and group contracts. To test the model's predictions, this paper uses the data of households' borrowings from institutional lenders. The main institutional lender in Thai rural villages is the Bank for Agriculture and Agricultural Cooperatives (BAAC). Approximately 70% of loans from institutional lenders in the data are those from the BAAC. To borrow from the BAAC, a household can apply for an individual loan but typically must put up assets (usually land) as collateral. A household can also join a BAAC group to secure a group-guaranteed loan[5].

Following Ahlin and Townsend (2007), this paper link individual loans with relative performance contracts and joint-liability (i.e., group-guaranteed) loans with group contracts. As discussed in Townsend and Yaron (2001), the BAAC adopts a risk-contingency system. When a client fails to repay on time, a credit officer goes into the field to verify the situation of the borrower. If the credit officer decides that the client could not repay due to *force majeure*, the loan will usually be rescheduled. On the other hand, if the failure to repay is deemed unjustified, the client could face an interest penalty of three percent. Since external factors that affect a farmer's output are usually common to a specific location (e.g., rainfall, temperature, or pests), a credit officer could make a decision based on the outcome of other farmers nearby. That is, a farmer's failure to repay is more likely to be justified if other farmers in the same area also fail to repay. Likewise, a

[5] A member who takes a group-guaranteed loan might not own any land but must have a guarantor within the group who does.

feature of relative performance contracts in the model is that an agent will be punished less severely for a bad outcome if another agent also has a bad outcome.

A group-guaranteed loan is provided under the stipulations of joint liability. Thus, if a group member fails to repay, other members in the group are also held liable for that members' debt. In the model, the consumption level of each agent in a group depends on the aggregate consumption, and a bad outcome of one agent leads to lower consumption level of both agents.

Table 2: Summary statistics

Variables	Obs.	Mean	Median	S.D.
Panel A: Loan type				
Group (0/1)	1,548	0.514	1.000	0.500
Panel B: Hypothetical situations				
SavingsS (0/1)	1,115	0.368	0.000	0.482
SavingsL (0/1)	1,115	0.126	0.000	0.333
Panel C: Instrumental variable				
Frequency	145	3.488	2.727	2.620
Panel D: Controls				
Wealth	1,115	1.277	0.395	4.108
Title	1,115	0.965	0.100	4.005
MaleHead (0/1)	1,115	0.822	1.000	0.382
HeadAge	1,115	50.406	49.000	12.693
Relative (0/1)	1,115	0.857	1.000	0.351
AvgGroup	1,115	0.496	0.500	0.486
EverGroup (0/1)	1,115	0.525	1.000	0.500

Note: Units of observation are loan for Panel A, household for Panel B and Panel D, and village for Panel C. In Panel A, *Group* is an indicator variable that equals one if the loan is a joint-liability loan. In Panel B, *SavingsS* is an indicator variable that equals one if the household would use own savings to absorb a small liquidity shock in the hypothetical situation. *SavingsL* is an indicator variable that equals one if the household would use own savings to absorb a large liquidity shock. In Panel C, *Frequency* is the number of deposits and withdrawals to/from savings accounts in the past 12 months of an average household in the village. In Panel D, *Wealth* is the value of household wealth, in million baht. *Title* is the value of titled lands owned by the household, in million baht. *MaleHead* is an indicator variable that equals one if the head of the household is male. *HeadAge* is the age of the head of the household. *Relative* is an indicator variable that equals one if the household has a relative living in the same village. *AvgGroup* is the fraction of the household's loans that are group loans. *EverGroup* is an indicator variable that equals one if the household has at least one group loan.
Source: Townsend Thai Project.

Table 2 reports summary statistics of the variables used in this paper. In Panel A, *Group* is an indicator variable that equals one if the loan is a joint-liability loan.

Out of 1,548 loans in the data, slightly more than half are joint-liability loans. Panel B reports the households' responses to hypothetical liquidity shocks. In the survey, there is a question asking what households would do if they faced a small (large) liquidity shock and needed 2,000 Baht (20,000 Baht) right away[6]. Two main responses are using own savings and borrowing money from friends or relatives, both of which account for 77% of households responses to small shocks[7]. In Thai rural areas, these informal loans from friends and relatives are sometimes similar to gifts as many of them have no due date (i.e., borrowers are expected to pay back "whenever they can"') and the punishment for not being able to repay is vague. Therefore, these households responses to liquidity shocks are closely related to self-insurance and within-group risk sharing in the model. The variable $SavingsS$ is an indicator that equals one if a household responds to a small liquidity shock by using own savings, and the variable $SavingsL$ is an indicator that equals one if a household responds to a large liquidity shock by using own savings[8]. From Table 2, around 37% of the households in our sample use own savings to absorb a small liquidity shock, and the percentage of households using own savings to absorb a large liquidity shock is slightly more than 12%.

The model developed in this paper suggests that the hidden savings problem could affect the relative benefits of the incentive contracts. To assess the severity of the hidden savings problem in each village, we use $Frequency$—the number of deposits and withdrawals to/from savings accounts in the past 12 months of an average household in the village—as a proxy variable. In the model, savings that affect the outcome of incentive contracts are those that cannot be observed by a principal. In the context of Thai rural villages, cash on hand is a good candidate due to the following reasons: cash is the primary medium of exchange; it is less observable than deposits at banks or co-operatives; and it is more liquid than other wealth-accumulating assets such as gold or jewelry. *Ceteris paribus*, households residing in the villages locating farther away from bank branches

[6] The small liquidity shock is approximately 60 USD, while the large liquidity shock is approximately 600 USD.

[7] Other responses include borrowing money from money lenders and selling their assets, which account for additional 16%.

[8] The two most common responses are by borrowing from relatives and friends and by using own savings. Other responses include by liquidating assets, by borrowing from financial institutions, and by borrowing from informal money lenders.

will travel to bank less frequently and have more cash on hand. Therefore, $Frequency$ should be negatively correlated with the degree of the hidden savings problem. Panel C in Table 2 reports the summary statistics of $Frequency$. The average number of bank visits is 3.5 times per year.

Panel D summarizes the control variables used in the estimations. On average, households in the data have total wealth of 1.28 million Baht (approx. 38,000 USD), and the value of titled lands accounts for most of their wealth. Most households have a male household head (82%) and have at least one relative living outside the household but in the same village (86%). Furthermore, slightly more than half of the households have at least one group loan.

4.2 Hidden Savings and Group Loans

The first prediction from the model is that, comparing across economies, group contracts will be preferred in economies where the hidden savings problem is more severe. The extent of the hidden savings problem in each village is proxied by the number of bank visits in each month by an average household. In the village that households travel to bank more frequently, households are less likely to hold a large amount of cash at home. And cash is arguably the least observable form of assets in our data.

To test the relationship between hidden savings and group contracts, I estimate the following specification:

$$Group_{ijk} = \mathbb{I}\left(\beta Frequency_j + \mathbf{X}_{ij}\mathbf{\Gamma} + \epsilon_{ijk} \geq 0\right) \tag{16}$$

where subscripts i, j, and k index household, village, and loan, respectively; $\mathbb{I}(\cdot)$ denotes the indicator function for whether the containing statement is true; $Group_{ijk}$ is an indicator variable equals one if the loan is a joint-liability loan; $Frequency_j$ is the number of deposits and withdrawals to/from savings accounts in the past 12 months of an average household in the village; $\mathbf{X}_{ij}$ is a vector of household i's characteristics, including household wealth, gender and age of the household head, and whether household i has relatives living in the same village.

Table 3: Hidden savings and the propensity to use group loans

Dependent Variable = *Group*	Institutional Lenders		Banks	
	(1)	(2)	(3)	(4)
$Frequency$	-0.035^{***}	-0.032^{**}	-0.044^{***}	-0.043^{***}
	(0.013)	(0.013)	(0.015)	(0.015)
$Wealth$	-0.051^{***}		-0.053^{**}	
	(0.017)		(0.023)	
$Title$		-0.093^{***}		-0.083^{***}
		(0.030)		(0.029)
$MaleHead$	0.417^{***}	0.427^{***}	0.403^{***}	0.418^{***}
	(0.089)	(0.089)	(0.105)	(0.104)
$HeadAge$	-0.008^{***}	-0.007^{***}	-0.008^{***}	-0.008^{***}
	(0.003)	(0.003)	(0.003)	(0.003)
$Relative$	-0.021	-0.022	0.024	0.018
	(0.095)	(0.095)	(0.107)	(0.107)
Number of Obs.	1,548	1,548	1,218	1,218

Note: This table presents the estimated effects of the unobserved savings on the propensity to use group loans. The unit of observation is loan. *Group* is an indicator variable that equals one for a group loan. $Frequency$ is the number of deposits and withdrawals to/from savings accounts in the past 12 months of an average household in the village. $Wealth$ is the value of household wealth, in million baht. $Title$ is the value of titled lands owned by the household, in million baht. $MaleHead$ is an indicator variable that equals one if the head of the household is male. $HeadAge$ is the age of the head of the household. $Relative$ is an indicator variable that equals one if the household has a relative living in the same village. Robust standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.
Source: Townsend Thai Project. Estimated by the author.

Column 1 of Table 3 reports the estimation result using the data of loans from all banks and institutional lenders. The negative correlation between $Frequency_j$ and $Group_{ijk}$ supports the model's prediction that group contracts will be preferred in the economies where hidden savings problem is likely to be more severe. The result also suggests that wealthier households or households with a younger household head are less likely to use group contracts, while households with a male household head are more likely to use group contracts.

Since different types of assets might not be equally collateralizable, this paper also uses $Title_{ijk}$, the value of titled land owned by household i, as an alternative control for household wealth. The result, as reported in column 2 of Table 3, also confirms the model's prediction. As additional robustness checks, this paper also reports the estimation results using the data of only the loans from the BAAC and commercial banks in columns 3 and 4 of Table 3. Again, the results support the model's prediction that group contracts will be preferred in the economies where hidden savings problem is likely to be more severe.

4.3 Group Loans and Self-Insurance

The second prediction from the model is that when facing liquidity shocks, agents under group contracts will rely less on own savings than those under relative performance contracts and will rely more on risk sharing within groups. To test the relationship between group contracts and self-insurance, this paper estimates the following probit model:

$$Savings_{ij} = \mathbb{I}\left(\beta AvgGroup_{ij} + \mathbf{X}_{ij}\mathbf{\Gamma} + \epsilon_{ij} \geq 0\right) \tag{17}$$

where subscripts i and j index household and village, respectively; $\mathbb{I}(\cdot)$ denotes the indicator function for whether the containing statement is true; $Savings_{ij}$ is an indicator variable that equals one if household i uses own savings to absorb liquidity shocks; $AvgGroup_{ij}$ is the fraction of household i's loans that are group loans; $\mathbf{X}_{ij}$ is a vector of household i's characteristics, including household wealth, gender and age of the household head, and whether household i has relatives living in the same village.

However, household i's choice between a group loan and an individual loan could be endogenous, and unobserved characteristics of household i that influence its loan choice could also affect its response to liquidity shocks. As shown in Section 4.2, the number of bank visits by an average household in a village is positively correlated with the likelihood of group loans being chosen by households in that village. Moreover, the average number of bank visits is unlikely to be affected by the unobserved characteristics of a household. Therefore, $Frequency_j$ is used as an instrumental variable for $AvgGroup_{ij}$ in equation (17).

Columns 1 and 2 of Table 4 report the estimation results for small liquidity shocks. The result from the first-stage estimation shows that the instrumental variable, $Frequency_j$, is significantly correlated with the endogenous variable, $AvgGroup_{ij}$. The result from the second-stage estimation confirms the model's prediction that households with a higher ratio of group loans are less likely to rely on own savings to protect themselves against a small liquidity shock. Moreover, the Wald test rejects the null hypothesis that there is no endogeneity. Columns 3 and 4 of Table 4 report the estimation results for large liquidity shocks. Again, the results suggest that households with group loans are less likely to use own savings to smooth out a large liquidity shock, and the Wald test rejects the null hypothesis of no endogeneity.

Table 4: Group loans and self-insurance

	Small Shocks		Large Shocks	
Dependent Variable = *Savings*	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	1^{st} Stage
	(1)	(2)	(3)	(4)
AvgGroup	-1.683^{***}		-1.668^{***}	
	(0.346)		(0.398)	
Frequency		-0.014^{**}		-0.014^{**}
		(0.005)		(0.005)
Wealth	0.023	-0.012^{***}	-0.002	-0.012^{***}
	(0.024)	(0.003)	(0.014)	(0.003)
MaleHead	0.402^{***}	0.133^{***}	0.241^{**}	0.133^{***}
	(0.097)	(0.038)	(0.121)	(0.038)
HeadAge	-0.006^{**}	-0.004^{***}	-0.004	-0.004^{***}
	(0.003)	(0.001)	(0.004)	(0.001)
Relative	-0.101	-0.044	-0.177^{*}	-0.044
	(0.092)	(0.041)	(0.106)	(0.041)
Wald Test for Exogeneity	0.018		0.035	
Number of Obs.	1,115		1,115	

Note: This table presents the estimated effects of group loans on self-insurance. The unit of observation is household. *Savings* is an indicator variable that equals one if the household would use own savings to absorb a liquidity shock in the hypothetical situation. *AvgGroup* is the fraction of the household's loans that are group loans. *Frequency* is the number of deposits and withdrawals to/from savings accounts in the past 12 months of an average household in the village. *Wealth* is the value of household wealth, in million baht. *Title* is the value of titled lands owned by the household, in million baht. *MaleHead* is an indicator variable that equals one if the head of the household is male. *HeadAge* is the age of the head of the household. *Relative* is an indicator variable that equals one if the household has a relative living in the same village. Robust standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.
Source: Townsend Thai Project. Estimated by the author.

As robustness checks, I replace $AvgGroup_{ij}$ with $EverGroup_{ij}$, an indicator variable that equals one if household i has any group loans in the past 12 months, and re-estimate equation 17. Table 5 reports the estimation results of this alternative specification. The results for small liquidity shocks are reported in columns 1 and 2, while the results for large liquidity shocks are reported in columns 3 and 4. These results confirm the model's prediction. Households that have any group loans in the past 12 months are less likely to rely on own savings, and the Wald tests reject the null hypothesis of no endogeneity for both small shocks and large shocks.

Table 5: Group loans and self-insurance - Robustness

	Small Shocks		Large Shocks	
Dependent Variable = *Savings*	2nd Stage	1st Stage	2nd Stage	1st Stage
	(1)	(2)	(3)	(4)
EverGroup	-1.769^{***}		-1.767^{***}	
	(0.301)		(0.337)	
Frequency		-0.011^{*}		-0.011^{*}
		(0.006)		(0.006)
Wealth	0.014	-0.013^{***}	-0.007	-0.013^{***}
	(0.025)	(0.003)	(0.013)	(0.003)
MaleH	0.394^{***}	0.137^{***}	0.258^{**}	0.137^{***}
	(0.098)	(0.040)	(0.113)	(0.040)
HeadAge	-0.007^{**}	-0.004^{***}	-0.005	-0.004^{***}
	(0.003)	(0.001)	(0.004)	(0.001)
Relative	-0.094	-0.041	-0.160	-0.041
	(0.089)	(0.042)	(0.103)	(0.042)
Wald Test for Exogeneity	0.023		0.040	
Number of Obs.	1,115		1,115	

Note: This table presents the estimated effects of the unobserved savings on the propensity to use group loans. The unit of observation is household. *Savings* is an indicator variable that equals one if a household would use own savings to absorb a liquidity shock in the hypothetical situation. *EverGroup* is an indicator variable that equals one if the household has any group loans in the past 12 months. *Frequency* is the number of deposits and withdrawals to/from savings accounts in the past 12 months of an average household in the village. *Wealth* is the value of household wealth, in million baht. *Title* is the value of titled lands owned by the household. *MaleHead* is an indicator variable equals one if the head of the household is male. *HeadAge* is the age of the head of the household. *Relative* is an indicator variable equals one if the household has a relative living in the same village. Robust standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.
Source: Townsend Thai Project. Estimated by the author.

5 Conclusion

This paper studies the effects of unobserved savings on the relative benefits of optimal incentive contracts. Two types of incentive contracts are considered herein, namely, relative performance contracts and group contracts. By evaluating agents against each other, relative performance contracts provide agents with strong incentives to choose high effort levels. On the other hand, through within-group risk sharing, agents are better protected against consumption uncertainty under group contracts.

The model developed in this paper provides two testable predictions. First, group contracts are more likely to be preferred in economies where the hidden savings problem is more severe. Second, agents under group contracts rely more on risk-sharing networks than on own savings. For empirical analyses, this paper uses a data set containing detailed information on households' characteristics, their choices of loans, and their responses to liquidity shocks. This unique data set allows me to directly test the predictions from the model. The empirical results confirm that households in the areas where the hidden savings problem is more severe are more likely to choose group loans and that households with group loans rely more on risk-sharing networks and less on own savings.

This paper contributes to the literature on optimal incentive contracts by investigating the effects of unobserved savings on the relative benefits of optimal incentive contracts. To the best of my knowledge, this topic has not been covered before. This paper also contributed to the literature on microfinance in developing economies by providing another channel through which group loans could have advantage over individual loans. These findings also have a policy implication on the design of effective microfinance programs in developing economies.

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