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Institutions and Development: Evidence from Vietnam

by

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ABSTRACT

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The dissertation is composed of three papers on institutions and development, with special focus on Vietnam. The first paper, "Club Good and Contract Enforcement," investigates the contract enforcement power of the communities whose members participate voluntarily. By investing in club goods, communities can use the power to exclude members from such club goods as a threat against potential violations of contracts and property rights. More club goods lead to stronger contract enforcement, which in turn encourages more investment that generates higher income and higher contribution to club goods. The optimal level of club-good spending absent perfect enforcement is higher than that with perfect enforcement. Even the weakest form of coordination in club good provision, the voluntary contribution, can create certain level of enforcement.

The first part of the second paper, "Can Religion Mitigate Credit Rationing: Evidence from Vietnam," presents a game-theoretical model of credit rationing. The model shows that increasing enforcement always mitigates credit rationing, and thus increases equilibrium loan size and interest rate. The second part argues that religious affiliation at both household and community levels increases contract enforcement. Therefore, in case of credit rationing, religious households, by paying higher interest rate, would be able to borrow more than non-religious households. An empirical model to test this hypothesis is constructed and applied to the Vietnam Living Standard Survey 1988 (VLSS 1988) dataset. Religious affiliation at village level is found to reduce default rate, and to increase loan value and interest rate significantly. To a lesser extent, household affiliation with Buddhism also increases loan size and interest rate.

The third paper, "Identifying Corruption: Local Officials and the Distribution of Disaster Relief in Vietnam," establishes an evidence of corruption of Vietnamese commune officials. The dataset is also compiled from VLSS 1998. The paper exploits unintended household information of the officials who answered the commune survey to trace their household-spending patterns. By connecting the data on the disasters and government's aids with the household spending data, we show that there is a significant distortion in the distribution of the government's natural relief aids toward the households of the local officials.

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Chapter 1

Club Good and Community Enforcement

1.1 Introduction

Although contract enforcement is a prerequisite to the functioning of the market, it was taken for granted throughout most of the history of economic theory. In the last two decades, the topic started to draw great attention of economists from many subfields: game theory, industrial organization, institutional economics, economics of law, international trade, development economics, economic history, and macro finance[1].

Economists discovered that in many cases, the formal contract enforcement via court system is to be supplemented by various informal contract enforcement mechanisms (as in repeated credit sale), or of a secondary role (as in stock trading, in inter-bank lending or diamond trading), or simply missing (as in long-distance trad-

[1]While waiting for a long-overdue literature survey, we can only give some well-known examples from a few subfields: in game theory see, for example, Alison (1984); in international trade, see Dixit (2003); in development economics, see Woodruff (1998); economic history, see Greif (1995) and in macro finance, see Kyiotaki (1995).

ing or in informal credit markets in developing countries). The limited power of formal contract enforcement hinders the capital flows and economic transactions, and magnifies market failures (for example, deepening business cycles, as suggested in Kyiotaki 1995).

Economic actors have developed several informal mechanisms to overcome the limited nature of formal enforcement. The most obvious mechanism is enforcing through repeated transactions: the contract is self-enforcing if the long-term gains from the repeated contracts in the future outweigh the short-term gain from breaching the present contract[2]. However, most modern economic interactions are not limited to a small number of partners with repeated transactions and thus require other forms of enforcement. A more widely applicable mechanism is through "reputation effect," in which economic actors can establish and benefit from the reputation of being honest within a business community with repeated transactions (for a vivid example among Middle-Age Maghribis long-distance traders, see Greif, 1995). A relatively new approach in economics suggests that social trust, when incorporates to the preference of the economic actors, can create certain level of enforcement.

In this chapter, we focus on another mechanism of informal contract enforcement, namely, enforcement based on club goods. Motivated by the unique role of the traditional Vietnamese communes in enforcing everyday economic and social activities, we raise the following questions: Can a community whose membership is voluntary enforce the contracts among its members? What would be the optimal club-good

[2]See Osborne and Rubinstein (1994) for a review of the so-called "folk theorems" on repeated contracts.

provision rule, taking into account the enforcement effect? What is the limit of such power? Can voluntary contribution to club good enforce contracts? How does the enforcement affect the welfare of the community members?

To address these questions, we will present a game-theoretical model of the community enforcement of the lending contracts between its members. We will show that by investing in club goods (e.g., excludable public goods), communities can use the power to exclude members from such club goods as a threat against potential contract violations. Such limited community enforcement will determine how much its members could invest in high-return, high-default-risk businesses. More club goods lead to stronger contract enforcement, which in turn encourages more investment, which generates higher income and higher contribution to club goods. In some circumstances, there are multiple equilibria according to which some communities with more efficient provision of club goods thrive while others are trapped in low equilibrium.

We will derive the optimal club-good contribution rule, taking into account the enforcement effect. We will show that the optimal level of club-good spending absent perfect enforcement is higher than the optimal level with perfect enforcement. We will also show that due to non-rivalry nature of the club good, even the weakest form of coordination in club-good provision, namely, the voluntary contribution, can create some level of enforcement.

Although club good as a mean of contract enforcement has not been discussed in detail, it was suggested elsewhere (Richman, 2006). In his paper, Richman presents a case study of how the community of Jewish diamond merchants in New York enforces credit sale of diamonds among its members and thus secures a long-time monopoly in the industry. Although the paper does not address formally the limitation, optimality and efficiency of enforcement mechanism based on community club good, it does suggest that such mechanism plays an important role in the case of the New York Jewish diamond merchants. The paper, therefore, is one of the most relevant case studies that motivate our theoretical model.

The remainder of the chapter is organized as follows. Section 1.2 describes the unique role of ancient Vietnamese communes in enforcing social and economic transactions as the motivation for our model and manifestation of the model in reality. Section 1.3 presents the setting of a three-stage game between the lenders and borrowers within a community. Section 1.4 analyzes the existence and the properties of the subgame-perfect Nash equilibrium of the game, the limit of community enforcement and the conditions under which the phenomenon of multi-equilibria arises. Section 1.5 shows that to find the optimal club-good contribution rules, we can focus on a smaller class of rules, namely, the linear income taxes. It also shows that taking into account the enforcement effect, the optimal contribution rule imposes higher level of club-good contribution and consumption than the efficient level with perfect enforcement. Section 1.6 demonstrates that even the weakest contribution rule, namely, voluntary contribution, can generate certain level of contract enforcement.

1.2 Enforcement in Ancient Vietnamese Communes

In ancient Vietnam, the central government largely limited its role to collecting taxes and providing large-scale public projects and national defense, leaving the management of everyday life to communes. The communes provided most of the local public goods such as clean water, village roads, local security, commune common house and commune-specific festivals. They also enforced most of economic relations. According to Fforde and Paine (1987), the basic framework of pre-modern Vietnamese society is "a fundamentally dualistic and hierarchical social organization articulating centralized state and local village". They also emphasized the durability of the Vietnamese communes despite the social upheavals. Wrote Fforde and Pain:

> " Some communes in the Red River Delta seem to have histories going back to the first millennium. This *long-run durability* suggests that interaction between changes in methods of production and the evolution of its social institutions had led to their general *suitability* in the face of violent social change, so long as that change did not take the form of a sharp alteration in the attitude of the state."

The communes remain largely intact, despite the fact that Vietnam has been attacked and invaded dozens of times by the Chinese, Mongols, Champa and Thai; occupied for nearly a thousand years by the Chinese and more than seventy years by the French; divided by more than two hundred years of civil wars. This extreme durability implies that the communes must have had effective enforcement mechanisms to enforce contract and property rights among their members.

Commune codes are the most concrete evidence of the informal enforcement mechanism in Vietnamese communes. As of 1991, out of 12000 villages in Vietnam, more than 5000 village codes had been collected by Institute of Social Science Information of Vietnam. In addition, the legitimacy of these commune codes had been recognized by various central governments. For example, at the end of the 14^{th} century, Vietnamese feudist government issued a decree recognizing village codes. In the 19^{th} century, French colonial authorities also recognized the legitimacy of village codes and attempted to modify them to augment their own regulations in Vietnam.

However, the contract and property-right enforcement provided by community is limited. The most severe punishment the community can apply to its members is to exclude a violator from the community (i.e., from consuming community public goods). For example, according to Phan Dai Doan and Bui Xuan Dinh (2000), in regions of Kinh (the major ethnic of Vietnam), commune codes provide different levels of punishment:

> (i) fine, compensate the damages; (ii) beat by stick [...]; (iii) dismiss from current social position temporarily or permanently; (iv) boycott the offender from community activities (both in the village scale and in each organization that he/she participates in). In serious cases, the village will boycott violator's funeral; (v) expel from the village.

In our theoretical model, we suggest that the optimal spending in community's club goods taking into account enforcement effect should be higher than in the case of perfect enforcement. This observation may explain the apparently paradoxical existence of costly religious activities and festivals, debt-financed life-cycle ceremonies, extravagant commune common houses, churches and pagodas in relatively poor communes. Many decrees issued by Vietnamese kings demanding lower spending in such costly club goods can be considered as indirect evidence of the seemingly overspending on the community club goods.

Phan Dai Doan and Bui Xuan Dinh (2000) concluded that

> In Vietnam, *huong uoc* or village codes are an autochthonous creation, developing from the "codes of precedents" that were oral regulations concerning village borders, public safety, and social interactions in communities [...]. The development of *huong uoc* links to that of the village community; that is to say, *huong uoc* is the product of village culture, a natural outcome of an imminent development process. They became a tool to manage village social relationships, a form of folk knowledge for community management.

1.3 Model Setting

1.3.1 Agents

Consider the set N comprised of n female Lenders and n male Borrowers[3]. Each Lender is endowed with one unit of capital. Each Borrowers is endowed with one unit of labor, which can be used in traditional production A or/and the capitalist production B. Technology A transforms one unit of labor into one unit of income and does

[3] In the model, we adopt a particular contract form, namely, the lending contract, for the ease of labeling the parties and the actions involved. The payoff specification in our model is not limited to lending contracts but is applicable to many other forms of contracts and economic cooperation. Some of the more typical examples are crop-sharing contracts between landowners and workers, credit sales among the merchants and investment contracts between local investors and entrepreneurs.

not require capital. Technology B is capital intensive, requires both labor and capital and generates higher output, which is determined by the function $\min\{2\beta k, 2\beta l\}$, where $\beta > 1$.

Additionally, agents have identical preferences, which can be represented as an additive separable utility function $U(g_i, x_i) = V_1(g_i) + V_2(x_i)$, in which x_i is the money spent on the private good, and g_i is the money spent on the club good. Assume that V_1 and V_2 are both positive, strictly increasing and concave.

1.3.2 Timeline

In stage 1, agents randomly match pairwise. Each pair is comprised of a Lender and a Borrower. Each Lender i determines the amount k_i he lends to Borrower i.

In stage 2, Borrowers observe the loan profile K. Each Borrower i then chooses to either (1) spend the share $l_i = k_i$ of his labor on project B and the rest on project A, or (2) default and take away the loan and spend his labor on the traditional technology.

If Borrower i does not default on the loan k_i, then by the end of stage 2, Lender i and Borrower i each gets βk_i, the equal share of the output. Borrower i's income is equal to Lender i's income, which is $1 + (\beta - 1)k_i$.

If Borrower i defaults on the loan and spends his labor in project A, then his income is $1 + k_i$, while Lender i's income is $1 - k_i$. For notational convenience, we assume that Borrower i chooses not to default when $k_i = 0$. The following table summarizes the incomes of Lender i and Borrower i in the two scenarios:

	Not Default	Default
Borrower i	$1+(\beta'-1)k_i$	$1+k_i$
Lender i	$1+(\beta-1)k_i$	$1-k_i$

In stage 3, the community observes the offenders in stage 2 and excludes them. Each member contributes to the club good according to a pre-specified contribution rule. (We will discuss the assumptions on the contribution rules in subsection 2.4). Each excluded Borrower spends all of his income on private good.

1.3.3 Notations

We distinguish two different scenarios by superscripts D and ND, where D means the contract is defaulted on, while ND means the loan contract is not defaulted on. We denote a particular contract by subscript i, $i \in \{1, 2, ..., n\}$. We use a second subscript to distinguish the counterparts of the contract, where B indicates Borrower, and L indicates Lender. For example, $w_{B,i}^{ND}$ and $U_{B,i}^{ND}$ are the income and the utility of the Borrower in contract i that is not defaulted on.

Let $K = (k_1, k_2, ..., k_n)$ be the vector of all the loans that Lenders make in Stage 1. When we focus on loan i, we will write (k_i, K_{-i}).

Let I_i be the reaction function of Borrower i given the loan profile K,

$$I_i(k_i, K_{-i}) = \begin{cases} 1 \text{ if } i \text{ does not default on the loan } k_i, \\ 0 \text{ if } i \text{ defaults on the loan } k_i. \end{cases}$$

Let $I = \{I_i(k_i, K_{-i})\}$ be the vector of Borrowers' choices in Stage 2. Let $\omega =$

$(w_1, w_2, ..., w_{2n})$ be the vector of incomes of all agents (community members and non-members). When we focus on agent i, we will write ω as (w_i, ω_{-i}), where ω_{-i} is the incomes of all agents other than i.

Let M ($M \subset N$) denote the set of all community members (M does not include defaulted Borrowers). Let W^M be the vector of the incomes of these members. When we focus on member i, we will write W^M as (w_i, W_{-i}^M), where W_{-i}^M is the incomes of all members other than i.

1.3.4 Contribution Rule

Let $g(W) = \{g_i(w_i, W_{-i})\}_{i \in M}$ be the contribution rule that determines the contribution of all members to the club good given income profile of all community members. $g_i(W)$ maps from $[0, \beta]^M$ to $[0, \beta]$ and is continuous in w_i and W_{-i}.

Assume that the contribution rule has the following properties:

(i) The contributions is independent of the name of the agents. Mathematically, $g(W^M) = g(W^{M'})$ if $W^{M'}$ is the profile of the members' incomes resulted from changing the names of the members in the profile W^M.

(ii) Individual contribution g_i is weakly monotone increasing in i's income and decreasing in others' income. Mathematically, $\frac{\nabla g_i}{\nabla w_i} \geq 0$, $\frac{\nabla g_i}{\nabla w_i} \leq 1$ and $\frac{\nabla g_i}{\nabla w_j} \leq 0$ for $j \neq i$, in which $\frac{\nabla g_i}{\nabla w_j}$ denotes the change in g_i that corresponds to a small increase in w_j. The second inequality indicates that when an agent's income increases, his disposable income for the private good should not decrease[4]. The third inequality

[4]Note that any contribution rule that violates this assumption will create very strong disincentive to invest.

requires that if a member j's income increases, then the burden of contribution on other agents should not increase.

(iii) Total contribution is weakly monotone increasing in member's income. In particular, $\frac{\nabla g_i}{\nabla w_i} + \sum_{j \neq i} \frac{\nabla g_j}{\nabla w_i} \geq 0$ with strict inequality if $\frac{\nabla g_i}{\nabla w_i} = 1$. This assumption requires that the net effect of the increment in i's income on the total club good should not be negative. Furthermore, an increment in the income of the member that goes to club good in full should have strictly positive effect on total club good.

We will call the property described in (i) anonymity, and the properties in (ii) and (iii) monotonicity for short.

For notational simplicity, we will write $g(W)$, $g(\omega, I)$ or $g(K, I)$ interchangeably, since there are one-to-one relationships among $(K, I), (\omega, I)$ and W^M.

It is easy to verify that with a few minor additional restrictions, lump sum, linear, progressive, regressive and Lindahl taxes all satisfy these assumptions. We will show later that voluntary contribution also satisfies these assumptions.

Given these properties, if contract i is not defaulted on, then Lender i's contribution and Borrower i's contribution are equal,

$$g_{B,i}^{ND} = g_{L,i}^{ND} = g(w_{L,i}^{ND}, W_{-i}) = g(1 + (\beta - 1)k_i, W_{-i})$$

On the other hand, if contract i is defaulted on, then Borrower i is excluded and Lender i contributes:

$$g_{L,i}^{D} = g(w_{L,i}^{D}) = g(1 - k_i, W_{-i})$$

Remark 1 *Total contribution to the club good is weakly increasing in k_i if $I_i = 1$*

and weakly decreasing in k_i if $I_i = 0$.

Proof. The proof is straightforward. If $I_i = 1$, an increase in k_i will raise the incomes of Lender i and Borrower i. By assumption (iii) of the contribution rule, $\frac{\nabla g_i}{w_i} \geq \sum_{j \neq i} \frac{\nabla g_j}{\nabla w_i}$. Therefore, G must not be decreasing in k_i. On the other hand, if $I_i = 0$, an increase in k_i will raise the loss of Lender i, and according to the same assumption, G must not increase. ■

1.3.5 Indirect Utility

The following table summarizes the indirect utility of Lender i and Borrower i in two scenarios:

Scenario 1: Loan i is not defaulted on, $w_{L,i}^{ND} = w_{B,i}^{ND} = 1 + (\beta - 1)k_i$	
Borrower i	$V_{B,i}^{ND} = V_1(G(w_{B,i}^{ND}, W_{-i}, I_{-i})) + V_2(w_{B,i}^{ND} - g(w_{B,i}^{ND}, W_{-i}, I))$
Lender i	$V_{L,i}^{ND} = V_1(G(w_{L,i}^{ND}, W_{-i}, I_{-i})) + V_2(w_{L,i}^{ND} - g(w_{L,i}^{ND}, W_{-i}, I))$
Scenario 2: Loan i is defaulted on	
Borrower i	$V_{B,i}^{D} = V_2(1 + k_i)$
Lender i	$V_{L,i}^{ND} = V_1(G(1 - k_i, W_{-i}, I_{-i})) + V_2(1 - k_i - g(1 - k_i, W_{-i}, I_{-i}))$

Lemma 1 *Lender i's utility is strictly increasing in loan size k_i when loan i is not defaulted on, and strictly decreasing in k_i when loan i is defaulted on. Borrower i's utility is strictly increasing in k_i.*

Proof. See Appendix 1.A. ■

Notice that the situation facing Lenders and Borrowers is similar to the Prisoner's Dilemma problem. The socially optimal strategies are that the Lender gives big loan and the Borrower does not default. However, if the loan is big, then the Borrower is better off defaulting on the loan. Knowing this, the Lender will not give big loan. Both Lender and Borrower end up with lower payoffs.

In the following sections, we will show how coordination among the matched pairs of agents would reduce the severity of the bad outcomes, although such coordination has its own limitations (e.g., multiple equilibria) and imposes new undesirable effects (e.g., excessive club-good spending).

1.4 Equilibrium

In this section, we will establish the existence, the (non-)uniqueness and the properties of the equilibrium(s) of the game. We will use the sub-game perfect pure-strategy Nash equilibrium[5].

Definition 1 *The equilibrium of the game is comprised of a vector* $I(k) = \{I_1(k), ..., I_n(k)\}$ *specifying Borrowers' default choice such that for* $I_i = 0$, $U_{B,i}^{ND}(k_i, K_{-i}, I_{-i}) < U_{B,i}^{D}(k_i)$, *and for* $I_j = 1$, $U_{B,j}^{ND}(k_j, K_{-j}, I_{-j}) \geq U_{B,j}^{D}(k_j)$ *and a loan profile* $K^* = (k_1^*, k_2^*, ..., k_n^*)$ *specifying the lending level for every Lender such that* k_i^* *maximizes Lender i's utility* $U_{L,i}(k_i^*, K_{-i}, I$

Proposition 1 *In any equilibrium, all contracts are honored.* $I = 1$.

[5]For a formal definition and discussion of subgame-perfect Nash equilibrium concept, see Mas-Collel, Whinston and Green (1995)

Proof. By contradiction, assume that in a particular equilibrium, Borrower i defaults in Stage 2. By assumption, Borrower i does not default when $k_i = 0$. Therefore, $k_i^* > 0$. In equilibrium, Lender i must correctly calculate that her loan will be defaulted on in Stage 2. By Lemma 1, Lender i's utility $V_{L,i}^D$ is strictly decreasing in k_i. Thus, she is better off reducing k_i^*. This contradicts with k_i^* being an equilibrium lending level. The contradiction is reached. ∎

Proposition 2 *In any equilibrium, all Lenders give the same amount of loan, all members have the same levels of income, club-good contribution and utility.*

Intuitively, the proof of Proposition 2 relies on the observation that if there are two different lending levels $k_i^* < k_j^*$ in an equilibrium, then Lender i can be better off increasing her lending to $k_i' = k_j^*$. By doing so, the total club good is (weakly) increasing, and thus the non-default utility of every other Borrower is higher, while their default utilities remain unchanged. Therefore, if they did not default in the initial lending profile, then they will not default in the new lending profile (with k_i increased). We then show that Borrower i's non-default utility in the lending profile with k_i' is higher than Borrower j's non-default utility with the initial profile with k_i^*. Therefore, if Borrower j does not default given the initial profile with k_j^*, then Borrower i will not default given the profile with increased loan k_i'. Hence, if Lender i increases k_i^* to k_j^*, then her loan will not be defaulted on and her income and utility are strictly increased. This contradicts with k_i^* being the equilibrium lending level. Therefore, it is not possible that there exist different levels of lending in any equilibrium.

Proof. See Appendix 1.B. ■

To state succinctly the condition for non-zero equilibrium lending, we introduce a new concept. The contribution rule is *moderate at breakdown point* if for all i, $g_i(1) > 0$ and $V_1\left(g_i(1) + \sum_j I_j g_j(1)\right) + V_2(1 - g_i(1)) \geq V_2(1)$ for $w = 1$. This assumption means that at the income level $\vec{1}$, the contribution rule should not be so excessive that it makes some members worse off than not having the club good at all. It also means that the members have incentive to participate in the community voluntarily at this income level.

Corollary 1 *If the contribution rule is moderate at the breakdown point, then in any equilibrium, the lending level and the club-good contribution are strictly positive.*

Proof. First, we will show that in any equilibrium, $G^* > 0$.

By contradiction, assume that $G^* = 0$ in an equilibrium. We can show that this assumption implies that in such equilibrium, there is at least one contract with non-zero loan amount being defaulted on. (Suppose not, then $w_l \geq 1$ for all $l \neq i$. In this case, the assumptions $\sum g_i\left(\vec{1}\right) > 0$ and $\frac{\nabla g_i}{w_i} + \sum_{j \neq i} \frac{\nabla g_j}{\nabla w_i} \geq 0$ imply that $G^* > 0$, which contradicts the assumption $G^* = 0$).

Without loss of generality, let j be one of the defaulted contracts with non-zero loan amount. Applying a similar line of argument in Proposition 1 to Lender j's maximization problem, we can show that she is better off reducing k_j^*. The contradiction is reached. Therefore, in equilibrium, $G^* > 0$.

By Proposition 2, $g_i = g^*$ for all i. Hence, $G^* = 2ng^*$. Combining this with the fact that $G^* > 0$, we have $g^* > 0$ as claimed in Corollary 1.

Now, by contradiction, assume that $k_i = 0$ for some i. We can show that Lender i can set $k_i > 0$ small enough so that $V_1(G^*) + V_2(1 + (\beta - 1)k_i) > V_2(1 + k_i)$. (Indeed, since V_2 is continuous, for any $\delta > 0$, we can find $\epsilon(\delta) > 0$ small enough so that $V_2(1 + \epsilon(\delta)) - V_2(1 + (\beta - 1)\epsilon(\delta)) < \delta$. Set $\delta^* = V_1(G^*)$, we know that $\delta^* > 0$, since $G^* > 0$ and $V_1(G) > 0$ for $G > 0$. Set $k_i = \epsilon(\delta^*)$ to yield $V_2(1+k_i) - V_2(1+(\beta-1)k_i) < V(G^*)$. Equivalently, $V_1(G^*) + V_2(1 + (\beta - 1)k_i) > V_2(1 + k_i)$ as required).

Notice that the above inequality is the condition for Borrower i not to default. Therefore, the loan k_i will not be defaulted on. From Lemma 1, we know that Lender i is strictly better off setting $k_i > 0$ than setting $k_i = 0$. This contradicts to the assumption that $k_i = 0$ is the equilibrium lending level for Lender i. The contradiction is reached. Therefore, in equilibrium, $k_i^* > 0$ for all i. ■

To state the next theorem succinctly, we will call an equilibrium in which $1 > k_i > 0$ for all i an *interior* equilibrium, and the equilibrium in which $K = \vec{1}$ and $K = \vec{0}$ *corner* equilibrium.

Theorem 1 *(i) All interior equilibrium loan profiles are characterized by:*

$$V_1(2ng_i(K^*)) + V_2(w_i^{ND}(k^*) - g_i(K^*)) = V_2(w_i^D(k^*)),$$

$$V_1(2g_i(k_i, K_{-i}^*) + 2(n-1)g(k_i, K_{-i}^*)) + V_2(w^{ND}(k_i) - g_{-i}(k_i, K_{-i}^*)) < V_2(w^D(k_i^*))$$

for any $k_i > k_i^*$.

(ii) The corner equilibrium in which $K = \vec{1}$ *arises when* $V_{L,i}^{ND}\left(K = \vec{1}\right) \geq V_B^D(k =$

1). *The corner equilibrium in which* $K = \vec{0}$ *arises when* $V_{L,i}^{ND} \geq V_B^D$ *for all* k.

Proof. First, recall that by Proposition 2, $k_i = k^*$ for all i. On the other hand, Proposition 1 implies that in equilibrium,

$$U_{B,i}^{ND} \geq U_{B,i}^{D}$$

The optimality of k_i^* requires that the Lender increases k_i up to the maximum level of k_i that satisfies $U_{B,i}^{ND}(K^*) \geq U_{B,i}^{D}(k^*)$ and $U_{B,i}^{ND}(k', K_{-i}^*) > U_{B,i}^{D}(k')$ for all $k' > k^*$. Since $U_{B,i}^{ND}(k', K_{-i}^*) - U_{B,i}^{D}(k')$ is continuous, such maximum k_i must satisfy the equation $U_{B,i}^{ND}(K^*) = U_{B,i}^{D}(k^*)$.

Thus, in any interior equilibrium, k^* is defined by

$$\begin{aligned} U_{B,i}^{ND}(k^*, K_{-i} &= k^*) = U_{B,i}^{ND}(k^*, K_{-i} = k^*) \text{ and} \\ U_{B,i}^{ND}(k', K_{-i} &= k^*) < U_{B,i}^{ND}(k', K_{-i} = k^*) \text{ for all } k' > k^*. \end{aligned}$$

Now, assume that $V_{L,i}^{ND}\left(K = \vec{1}\right) \geq V_B^D(k = 1)$. We will show that $K = \vec{1}$ is one of the equilibria of the game by showing that no agent can beneficially deviate from the specified strategy. Note first that no Borrower has incentive to default at $k = 1$, since by assumption, $U_{B,i}^{ND}(K = \vec{1}) > U_{B,i}^{D}(k_i = 1)$. Knowing this, no Lender has incentive to reduce the loan, since by doing so, she will strictly reduce her income and utility.

Finally, assume that $V_{L,i}^{ND} \geq V_B^D$ for all k. Clearly, no Lender is better off by setting a non-zero loan amount, since by doing so, her loan will be defaulted on with certainty. ∎

Theorem 2 *For any contribution rule satisfying continuity, anonymity and monotonicity, equilibrium exits. Multiple equilibria with rankable equilibrium payoffs arise when Borrowers' non-default utility as the function of equilibrium lending level intersects the default utility function from above more than once.*

Proof. First, recall that by Proposition 1 and Proposition 2, in any equilibrium, $k_i = k^*, I_i = 1$ and $g_i = g(k^*)$ for all i. Thus, for the purpose of investigating equilibrium lending level, we can "collapse" the domain of the non-default utility function U_i from $2n$ dimension (of $K^N \times I^N$) into single dimension (of k^*). That is, in equilibrium, $U_i(K, I) = V_1(2ng(k)) + V_2(1 + (\beta - 1)k - g(k))$.

Define $h^{ND}(k) = V_1(2ng(k)) + V_2(1 + (\beta - 1)k - g(k))$. Note that h^{ND} is continuous in k, since g is continuous in K, w is continuous in k, V_1 is continuous in G and V_2 is continuous in x_i. Define $h^D(k) = V_2(1 + (\beta - 1)k)$. Note that h^D is also continuous in k. Finally, define $h(k) = h^{ND}(k) - h^D(k)$. Note that h is a continuous function of k.

We will show that equilibrium exists, regardless of which contribution rule being used.

Case 1: $h^{ND}(k) < h^D(k)$ for all k. In this case, the unique equilibrium is $K = \vec{0}$.

Case 2: $h^{ND}(0) < h^D(0)$ and $h^{ND}(1) > h^D(1)$. In this case, by Theorem 2, $\left(K = \vec{1}, I = \vec{1}\right)$ is one of the equilibria. Furthermore, since $h^{ND}(k) - h^D(k)$ is continuous, $h^{ND}(0) - h^D(0) < 0$ and $h^{ND}(k) - h^D(k) > 0$, there must exist at least one k^* such that $h^{ND}(k) - h^D(k) = 0$ and $h^{ND}(k) > h^D(k)$. This is also equilibrium of the game.

Case 3: $h^{ND}(0) > h^D(0)$ and $h^{ND}(1) > h^D(1)$

Using similar argument used in case 2, we can also show that $K = \vec{1}$ is one equilibrium of the game. However, it is possible that in this case, $K = \vec{1}$ is the unique equilibrium.

Case 4: $h^{ND}(0) > h^D(0)$ and $h^{ND}(1) < h^D(1)$

In this case, there must be at least one k^* such that $h^{ND}(k) - h^D(k) = 0$ and $h^{ND}(k) > h^D(k)$.

We have shown that in all possible cases, equilibrium exists.

If $U^{ND}_{B,i}(G(k), k)$ and $U^D_{B,i}(k)$ cross at most twice, then the equilibrium is unique. When these two curves cross more than twice, multiple equilibria exist.

Note that an identical increment in all k_j $(j \in N)$ would increase non-default payoff more than an increment in k_i. Therefore, when $\frac{dU^{ND}}{dk} < \frac{\nabla U^D}{\nabla k_i}$, we have $\frac{\nabla U^{ND}}{\nabla k} < \frac{\nabla U^D}{\nabla k_i}$.[6] ■

[6] If the contribution rule is differentiable, then we have the following remark: We need to consider two types of derivatives with respect to k: to establish a particular equilibrium, we consider the partial change of Borrower i's utility with respect to the change in k_i. However, to investigate the existence and uniqueness of equilibria (as in Theorem 2), we need to consider the total change of the Borrowers' utility with respect to the identical changes in all k_i. The partial derivative determines whether or not a $k_i = k^*$ is an equilibrium. The total derivative is neither necessary nor sufficient condition for equilibrium. It only helps to determine number of equilibriums.

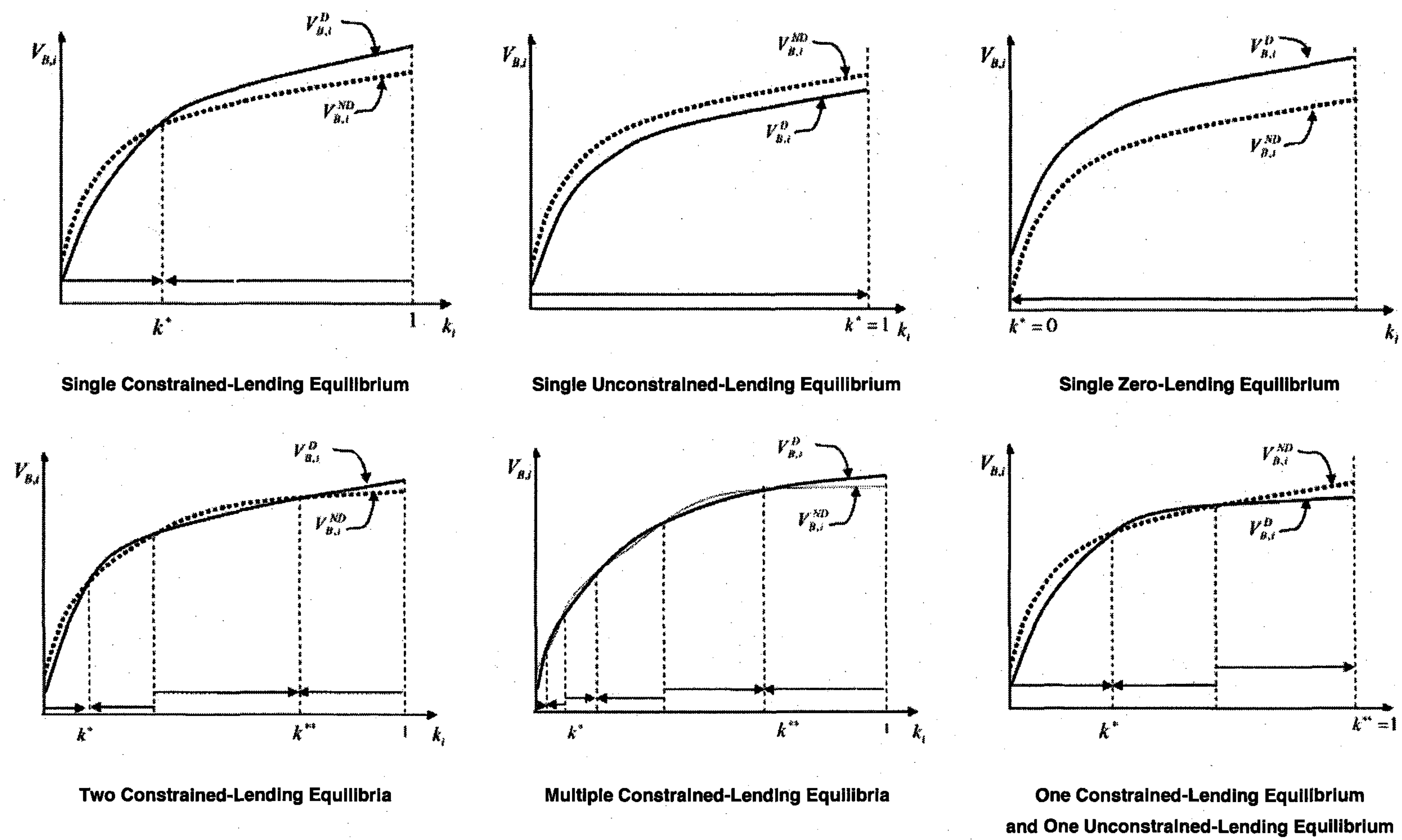

Figure 1.1: Multiple Equilibria in Community Enforcement of Lending Contracts

As a consequence, if $V_1\left(2n * g(1)\right) + V_2(w_B(1) - g\left(\vec{1}\right)) \geq V_B^D(w_B(1))$, then $k = 1$ is one of the equilibria of the game. The other possible equilibria are the third, fifth, ..., k_i satisfying $U_{B,i}^{ND}(k, K_{-i} = K^*) = U_{B,i}^D(k^*)$. If $V\left(2n * g(1)\right) + V_2(w_B(1) - g\left(\vec{1}\right)) < V_B^D(w_B(1))$, then the possible equilibria are the first, third, fifth, ..., highest k_i satisfying $U_{B,i}^{ND}(k, K_{-i} = K^*) = U_{B,i}^D(k^*)$.

1.5 Optimal Contribution Rule

In this section, we will introduce three new definitions:

1. The utility profile $Q = \{U_i\}_{i \in M}$ is said to *weakly dominate* another utility profile $Q' = \{U_i'\}_{i \in M}$ if $U_i \geq U_i'$ for all i. (Note that this bi-relation is incomplete).

2. For a given contribution rule g, if multiple equilibria exist, then the equilibrium whose utility profile weakly dominates utility profiles of other equilibria is called the *top-ranked equilibrium* under contribution rule g. (If under a contribution rule g', the equilibrium is unique, then it is the top-ranked equilibrium of g').

3. A contribution rule is *optimal* if it satisfies the assumptions of continuity, anonymity and monotonicity, and the utility profile in its top-ranked equilibrium weakly dominates the utility profile of the top-ranked equilibrium under any other contribution rule.

The optimal contribution rule can be derived by adding a Stage 0 at the beginning of the game, in which there is a Social Planner who sets the contribution rule in order to maximize a weighted sum of the utilities of all agents.

The optimal contribution rule maximizes:

$$\max U^{ND}$$

subject to the incentive compatibility constraints:

$$U^{ND}_{B,i}(k^*, K_{-i} = k^*) = U^{D}_{B,i}(k^*)$$

in which

$$k^* = \min\{k \text{ such that } U^{ND}_{B,i}(k', K_{-i} = k^*) < U^{ND}_{B,i}(k', K_{-i} = k^*) \text{ for all } k' > k\}$$

Theorem 3 *Any top-ranked equilibrium under any optimal contribution rule g^* is also achievable under a linear income tax rule αw_i, in which $\alpha = \frac{g^*(k^*)}{1+(\beta-1)k^*}$*

Proof. Let g be an optimal contribution rule and consider the top-ranked equilibrium under g. From Proposition 1 and 2, we know that $k_i = k^*$, $w_i = w^*$, $I_i = 1$ and $g_i = g^*$ for all i. Consider the contribution rule α such that $\alpha = \frac{g^*(k^*)}{w^*}$. We will show that this simple contribution rule yields the same level of utility and can maintain the lending level k^*.

Indeed, for k^* and $g^*(k^*)$ to be the equilibrium investment and contribution profiles under contribution rule g^*, it must be that $U^{ND}_{B,i}(2ng^*(k^*)) = U^{D}_{B,i}(k^*)$. Therefore, at k^*, $U^{ND}_{B,i}(2n\alpha w^*) = U^{D}_{B,i}(k^*)$ must also hold. Thus, each Borrower i is not better off deviating from the non-default strategy.

Furthermore, we can show that $U^{ND}(\alpha w', K_{-i} = k^*)) < U^D_{B,i}(k')$ for all $k' > k^*$. (Suppose that $U_B^{ND}(\alpha k', K_{-i} = k^*)) \geq U^D_{B,i}(k')$ for some $k' > k^*$, then each Lender i is better off increasing k_i to k', knowing that his Borrower will not default on the loan. This contradicts the assumption that g^* is an optimal contribution rule). Given this, no Lender has incentive to increase her lending. This confirms that k^* is optimal for each Lender i under the linear contribution rule α. ■

Note that the equal payoffs of the two optimal contribution rules apply only to the highest level of equilibrium. In non top-ranked equilibria, they may achieve different utility profiles.

Theorem 3 implies that to investigate the properties of optimal contribution rule, we can focus on a subset of such rules, namely the linear contribution rule α.

The linear optimal contribution rule α maximizes

$$\max_{\alpha} V_1\left(2n\alpha(1+(1-\beta)k^*)\right) + V_2((1-\alpha)(1+(1-\beta)k^*))$$

subject to the condition that for any α, k^* satisfies

$$V_1\left(2n\alpha(1+(1-\beta)k^*)\right) + V_2((1-\alpha)(1+(1-\beta)k^*)) = V_B^D(1+k^*)$$

Theorem 4 *The optimal contribution rule taking into account the enforcement effect of the club good specifies higher contribution level than Pareto optimal level in the case of perfect enforcement.*

Proof. First, notice that without enforcement problem, the optimal tax can be derived from the first-order condition of the above maximization problem neglecting the constraint and the effect of α on k^* and w^*. That is, $2nV_1' - V_2' = 0$. This condition is identical to Samuelson first-order condition for efficient public good allocation: The total of the marginal rates of substitution between the public good and the private good should be equal to the marginal rate of transformation between the public good and the private good. When prices of the public good and the private good are equal, the efficient allocation should be such that $2nV_1'/V_2' = 1$. Let G^{UC}, g^{UC} and α^{UC} be the optimal total club good, members' public contribution and tax rate in case of perfect enforcement, respectively.

Now, in our constrained optimization problem stated above, the Lagrangian is:

$$V_1(2n\alpha(1+(1-\beta)k^*)) + V_2((1-\alpha)(1+(1-\beta)k^*)) +$$

$$\lambda\left[V_1(2n\alpha(1+(1-\beta)k^*)) + V_2((1-\alpha)(1+(1-\beta)k^*)) - V_B^D(1+k^*)\right] = 0$$

$$(1+\lambda)[V_1(2n\alpha(1+(1-\beta)k^*)) + V_2((1-\alpha)(1+(1-\beta)k^*))] - \lambda V_2(1+k^*) = 0$$

First-order condition for α is:

$$(1+\lambda)(2nV_1' - V_2')[(1+(1-\beta)k^*) + (1-\beta)\frac{\partial k^*}{\partial \alpha}] + (1-\beta)\frac{\partial k^*}{\partial \alpha}V_2' = 0$$

It is easy to show that $\frac{\partial k^*}{\partial \alpha} > 0$. Thus, comparing to Samuelson first-order condition for efficient club-good allocation, there is an extra positive term added to the left-hand side of the equation. Therefore, $2nV_1'(\alpha^* w_i) < V_2'(w_i - \alpha w_i)$. In order for this to hold, it must be the case that $G^* > G^{UC}$. Since $g_i = g^*$ for all i, $g^* = G^*/2n$.

Hence, $g^* > g^{UC}$. This implies that $\alpha^* > \alpha^{UC}$. ■

1.6 Voluntary Contribution to Club Good

In this section, we will analyze voluntary contribution as a contribution rule, based on the results from Bergstrom, Bloom and Varian (1986) (henceforth BBV). BBV presented an one-stage game in which each player i is endowed with wealth w_i and has the utility function $u_i(x_i, G)$,where u_i is continuous and strictly increasing in x_i and G. Each player i simultaneously chooses how much to contribute to the public good g_i[7], $g_i \geq 0$, and spends the rest of the endowment on his private consumption x_i, $x_i \geq 0$ to maximize his utility. The Nash equilibrium in BBV model is a vector of contributions g_i^*, $i = 1, ..., n$ such that for each i, (x_i^*, g_i^*) solves

$$\max u_i(x_i, g_i + G_{-i}^*)$$

$$\text{s.t. } x_i + g_i = w_i$$

$$g_i \geq 0$$

BBV showed that if there is a single-valued demand function for the club good, which is a differentiable function of income, and if the marginal propensity to consume the club good is greater than zero and less than 1, then the Nash equilibrium of the contribution game exists and is unique up to the quantity of the public good provided

[7]In BBV (1986) the authors derive the equilibrium voluntary contribution to the *public good.* In our model, the subgame of voluntary *club good* contribution in Stage 3 involves the community members only, and thus is equivalent to BBV's public good contribution game.

and the set of contributors. Furthermore, if the players' preferences are identical, then there is a critical level of income w^* such that all players with income $w_i > w^*$ contribute $w_i - w^*$ to the public good, while all players j with $w_j < w^*$ contribute nothing ($g_j = 0$). The critical income level is determined by $w^* = \phi(G^*) - G^*$, in which G^* is the equilibrium supply of the club good and ϕ is the inverse demand function for the club good.

Intuitively, the equilibrium in BBV (1986) can be considered a particular contribution rule that specifies the contribution of the community members in Stage 3 in our model.

Formally, consider the three-stage game among the players with the same characteristics (i.e., endowment, utility function, production etc.) described in Section 1.3.1. The first two stages specified in 1.3.2 remain unchanged, but in Stage 3, members simultaneously choose how much to contribute to the club good[8], and spend the rest on his private consumption. In other words, in the third stage, the community members play the game described in BBV (1986).

Note that in our model, the players have identical preferences. It is also easy to verify that given the income, there is a single valued demand function for the club good. Assume that the marginal propensity to consume the club good is greater than zero and less than 1. Then, the subgame including the third stage in our model admits the Nash equilibrium described by BBV.

Let $g_i^{BBV}(w_i, W_{-i})$ denote the contribution rule described by BBV. We will show

[8]In BBV (1986) the authors derive the equilibrium voluntary contribution to the *public good*. In our model, the subgame of voluntary *club good* contribution in Stage 3 involves the community members only, and thus is equivalent to BBV's public good contribution game.

that the voluntary contribution rule described in BBV (1986) satisfies our assumptions on the contribution rule.

Lemma 2 $g_i^{BBV}(w_i, W_{-i})$ *is continuous and has the following properties:*

(i) $g(W^M) = g(w^{M'})$ *if* $W^{M'}$ *is the members' income profile resulted from changing the names of the members in the profile* W^M

(ii) $\frac{\nabla g_i}{\nabla w_i} \geq 0$, $\frac{\nabla g_i}{\nabla w_i} \leq 1$ *and* $\frac{\nabla g_i}{\nabla w_j} \leq 0$ *for* $j \neq i$

(iii) $\frac{\nabla g_i}{\nabla w_i} + \sum_{j \neq i} \frac{\nabla g_j}{\nabla w_i} \geq 0$ *with strict inequality if* $\frac{\nabla g_i}{\nabla w_i} = 1$

Proof. See Appendix 1.C. ■

Theorem 5 *If in stage 3, members contribute voluntarily to the club good, and if the marginal propensity to consume club good is greater than zero and less than one, then there is a unique Nash equilibrium in which all Lenders give the same amount of loan, no Borrower defaults, all the members contribute the same amount to the club good. The utility profile under voluntary contribution is dominated by the profile under optimal contribution rule.*

Proof. From Lemma 2, we know that in equilibrium, the voluntary contribution satisfies the assumptions of the contribution rule. Thus, Proposition 1, Proposition 2, Theorem 1 and Theorem 2 all hold. Therefore, all loans are identical, and none of them is defaulted on. Members have the same income level, and thus contribute the same amount to the club good.

Note that in Stage 3, each member i contributes to the club good up to the level at which his marginal utility of the club good is equal to the marginal utility of the private good. In particular, $V_1'(2ng) = V_2'(w - g)$. Notice that i does not take into account the positive externalities of his contribution. Solving this equation to yield voluntary contribution as an increasing function of w. Now, in Stage 1, Lenders take into account the fact that by increasing k, they can increase their incomes, and thus increase the voluntary contribution to the club good, and hence, can enforce more investments. ■

The difference between participating voluntarily in the community and contributing voluntarily to the club good is note-worthy. In the former case, although individuals can choose not to participate in the community, once they become members, their contribution to the club good is involuntary and pre-determined by given rules. In this case, the power of communities to make take-it-or-leave-it membership offer can be significant. Therefore, such power can help increase the total club-good spending. In the latter case, not only individuals can choose to participate in the community, they can also choose how much to contribute to the community. Obviously, such extra freedom of choice creates more severe free-riding problems.

1.7 Conclusion

Our paper is motivated by the observation that ancient Vietnamese communes played a central role in enforcing economic and social transactions. We developed a theoretical explanation of the enforcement power of the communities whose members participate voluntarily.

We showed that by investing in club goods, communities can use the power to exclude members from the club goods as a threat against potential contractual violations. Such limited community enforcement would determine how much its members could invest in high-return, high-default-risk industries. More club goods lead to stronger contract enforcement, which in turn encourages more investment, generating higher income and higher contribution to club goods. There would be multiple equilibria in which some communities with more efficient provision of club goods thrive while others are trapped in low equilibrium.

We also showed that, due to non-rivalry nature of the club good, even the weakest form of coordination in club-good provision, namely, the voluntary contribution, can create a certain level of enforcement. Since the community enforcement is limited, there exists an upper bound for investment. When this constraint is binding, the level of investment is sub-optimal.

The "big push" model (Murphy et. al., 1989) suggested that industrialization often requires big investments. However, investments in modern commerce and industrial production are easier to be encroached upon than those in agriculture. Due to the division of labor, investors often have limted control of their investments. There are many opportunities for encroaching on loan, deferred payment and financial contracts. Weak governments often fail to enforce contracts effectively, making large investments too vulnerable to be profitable.

Absent strong formal contract enforcement, traditional communities can be good starting points of the process of industrialization and capital accumulation, especially if they have been efficiently coordinating members in providing club goods and thus can utilize such club goods to enforce contracts effectively[9]. Therefore, regulations broadening or narrowing the common property rights of communities. For example, collectivization, privatization or land reforms might have tremendous impacts on the enforcement power of the communities. Therefore, governments should be extremely cautious in implementing developmental policies to avoid shocks that can weaken the power of the communities and thus dampen the very communities they mean to help.

[9] The economic boom of the village and township entrepreneur in China in the early 1980s is a good example supporting this claim.

Appendix 1.A Proof of Lemma 1

First, recall that $w_{B,i}$ and $w_{L,i}$ are strictly increasing in k_i when contract i is not defaulted on, and $w_{L,i}$ is strictly decreasing with k_i when contract i is defaulted on. Thus, to prove (i), it suffices to show that the utilities of the community members (i.e., Lenders and non-default Borrowers) are strictly increasing in w_i.

Assume that w_i increases. Recall assumption (iii) on the contribution rule:

$$\frac{\nabla g_i}{\nabla w_i} + \sum_{j \neq i} \frac{\nabla g_j}{\nabla w_i} \geq 0 \text{ with strict inequality when } \frac{\nabla g_i}{\nabla w_i} = 1$$

If $\frac{\nabla g_i}{\nabla w_i} = 0$, then the assumption implies that $\frac{\nabla g_i}{\nabla w_j} = 0$. That is, agent i's contribution to the club good is unchanged and the total contribution to the club good remains unaffected. Meanwhile, agent i's disposable income, $w_i - g_i$, increases. Therefore, his utility increases.

If $\frac{\nabla g_i}{\nabla w_i} = 1$, then $\frac{dG}{dw_i} > 0$. The total club good strictly increases, while agent i's disposable income is unchanged. Thus, agent i's total utility increases.

If $1 > \frac{\nabla g_i}{\nabla w_i} > 0$ then the total club good weakly increases, and the disposable income of agent i strictly increases. Thus, his utility must strictly increase.

Part (ii) is obvious, since Borrower i's default payoff is $V_{B,i}^{D} = V_2(1 + k_i)$, which is strictly increasing in k_i. Q.E.D.

Appendix 1.B Proof of Proposition 1

Note that if $k_i = k_j = k^*$ for all i and j, then $w_i = w_j = 1 + (\beta - 1)k^*$. By the anonymity of the contribution rule, $g_i = g_j$. Hence, $x_i = x_j$ and $U_i = U_j$. Thus, to complete the proof of Proposition 1, we only need to show that $k_i = k_j$ for all i and j.

By contradiction, assume that there exists an equilibrium in which $k_i^* \neq k_j^*$. Without loss of generality, assume that $i = 1$, $j = 2$ and $k_1^* < k_2^*$.

From the Lemma 2, we know that no Borrowers, including 1 and 2, default on the loan ($I_l = 1$ for all $l \in N$). Therefore, we know that for all l,

$$V_{B,l}^{ND}(k_l^*, G(k_l^*, K_{-l}, I_{-l}^*)) \geq V_{B,l}^{D}(k_l^*) \tag{1.1}$$

Now, we want to show that Lender 1 is better off setting $k_1' = k_2^* > k_1^*$. Denote w_1' the Borrower i's income associated with the new loan k_1'. Note that $w_1' > w_1^*$ and $w_i' = w_i^*$ for all $i \neq 1$. We will do this in three steps:

Claim 1: For any Borrower l other than 1, *if k_1^* increases and all Borrowers other than l do not default, then the non-default strategy is also optimal for l in this new subgame.*

Consider a Borrower l's choice, $l \neq \{1\}$. To simplify the notation, when $I_{-l} = 1$, we will drop the notation I and write $g(k_1^*, K_{-1})$ or $g(w_i, W_{-i})$ (since there exists a one-to-one mapping between k_i and w_i).

Borrower l's non-default utility is:

$$V_{B,l}^{ND}|_{k_1'} = V_1(G(w_l^*, W_{-l}')) + V_2(w_l^* - g^*(w_l^*, W_{-l}')), \tag{1.2}$$

where W_{-l}' is the income profile in which only w_1^* is changed to w_1'.

Given that k_1 increases and all borrowers rather than l choose not to default, w_1 increases while all other agents' incomes remain unchanged. Therefore, the total contribution to the club good weakly increases by Remark 1. That is, $G(w_1', W_{-1}) \geq G(w_1^*, W_{-1})$. Since V_1 is strictly increasing,

$$V_1(G(w_1', W_{-1})) \geq V_1(G(w_1^*, W_{-1})) \tag{1.3}$$

Applying assumption (ii) on the contribution rule to l and 1 to yield $\frac{\nabla g_l}{\nabla w_1} \leq 0$. Combining this with the fact that $w_1' > w_1^*$, we have $g_l(w_l, W_{-l}') \leq g_l(w_l, w_{-l}^*)$.

Hence,

$$V_2(w_l^* - g(w_l^*, W_{-l}')) \geq V_2(w_l^* - g(w_l^*, w_{-l}^*)) \tag{1.4}$$

Combining (1.2), (1.3) and (1.4) yields

$$\begin{aligned} V_{B,l}^{ND}|_{k_1'} &= V_1(G(w_1', W_{-1})) + V_2(w_l^* - g(w_l^*, W_{-l}')) && (1.5) \\ &\geq V_1(G(w_1^*, W_{-1})) + V_2(w_l^* - g^*(w_l^*, w_{-l}^*)) = V_{B,l}^{ND}|_{k_1^*} && (1.6) \end{aligned}$$

On the other hand, applying equilibrium condition to Borrower l yields

$$V_{B,l}^{ND}|_{k_1^*} \geq V_{B,l}^{D}(k_l)|_{k_1^*} \tag{1.7}$$

Finally, since Lender i's default income does not depend on other loans and since k_l remains unchanged, it must be that

$$V_{B,l}^{D}(k_l)|_{k_1'} = V_{B,l}^{D}(k_l)|_{k^*} = V_{B,l}^{D}(k_l) \tag{1.8}$$

Combining equations (1.5), (1.7) and (1.8) yields

$$V_{B,l}^{ND}(w_1', W_{-1}) \geq V_{B,l}^{D}(w_1^*, W_{-1})$$

Therefore, non-default strategy is optimal for Borrower l as claimed.

Claim 2: Given that all other agents do not default, Borrower 1 *optimal strategy is not default.*

We will prove this claim by first showing that if $I_{-1} = 1$, then Borrower $1's$ non-default utility at the loan profile (k_1', K_{-1}) is (weakly) greater than Borrower $2'$s non-default utility at the loan profile (k_1^*, K_{-1}), while $1's$ default utility at (k_1', K_{-1}) is equal to $2'$s default utility at (k_1^*, K_{-1}). Utilizing equilibrium condition for Borrower 2, we can show that Borrower $1's$ no-default utility at k' is (weakly) greater than his default utility at k'.

By the assumption in the claim, $\vec{I}_{-1} = \vec{1}$. Therefore, Borrower 1's non-default utility at k_1' is:

$$V_{B,1}^{ND}|_{k_1'} = V_1(G(w_1', W_{-1})) + V_2(w_1' - g(w_1', W_{-1})) \tag{1.9}$$

By assumption, $k_1' = k_2^*$. Therefore, Borrower $1's$ non-default income $w_1' = w_2^*$. Replacing the term w_1' in (1.9) by w_2^* gives:

$$V_{B,1}^{ND}|_{k_1'} = V_1(G(w_2^*, W_{-1})) + V_2(w_2^* - g(w_2^*, W_{-1}))$$

Meanwhile, Borrower 2's non-default utility at k_1^* is:

$$V_{B,2}^{ND}|_{k_1^*} = V_1(G(w_1^*, W_{-1})) + V_2(w_2^* - g(w_2^*, W_{-2})) \tag{1.10}$$

Note that in (1.9) and (1.10), W_{-1} and W_{-2} are two income profiles that defer only in one element. In particular, W_{-2} includes w_1^*, whereas W_{-1} includes w_2^*, $w_2^* > w_1^*$.

By the anonymity property of the contribution rule, we can compare $g(w_2^*, W_{-1})$ and $g(w_2^*, W_{-2})$ across two (incomplete) income profiles involving different agents, namely 1 and 2, as if such differences arise from the changes in the incomes of the same agents (namely, income of agent 1 increases by $w_2^* - w_1^*$).

By assumption (ii), we know that when Borrower $1's$ income increases, Borrower 2's contribution to the club good should not be decreasing. Combining this with the fact that $w_1^* < w_2^*$ gives

$$g(w_2^*, W_{-1}) \leq g(w_2^*, W_{-2}),$$

and hence

$$V_2(w_2^* - g(w_2^*, W_{-1})) \geq V_2(w_2^* - g(w_2^*, W_{-2})). \tag{1.11}$$

Furthermore, $k_1' > k_1^*$, G is (weakly) increasing and V_1 is strictly increasing. These facts imply that

$$V_1(G(w_1', W_{-1})) \geq V_1(G(w_1^*, W_{-1})). \tag{1.12}$$

Combining (1.9), (1.10), (1.11) and (1.12) gives

$$V_{B,1}^{ND}|_{k_1'} \geq V_{B,2}^{ND}|_{k_1^*}. \tag{1.13}$$

On the other hand, the equilibrium condition for Borrower 2 at $k^* = (k_1^*, K_{-1})$ implies

$$V_{B,2}^{ND}|_{k_1^*} \geq V_{B,2}^{D}(k_2^*). \tag{1.14}$$

Combining (1.13) and (1.14) gives

$$V_{B,1}^{ND}|_{k_1'} \geq V_{B,2}^{D}(k_2^*). \tag{1.15}$$

Finally, since $V_{B,1}^{D}$ depends on k_1' only,

$$V_{B,1}^{D}(k_1', K_{-1}) = V_{B,1}^{D}(k_1') = V_{B,2}^{D}(k_2^*) \tag{1.16}$$

where the last equality is due to the fact that $k_1' = k_2^*$. Combining (1.15) and (1.16) gives

$$V_{B,1}^{ND}|_{k_1'} \geq V_{B,2}^{ND}|_{k_1^*} \geq V_{B,2}^{D}(k_2^*) = V_{B,1}^{D}(k_1').$$

Therefore, when k_1' increases to k_2^*, Borrower $1'$s no-default utility is higher than his default utility. Thus, if all Borrowers other than 1 do not default, then the optimal strategy for Borrower 1 is not to default. This completes the proof of Claim 2.

The two steps confirm that no-default strategy profile ($I = \vec{1}$) is the Nash equilibrium for this game. Furthermore, by Lemma 1, this profile is the unique equilibrium profile.

Claim 3: Given that the unique equilibrium strategy profile in the subgame with the new loan profile (k_1', K_{-1}) is no-default for all l, Lender i is better off by increasing $k_1' = k_2^*$

Since Lender 1 knows with certainty that by setting $k_1' = k_2^*$, the loan will not be defaulted on, but doing so will strictly increase her income. As shown in Lemma 1, $1's$ utility is strictly increasing in w_1. Hence,

$$V_{L,1}(k_1', K_{-1}) > V_{L,1}(k_1^*, K_{-1}). \tag{1.17}$$

This proves the Claim 3. Notice the strict inequality in (1.17) and recall that we only achieve weak inequality in Claim 2. This is because in Claim 2, we compare the payoff of Borrower 1 in the new equilibrium with that of Borrower 2 in the old equilibrium.

Claim 3 demonstrates that a Borrower can be better off by deviating from the optimal strategy, which contradicts to the definition of Nash equilibrium. This completes the proof of the Proposition. *Q.E.D.*

Appendix 1.C Proof of Lemma 2

In this proof, we will use two important facts derived in BBV:

Fact 2. *There exists a real valued function $F(G,C)$, differentiable and increasing in G, such that in a Nash equilibrium, $F(G,C) = \sum_{i\in C} w_i$*

Fact 3. *Let (g_i) and (g_i') $i = 1, ..., n$ be Nash equilibria given the wealth distribution (w_i) and (w_i'), let C and C' be the corresponding sets of contributing consumers, and let function $F(G,C)$ be as defined in Fact 2.*

Then

$$F(G',C) - F(G,C) \geq \sum_{i\in C}(w_i' - w_i)$$

Now, we will show that the equilibrium voluntary contribution in BBV admits continuity, anonymity and monotonicity properties.

First, since g_i^{BBV} depends on the levels of incomes only, it is clear that it satisfies anonymity.

To demonstrate that g^{BBV} is continuous and satisfies monotonicity, assume that income of agent i increases from w_i to $w_i' = w_i + \epsilon$, $\epsilon > 0$ and small. We will show that in all possible cases, the following inequalities are satisfied:

$$1 \geq \frac{\nabla g_i}{\nabla w_i} \geq 0 \tag{1.18}$$

$$\frac{\nabla g_j}{\nabla w_i} \leq 0 \tag{1.19}$$

$$\frac{\nabla g_i}{\nabla w_i} + \sum_{j \neq i} \frac{\nabla g_j}{\nabla w_i} \geq 0 \tag{1.20}$$

Note that the voluntary contribution game in Stage 3 involves the members of the community only, and the lenders and non-default borrowers are treated equally.

For the initial profile of incomes $W = (w_1, w_2, ..., w_i, ..., w_{2n})$, let G^* be the unique equilibrium level of total contribution, C^* be the equilibrium set of contributors, w^* be the critical wealth level, and g_i^* be individual $i's$ equilibrium contribution. Similarly, define G^{**}, C^{**}, g_i^{**} and w^{**} for the new profile of incomes $W' = (w_1, w_2, ..., w_i', ..., w_{2n})$.

Case 1: i is the non-contributor before and after the income change. In this case, $\frac{\nabla g_i}{\nabla w_i} = 0$, g_i remains unchanged, thus, does not have a large jump that violates continuity. g_j remains unaffected, because the change in w_i will affect g_j only when it changes the total contribution to the club good. Thus, g_j does not have a large jump that violates continuity. Since $\frac{\nabla g_i}{\nabla w_i} = 0$ and $\frac{\nabla g_j}{\nabla w_i} = 0$ for all $j \neq i$, we have $\frac{\nabla g_i}{\nabla w_i} + \sum_{j \neq i} \frac{\nabla g_j}{\nabla w_i} = 0$ as (1.20) required.

Case 2: i is a non-contributor before but becomes a contributor after the change. In particular, after the income increment, i contributes $w_i' - w^{**} > 0$. In this case, his contribution increases from zero to positive, thus, $\frac{\nabla g_i}{\nabla w_i} > 0$.

Now, we want to show that in this case, $\frac{\nabla g_j}{\nabla w_i} \leq 0$ and $\frac{\nabla g_i}{\nabla w_i} + \sum_{j \neq i} \frac{\nabla g_j}{\nabla w_i} \geq 0$. First, we will show that $G^{**} > G^*$.

By assumption, $w_i' > w_i$, and $w_j' = w_j$. Thus,

$$\sum_{l \in C} (w_l' - w_l) > 0.$$

By Fact 3,

$$F(G^{**}, C) - F(G^*, C) \geq \sum_{l \in C} (w_l' - w_l).$$

Hence,

$$F(G^{**}, C) - F(G^*, C) > 0.$$

But by Fact 2, $F(G, C)$ is strictly increasing in G. Therefore, $G^{**} > G^*$. This implies that $\frac{\nabla g_i}{\nabla w_i} + \sum_{j \neq i} \frac{\nabla g_j}{\nabla w_i} > 0$. Inequality (1.20) is satisfied.

On the other hand, by the definition of critical income level,

$$w_i^* = \phi(G) - G.$$

Note that ϕ is the inverse function of f, which is increasing and $\frac{\nabla f}{\nabla w} < 1$. Thus, ϕ is increasing and $\frac{\nabla \phi}{\nabla w} > 1$. Therefore, $\phi(G^{**}) - G^{**} > \phi(G^*) - G^*$. Hence, $w^{**} > w^*$.

Thus, when an agent's income increases so that such agent is recently included in the set of contributor, w^{**} increases. We know that before the increase, i is a non-contributor. Hence, $w_i \leq w^*$. Therefore, i has to contribute no more than the increment in his income:

$$0 < w_i' - w_i^{**} \leq w_i' - w_i^* \leq w_i' - w_i$$

Thus, $0 < \frac{\nabla g_i}{\nabla w_i} < 1$ as (1.18) requires.

Furthermore, since w_j is unchanged but w^{**} increases, one of the following three cases must be true. If j is initially a non-contributor, then after the change, j is also a non-contributor. If j is initially a contributor, then after the change, j becomes a non-contributor. In this case, $\frac{\nabla g_j}{\nabla w_i} < 0$. If j is a contributor both before and after the income change. In this case, after the change, j contributes $g_j = w_j - w^{**} < w_j - w^*$, which also implies that $\frac{\nabla g_j}{\nabla w_i} < 0$.

Case 3: i is a contributor both before and after the income increment.

Before the change, $g_i = w_i - w_i^*$. After the change, $g_i' = w_i' - w_i^{**}$. Applying similar arguments presented in Case 2, we can show that $w^{**} > w^*$, and $w_i^{**} - w_i^* \leq w_i' - w_i$. The only difference is that in this case, it is possible that $\frac{\nabla g_i}{\nabla w_i} = 1$.

To show that $\frac{\nabla g_j}{\nabla w_i} < 0$, we also use the same argument presented in Case 2 (utilizing the fact that the critical wealth level increases but w_j remains unchanged). Finally, note that since F and ϕ are continuous functions of $\{w_i\}_{i \in N}$, the critical wealth level w^{**} is also a continuous function of w_i for all i. Hence, g is also a continuous function of w_i and w_j. *Q.E.D.*

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Chapter 2

Can Religion Mitigate Credit Rationing? Evidence from Vietnam

2.1 Introduction

Since the path-breaking work by Max Weber (1904), *Protestant Ethic and the Spirit of Capitalism,* there have been many attempts to theorize and quantify the economic consequences of religion. More recently, social capital literature pays special attention to religious participation, one of the key indicators of social capital (Putnam, 1993). However, so far, empirical evidence of the direct links between religion and *economic activities* (in contrast with economically relevant social activities, such as marriage, divorce etc.) seems to be missing (Iannaccone 1998). This "missing link" may be due to the fact that in highly developed and institutionalized economies, religious norms concerning economic activities have been replaced by modern market institutions and thus ceased to have economic consequences they used to have.

Our contribution to the economics of religion and social capital theory is twofold. Firstly, we formulate theoretically a channel through which religion can influence economic transactions, namely, via contract enforcement. Secondly, we provide an empirical evidence of the impact of religious affiliation on economic transactions in credit markets in Vietnam.

The remainder of Chapter 2 is organized as follows. Section 2.2 presents a theoretical model of the lender's trade-off between insolvent default risk and misdeed default risk and analyzes its consequences on credit-rationing problem. In particular, Subsection 2.2.1 reviews quickly three main approaches to credit-rationing problem, namely, adverse selection, moral hazard and limited enforcement. We argue that combining the last two approaches will shed new light on the issue. Subsection 2.2.2 presents the setting of a sequential game between a Lender who sets credit line and interest rate, and a Borrower who decides whether to intentionally default on the loan and if not, how much effort he will exert in the project. Subsection 2.2.3 derives equilibrium strategies for the Lender and Borrower. Subsection 2.2.4 shows comparative statics results. The key insight is that increasing enforcement always reduces the severance of credit rationing and thus increases equilibrium loan size and interest rate. However, in some cases, better enforcement also increases insolvent default risk. Additionally, increasing enforcement may not always benefit the Lender, since it allows Borrower to increase interest rate without increasing the risk of misdeed default.

Section 2.3 presents an empirical model to test our hypothesis that religious affiliation has important impacts on the behaviors of lenders and borrowers in credit markets. Subsection 2.3.1 argues that if religious affiliation increases enforcement, then religious households should be able to pay higher interest rates to borrow more. Subsection 2.3.2 provides a brief review of related literature. Subsections 2.3.3, 2.3.4 and 2.3.5 explain the dataset and main variables used in the rest of the paper. Subsection 2.3.6 provides descriptive analysis, which gives the first indication of the relevance of religious affiliation in studying borrower's behavior in credit markets. Subsection 2.3.7 explains the specification of the models and empirical strategies. Subsection 2.3.8 focuses on the question whether religions influence borrower's perception and behavior, namely the loan size, interest rate and default rate.

2.2 A Model of Insolvent Default vs. Misdeed Default

This section presents a game between a lender and a borrower and demonstrates the trade-off between the insolvent default risk and misdeed default risk facing the lender. We will show that in equilibrium, the lender can always set interest rates and credit line to avoid misdeed default risk. Increasing enforcement always reduces the severance of credit rationing, and increases equilibrium loan size and interest rate. However, in some circumstances, it also increases insolvent default risk. We will also show that increasing enforcement may not always benefit the lender, since it allows the borrower to charge a higher interest rate without increasing the risk of misdeed default.

We will use the analytical results derived in Section 1 to formulate the main hypothesis in Section 2 that religious affiliation increases contract enforcement.

2.2.1 Motivation and Related Literature

A Quick Look at Credit-Rationing Problem

Credit rationing describes the situation in which a lender limits the supply of the loan even when potential borrowers are willing to pay a higher interest rate to borrow more. There are three main theoretical approaches to explain the credit-rationing phenomenon. The first approach (Stiglitz and Weiss, 1981) focuses on adverse selection of the borrowers who have limited liability on the loan. In particular, lender may not be able to identify the riskiness associating with each borrowers. High interest rate induces only high-risk borrowers to apply for the loan. Thus, the interest rate must be set low enough so that both high-risk and low-risk borrowers will apply for the loans (the case of pooling equilibrium).

The second approach focuses on the moral hazard problem of the borrower who borrows to invest in a risky project. The lender may not be able to observe or contract on the borrower's effort that affects the chance the project will succeed. The higher the interest rate, the less effort the borrower will exert. Therefore, increasing the interest rate beyond some threshold will reduce the lender's profit. The borrower would not be able to borrow more, even if he is willing to pay a higher interest rate.

The third approach focuses on the limited enforcement of the lending contract. In particular, the borrower can refuse to repay the loan (intentionally default) even if he has the means to do so. Giving too much loan will increase the borrower's incentive to intentionally default. Hence, the lender is not willing to lend more than a particular amount, even if the borrower is willing to pay a higher interest rate to borrow more. A typical way to overcome this type of credit rationing is to require a collateral for the loan. However, as long as the value of the collateral is less than the value of the loan, the credit is still rationed.

In all three approaches, there is a fundamental trade-off between increasing the interest rate and/or loan value to increase the return on the loan and reducing the interest rate and/or loan size to reduce the default risk.

Insolvent Default vs. Misdeed Default

In our model, we will analyze the interaction between the moral hazard and the limited enforcement and its impact on the lending contracts. In particular, we will distinguish two types of default. We call *insolvent* or *unintentional* default the case in which the borrower invests in the project and exerts effort but is unable to repay the loan because of the project failure. In contrast, we call *misdeed* or *intentional* default the case in which the borrower neither exerts effort nor invests in the project but does not repay the loan. While the first type relates to moral hazard, the second type relates more closely to limited enforcement problem.

The main motivation for the combination approach in our model is that it will reveal the lender's trade-off between the insolvent default risk and misdeed default risk. In particular, increasing the loan size increases the borrower's effort and thus the chance that the project succeeds (lower insolvent default risk), but doing so also makes intentional default more tempting for the borrower.

Note that the three-way differentiation of the lending contracts (i.e., high interest-large loan-high default rate vs. low interest-small loan-low default rate) in our empirical result cannot be easily explained using any of the three approaches alone. The screening approach could not explain interest rate differentiation, since the Lender's optimal strategy in case of credit rationing is to charge the same interest rate to both low-risk and high-risk borrowers (pooling equilibrium). Meanwhile, the moral hazard approach would predict that larger loan size must be associated with lower interest rate. Finally, the limited liability approach would predict that higher default rate must be associated with smaller loan size[1].

The trade-off between insolvent default and misdeed default can explain our result that bigger loan tends to have higher interest rate[2]. It also can explain the seemingly counter-intuitive result that religious households, although report higher default risk, can borrow more than non-religious households.

2.2.2 Setting

Consider a two-stage game between a risk-neutral Lender and a risk-neutral Borrower. In Stage 1, the Lender sets the credit line b (the maximum amount the Borrower can borrow, $b \geq 0$) and the interest rate r ($r \geq 0$) taking into account the unit cost of

[1] Our empirical result suggests that collateral plays a limited role in enforcing the loan contracts in the case of Vietnam. Thus, we need to investigate other mechanisms that lenders and borrowers use to overcome limited enforcement problem.

[2] Note that our theoretical model assumes that the Lender has the monopoly power to set the interest rate and loan size. The main argument for the relevance of the assumption in our research comes from the empirical results presented in the next section. In particular, we will show that borrowers who are under stronger enforcement have to pay higher interest rates. This means that a large part of the social surplus generated by better enforcement was captured by lenders. This is the main characteristics of the monopolistic markets.

the capital v, where $v > 1$.

In Stage 2, the Borrower decides whether to default on the loan intentionally. If he chooses to do so, he will borrow the loan, not invest and refuse to pay back. If he chooses to honor the contract, then he will decide the amount k' he will borrow from the Lender, the amount k he will invest and the effort e he will exert in the project. The level of investment determines the payoff of the project, whereas the Borrower's effort determines the probability of success. Assume that there is a one-to-one mapping between the Borrower effort e and the probability of success.

To simplify the analysis without loss of generality, we model the effort-probability relationship in reverse direction. Instead of choosing effort level, the Borrower chooses the probability of success p, $p \in [0, 1]$, taking into account the effort cost associated with p. Assume that the effort cost function $e(p)$ is positive for $p > 0$, strictly increasing and strictly convex in p. Furthermore, assume that $\lim_{p \to 1} e(p) = \infty$, $\lim_{p \to 0} e'(p) = \infty$, $\lim_{p \to 1} e'(p) = 0$.

At the end of Stage 2, the outcome of the investment realizes. If the Borrower borrows k', invests k and exerts effort $e(p)$ to the project, then with probability p, $1 \geq p \geq 0$, the project succeeds, which gives revenue k^α, $1 > \alpha > 0$, to the Borrower. The Lender receives the principal plus interest $k'(1 + r)$. With probability $1 - p$, the project fails, and the Borrower looses $-e(p)$. The loan is unintentionally defaulted on and the Lender looses $-k'$.

If the Borrower borrows k' and defaults intentionally after that, then the Lender also looses $-k'$. The Borrower gets $k' - c(k')$, in which $c(k')$ represents the punishment against the misdeed default. For simplicity, we assume that the punishment is linearly related to the size of the loan defaulted on intentionally, $c(k') = c * k'$. To focus on the case of imperfect enforcement, we assume that $c < 1$.

Note that the punishment c is different from the collateral: while the collateral punishes the insolvent default and misdeed default indiscriminately, the punishment c only applies to misdeed default. Therefore, c is a better approximation for the loss of "social capital" or social trust and psychological costs of misdeed default.

To summarize, the Borrower's maximization problem is:

$$\max_{p,k,k'} \pi^*(p(r,b),k,k') = \{p[k^\alpha - (1+r)k'] - e(p) + (k'-k), (1-c)b\}$$

in which $k' - k$ is the amount of the loan the Borrower borrows but does not invest in the project.

2.2.3 Equilibrium Analysis

Borrower's Maximization Problem

First, observe that if the Borrower intends to default on the loan, then he will not invest any capital or effort in the project and borrow as much as he can. In this case, $k' = b$, $p = 0$.

On the other hand, if the Borrower decides to invest any positive amount of capital on the project, he will then borrow exactly the amount he plans to invest. In this case, $k' = k^*$.

Therefore, the Lender's maximization problem can be simplified as

$$\max_{r,k}\{p[k^\alpha - (1+r)k] - e(k), (1-c)b\}$$

subject to the lending-limit constraint $k \leq b$. For notational simplicity, define $g(h) = e'^{(-1)}(h)$ and $h(r,b) = b^\alpha - (1+r)b$.

Proposition 3 *1. If the lending-limit constraint is not binding, then the Borrower's optimal level of effort and investment (k^*, p^*) is the solution of the following system of equations:*

$$\begin{aligned} k^* &= (\frac{\alpha}{1+r})^{\frac{1}{1-\alpha}} \\ p^* &= g((1+r)^{\frac{\alpha}{1-\alpha}}\alpha^{\frac{1}{1-\alpha}}(1+\alpha^{\frac{1-2\alpha}{1-\alpha}})) \end{aligned}$$

2. If the lending-limit constraint is binding, then $k^* = b$ and $p^* = g(h(r,b))$

Proof. See Appendix 2.A. ■

Proposition 4 *1. If the lending-limit constraint is not binding, then increasing the interest rate lowers the Borrower's effort and increases the chance the project will fail. However, changing the loan size does not affect the Borrower's effort or investment on the project.*

2. If the lending-limit constraint is binding, then increasing the interest rate and/or decreasing the loan size lower the Borrower's effort and increase the chance the project will fail.

Proof. Also see Appendix 2.A. ■

Borrower's profit can be rewritten as $\pi^*(p(r,b)) = g(h(r,b))h(r,b) - e(g(h(r,b)))$.

Lender's Maximization Problem

The Lender sets the credit line and interest rate to maximize his expected payoff from the loan, taking into account the unit cost of capital v and their influence on the Borrower's effort and his intention to default. Furthermore, the credit line b^* must be set equal or less than the Borrower's optimal investment level, $(\frac{\alpha}{1+r^*})^{\frac{1}{1-\alpha}}$. Otherwise, the Lender will not be able to lend all of the capital he pays for. We will call the excess capital that the Lender possesses but cannot lend to the Borrower *idle credit.*

We will show that the Borrower is able to set interest rate r and credit line b to avoid misdeed default and idle credit problems. However, in order to maximize profit, he may not always minimize the insolvent default risk, as long as the marginal gain from high interest rate can offset the marginal loss from the Borrower's effort.

The Lender's maximization problem can be simplified as $\max_{b,r} \psi(r,b) = p^*(r,b)(1+r)b - vb$ subject to the no-misdeed-default constraint $\pi^*(p(r,b)) \geqslant (1-c)b$ and the no-idle-credit constraint $b \leq (\frac{\alpha}{1+r})^{\frac{1}{1-\alpha}}$.

Equivalently,

$$\max_{b,r} \Pi(r,b) = g(h(r,b))(1+r)b - vb$$

$$\text{s.t. } g(h(r,b))h(r,b) - e(g(h(r,b))) \geqslant (1-c)b$$

$$(\frac{\alpha}{1+r})^{\frac{1}{1-\alpha}} - b \geq 0.$$

For notational clarity, we will use superscript uc for the case in which no-misdeed-default constraint is not binding, and superscript co for the case in which the no-misdeed constraint is binding.

Theorem 2 *(i) If the no-misdeed-default constraint is not binding, then the optimal interest rate r^{uc} and credit line b^{uc} are characterized by the following system of two equations:*

$$b^{uc} = (\frac{\alpha g}{v})^{\frac{1}{1-\alpha}} \tag{2.1}$$

$$r^{uc} = \frac{1}{g'}(\frac{v}{\alpha})^{\frac{1}{1-\alpha}}(\frac{1}{g})^{\frac{\alpha}{1-\alpha}} - 1; \tag{2.2}$$

(ii) If the no-misdeed-default constraint is binding, then the optimal interest rate r^{co} and credit line b^{co} are characterized by the following system of two equations:

$$b^{co} = \frac{g(h)h - e(g(h))}{1-c}, \tag{2.3}$$

$$r^{co} = \frac{g}{g'}\frac{(1-c+v) - \alpha(b^{co})^{\alpha-1}g}{(1-c)b^{co}} - 1. \tag{2.4}$$

Proof. See Appendix 2.B. ■

We call the equilibrium in which the no-misdeed-default constraint is binding *credit-rationing equilibrium.* In this case, although the Borrower is willing to pay higher interest to borrow more, the Lender chooses not to lend him, because the Borrower cannot credibly commit that he will not intentionally default on the loan. The credit rationing arises due to the lack of the commitment mechanism.

2.2.4 Comparative Static Analysis

In this section, we will show how increasing punishment against misdeed defaults mitigates credit rationing (by increasing the interest rate and loan size), and the conditions in which such higher enforcement gives rise to the seemingly counter-intuitive phenomenon of higher default rate, higher interest rate and bigger loan. In particular, we vary punishment level c to see how the equilibrium rate p^*, equilibrium interest rate r^* and equilibrium credit line b^* differ from the initial equilibrium.

Theorem 3

1. *If credit is not rationed in the initial equilibrium, then increasing the enforcement level c does not affect the equilibrium interest rate or credit line.*
2. *If credit is rationed in the initial equilibrium, then a gradual increment of enforcement level c increases the optimal interest rate and credit line until the no-misdeed-default constraint is no longer binding.*

Proof. See Appendix 2.C. ■

Theorem 4 *Increasing enforcement lowers the Borrower's effort and increases the probability of the unintentional default if* $gh_b \leq \frac{(1-c)}{2}$.

In other words, increasing c will help increasing the loan size until the shadow price of the capital invested is equal to half of the shadow price of the intentionally defaulted loan.

Proof. See Appendix 2.D. ■

Theorem 5 *If credit is rationed in the initial equilibrium, then increasing the enforcement always improves the Lender's profit in the new equilibrium.*

Proof. See Appendix 2.E. ■

Theorem 6 *If credit is rationed in the initial equilibrium, then increasing the contract enforcement improves the Borrower's profit only if* $b^* \leq \frac{2gh_b}{1-c}$.

Proof. See Appendix 2.F. ■

Corollary 2 *If credit is rationed in the initial equilibrium, and if increasing the cost of voluntary default increases the Borrower's effort, then it also increases the Borrower's profit. However, the reverse may not necessarily be true.*

Proof. Also see Appendix 2.F. ■

To summarize, Theorem 2 and 3 in this section establish two important facts: (i) increasing contract enforcement always increases the equilibrium loan size and interest rate and (ii) increasing contract enforcement sometimes increases the chance of unintentional default. In Section 2, we will test these conclusions on data compiled from the most extensive survey on Vietnamese households.

2.3 Religion and Credit in Vietnam

In this part, we will discuss the hypothesis that religious affiliation increases enforcement. According to the theoretical model in Section 1, increasing contract enforcement always mitigates credit rationing, and thus increases the equilibrium lending volume and interest rate. Therefore, religious households must be able to borrow more than non-religious households, and the interest rates applied to their loans should be higher than those of non-religious households. We will also construct empirical models and strategies to test this hypothesis.

2.3.1 Religion as an Enforcement Mechanism

In this section, we will argue that religious affiliation can increase contract enforcement. At individual level, religious borrowers may internalize the "spiritual costs" of misdeed default. Almost all religions explicitly prohibit violations of property rights. For example, in the Bible, there is a commandment stating: "You shall not steal". This commandment appears in Judaism, Orthodox and Roman Catholic. Similarly, one of the five precepts or codes of ethics in Buddhism states that one should not steal. Violating property rights leads to serious negative consequences that believers would want to avoid.

Religious affiliation is also a form of social capital. Indeed, according to social capital literature, one of the key indicators of social capital is to what extend people attend to religious activities[3]. A known violation in property rights may adversely affect the

[3]There have been two approaches to measure social capital. The first approach tries to measure directly how much people trust each other. The second approach measures indirectly, but objectively,

social capital of the offender. Furthermore, religious individuals often participate in religion-based networks or communities. A contract violation might be informed more thoroughly through these communities, making secular collective punishment more effective. In addition, religion-based networks or communities can actively enforce contracts among its members and punish offenders (Chapter 1 of this dissertation discusses how communities enforce contracts by using the power to exclude members from the community club goods).

2.3.2 Related Literature

In the last few decades, the resurgence of Evangelical Christianity in the United States, of Islamic fundamentalism in the Middle East, of Protestantism in Latin America and the return of religions in Eastern Europe revived the interest in economics of religion. Since then, the literature has been growing steadily. However, so far, most studies focus on the United States (and hence, on Judeo-Christian beliefs) due to limited data and funding availability elsewhere. Data on religion in the United States have helped shedding new light on the influence of religion on *economically relevant* social behaviors such as crime (Evans et al. 1995), suicide (Bainbridge 1989), drinking and drug abuse (Gruber and Hungerman, 2008) and divorce (Heaton and Pratt 1990).

However, the direct link between religion and *economic activities* seems to be

other dimensions of social capital, such as civic engagements. Putnam (1993) approximates social capital by voter turnout at referenda, newspaper readership, membership in non-profit "horizontal" associations etc. This approach has the advantage over the former one because the measures are much more reliable than subjective surveys.

missing (Iannaccone 1998). This "missing link" may be due to the fact that in highly developed and institutionalized economies, religious norms and institutions concerning economic activities have been replaced by modern market institutions and thus ceased to have economic consequences it used to have. Our paper is a direct contribution to economics of religion by extending its considerations to the context of a developing country, where direct influences of religion in economic activities may be found.

Our paper also relates to social capital literature. Since the groundbreaking work by Putnam (1993), social capital and its ubiquitous effects have attracted attention from social scientists. There are important evidences showing that (i) the extent people participate in social activities and trust each other differ widely across regions and countries; and (ii) such differences have substantial political and economic consequences including better institutions, bigger firms, less corruption and higher economic growth (see, for example, Putnam, 1993 and Fukuyama, 1995). However, on empirical ground, social capital theory still has a long way to go. In particular, it needs to come up with reliable measurement of social capital, and to identify the channels through which social capital can influence economic activities[4].

Credit markets are the best environment for researchers to empirically identify the impacts of social capital. A loan contract is an "exchange of a sum of money today for a promise to return money in the future" (Guiso et al., 2000). The value

[4]Putnam (1993) defines social capital the "feature of social life-networks, norms, and trust- that enable participants to act together more effectively to pursue shared objectives". Fukuyama (1995, 1997) equates trust with social capital. However, as Guiso et. al. (2000) point out, the exact definition of social capital does not matter much from empirical point of view, since all of them are highly correlated.

of such promise depends significantly on trust or social capital in the society. It is even more so in developing countries, where formal enforcement is severely limited. On the other hand, literature on credit markets in developing countries finds that the access to credit is often limited in formal financial sector, yet flourishes in informal sector (especially in rural area). Due to imperfect information and limited enforcement (see, for example, Hoff and Stiglitz, 1993), these two sectors coexist. Facing severe constraints on the formal enforcement of the loan repayment, informal credit markets have to rely on extensive social networks. These networks can provide better information on the characteristics of the borrowers. Additionally, the access to this network can be used as "social collateral" to the loans.

Finally, our paper relates to a small number of empirical studies using the same dataset. Most closely related is Tra Pham and Lensink (2007), which investigated lending policies of formal, informal and semiformal lenders to Vietnamese households. The paper identified factors determining how different types of lenders select their customers. However, the role of religious affiliation was not discussed.

In this part, we will take for granted that religious participation is a particular form of social capital, and ask the following specific question: How does the religious affiliation on household and community levels affect informal credit markets in rural areas in Vietnam.

2.3.3 Dataset

Our dataset is drawn from the most extensive household survey on living standards in Vietnam, the Vietnam Living Standard Survey, conducted by Vietnam's General Statistical Office in 1997 and 1998 with technical assistance from the World Bank (henceforth, VLSS). VLSS covers four levels of data: commune/ward, village/block[5], household and individual. At household level, VLSS covered a sample of 5999 households from 299 villages and included information on the characteristics of households, such as household expenditures and consumption; educational level of the household members; health, fertility and nutrition; employment and earnings; demography including migration; housing and durable assets; agricultural activities; non-agricultural self-employment; credit and saving and general community characteristics. The household surveys were conducted in two rounds. Issues considered "sensitive," such as lending, borrowing and saving were conducted at the end of the second round of the survey.

Section 14B of the dataset covered borrowing activities of the households. Information on the amount of indebtedness of household members to people or institutions outside the household was collected. If money or goods have been borrowed, or borrowed and repaid by any household member in the last twelve months, then information on those loans was collected. Such information included the source and amount of loan, interest, side payments, collateral, repayment schedule and reason for borrowing.

[5]Village is the smallest administrative unit in Vietnam, with population ranging from several hundred to several thousands. Each commune includes several villages.

Of the 5999 households in the survey, there were 4,526 borrowing contracts conducted by 2,947 households. We drop the observations associated with the households whose answers are evaluated as unreliable by the interviewers. Furthermore, in our regression, we exclude the loans that were made by not-for-profit institutions/programs such as Bank for the Poor, poverty alleviation programs, and job creation programs. (Since these institutions may not necessarily be profit maximizers, they may not differentiate lenders by their riskiness the way our theoretical model predicts). We also drop the outliers which are the loans that have unusually high value (more than 8 standard deviations from the mean).

In the database, there were 4266 households (70%) whose heads practice no religion, 1094 Buddhism (18%), 462 Catholic 8%, 68 Protestant (1%), 25 Caodai (.4%), 115 Hoahao (2%), 2 Muslim (.03%) and 7 other religions (.1%). In our regressions, we drop Protestant, Caodai, Hoahao and other religions that represent less than 2% as the numbers of observations are too small to be representative. The analysis will focus on the borrowing patterns of the households affiliated with two main religions, Buddhism and Roman Catholic, in contrast with non-religious households.

On village/block level, the dataset included information on geographic, demographic and economic conditions of 299 villages/blocks from 156 communes/wards in small towns and rural areas (which in turn selected from seven geographical regions). For our purposes, we are interested in the dominant religion in each village. However, such information is not available for villages/blocks located in small towns. Therefore, in regressions that include commune characteristics, the results apply only to rural areas. The resulting sample contains 3456 loans.

2.3.4 Dependent Variables

This study aims at examining the influence of the religion (on household and community levels) on credit markets. In particular, we want to study whether and how borrowing activities differ across borrowers who practice different religions and who come from villages with different dominant religions. We use three variables to capture three key dimensions of the borrowing activities.

The first variable is the monetary value of every loan borrowed by members of every household in the past 12 months. The second variable is the interest rate associated with each financial contract. The third is an ordinal variable that captures the borrower's subjective evaluation of the default risk of each financial contract. The question presented to the borrowers was, "Is there a possibility that you won't be able to pay back this loan, or will have difficulty paying back this loan?". The answer was a multiple choice, with three options: 1 means "cannot repay"; 2 means "can repay with difficulty"; and 3 means "can repay without difficulty".

2.3.5 Independent Variables

Our key independent variables, which are designed to capture the religious affiliation of the borrowers, comprise of dummies for the dominant religion in the village the borrower lives in and dummies for the religion that the head of the borrower's household practices.

In addition, we include two sets of independent variables in the regressions. The first set of variables represents the characteristics of each loan. The set includes the maturity of the loan ($MATURITY$), interest rate ($INTEREST$), loan size ($LOANSIZE$), term of repayment (if the loan regularly repaid, then $REGULARPAY = 1$), secured status (whether the loan is backed by a guarantor and/or by collateral, $GUARANTOR$ and $COLLATERAL$, respectively) and the use of the loan (if the loan is used for business purposes, $BUSILOAN = 1$; for housing, $HOUSELOAN = 1$, for consumption, $CONSUMLOAN = 1$; and other purposes, $OTHERLOAN$). The second set of variables captures general information on borrowing households. The set includes the number of persons in the household ($HHSIZE$), whether the household is a farming household ($FARM = 1$ for farming household), location ($URBAN = 1$ for urban household), various proxies for household welfare such as household expenditures ($INCOME$), household expenditures per capital (log expression), household asset value ($ASSETVAL$), house value ($HOUSEVAL$), and household savings ($SAVING$).

Table 2.1 lists all variables in our regressions.

2.3.6 Descriptive Statistics

There is a relatively strong correlation between individual's religion and the dominant religion in his/her village. In particular, there is a 49% chance a household head in a Catholic dominated village is a Catholic, while the chances are 50% for Protestant and 33% for Buddhist communities. The fact that most communities are dominated by a particular religion implies that religion influences village members

Variable	Definition
default	Dummy (1/2/3) variable equals 1 if loan can't be paid; 2 if loan can be paid with difficulty; 3 if loan can be paid without difficulty
hhloan	Value of all loans borrowed by all household members
loansize	Size of loan (in million VND)
interest	Interest rate (%/month)
regularpay	Dummy (0/1) variable =1 if loan repayment is on a regular basis
guarantor	Dummy (0/1) variable =1 if loan is backed by a guarantor
collateral	Dummy (0/1) variable =1 if loan is secured
lendbefore	Dummy (0/1) variable =1 if the borrower gave loan to the lender before
borrowbefore	Dummy (0/1) variable =1 if the borrower borrow from the lender before
busiloan	Dummy (0/1) variable =1 for business loans
consumloan	Dummy (0/1) variable =1 for consumption loans
hhsize	Number of household members
income	Household expenditure (1000 VND/year)
farm	Dummy (0/1) variable =1 for famr households
urban	Dummy (0/1) variable =1 for urban households
sex	Dummy (0/1) variable =1 for male household's head
age	Age of the head of the household
headedu	Household head's Years in education
IndBuddhism	Dummy (0/1) variable =1 if the borrower's household's head practices Buddhism
IndCatholic	Dummy (0/1) variable =1 if the borrower's household's head practices Catholic
VilBuddhism	Dummy (0/1) variable =1 if the dominant religion in the borrower's village is Buddhism
VilCatholic	Dummy (0/1) variable =1 if the dominant religion in the borrower's village is Catholic
VilProtestant	Dummy (0/1) variable =1 if the dominant religion in the borrower's village is Protestant

Table 2.1: Religion and Credit Contracts: Variables and Definitions

strongly.[6] Therefore, we believe that taking into account the influence of the religion on community level is critical to understand overall influence of religion on social capital in general, and on credit market in particular.

In this paper, we call loans given by individuals who do not belong to the borrowing household private loans, while loans given by institutions (private and state banks, governmental credit programs) public loans. In our dataset, there were 2332 private loans (52%), 1869 public loans (42%), and 244 loans with unspecified source (6%). In terms of volume, private loans, public loans account for 52% and 43% of total loan value, respectively.

Average household borrowing differs widely across religions. In general, religious households have larger loan volume. However, the distribution of loan sources varies widely across lender's type and religions. Notice that religious households seem to have higher total value of loans and better access to public (or formal) lending than non-religious households.

The descriptive statistics on contract level also reveal different patterns across religions. There is no significant difference between the interest rates of the public loans borrowed by religious households and non-religious households or among households with different religions. This suggests that institution lenders do not discriminate customers by religion. However, the situation is very different with the private loans. Except for Protestant, religious households have to pay much than non-religious ones.

[6]Villages in Vietnam usually have a long history, with many in Red River Delta dated back more than a thousand years. Over generations, village members establish extensive social networks, norms and in many cases, the by-laws and administrative bodies of the village. Therefore, when new religions were introduced to Vietnamese, they tended built institutions within the village boundaries (for example, churches and pagodas for the village).

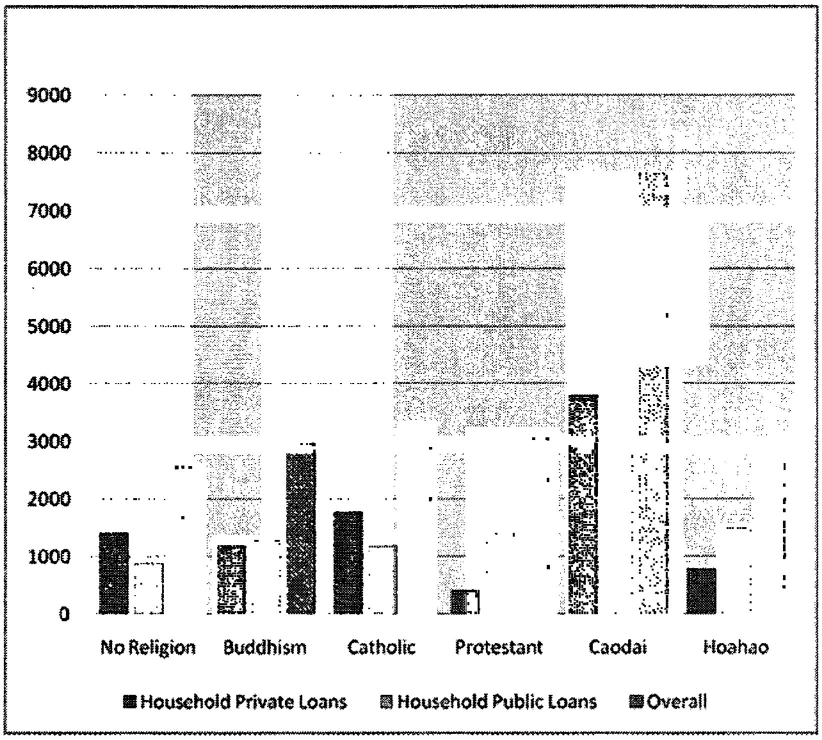

Figure 2.1: Household Total Borrowing by Lender Types, across Religions

	No Religion	Buddhism	Catholic	Protestant	Caodai	Hoahao	Other Religions	Overall
Overall								
Number of Obs.	2885	796	361	40	32	71	8	4193
mean	1.44	2.19	1.58	0.86	2.53	2.16	3.54	1.61
p50	1.00	1.20	1.00	0.90	1.20	1.20	1.65	1.20
max	20.06	20.00	15.00	3.00	10.00	15.00	10.00	20.06
min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sd	2.38	3.27	2.29	0.91	2.55	2.48	3.71	2.58
Private Lender								
N	1599	427	237	13	21	25	5	2327
mean	1.66	3.09	1.78	0.88	3.10	3.97	4.96	1.97
p50	0.00	1.00	0.00	0.00	5.00	4.00	5.00	0.00
max	20.06	20.00	15.00	3.00	10.00	15.00	10.00	20.06
min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sd	3.14	4.25	2.79	1.38	3.00	3.51	4.16	3.39
Public Lender								
N	1286	369	124	27	11	46	3	1866
mean	1.17	1.15	1.19	0.85	1.45	1.17	1.18	1.16
p50	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
max	9.00	3.30	2.80	2.50	2.80	3.00	1.50	9.00
min	0.00	0.00	0.00	0.00	1.20	0.15	0.84	0.00
sd	0.55	0.41	0.43	0.61	0.51	0.40	0.33	0.52

Table 2.2: Interest Rate per Lender Types across Religions

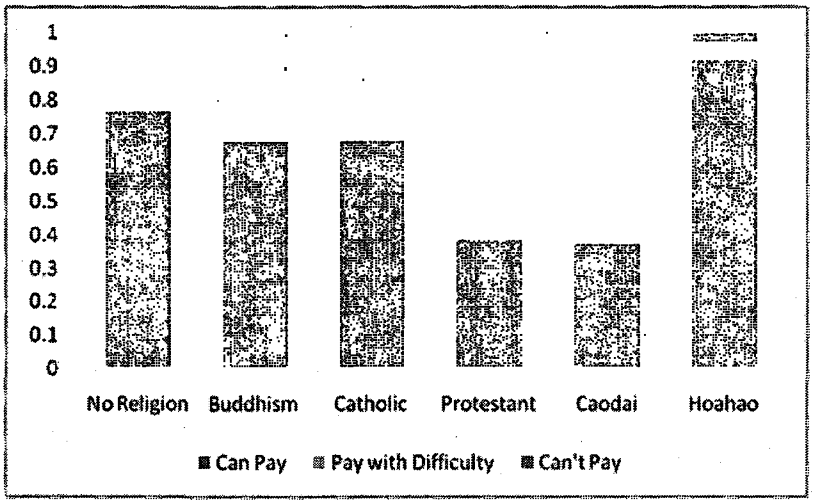

Figure 2.2: Default Rate Across Religions

The statistics on default rates seem to be counter-intuitive. We found that except for Hoahao, the default risks are higher for religious households.

When we decompose Household Loans into Private Loans and Public Loans, the same pattern reappears.

In conclusion, religious households borrow more in total, and have much better access to institutional lenders. The default rates of the loans of the non-religious households are significantly lower than that of religious ones. While the interest rates of loans borrowed from formal lenders do not differ significantly, the interest rates of loans borrowed from informal lenders are much higher for religious borrowers.

2.3.7 Model Specification and Empirical Strategies

We will use two types of regression models in this paper: Two-Stage Least Squares for regressions with $LOANSIZE$ and $INTEREST$, and Ordered Logit Model for

DEFAULT.

From our theoretical model, interest rate and credit line are determined simultaneously by the Lender, whereas the insolvent default is the consequence of this combination. In other words, interest rate and credit line are the two endogenous variables in a system of two linear equations. In particular,

$$\begin{aligned} b_i &= \gamma_0 + \gamma_r r_i + \gamma X_i + \epsilon \\ r_i &= \theta_0 + \theta_b b_i + \theta X_i + \varepsilon \end{aligned}$$

where b_i is the size of loan i, r_i is the interest rate associated with loan i, and X_i is the vector of relevant independent variables.

The two-stage least squares procedure is required to address the simultaneous equation problem. In the first stage, we regress interest rate and loan size on a set of exogenous variables concerning the borrower's household characteristics (such as number of the members in the household, house value, education, age, sex and religion of the head of the household), and contract-specific characteristics (such as collateral, guarantors and term of payment). That is, we regress r_i and b_i on X_i and constant terms to get estimated values of $\widehat{r}_i$ and $\widehat{b}_i$.

In the second stage, we regress b_i on estimated $\widehat{r}_i$ and X_i and r_i on $\widehat{b}_i$ and X_i. That is,

$$\begin{aligned} b_i &= \gamma_0 + \gamma_r \widehat{r}_i + \gamma X_i + \epsilon \\ r_i &= \theta_0 + \theta_b \widehat{b}_i + \theta X_i + \varepsilon \end{aligned}$$

We then use the estimated values of interest rate and credit line as independent variables for the regression of default.

In the regression on default rate, we use ordered logit regression method, which models the cumulative logit as a linear function of independent variables. Recall that the dependent variable, $DEFAULT$ can be one of the three categories, 1 for "cannot repay the loan," 2 for "can repay the loan with difficulty" and 3 for "can repay the loan without difficulty". Therefore, $DEFAULT$ values are qualitative and rankable.

Consider cumulative probability C_{ij}, the probability that the ith individual is in the jth or higher category. $C_{ij} = \Pr(y_i \leq j) = \sum_{k=1}^{j} \Pr(y_i = k)$ and $\text{Logit}(C_{ij}) = \log(\frac{C_{ij}}{1-C_{ij}})$. As the first approximation, our regression model is linear:

$$\text{Logit}(C_{ij}) = \alpha_j + \beta X_i$$

There is a different intercept (cutpoint) for each level of the cumulative logit. However, β does not vary by the level of the cumulative logit. The intercept α_j indicates the probability of the odds of being equal to or less than category j for the baseline group (the case in which all independent variables are zero). These intercepts will increase over j. The coefficient β reflects the positive effect of a one-unit increase in the independent variable on the log-odds of being higher than category j. When β is not indexed by j, we are assuming that the one unit increase affects the log-odds the same regardless of which cut-point being considered.

2.3.8 Empirical Results

Table 2.3 summarizes the regression results.

From the table, note that religious affiliation at commune level increases the loan size and the interest rate, and reduces default rate. Furthermore, the impact on the loan size is particularly strong. Ceteris paribus, being in a Buddhism or Catholic dominated village increases the loan size by about 64% (VND 1.8 million over the mean of VND 2.8 million) while increases the interest rate by 38%, (0.94% more than the mean of 2.48% per month. Affiliation with Buddhism at household level also increases loan size albeit in smaller magnitude (VND .6 million) while increases the interest rate in smaller magnitude (.41%).

These observations confirm our hypothesis that religious affiliation improves contract enforcement and reduces credit-rationing constraints in religious households.

Note also that, religious affiliation at household level is found to *increase* the chance of default. Our theoretical model can explain this phenomenon. In particular, the loan size is determined jointly by misdeed default risk and insolvent default risk. If enforcement is in general extremely weak, then the misdeed default risk dominates the lender's lending decision. If enforcement is higher in one category of borrowers, it might be that the lender no longer finds the misdeed default risk is not the biggest threat, and a small increment in interest rate would not induce misdeed default. Therefore, she can increase the interest rate to maximize her profit, even if the higher interest rate reduces the borrower's effort and leads to a higher default risk. However, we must be careful in interpreting this result, since the default risk is sub-

	Loan Size	Interest Rate	Default
Equilibrium loan size and interest rate			
loansize_hat		-0.80	-4.2140
		(0.06)***	(0.7634)***
interest_hat	-1.26		0.88
	(0.08)***		(0.23)***
Religious Affiliation			
indbuddhism	0.6058	0.4821	-1.65
	(0.1372)***	(0.1406)***	(0.29)***
indcatholic	0.11	0.09	-0.38
	(0.19)	(0.22)	(0.17)**
vilbuddhism	1.18	0.94	1.06
	(0.12)***	(0.13)***	(0.24)***
vilcatholic	1.19	0.94	1.70
	(0.21)***	(0.25)***	(0.33)***
Household Characteristics			
income	0.44	0.35	2.64
	(0.04)***	(0.07)***	(0.42)***
consumloan	0.67	0.53	-1.56
	(0.14)***	(0.15)***	(0.39)***
age	-0.03	-0.02	-0.05
	(0.00)***	(0.01)***	(0.01)***
sex	0.81	0.65	-0.39
	(0.13)***	(0.15)***	(0.13)***
headedu	-0.07	-0.06	-0.02
	(0.01)***	(0.02)***	(0.02)
farm	-0.53	-0.42	-0.21
	(0.12)***	(0.13)***	(0.11)*
hhsize	0.48	0.38	0.99
	(0.03)***	(0.04)***	(0.17)***
urban98	-0.23	-0.19	-1.21
	(0.17)	(0.20)	(0.19)***
houseval	0.02	0.02	0.11
	(0.00)***	(0.00)***	(0.02)***
Contract Characteristics			
collateral	0.00	0.00	8.55
	(0.00)	(0.00)	(1.67)***
guarantor	-1.98	-1.57	
	(0.18)***	(0.12)***	
regularpay	0.07	0.06	
	(0.10)	(0.11)	
Constant	2.52	2.00	
	(0.41)***	(0.43)***	
Observations	3456	2420	3056
R-squared	0.28	0.19	

Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2.3: Religion and Credit Rationing: Regression Results

jectively evaluated. It could be that religious borrowers tend to be more conservative in evaluating the risks, or they are more honest in revealing their true preference to the interviewers.

There is a highly significant negative correlation between loan size and interest rate. Our theoretical model can be extended to incorporate heterogeneous investment projects to explain this relationship. In particular, the bigger the loan, the more tempting for the borrower to default intentionally. Therefore, interest rates must be lowered to increase the payoffs of not defaulting intentionally. Thus, if lenders have different loan size requirements, then we will observe the inverse relationship between interest rate and loan size in a sample.

Note that there are independent variables that are highly significant in determining some dependent variables but are not affecting other dependent variables. For example, the education of the household's head ($HEADEDU$) does affect the loan size and the interest rate, but does not affect the default rate. On the contrary, having collateral does not affect the loan size and interest rate, but does reduce the chance of default.

2.4 Conclusion

In this paper, we presented a theoretical model of the lender's trade-off between insolvent default risk and misdeed default risk. We also analyzed the consequences of the trade-off on credit-rationing problems. The key insight of the model is the observation that increasing enforcement always reduces the severance of credit rationing, and thus increases the equilibrium loan size and interest rate. However, in some cases, increasing enforcement also increases insolvent default risk.

In Section 2, we presented an empirical model to test our hypothesis that religious affiliation has important impacts on lenders' and borrowers' behavior in credit markets. In Subsection 3.3.1, we argue that if religious affiliation increases enforcement, then according to our theoretical model, religious households should be able to borrow more, and the interest rate applied to their loan should be higher. Our empirical results confirm that religious affiliation does mitigate credit rationing. However, it sometimes increases the default rate.

Appendix 2.A Proof of Proposition 1 and 2

First, we will establish an important result for the proof.

Lemma 3 *1.* $g'(h) = \frac{1}{e''(g(h))} > 0$

2. $g''(h) = \frac{-e'''(g(h))g'(h)}{[e''(g(h))]^2}$

3. $e'(g(h)) = h$

Proof. Define $f(h) = e'(h)$ and note that

$$\begin{aligned} f'(h) &= e''(h) \\ f^{[-1]}(h) &= (e')^{[-1]}(h). \end{aligned}$$

Recall that $g(h) = (e')^{[-1]}(h)$, we have $g(h) = f^{[-1]}(h)$. Invoking the rule of the derivative of inverse function yields

$$g'(h) = (f^{[-1]})'(h) = \frac{1}{f'(f^{[-1]}(h))} = \frac{1}{e''(g(h))} > 0 \tag{2.5}$$

This completes the proof of part 1 of the Lemma.

From the equation (2.5), we also have

$$g''(h) = \frac{-e'''(g(h))g'(h)}{[e''(g(h))]^2}.$$

Finally, part 3 is obvious because $g(\cdot)$ is the inverse function of $e'(\cdot)$. ∎

Case 1: Borrower chooses not to default intentionally:

The Lagrangian for the maximization problem is:

$$L = p[k^{\alpha} - (1+r)k] - e(p) + \mu(b-k)$$

The Kuhn-Tucker conditions for k, p and μ are:

$$\begin{aligned} \frac{\partial L}{\partial k} &= p[\alpha k^{\alpha-1} - (1+r)] - \mu = 0, & (2.6) \\ \frac{\partial L}{\partial p} &= k^{\alpha} - (1+r)k - e'(p) = 0 \text{ and} & (2.7) \\ \mu\frac{\partial L}{\partial \mu} &= b - k \geq 0, \mu \geq 0 & (2.8) \end{aligned}$$

Subcase 1.1: $\mu = 0$, the constraint is not binding.

$$\begin{aligned} k^* &= (\frac{\alpha}{1+r})^{\frac{1}{1-\alpha}} \text{ by (2.6), and} & (2.9) \\ p^* &= (e')^{[-1]}((\frac{\alpha}{1+r})^{\frac{\alpha}{1-\alpha}} + (1+r)(\frac{\alpha}{1+r})^{\frac{1}{1-\alpha}}) \text{ by Lemma 1 and (2.7)} \\ &= (e')^{[-1]}((1+r)^{\frac{\alpha}{1-\alpha}}\alpha^{\frac{1}{1-\alpha}}(1+\alpha^{\frac{1-2\alpha}{1-\alpha}})). & (2.10) \end{aligned}$$

This completes the proof of the first part of Proposition 1.

Note that in this case, k^* does not depend on b, thus, $\frac{\partial k^*}{\partial b} = 0$. Note also that $\frac{\partial p^*}{\partial r} = g'h'h_r$. From (2.9), we have $\frac{\partial k^*}{\partial r} < 0$. Finally, recall that function $g(\cdot)$ is increasing, and hence, $\frac{\partial p^*}{\partial r} < 0$. This completes the second part of Proposition 2.

Subcase 1.2: $\mu > 0$, the constraint is binding. From the definition of $g(h)$ and $h(r,b)$, we have $k^* = b$ and $p^* = (e')^{[-1]}(b^\alpha - (1+r)b) = g(h(r,b))$. Note that

$$\begin{aligned} h_b &= \alpha b^{\alpha-1} - (1+r) \geq 0 \text{ for } b \in [0, (\frac{\alpha}{1+r})^{\frac{\alpha}{1-\alpha}}] \\ h_b &\leq 0 \text{ for } b \in [(\frac{\alpha}{1+r})^{\frac{\alpha}{1-\alpha}}, \infty]. \end{aligned} \tag{2.11}$$

.

This completes the proof of the first part of Proposition 2.

Furthermore, $\frac{\partial k^*}{\partial r} = 0$. Thus,

$$\begin{aligned} \frac{\partial p}{\partial r} &= g' h_r = -g' b < 0 \\ \text{and } \frac{\partial p}{\partial b} &= g' h_b \frac{\partial k^*}{\partial b}. \end{aligned}$$

Note that $h_b = \alpha k^{\alpha-1} - (1+r) \geq 0$ for $b \leq (\frac{\alpha}{1+r})^{\frac{1}{1-\alpha}}$ and $\frac{\partial k^*}{\partial b} = 1$. Thus, $h_b \geq 0$. This completes the proof of the second part of Proposition 2.

Inserting $p^* = g(h(r,b))$ to (2.7) gives

$$e'(g(h(r,b))) = h(r,b) \tag{2.12}$$

Sufficient Conditions: Note that $\pi''(p) = -e''(p) < 0$ by convexity of $e(\cdot)$. Hence, $\pi(p)$ is concave. Therefore, any p^* satisfying the first-order conditions is the global maximizer.

Case 2: Borrower intentionally defaults on the loan.

If $\pi^*(p(r,b),b) \leq (1-c)b$, or $\pi^*(p(r,b),k^*(r,b)) \leq (1-c)b$, then the Borrower will intentionally default, and borrow as much as he can $k^* = b$. *Q.E.D.*

Appendix 2.B Proof of Theorem 1

Necessary Conditions:

Lagrangian:

$$\begin{aligned} L(r,b,\lambda) &= g(h(r,b))(1+r)b - vb \\ &\quad +\lambda\{g(h(r,b))h(r,b) - e(g(h(r,b)) - b + cb\} + \gamma(b_h - b) \end{aligned} \tag{2.13}$$

The Kuhn-Tucker conditions for r, b and r are:

$$\begin{aligned} &\frac{\partial L}{\partial b}(r,b,\lambda,\gamma) = g'h_b(1+r)b + g(1+r) - v + \lambda\{g'h_b h + gh_b - e_b - (1-c)b\} = 0 \\ &\frac{\partial L}{\partial r}(r,b,\lambda,\gamma) = g'h_r(1+r)b + gb + \lambda\{g'h_r h + gh_r - e_r\} = 0 \\ &\lambda\frac{\partial L}{\partial \lambda}(r,b,\lambda,\gamma) = \lambda\{g(h(r,b))h(r,b) - e(g(h(r,b)) - b + cb\} = 0 \\ &\frac{\partial L}{\partial \lambda}(r,b,\lambda,\gamma) \geq 0 \\ &\quad \gamma(b_h - b) = 0,\ \gamma \geq 0,\ b_h - b \geq 0 \end{aligned}$$

Case 1: $\lambda = 0$, **No-misdeed-default constraint is not binding**

We will first solve the optimization problem without the Borrower's Optimal Investment constraint, and then prove that such solution satisfies the constraint. First, neglecting the constraint, the FOC with respect to r becomes

$$\begin{aligned}\frac{\partial L}{\partial r} &= g'h_r(1+r)b + gb = 0 \\ &\Leftrightarrow\ b(1+r) = \frac{g}{g'}.\end{aligned} \tag{2.14}$$

The FOC with respect to b becomes

$$\frac{\partial L}{\partial b} = g'h_b(1+r)b + g(1+r) - v = 0 \tag{2.15}$$

$$\Leftrightarrow\ (1+r)(g'h_b b + g) = v$$

$$\Leftrightarrow\ (1+r)b = \frac{v-(1+r)g}{g'h_b}. \tag{2.16}$$

Combining (2.14) and (2.16) gives

$$\begin{aligned}\frac{v-(1+r)g}{g'h_b} &= \frac{g}{g'} \\ g[h_b + (1+r)] &= v \\ g[\alpha b^{\alpha-1} - (1+r) + (1+r)] &= v \\ b^* &= (\frac{\alpha g}{v})^{\frac{1}{1-\alpha}},\end{aligned} \tag{2.17}$$

which is the equation (2.1) in Theorem 1.

In the following, we will show that when the no-misdeed-default constraint is not binding, the solution $b^* = (\frac{\alpha g}{v})^{\frac{1}{1-\alpha}}$ satisfies no-idle-credit constraint.

Note that (2.15) implies that $g'h_b b + g = \frac{v}{1+r}$. For Lender to make positive profit, the interest rate Lender sets should be higher than the opportunity cost of the loan.

That is, $1 + r \geq v$. On the other hand, $p(r, b) = g(h(r, b)) \leq 1$. Therefore, it must be the case that $g' h_b b \geq 0$. This implies that $h_b \geq 0$ (as $g' \geq 0$ by Lemma 1, and $b \geq 0$ by assumption). Therefore, it that

$$b^* \leq (\frac{\alpha}{1+r})^{\frac{1}{1-\alpha}} \tag{2.18}$$

Lemma 3 implies that Lender is never better off lending more than the Borrower's optimal investment. Inserting b into (2.14) yields

$$\begin{aligned} (1+r) &= \frac{g}{g'}(\frac{\alpha}{v})^{-\frac{1}{1-\alpha}} g^{-\frac{1}{1-\alpha}} \\ r &= \frac{1}{g'}(\frac{v}{\alpha})^{\frac{1}{1-\alpha}}(\frac{1}{g})^{\frac{\alpha}{1-\alpha}} - 1, \end{aligned} \tag{2.19}$$

This is the equation (2.2) as needed. The combination of (2.17), (2.18) and (2.19) completes the proof of the part (i) of Theorem 1.

Case 2: $\lambda > 0$, No-misdeed-default constraint is binding

Note that $\lambda > 0$ implies that $\gamma = 0$, because for the no-misdeed-default constraint to be binding, it must be the case that the Borrower is not able to borrow up to his optimal level of investment.

The FOCs become:

$$\frac{\partial L}{\partial b} = g' h_b (1+r) b + g(1+r) - v + \lambda\{g' h_b h + g h_b - e_b - 1 + c\} = 0, \tag{2.20}$$

$$\frac{\partial L}{\partial r} = g' h_r (1+r) b + g b + \lambda\{g' h_r h + g h_r - e_r\} = 0, \tag{2.21}$$

$$\frac{\partial L}{\partial \lambda} = g(h)h - e(g(h)) - b + cb = 0. \tag{2.22}$$

Note that

$$
\begin{aligned}
e_r &= \frac{\partial e(g(h(r,b)))}{\partial r} \\
&= e'(g(h(r,b)))g'(h(r,b))h_r(r,b) \\
&= h(r,b)g'(h(r,b))h_r(r,b) \text{ by (2.12)} \\
&= hg'h_r.
\end{aligned}
$$

Similarly,

$$e_b = hg'h_b \text{ by (2.12)}$$

Thus,

$$
\begin{aligned}
\frac{\partial L}{\partial r} &= g'h_r(1+r)b + gb + \lambda\{g'h_rh + gh_r - hg'h_r\} \\
&= g'h_r(1+r)b + gb + \lambda gh_r = 0 \text{ by (2.12)}. \qquad (2.23)
\end{aligned}
$$

Hence,

$$
\begin{aligned}
\lambda &= -\frac{(1+r)bg'h_r + bg}{gh_r} \\
&= -\frac{(-b)(1+r)bg' + bg}{(-b)g} \text{ (since } h_r = -b) \\
&= \frac{g - (1+r)bg'}{g}. \qquad (2.24)
\end{aligned}
$$

Since $\lambda > 0$, we have $g \geq (1+r)bg'$.

Similarly, from the equation (2.20), we have

$$\begin{aligned}\frac{\partial L}{\partial b} &= g'h_b(1+r)b + g(1+r) - v + \lambda\{g'h_bh + gh_b - hg'h_b - 1 + c\} \quad (2.25)\\ &= g'h_b(1+r)b + g(1+r) - v + \lambda\{gh_b - 1 + c\} = 0 \text{ by } (2.12). \quad (2.26)\end{aligned}$$

Because the objective function is concave (i.e., derivative of the objective function is decreasing) and the optimal b in the constrained optimization case is less than that in the unconstrained optimization case, we know that:

$$g'h_b(1+r)b + g(1+r) - v \geq 0 \text{ for } b_c^* < b_{uc}^*.$$

Therefore,

$$gh_b - 1 + c \leq 0 \tag{2.27}$$

From (2.25), we have:

$$\lambda = \frac{(1+r)bg'h_b + (1+r)g - v}{(1-c) - gh_b}. \tag{2.28}$$

Combining (2.24) with (2.28) gives

$$\begin{aligned}\frac{(1+r)bg'h_b + (1+r)g - v}{(1-c) - gh_b} &= \frac{g - (1+r)bg'}{g}.\\ (1-c)g - (1-c)(1+r)bg' - g^2h_b + (1+r)bgg'h_b &= (1+r)bgg'h_b + (1+r)g^2 - vg\\ (1-c)g - (1-c)(1+r)bg' - g^2h_b &= (1+r)g^2 - vg\\ (1-c+v)g - (1-c)(1+r)bg' - g^2[h_b + (1+r)] &= 0.\end{aligned}$$

Inserting $h_b = \alpha b^{\alpha-1} - (1+r)$ into the above equation yields

$$(1-c+v)g - (1-c)(1+r)bg' - \alpha b^{\alpha-1}g^2 = 0 \tag{2.29}$$

Dividing both sides of the equation (2.29) by g gives

$$\begin{aligned}(1-c+v) - (1-c)(1+r)b\frac{g'}{g} - \alpha b^{\alpha-1}g &= 0 \\ (1-c)(1+r)b\frac{g'}{g} + \alpha b^{\alpha-1}g &= (1-c+v)\end{aligned} \tag{2.30}$$

Thus,

$$r = \frac{g}{g'}\frac{(1-c+v) - \alpha(b^C)^{\alpha-1}g}{(1-c)b^C} - 1, \tag{2.31}$$

This is the equation (2.4) in Theorem 1 as needed.

Now, we will derive the equation (2.3) in Theorem 1 by studying FOC for λ. Recall that

$$\frac{\partial L}{\partial \lambda} = G(r,b) = g(h)h - e(g(h)) - b + cb = 0.$$

Hence,

$$b = \frac{g(h)h - e(g(h))}{1-c}, \tag{2.32}$$

This is the equation (2.3) as needed.

Now, we will to show that for any given r, b^* exists by showing that for any b, we can find solution r^* for the equation (2.30). Let $H(r,b)$ be equal to the left-hand side of the equation (2.30). That is, $H = (1-c)(1+r)b\frac{g'}{g} + \alpha b^{\alpha-1}g$.

Note that, for any fixed r, $H = 0$ for $b \to 0$. Furthermore, since the second term goes to infinity when b goes to infinity, while the first term is positive, we have $H = \infty$ as $b \to \infty$. Finally, observe that $H(b)$ is a continuous function in $(0, \infty)$. Therefore, the left-hand side is a continuous function in $(0, \infty)$, while the right-hand side is a constant. Therefore, for any b, we can find solution r^* for the equation (2.30).

Similarly, we can check that for any fixed b, we can find r such that for c, v, α in suitable range, the FOC is satisfied. That is, $G(r, b) = g(h)h - e(g(h)) - b + cb = 0$. Therefore, the solution for the system (2.3) and (2.4) always exists. Together with the equations (2.31) and (2.32), this completes the proof of the part (ii) of Theorem 2. *Q.E.D.*

Appendix 2.C Proof of Theorem 2

Recall the FOC of Lender 's maximization problem when no-misdeed-default constraint is binding:

$$\frac{\partial L}{\partial \lambda} = G(r, b) = g(h)h - e(g(h)) - b + cb = 0.$$

Define $G(r,b) = g(h)h - e(g(h)) - b + cb = 0$ and take the partial derivatives of $G(\cdot)$ with respect to r, b and c:

$$\begin{aligned}
\frac{\partial G}{\partial c} &= b \\
\frac{\partial G}{\partial b} &= g'h_b h + gh_b - hg'h_b - 1 + c \\
&= gh_b - 1 + c \\
\frac{\partial G}{\partial r} &= g'h_r h + gh_r - hg'h_r \\
&= gh_r.
\end{aligned}$$

Furthermore, applying Implicit Function Theorem to $G(r,b) = 0$ yields

$$\frac{\partial r}{\partial c} = -\frac{\partial G/\partial c}{\partial G/\partial r} = -\frac{b}{gh_r} = \frac{1}{g} > 0 \text{ (since } h_r = -b \text{ by Lemma 1).} \tag{2.33}$$

Hence,

$$\frac{\partial b}{\partial c} = -\frac{\partial G/\partial c}{\partial G/\partial b} = \frac{b}{(1-c) - gh_b}. \tag{2.34}$$

Therefore, $\frac{\partial b}{\partial c} \geq 0$ iff $gh_b \leq (1-c)$, which is true by (2.27).

Appendix 2.D Proof of Theorem 3

Invoking $\frac{\partial p}{\partial c} = \frac{\partial p}{\partial r}\frac{\partial r}{\partial c} + \frac{\partial p}{\partial b}\frac{\partial b}{\partial c}$, recalling $\frac{\partial p}{\partial r}$, $\frac{\partial p}{\partial b}$ from Proposition 2 and $\frac{\partial r}{\partial c}$, $\frac{\partial b}{\partial c}$ from Theorem 2, we have

$$\begin{aligned}
\frac{\partial p}{\partial c} &= -bg'\frac{1}{g} + \frac{bg'h_b}{(1-c) - gh_b} \\
&= -bg'(\frac{1}{g} + \frac{h_b}{gh_b - (1-c)}).
\end{aligned} \tag{2.35}$$

Combining equation (2.35) with the fact that $bg' > 0$ yields

$$\begin{aligned}
\frac{\partial p}{\partial c} \geq 0 \ \Leftrightarrow\ & \frac{1}{g} + \frac{h_b}{gh_b - (1-c)} \leq 0 \\
\Leftrightarrow\ & \frac{2gh_b - (1-c)}{g[(gh_b - (1-c)]} \leq 0 \\
\Leftrightarrow\ & \frac{2gh_b - (1-c)}{gh_b - (1-c)} \leq 0 \text{ (since } g > 0) \\
\Leftrightarrow\ & gh_b \leq \frac{1-c}{2} \text{ or } gh_b \geq 1-c \\
\Leftrightarrow\ & gh_b \leq \frac{1-c}{2} \text{ since } gh_b \geq 1-c \text{ is not possible by (2.27).}
\end{aligned}$$

This completes the proof of Theorem 3. *Q.E.D.*

Appendix 2.E Proof of Theorem 4

The proof of Theorem 4 is rather straightforward. In particular, we want to show that:

$$\frac{\partial \Pi(r^*(c), b^*(c))}{\partial c} = \frac{\partial \Pi}{\partial r}\frac{\partial r}{\partial c} + \frac{\partial \Pi}{\partial b}\frac{\partial b}{\partial c} \geq 0.$$

First, recall from the Theorem 2 that $\frac{\partial r}{\partial c} \geq 0$ and $\frac{\partial b}{\partial b} \geq 0$. In addition, recall FOC with respect to r stated in (2.23)

$$\frac{\partial L}{\partial r} = g' h_r (1+r)b + gb + \lambda g h_r = 0$$

and recall that $\lambda \geq 0, g \geq 0, h_r = -b \leq 0$. Therefore,

$$\frac{\partial \Pi}{\partial r} = g' h_r (1+r)b + gb \geq 0.$$

Similarly, recall the FOC with respect to b stated in (2.26)

$$\frac{\partial L}{\partial b} = g' h_b (1+r)b + g(1+r) - v + \lambda\{g h_b - 1 + c\} = 0$$

and invoke (2.27), we have

$$\frac{\partial \Pi}{\partial b} = g' h_b (1+r)b + g(1+r) - v \geq 0.$$

These facts complete the proof of Theorem 4. *Q.E.D.*

Appendix 2.F Proof of Theorem 5

Recall that Borrower's profit is

$$\pi = p[b^{\alpha} - (1+r)b] - e(p) = g(h)h - e(g(h)).$$

we have

$$\begin{aligned}
\frac{\partial \pi}{\partial c} &= \frac{\partial \pi}{\partial r}\frac{\partial r}{\partial c} + \frac{\partial \pi}{\partial b}\frac{\partial b}{\partial c} \\
&= \frac{\partial r}{\partial c}[g'h_r h + gh_r - e'g'h_r] + \frac{\partial b}{\partial c}[g'h_b h + gh_b - eg'h_b] \\
&= \frac{\partial r}{\partial c} gh_r + \frac{\partial b}{\partial c} gh_b, \text{ since } e' = h.
\end{aligned}$$

Using $\frac{\partial r}{\partial c}$ from (2.33) and $\frac{\partial b}{\partial c}$ from (2.34), we have

$$\begin{aligned}
\frac{\partial \pi}{\partial c} &= gh_r \frac{1}{g} + gh_b \frac{1}{(1-c)gh_b} \\
&= -b + \frac{gh_b}{(1-c) - gh_b}.
\end{aligned}$$

Thus,

$$\begin{aligned}
\frac{\partial \pi}{\partial c} &\geq 0 \Leftrightarrow \frac{gh_b}{(1-c) - gh_b} \geq b \\
&\Leftrightarrow gh_b \geq (1-c)b - gh_b \\
&\Leftrightarrow gh_b \geq \frac{1-c}{2} b \\
&\Leftrightarrow b \leq \frac{2gh_b}{1-c}.
\end{aligned}$$

This completes the proof of the Theorem 5.

Note that if $\frac{2gh_b}{1-c} \geq 1$, that is, $\frac{\partial p}{\partial c} \geq 0$, then the inequality is always satisfied. This completes the proof of the Corollary of the Theorem 5. *Q.E.D.*

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Chapter 3

Identifying Corruption: Distribution of Disaster Relief Aids in Vietnam

"It is just as difficult to detect an official's dishonesty as it is to discover how much water is drunk by the swimming fish." *Kautilya, Arthashastra, around 400 B.C.*

3.1 Introduction

Corruption, defined as the misuse of public office for private gain, has been in the center of development economics and policy. Corruption is widely believed to be detrimental to economic growth by diverting capital, technology and human resources away from their socially most productive uses (Murphy, Shleifer and Vishny, 1991, 1993)[1]. Extrapolating from company and household data, the World Bank Institute

[1] In particular, corruption increases the costs for establishing and running businesses, thus discourages the establishment and expansion of the firms. To avoid being exploited by corrupt officials, businesses choose to operate in the informal economy, in smaller size and adopt less efficient "flight-

estimated that the world's total bribe is about $1 trillion per year, or 3% of the world GDP (Rose-Ackerman, 2004), suggesting the enormous scale of the problem.

However, until the last ten years, there have been very few empirical studies successfully identifying and measuring corruption using objective data. The obstacles are abundant: the secretive nature and the variety in forms of corruption, the unwillingness of the interviewees to reveal their true preferences, the poor quality of the financial records in developing countries etc.

In this paper, we will establish the evidence of corruption at local governments in Vietnamese communes. The data set is extracted from the most extensive and informative household survey conducted in Vietnam. We will utilize unintended household information of the officials answering the commune survey to trace their household-spending patterns. By connecting official data on natural disasters and government's relief aids (reported by the local government) with household-spending data, we will be able to show that there is a significant distortion of the distribution in the government's natural relief aids toward the households whose members are the communes' officials.

The rest of the paper is organized as follows. Section 3.2 summarizes related literature on corruption. Section 3.3 outlines the local context of corruption in Vietnam and argues that natural disasters and the government's relief aids could serve as a

by-night" technology with high degree of reversibility (Choi and Thum, 1998; Svensson, 2003). Institutionalized corruption distorts the industrial organization as the government establishes artificial monopolies, while firms spend resources to compete for valuable licenses and privileges rather than to increase productivity (Murphy, Shleifer and Vishny, 1991). In countries in which getting a "right" position in the government (such as custom officials) pays off handsomely, talent is allocated to competing to get the position rather than to start one's own business. Corruption also affects the life of the citizens directly by demanding bribes and embezzling public funds for social services such as education, health care and insurance (Reinikka and Svensson, 2005).

"natural experiment", which allows for the evidence of the corruption of the relief aids to be found. Section 3.4 outlines the theoretical model and empirical strategies. Section 3.5 describes the data set and the key variables. Section 3.6 presents the empirical results. The final section discusses policy implications and directions for future research.

3.2 Related Literature

The variety in forms and the secretive nature of corruption pose a great challenge for economists to come up with an acceptable measure of it. There have been two main approaches to address this challenge: macro-level/survey data approach and micro-level/objective data approach.

3.2.1 Indexing Corruption at Macro Level

The first approach to measure corruption uses survey data at macro level (mainly country level) from various evaluation sources to form a ranking for countries[2]. Three important corruption indicators emerge from this approach. The first indicator, the Corruption Indicator, measures the political risk involved in corruption in different countries. This indicator is compiled from the data collected by private risk-assessment firms and published by International Country Risk Guide. The second indicator, the Corruption Perception Index, measures the overall extent of corruption.

[2]The survey method applied in the corruption context has a severe weakness: people often under-report or do not report corruption incidents at all. Furthermore, the corruption rankings based on subjective judgment do not represent the magnitude of the corruption.

It is based on various corruption-evaluation surveys and published by Transparency International. The third indicator, the Control of Corruption, combines most of cross-country indexes that include the ranking of countries on some aspect of corruption. This indicator was created by Kaufmann, Kraay and Mastruzzi (2003). These three indicators are highly correlated.

Empirical studies using corruption rankings have been able to point out the correlations between corruption and GDP per capita, human capital, the openness of the economy and colonial/communist origins. However, the ranking data is too crude to address sophisticated questions on detecting and preventing corruption.

3.2.2 Quantifying Corruption at Micro Level

Rather than using survey data at macro level, the micro-level approach to measure corruption, which emerges only in the last ten years, utilizes the discrepancies in the objective data coming from different sources (for example, between the public aids giver and receiver) or different periods to point out the existence of corruption, and to quantify its magnitude at micro level.

In a case study examining the public education funding program in Uganda, Reinikka and Svensson (2004a) investigated the difference between the data reported by the central government on its funding to the school districts with the data on actual receipts reported by schools that were supposedly received such funding. The authors found that during the period from 1991 to 1995, on average the schools received only 13% of the government funding on the program and most schools received nothing.

The evidence showed that local officials captured a large amount of the funding. The authors later found similar situation in various sub-Saharan countries. Olken (2003, 2004) used this method to show that 29% of the funds allocated to a road-building project and 18% of subsidized rice in a large antipoverty program in Indonesia were stolen.

Price comparison is another useful tool to quantify the magnitude of corruption. The most famous example of this approach is the estimation of the extent of under-pricing of Iraqi oil during the United Nation's Oil for Food Program, done by Hsieh and Moretti (2005). The authors compared the gap between the official selling price and various estimates of the market price of Iraqi oil during and prior to the program. They argued that underpricing was a way the Iraq regime utilized to obtain illegal kickbacks from oil buyers. The value of such kickbacks was estimated to be from $1 to $4 billion in bribes from 1997 to 2001.

Although the scope to which the conclusions derived from this approach can be applied is rather limited, it can shed new lights on the determinants of corruption at micro level.

Reinikka and Svensson (2004b) successfully demonstrated the impact of information accessibility on corruption in their case study of Ugandan education-grant program. In particular, they employed a two-step procedure to measure the effect of the government's campaign to publish the newspaper accounts of monthly transfer from the central government to the school districts. In the first step, they confirmed that distance from the schools to the nearest newspapers outlet is positively correlated with the knowledge of the head teachers about the program. Then, using the distance as an instrument, the authors showed that better informed schools had substantial reduction in the shares of funds captured by corruption.

In this paper, we will follow this emerging trend of identifying corruption at micro level using the discrepancies and changes in objective data. We will also test various hypotheses on the determinants of corruption, such as income and education of the population.

3.3 Local Corruption in Vietnam

Vietnam ranked 111th out of 163 countries in Transparency International's Corruption Perceptions Index for 2006. Although the Vietnamese government recognized corruption as one of the most serious threats to the survival of the regime, there are very few empirical studies on corruption in Vietnam. In this section, we will briefly describe the political and social context of the local governance and explain the reason the distribution of the government's relief aids could be a useful measure of local corruption.

3.3.1 Local Governance: Low Level of Transparency and Accountability

The commune[3] governance in Vietnam shows very little transparency. Officially, the People's Committee is the administrative unit elected by the People's Council to

[3] Commune is the smallest administrative unit in Vietnam. Each commune includes several villages (which are the traditional form of the communities in Vietnam). The average population size of the communes is 6500.

implement the policies proposed by the Council. In reality, the real power lies in the hands of the leaders of the Communist Party Organ of the commune, who often hold key positions in the Council, the Committee and the Commune's Police Station[4]. There is very little separation between these bodies, while the operation of the Party Organ is usually kept out of the public scrutiny.

There are very few credible mechanisms to detect the embezzlement of public funds. Formal political opposition does not exist in the Council or the Committee. The media, local and national, is state-owned, and civil-society organizations barely exist at grass-root level. The police are also under the control of the Party Organ[5].

Meanwhile, the use of "efficiency wage" as the way to prevent corruption (Becker, 1979) has not been in place in Vietnam. Over-staffed and obsessed with egalitarianism[6], the Vietnamese government has failed to keep the wage of the public servants above the "reservation" wage. In fact, the average wage of the public servants is no more than the minimum wage set to low-skill labor in the foreign-owned companies. (We will show in this paper that beside the "corruption windfalls", the income of the local officials is indistinguishable from that of the non-officials).

In sum, the institutional arrangements and the tight public budget create a fertile

[4]Candidates for the People's Council of the commune are nominated largely by the Party Organ. Understandably, the candidates are mostly Party members. Once elected, the Council members nominate the candidates for the People's Committee, who are also members of the Party. The Party Organ controls the operation of the Council and Committee in regular basis, via senior Party members holding the key positions in the two offices. This pattern of power centralization repeats at all level: district, provincial and national.

[5]The Communist Party Organs also represent in and influence the procure system and the courts at all levels.

[6]In 2006, the wages of the Vietnamese Prime Minister, the President and the Chair of the National Congress is about 240-250USD/month, according to Industrial Review of Vietnam, a publication of the Ministry of Industry of Vietnam (Hoang Du, 2006)

ground for corruption at local level. In the next section, we will show that the government's disaster-relief aids presents a "natural experiment" needed to capture corruption.

3.3.2 Frequent Natural Disaster, Frequent Relief Aids

Until recently, abundant rainfall, a dense network of rivers and an extensive irrigation system in Vietnam have allowed for a wide range of crops including rice and other cash crops. With 63% of the labor force working 7.2 million hectares in 1998 (the time the survey was conducted), Vietnam was one of the major exporters of rice, coffee, tea and cashews.

However, Vietnam also has to cope with serious natural disasters, which could cause severe damages to its agriculture and aquaculture. About a dozen typhoons each year from May to January create extensive flooding in the lowland Mekong delta and threaten the flood-control levees and dams in other coastal areas. In our sample, the correlation between typhoon and flood is quite high (0.29). Within the two years the survey was conducted, one in four communes experienced a flood that had reduced the crop output by at least 10% while one in five communes experienced a typhoon that reduced the crop output by at least 10%.

During the time this survey was conducted (from late 1997 to 1998), Vietnam experienced a very severe drought that caused extensive damages to rice crops and aquaculture. This incident is the reason for the extremely high frequency of the drought in our sample: within less than two years, every one in two surveyed com-

Variable	Obs	Mean	Std.Dev	Min	Max
Flood	228	.254386	.52784	0	3
Drought	224	.5669643	.7243229	0	4
Pest	227	.4845815	.6935098	0	3
Typhoon	219	.1872146	.4756656	0	3
Other	219	.2146119	.4926675	0	2

Table 3.1: Number of Disasters Destroying at least 10 percent Crop

	Typhoon	Flood	Drought	Pest
Typhoon	1			
Flood	0.2948	1		
Drought	0.1082	0.0121	1	
Pest	0.3503	0.3710	0.0112	1

Table 3.2: Correlations of Natural Disasters in Vietnam

munes suffered from drought.

Because the intense agriculture activities concentrated on a small number of crops, pest is chronic. Pest also tends to outbreak after a typhoon or a flood (see Table 2). As the result, pest is the second most frequent disaster in our survey.

Given such high frequency of natural disasters, the natural relief aids from government to the affected communes is expected to be abundant. Indeed, 64% of the communes in the survey received some forms of government's natural relief aids such as cash, food, seeds and fertilizer or construction materials.

3.3.3 Natural Experiment: Disaster and Government Aids

In this section, we will argue that the disaster-relief aids from the government should be directed to the most affected ones, and that the local officials' households are unlikely to be affected more than regular households. We will also recall some anecdotal evidences.

The government aids programs, as any disaster relief aids, will focus on alleviating the most affected victims. By the nature of disasters and the wide variety of the types of disasters included in our dataset, the chance that an official's household is affected by a disaster should be equal to the regular households.

There were several anecdotal evidences of embezzlement of natural relief aids. After the historic flash flood in 2002, HaTinh, the province with the most damage, received 95 billion VND (about 7 million USD) and 2560 ton of foodstuff from central government. The provincial investigation agency later found out a massive embezzlement of aids, inflated contracts for rebuilding the infrastructure (roads, irrigation system etc.)(Chi Mai, 2006 and Chi Mai and Nhat Truong, 2006). Overall, only 9% of the relief cash was distributed to the victims. In one district, only 34 ton out of 70 ton of rice was distributed to the victims. The rest was sold and pocketed by local officials.

In 2006, another scandal of embezzlement of the government's aids in Quang Binh was publicized. The local officials in several communes demanded up to 70% of the provincial and district relief aids from the receivers to redistribute to their family members (Ngo Vinh, 2006). In 2007, local officials in another commune in Quang

Nam, a province hard hit by Xangsane tropical storm, demanded up to 90% of the relief aids from the victims (Phuc Lam and Viet Tuyen, 2007).

3.4 Dataset

Our dataset is drawn from the Vietnam Living Standard Survey (VLSS) 1998, which followed a similar survey conducted in 1993. VLSS 1998 was conducted by Vietnam's General Statistical Office from the end of 1997 to 1998, with technical assistance from the World Bank and funding from United Nations Development Program and the Swedish International Development Agency.

The sample of VLSS 1998 was based on the VLSS 1993, which was a self-weighted sample drawn from all areas of Vietnam. Sample was stratified so that 20% of the households were from urban areas (which corresponded to the rural/urban population ratio of Vietnam at that time). Within each of the two strata, the list of all communes (around 10,000 in total) was drawn up province by province. The communes were then selected in the way that they were spread out evenly among all provinces in Vietnam. Within each commune, two villages were selected, and 16 households in each village were interviewed.

Each month, VLSS covered one tenth of the sample, so the total fieldwork took about 12 months. VLSS was implemented at the highest standards set out by the World Bank's LSMS. Intensive supervision was implemented to ensure the reliability of the data: one supervisor for every two interviewers, one anthropometrist and one data entry operator.

VLSS 1998 covered three types of data: household questionnaire, a community questionnaire and a price questionnaire. At household level, VLSS 1998 covered a sample of 6000 households. The information included the characteristics of the households: household expenditures and consumption; educational level of the household's members; health, fertility and nutrition; employment and earnings; demography including migration; housing and durable assets; agricultural activities; non-agricultural self-employment; and credit and saving and general community characteristics. At commune level, VLSS 1998 covered 150 communes in rural and minor urban areas with the information provided by the local government officials, village chiefs, teachers (for Education section), and health workers (for Health section).

In our regressions, we drop: (i) households whose answers were judged not reliable by the interview team; (ii) the households with spending larger than 8 standard deviations; (iii) communes located in urban or minor urban areas; (iv) communes with missing information on public spending and budget; (v) the communes with too few observations included (less than 10). An explanation of the variables and the descriptive statistics can be found in the Table 3 and Table 4.

3.5 Model and Empirical Strategy

Since the higher/lower income of the officials might due to the unobservable qualities, we cannot estimate the effect of corruption on the official's regular income. Fortunately, natural disaster aids relief served as a natural experiment. As argued above,

Variables	Explanation
Log_hhspending	Log of total yearly household's per capita spending (adjusted for regional and monthly price index)
clerk	Dummy variable represents whether the household has at least one member who is the local (commune) official.
disasterdum	Dummy variable represents whether the commune was affected by at least 5 disasters last year, each reduces one crop at least 10%.
disrelief	Dummy variable represents whether the commune receive natural disaster aids within the last twelve months
disreliefclerk	Dummy variable represents the product of clerk and disrelief
log_headedu	Log of the years in school of the head of the household
log_age	Log of the household's head's age
log_hhsize	Log of the number of members in the household
log_workmem	Log of the number of working members in the household
urban98	Dummy variable represents whether the commune is urban in 1998
farm	Dummy variable represents whether the household is involved in farming
log_housval	Log of the market value of the household's lodging
north **northcentral** **southcentral** **highland** **southeast** **mekong**	Dummy variables represent which geographic region the household is in.

Table 3.3: Local Corruption: Variables and Definitions

Table 4: Descriptive Statistics

Variable	n	Mean	S.D.	Min	.25	Mdn	.75	Max
Household spending	3550	2616.49	1534.09	377.45	1678.41	2229.74	3109.73	25098.3
Commune revenue	3550	560.61	587.28	0.49	224.57	384.80	673.00	3542.08
Commune spending	3550	450.03	407.62	0.38	190.79	360.66	577.97	3004.76
Disaster dummy	3550	0.49	0.50					
Disaster Relief	3550	0.62	0.49					
House value	3429	27.93	38.27	0.00	8.50	16.00	30.00	600.00
Head's education	3550	6.77	4.12	0.00	4.00	7.00	9.00	19.00
Age	3550	47.63	13.74	16.00	37.00	45.00	58.00	95.00
Household size	3550	4.76	1.92	1.00	4.00	5.00	6.00	16.00
Work members	3550	0.84	0.37					
Clerk	3550	0.07	0.26					
urban98	3550	0.13	0.33					
Farm	3550	0.71	0.45					
North	3550	0.18	0.38					
northcentral	3550	0.13	0.34					
southcentral	3550	0.10	0.30					
highland	3550	0.08	0.27					
southeast	3550	0.09	0.28					
mekong	3550	0.22	0.41					

Table 3.4: Local Officials, Disasters and Aids: Descriptive Statistics

natural disaster tends to hit everybody in the commune equally. However, only officials can embezzle the disaster-relief aid. Our model and empirical strategy will be developed around this key insight.

3.5.1 Empirical Model

In this section, we will present a simple model based on Becker-Stigler's (1979) model of efficiency wage and corruption to formulate the embezzlement of the disaster relief aid.

Consider a population divided into different communes with the population p_j, each with two types of agents: Officials and Members. Let w_{ij} be Official's normal-time income (wage) and w_{kj} be Members' normal-time income.

When a disaster hits commune j, each member in this commune will suffer financial loss l_j, which is arguably the same among all members of the commune (including Officials).

The government provides disaster-relief aids $g_j > 0$ to each member of the commune j, which is uniform among all commune Members and Officials.

However, when there is government aids, all Officials in commune j have an equal opportunity to embezzle an amount e_j from the government's disaster relief aids, with a risk of being exposed.

With the probability $P(e_j, \mu_j)$, Official ij (e.g., Official i in commune j) can get away with the embezzlement e_j. The parameter μ_j captures the corruption monitoring process in commune j (μ_j could be the distance between the commune and the provincial center, or the education level of the population.)

Case 1: Officials do not embezzle the government aid

Member's payoff is $wk_j - l_j + g_j$, whereas the Official's payoff is $w_{ij} - l_j + g_j$

Case 2: Officials embezzle the government aid

If Official ij is not detected, then he will receive payoff $w_{ij} - l_j + g_j + ej$. (To simplify the model, we assume that e_{ij} is the same for all Officials within the commune).

With the probability $1 - P(e_j, \mu_j)$ Official ij's embezzlement is detected, and he will be fired and the wage w_{ij} will be zero.

Therefore, Official ij's expected income who embezzles the government aids is $P(e_j, \mu_j)(w_{ij} - l_j + g_j + e_j) + [1 - P(e_j, \mu_j)](-l_j + g_j)$. Equivalently, $P(e_j, \mu_j)(w_{ij} + e_j) - l_j + g_j$

The Official ij embezzles the government aids if and only if $P(e_j, \mu_j)(w_{ij} + e_j) - l_j + g_j > w_{ij} - l_j + g_j$. Equivalently, $e_j > [w_{ij} - P(e_j, \mu_j)]/P(e_j, \mu_j)$

This is the Officials' "incentive comparability constraint" to conduct embezzlement. The function $P(e_j, \mu_j)$ is decreasing in e_j, since the smaller the embezzlement, the harder it is to be detected.

The payoff of the Members in the commune j is $w_{kj} - l_j + g_j - b_j$ where b_j is the loss per capita from the aids embezzlement imposed on the Members. We will simplify the model by assuming that the Officials' gain from embezzlement does not affect the Members' income.

3.5.2 Implications of the Model

From the model, we derive several ways to check for the existence of aids embezzlement[7]:

Assumption A0: The counter-factual regular income of the Officials and Members in communes with disasters can be proxied by the regular income of their counterparts in the communes without disaster, after controlling for relevant variables[8]. Given this assumption, and after controlling for factors influencing regular income, we have:

1. Without aids embezzlement, the difference between the incomes of the Members and the Officials in communes with disaster should be equal to the income difference of those in the communes without disaster. If the former is larger than the later, then aids embezzlement is present. Mathematically, if $(w_{ij} - l_j + g_j + e_j) - (w_{k_j} - l_j + g_j) > w_{ij} - w_{kj}$, then $e_j > 0$

2. Without aids embezzlement, if the income of the Members in communes with disaster is less than the income of the ones in communes without disaster, then income of Officials in the communes with disaster should also be less than that of Officials in the communes without disaster. Mathematically, if $w_{kj} - l_j + g_j < w_{kj}$, then $w_{ij} - l_j + g_j < w_{ij}$.

If, after the disaster relief, only Members are worse off while Officials are better off, then aids embezzlement is present. That is, if $w_{kj} - l_j + g_j < w_{kj}$ and $w_{ij} - l_j + g_j + e_j >$

[7]Our empirical strategy can be viewed as an extension to the difference-in-difference method. In our model, we compare across four categories (regular households with disasters, regular households without disasters, officials' households with disasters and officials' households without disasters) instead of two categories (treated and non-treated groups) as usually the case in difference-in-difference analysis.

[8]Note that this assumption is very common among treatment-effect models.

w_{ij}, then $e_j > 0$

3. Adding the following assumption: (A1) the disaster relief aids is always strictly less than the loss caused by disaster, then, after controlling for regular income, without aids embezzlement, the income of the Officials in the commune with disaster should be strictly less than that of the Officials in the commune without disaster. If the reverse is true, then aids embezzlement is present (the Officials become richer after the disaster). That is, if $g_j - l_j < 0$ and $w_{ij} - l_j + g_j + e_j > w_{ij}$, then $e_j > 0$.

Because in normal time, the higher/lower income of the officials might due to the unobservable qualities, we cannot estimate the effect of corruption on the official's normal-time income. However, natural disaster aids relief served as a natural experiment. As argued above, natural disaster tends to hit everybody in the commune equally. However, only the officials can embezzle the disaster-relief aid.

3.5.3 Empirical Strategy

Let $LN\_HHSPEND$ be the natural log of household spending per capita. We take the log of the variable to compensate for the heteroskedasticity associated with the dependent variable (i.e., the consumption varies more at higher income level). Let X be the set of variables relevant to income (education, sex, house value, household size etc.). Let $CLERK$ be a binary variable, $CLERK = 1$ if the household has at least one member who is a local official, and $CLERK = 0$ otherwise. Let $DISASTER$ be a binary variable, $DISASTER = 1$ if the commune with disaster, and $DISASTER = 0$ otherwise. Let $DISRELIEF$ be a binary variable, $DISRELIEF = 1$ if the commune the household lives in receives disaster-relief aids and $DISRELIEF = 0$ otherwise.

The first regression model, which corresponds to the claim 1 in the previous section, is:

$$\begin{aligned} LN\_HHSPEND = \alpha X + \beta_0 CLERK + \beta_1 DISASTER \\ + \beta_2 DISRELIEF + \beta_3 DISRELIEF * CLERK + \epsilon \end{aligned}$$

where β_0 represents the effect of having a local official in the household on the household's income, β_1 represents the effect of the disaster on the household's income, β_2 represents the effect of the disaster relief aids on the household's income and β_3 represents the aids embezzlement in the case of natural-relief aid. Our key hypothesis is $\beta_3 = 0$

The second regression model, which corresponds to Claim 2 in the previous section, is applied to a subset of the dataset, namely, to the households in the communes hit by natural disasters only.

$$LN\_HHSPEND|_{DISASTER=1} = \alpha X + \beta_4 CLERK + \epsilon$$

where β_4 represents the effect of having a local official in the household on the household's income in a village with disaster. Our key hypothesis is $\beta_4 = 0$.

3.6 Empirical Results

In this subsection, we presents three models designed to test three hypotheses presented in the previous section, to show that local officials' households receive more of the government relief aids. The main results are presented on the Table 5.

Model 1 includes two regressions (1) and (2). Regression 1 confirms that overall, the spending of the Official's households are not higher than the average. This means that the efficiency wage was not implemented in Vietnam at the time. Disasters reduce the household spending. Furthermore, the event that the commune receives the government's disaster relief aids reduces the spending of all households by about 6%. The negative sign of the $DISRELIEF$ might be because the relief aids was provided to the more severely affected communes. In the survey, the severance of the disasters is censored (all disasters that reduced crops by more than 10% were treated equally).

Regression 2 (without variable $CLERK$) shows that the event that the commune receives the government's disaster relief aids actually increases the spending of the official's households by 8%. This result is the evidence that the distribution of the relief aids is highly distorted in favor of the local officials' households.

Model 2 includes one regression, which regresses Household Spending per Capita on the same set of variables but only on the communes with disasters. The regression results strengthen the conclusion in Model 1: overall, the officials' households are 6.3% better off post-disaster than the regular households. The regression does not show the impact of relief aids on households. This might be interpreted as the negative effects of the disasters and relief aids (due to censored data) are neutralized by their positive effects on the officials' households.

3.7 Conclusion

In this paper, we established an evidence of a form of corruption: the distorted distribution of the government's disaster-relief aids by local officials in Vietnamese communes. Utilizing unintended household information of the officials answering the commune survey section in the Vietnam Living Standard Survey 1998, we are able to trace their household-spending patterns. By connecting official data on disasters and government's aids (reported by the local government) with household-spending data, we have shown a significant distortion in the distribution of the natural-relief aids toward the households whose members are commune officials.

Our research is the first empirical evidence ever on corruption at the local level in Vietnam. The key policy insight is the need to improve the aids distribution monitoring. As pointed out in the paper, the efficiency wage has never been in place in Vietnam. Therefore, increasing the wage for local public servants could contribute to the battle against corruption in Vietnam.

In future research, we may be able to identify factors influencing corruption using the distortion of aids distribution as one of the indicators of local corruption.

	Model 1		Model 2
	All Households Included	**Variable Clerk Dropped**	**Disaster Affected Only**
Household Spending per Capita	**(1)**	**(2)**	**(3)**
Clerk	**0.00**		**0.063**
	(0.994)		(0.044)**
disasterdum	**-0.048**	**-0.048**	
	(0.001)***	(0.001)***	
Disrelief	**-0.058**	**-0.058**	**-0.021**
	(0.002)***	(0.002)***	(0.407)
disreliefclerk	**0.081**	**0.081**	
	(0.09) *	(0.043)**	
ln_headedu	**0.154**	**0.154**	**0.145**
	(0.00)***	(0.00)***	(0.00)***
ln_hhsize	**-0.538**	**-0.538**	**-0.540**
	(0.00)***	(0.00)***	(0.00)***
ln_workmem	**0.147**	**0.147**	**0.168**
	(0.00)***	(0.00)***	(0.00)***
urban98	**0.130**	**0.130**	**0.198**
	(0.00)***	(0.00)***	(0.00)***
ln_age	**0.146**	**0.146**	**0.125**
	(0.00)***	(0.00)***	(0.00)***
Farm	**-0.082**	**-0.082**	**-0.064**
	(0.00)***	(0.00)***	(0.003)***
ln_houseval	**0.214**	**0.214**	**0.211**
	(0.00)***	(0.00)***	(0.00)***
North	**0.059**	**0.059**	**0.046**
	(0.237)	(0.234)	(0.405)
northcentral	**0.134**	**0.134**	**0.181**
	(0.027)**	(0.026)**	(0.002)***
southcentral	**0.187**	**0.187**	**0.171**
	(0.004)***	(0.004)***	(0.007)***
highland	**0.240**	**0.240**	**0.337**
	(0.001)***	(0.001)***	(0.00)***

Table 3.5: Local Officials and Allocation of Relief Aids: Regression Results

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