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Wang, Ruixin

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WHO SHOULD I SHARE RISK WITH? GIFTS CAN TELL: THEORY AND EVIDENCE FROM RURAL CHINA

By

Ruixin Wang

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Who Should I Share Risk with? Gifts Can Tell: Theory and Evidence from Rural China

Ruixin Wang*

Abstract

This paper studies how gift exchange may help to overcome limited commitment problem in risk sharing. When efficient contract enforcement is lacking, people rely on friends (or relatives) to share risk since emotional or moral cost of defaulting between friends can help to prevent moral hazard. The problem is how to distinguish between friends and non-friends? Gift expense serves as a signal of friendship since giving a gift is less costly for a friend than a non-friend due to altruism. The model re-evaluates the role of gift exchange in developing economies, and helps to rationalize the large amount of gift exchange in China (10% of living expenditure). As a signal, gift exchange improves the efficiency in risk sharing and facilitates favor exchange, but I also demonstrate that the welfare gains due to this improvement may be offset by increased inequality. By using a unique data set containing detailed records about gift exchange in rural China, the empirical study suggests gift expenses, as a signal, significantly increase the probability of risk sharing. I also show further empirical evidence to the theory by testing more model predictions.

JEL classification: O16, O17, L14, D03

Key words: Gift Exchange, Risk Sharing, Emotional Collateral, Signaling

*Department of Economics, Tilburg University. Email: rey.rxwang@gmail.com. Phone: (31) 13 466 4035. I deeply appreciate the supervision and support of Erwin Bulte, Xiaobo Zhang and Peter Kooreman. Part of this research was done while the author was visiting International Food Policy Research Institute, which I thank for the hospitality. I thank Anna Dreber Almenberg, Cédric Argenton, Patricio Dalton, Martin Dufwenberg, Magnus Johannesson, Tobias Klein, Xu Lang, Florian Schuett, Gyula Seres, Eric van Damme, Gonzague Vannoorenberghe, Jörgen Weibull, Danyang Xie, Yifan Yu and Yu Zhu, for some very useful comments and discussions, as well as seminar audiences at Tilburg University and Stockholm School of Economics. Remaining errors are my own. I am indebted and extremely grateful to the International Food Policy Research Institute and Xiaobo Zhang for granting me access to the data set I am using in this analysis.

She throws a peach to me,
I give her a white jade,
Not in return, you see,
But to show friendship made.

—— **Gifts, Shi Jing (*Classic of Poetry*)**

1 Introduction

Across the developing world, people face various and severe risks in daily life. These risks range from diseases and accidents to poor weather conditions and natural disasters. As a result, risk sharing is an important determinant of household welfare. However, Udry (1994) and Fafchamps (1999) point out that typically in these regions, due to lack of written records, collateral or legal procedures to enforce repayments, limited commitment problem (default) is a main barrier to effective risk sharing. A usual solution is to solve the problem in the framework of repeated game, specifically, by sanction in future or from other members of the community. However, consider the economic vulnerability in developing areas, it might be too risky or costly if people simply count on punishment in future or from the other people. A natural question will be whether there is any alternative approach to prevent defaulting.

A possible solution is relying on friends (or relatives). Due to the emotional connection, friends may endure more emotional or moral cost if they default. So one may suffer less from limited commitment problem if she shares risk only with friends, who are actually more trustworthy than others. But a crucial question is how to distinguish a (real) friend, who has emotional attachment, from those who only pretend to be, particularly when the benefits involved are large. Regarding the question, some behavioral modes of risk sharing in China, where "guanxi" (friendship) is much emphasized in social life, may suggest a mechanism to distinguish friends from non-friends, so that solve the limited commitment problem in a framework of non-repeated game.

By using recent census survey in 26 natural villages, we can take a close scrutiny on the the behavior patterns regarding risk sharing in rural China[1]. Similar to other less developed regions[2], people highly rely on friends and relatives, and most loans are only made between friends following a reciprocal principle, namely they require no collateral or interest but are rewarded by expected future help[3]. However, to highlight the friendship or social distance between each other, people spend a surprisingly large amount of money on gifts at specific social events, e.g. wedding, funerals, come-of-age and birth-of-old ceremonies, and many festivals. On average, more than 10 percent of household expenditures is spent on gifts, and in some villages this share is around 20 percent. This is consistent with "Peking University-CITI Group"

[1]This survey was jointly conducted by the International Food Policy Research Institute (IFPRI), Chinese Academy of Agricultural Sciences (CAAS) and Guizhou University.

[2]where is typically featured as absent of formal opportunities for risk pooling. From the survey, other than self-financing, the first choice for most people to deal with shortage of cash is to borrow from friends or relatives. In 2011, only 2% of households borrowed from formal financial institutions.

[3]In 2011, only 2% of debts required physical collateral.

rural financial investigation data, in which the gift-income ratio is 8.69%[4]. Among the gift giving, a large share is directed to close friends (or relatives) who they count on if in need[5].

As we observe, gift expenses play a key role in linking friendship and risk sharing. So in this paper, I attempt to formulate the underlying mechanism and demonstrate why gift expenses can help to form a reliable risk sharing group only between friends. Specifically, the paper aims to addresses three questions. First, why emotional connection between friends can help to prevent default problem? Second, how can gifts help people to distinguish between friends and non-friends? Third, what is the welfare implication of the mechanism?

Regarding the first question, I demonstrate that friends are more reliable and less likely to default in risk sharing due to the emotional or moral cost of defaulting. The emotional cost is not only out of altruism, but also because of some relationship-based moral emotions, such as guilt-aversion. In this paper, guilt-aversion is assumed to be particularly strong between friends, and can result in a large emotional cost if one defaults to her friend. Hence, akin to the role of physical collateral, guilt-aversion serves as "emotional collateral" between friends, which makes them more trustworthy than a random stranger. As Battigalli and Dufwenberg (2007) suggests, guilt-aversion may help to regulate limited commitment problem.

Second, since altruism (or friendship) is not always observable, people need to use a mechanism to distinguish friends from non-friends. I employ a signaling-game framework where people interpret gifts as a signal of altruism (friendship). Gift giving is purely a cost to non-friends, whereas it is less costly to friends thanks to altruism. I show that gifts can signal altruism and help individuals identify friends. Accordingly, the level of risk sharing depends heavily on costly signals, in particular, gift expenses.

The third main result concerns the welfare implications of gift expenses. When society is equal, gift giving improves welfare through reducing informational asymmetries in risk sharing. But the situation is more complex in unequal societies, where welfare improvements to the poor may be offset. Compared to a rich non-friend, it is more beneficial for a poor non-friend to pretend to be a friend, so the poor friend has to spend more on gifts to compete and distinguish herself. I demonstrate that the competition in gifts may hurt the poor in an unequal society.

To summarize, I propose that gift expense serves as a signal of altruism and helps to distinguish friends from non-friends. In equilibrium, friends can form risk-sharing groups by using "emotional collateral" to reduce default, but the welfare improvement associated with risk sharing may be offset for the poor by increased inequality. The contribution of this paper is two-folded. First, the paper is the first to study the interrelation between gift giving on risk sharing through the perspective of a signaling game. The model helps to rationalize high gift expenses in some developing countries, and evaluate the efficiency gain and loss of gift giving. It is worth noticing that in China, the purpose of signaling friendship (in general, social

[4] From summary statistics of "Peking University-CITI Group" rural financial investigation data in Yi, Zhang, Yang, and Yang (2012).

[5] In 2011, the highest single-time gift expense exceeded 1.5 times the average gift for more than 80% of households. For 20% of the cases, the highest gift exceeded the average gift by a factor of 3.5.

distance) by gift expenses is to facilitate all kinds of reciprocal exchange, rather than only risk sharing. I just narrow the focus on risk sharing in this paper, considering its importance to underdeveloped areas. Second, by using a unique data set containing detailed gift records in 26 villages in rural China, I provide empirical evidence by testing three key model predictions. The empirical findings also help to formulate policy implications.

This paper fits into the recent literature on non-market institutions as a response to problems of imperfect monitoring and limited enforcement (e.g. Greif (1993)), and is related to several strands of literature. First, this paper discusses a novel approach to form risk-sharing groups in the absence of effective contract enforcement. Limited commitment, in previous literature, is mainly overcome by sanctions such as disrepute or social pressure. The former solves the problem by repeated interaction (e.g. Coate and Ravallion (1993) and Ligon, Thomas, and Worrall (2002)). The latter refers to the "social punishments" imposed by members of close-knit communities as "social collateral" (e.g. Udry (1994), **?** and Ferrara (2003)). However, these mechanisms may be too costly or risky, considering the vulnerability of the poor in the rural economy.

The role of gift expense in risk sharing is also discussed in Fafchamps (1999) where the gift is taken as quasi-credit or reciprocal exchange, rather than a signal. In Fafchamps and Gubert (2007) and Fafchamps and Lund (2003), the correlation between gift giving and income shocks is based on a data set from the Philippines, and is interpreted as evidence for the quasi-credit hypothesis (c.f. Fafchamps (1999)). However, as most gifts are not given to cope with specific income shocks, but rather at festivals or ceremonies, this paper suggests that gift giving can also serve as a signal in risk sharing[6].

Following Foster and Rosenzweig (2001), this paper extends the analysis of altruism in risk sharing. In particular, it considers the realistic case when altruism is difficult to observe. This paper is also related to the literature on "impure altruism" (e.g. Andreoni (1989), Andreoni (1990), Ellingsen and Johannesson (2011) and Hopkins (2014)). One common feature is the notion of "signaling altruism". In this paper, I emphasize the role of "signaling altruism" in overcoming limited commitment and facilitating risk sharing. As a contribution to theory, "signaling altruism" in this paper is not simply to signal an intention to reciprocate kind acts, but rather an emotional cost or collateral. Thus, one can be trusted in risk sharing even if the interest involved is considerable, as long as her emotional cost of default is sufficiently large. This paper also discusses the downside of "signaling altruism". If capabilities or statuses are unequal, "signaling altruism" may cause efficiency losses to the poor, and worsen inequality.

The remainder of the paper is organized as follows. Section 2 introduces the notion of gift exchange and its economic and social functions as they emerge from the anthropological literature and related studies in economics. I pay special attention to gift giving in China. Section 3 develops the theoretical framework and derives several testable implications from the model. Section 4 describes the data. In Section 5, I outline the empirical strategy to address the hypotheses. I present estimation results in Section 6. Section 7 concludes.

[6] Gifts are defined as quasi-credit, when they are directly given as credit to solve difficulties and share risks.

2 Gift Exchange, Guanxi and Risk Sharing

When discussing risk-sharing network in China, it is inevitable to refer to the term "guanxi", the social network built only between close friends. People rely on guanxi, and spend much time, energy and money on developing and sustaining these networks. A growing body of literature studies the role that guanxi plays in Chinese social and economic life: not only in rural areas, as described in Yan (1996), where "residents rely heavily on their guanxi network for agricultural production, personal financing and..." but also in urban area, where guanxi affects entrepreneurship, see Yueh (2009), and the labor market in a transition economy, see Knight and Yueh (2008), Zhang and Li (2003) and Gold, Guthrie, and Wank (2002). The impact of guanxi cannot be ignored in any field in China.

Guanxi can be taken as a kind of social capital, but "there are important aspects that set it apart from a generalized notion of social capital" (Gold, Guthrie, and Wank (2002)). First is that it is "based implicitly on mutual interest and benefit. Once guanxi is recognized between two people, each can ask a favor of the other with the expectation that the debt incurred will be repaid sometime in the future (Yang (1994)). In other words, guanxi is based on friendship, but in nature, it is a kind of reciprocal relationship, which facilitates risk sharing and favor exchange.

The second distinctive aspect is the importance of affection or sentiment in guanxi. As Kipnis (1997), "in guanxi, feelings and instrumentality are a totality", instrumentalism and sentiment come together, as cultivating guanxi successfully over time creates a basis of trust in a relationship (Smart (1993)). This trust is based not only on personal sentiment, but also on moral sentiment.

Thirdly, gift exchange plays a key role in maintaining a guanxi. As Gold, Guthrie, and Wank (2002) summarize, guanxi is the basis for a particular type of gift economy in China. In Euro-American ideology, a gift is construed as a pure, disinterested, unconstrained "present", which is nothing more than a voluntary, spontaneous expression of the inner feeling. But when studying the case in China, as pointed out in Yan (1996), such ideology actually obscures the fact that gift exchange is regulated by many rules and serves to deal with "relationships that are important but insecure". In China, gift exchange serves as an important expressive function, which means the existing status relationship (guanxi) between giver and receiver determines the types and values of the gift expenses, and the gift giving supports this status relationship.

Finally, guanxi depends on people's statuses, so gift exchanges are not always balanced or equal between friends, as documented in Yan (1996). People may give more gifts than they receive, especially the poor, but "where do these excess gifts end up?" In rural areas, the answer is village cadres and the rich. When the rich or cadres host family ceremonies, guests have to show respect by presenting gifts, but when the poor or common villagers host ceremonies, only a few can expect a return gift. There is no doubt that all the patterns in anthropology are quite inspiring. In the following section, I generalize the concept "guanxi" to "friendship" based on altruism, and apply the insights into economics.

3 The Model

3.1 Setup

The model studies the effect of gift expenses on risk sharing in the circumstances where efficient contract enforcement is lacking. In previous studies, limited commitment in risk sharing is overcome by punishment such as disrepute or peer pressure in a repeated game. This model suggests that in a non-repeated game setup, limited commitment problem can be overcome by "emotional collateral", which is defined as an emotional cost of betrayal or cheating to friends. The cost disincentivizes people from default[7], so in the First Best case, people can share between friends risk without any concern, and keep autarky when there is no "emotional collateral" in between. However, friendship is not perfectly observable in reality, even in small villages, relationship can change over time. The main contribution of this model is to prove that, in this case, gifts can facilitate risk sharing by serving as a signal of friendship. I start the model with the basic setup, and discuss the equilibrium and efficiency in various occasions in the rest of the section.

3.1.1 Basic setup

Consider a two-player, two-type, multiple-stage game. There are two types of player: friend and non-friend. Player i is a friend if she is altruistic[8] to another player $-i$, so the utility function of Player 1, for example, is

$$U_1\left(c_1,\, c_2\right) = u_1\left(c_1\right) + \mu u_2\left(c_2\right), \qquad \mu = \begin{cases} \delta, & if\ friend \\ 0, & if\ non-friend \end{cases} \tag{1}$$

where μ is the coefficient of altruism, which equals $\delta \in (0,\, 1)$ if Player 1 is a friend, otherwise zero. $u\left(c_1\right)$ is the self-interest part of Player 1's utility function, the rest is the altruism part[9]. The utility function of Player 2 is symmetric. Friendship is assumed to be not necessarily mutual or symmetric[10], this assumption allows the possibility that Player 1 is altruistic to Player 2, but Player 2 is purely self-interested. Under the assumption, type of player is not always a common knowledge, so a non-friend can claim to be a friend if it is beneficial.

3.1.2 Risk-averse utility function

Assume both players are risk-averse, so risk sharing can improve ex-ante efficiency. In this model, I employ a loss-aversion utility function to capture the risk-aversion preference. The kinked form of function not only ensures concavity of the utility function, but also applies better to the reality of developing

[7]The nature of collateral is to cause cost to a defaulter. In this sense, guilt to a friend plays a similar role to physical collateral.

[8]Altruism is exogenously given in this paper, rather than endogenous to gifts. This is not only for simplicity, but also because altruism is a result of many factors, such as common experience, common ideas, similar preferences and so on, rather than simply by gifts.

[9]It does not mean the utility of a friend is in nature higher than a non-friend, since in the setup of this model, utility function is specific to a pair of players. But in reality, Player 1 can be a non-friend to Player 2, but can be a friend to Player 3 or Player 4. Given the same share of friend, q, the utility function of each player is actually identical.

[10]For lack of better word, I have to use "friend" here to denote the player who has altruism to the other player, although in daily life, this term is mainly used to describe a bilateral relationship.

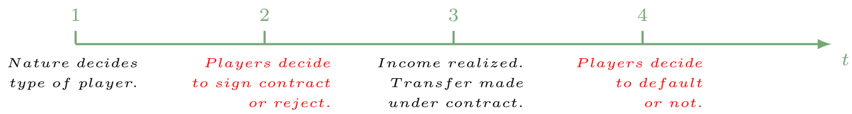
countries. Specifically, the self-interest part of Player 1 is

$$u_1(c_1) = \begin{cases} c_1, & if\ c_1 \geq h \\ c_1 + \alpha(c_1 - h), & if\ c_1 < h \end{cases} \tag{2}$$

where h is the threshold level of subsistence, and $\alpha > 0$ is the loss-aversion coefficient. The self-interest part of Player 2 follows the same form. It is easy to prove that the linear combination of a concave function is still concave, so $U_1(c_1, c_2)$ and $U_2(c_1, c_2)$ are both concave.

3.1.3 Game structure

The structure of the game is as follows.



- Stage 1: Nature decides the type of player. The probabilities of friend and non-friend are q and $(1-q)$. Each player has endowment κ.

- Stage 2: Both players decide whether or not to join a risk sharing group (by a risk-sharing contract of loans) simultaneously.

- Stage 3: Nature chooses shocks to both players. For simplicity, all kinds of shocks are considered as income shock. So the incomes of both players are realized in Stage 3. This consists of two elements, a certain part, w; and an uncertain part, which is m with probability p, and $-m$ with probability $(1-p)$. The income shock is denoted by ε_i, $i \in \{1, 2\}$,

$$\varepsilon_i = \begin{cases} m, & with\ p \\ -m, & with\ 1-p \end{cases} \tag{3}$$

  Once income is realized, a loan is made between players if the contract is signed by both players. They must maintain autarky as long as any player refuses to sign.

- Stage 4: Players have a certain income, $(1+r)w$ in this stage. Assume $rw = m$, which ensures that borrowers have capacity to repay. Meanwhile, players decide to default or repay if the loan was made in Stage 3.

3.1.4 The rule risk-sharing

The rule of risk-sharing in the paper follows the income-sharing contract in Genicot and Ray (2003), Ligon (1998) and Bloch, Genicot, and Ray (2008). Following such a rule, after realization of income, each player offers a share of income, π to form a risk pooling, and obtains a certain share from the pooling income. For simplicity, the share is assumed to $1/2$. In the context of this paper, the pooling income is $\frac{\pi(w+\varepsilon_1)+\pi(w+\varepsilon_2)}{2}$, so the income of Player 1 after sharing is

$$(1-\pi)(w+\varepsilon_1)+\pi\cdot\frac{(w+\varepsilon_1)+(w+\varepsilon_2)}{2} \tag{4}$$

The income of Player 2 is symmetric. The rule of risk sharing indicates that, when both players face positive or negative shocks, neither of them will make any loan. Only if Nature chooses different shocks for each player, the one with positive shock will transfer a certain amount to the other player in negative shock.

For simplicity, and without loss of generality, I assume $\pi=\frac{m}{m-\kappa}$, so that in nature it is a problem-solving contract. When players receive different shocks, the one with positive shock will lend to the other player until the actual income of any player reaches the threshold level of subsistence. It is worthy of note that the rule of risk sharing is realistic, since in most cases, we only help friends back to the normal condition, rather than a much higher level in expense of our utility. Consider no third party enforcing the contract, it must be self-enforcing.

3.1.5 Payoff of the game

Assuming $\kappa<m$, and the endowment is not sufficiently large to be taken as physical collateral. So the payoff of Player 1 in each stage is shown as follows,

$$\begin{cases} z_{11}=w+\varepsilon_1+\kappa+t_{21} \\ \begin{cases} z_{12}=(1+r)\,w, & if\ default\ happens \\ z_{12}=(1+r)\,w-t_{21}, & if\ no\ default\ happens \end{cases} \end{cases} \tag{5}$$

where t_{21} is the net transfer from Player 2 to Player 1. z_{11} is the income of Player 1 before Stage 3, and z_{12} is the income of Player 1 in Stage 4. The income of Player 2 after transfer follows the same rule. Each player maximizes her expected utility given the other player's strategy. Since the utility function is piecewise linear and $\mu\in[0,\,1)$, the optimal condition is reached when one player uses up all the income.

3.1.6 The emotional cost of default

To prevent limited commitment problem, we introduce an emotional cost of default into the model. Such emotional cost can help to regulate default behavior, since it can result in an emotional loss to the one who defaults. In reality, such emotional cost exists between people having some specific relationships, such as friends or relatives.

Altruism between friends or relatives can be a source of emotional cost. One would feel painful if she hurts friends by defaulting. However, the emotional cost will be not sufficiently large if it is only because of altruism. That is because the parameter of altruism, δ is smaller than one. It indicates that the emotional cost is always smaller than the benefits of default.

Other sources can also generate emotional costs, particularly between friends, such as guilt aversion. As Battigalli and Dufwenberg (2007), Battigalli, Charness, and Dufwenberg (2013) suggest, people feel guilty when they let others down or get hurt, so this moral emotion can help to regulate the moral hazard problem. Similar to altruism, guilt-aversion is also relationship dependent. Sugato Chakravarty (2011), Morell (2014) and Blum (2009) all suggest that guilt-aversion is much stronger between friends than with a random stranger. In reality, this relationship-based preference is not simply out of human nature, but also fostered by culture and social norms. For example in China, moral code is differential over social distance. As Fei, Hamilton, and Wang (1992) demonstrated, society in China is characterized by "chaxugeju"[11], which means that most benefits are shared only with a few close relatives and friends, but the moral code will also differ depending on the closeness of the friendship or guanxi. Traditional Chinese ethics (in particular, Confucian ethics) emphasizes the moral code between friends rather than a random stranger, resulting in a large emotional or moral cost only between friends.

Both sorts of emotional costs help to prevent limited commitment problem between friends, as a result, people will prefer to share risk only with friends rather than non-friends. We model the relationship-based emotional cost as follows. Suppose both players sign the contract, once the loan is made in Stage 3, the lender (e.g. Player 1) expects to receive repayment in Stage 4. If the borrower (Player 2) is a non-friend, she will definitely default because there is no cost of defaulting. However, if the borrower happens to be a friend of Player 1, she will feel guilty for defaulting, and there will be an emotional cost. Define the emotional cost of Player 1 as

$$EC_1 = \delta\,(1+\theta)\,t_{12} \tag{6}$$

where EC represents the emotional cost, which is larger than the economic cost t_{12} as long as $\delta\,(1+\theta) > 1$. The emotional cost of Player 2 is symmetric. As defined above, δ is the parameter to altruism, when it is larger, people may feel more guilty, and the emotional cost of defaulting is higher. θ decides the level of guilt-aversion, when it is larger, the emotional cost is higher, so θ is defined as the parameter to guilt-aversion.

3.2 First Best

First Best is defined as the case with no informational asymmetry between players, so type of player is common knowledge. Using backward induction, the decision in Stage 4 determines if the contract is self-enforcing, which is a key to the decision of signing contract in Stage 2, and players may make different decision about default given their different types. Assume $h = w$, we have[12]

[11] The term is to define the differential mode of association (social sphere) in Chinese society.

[12] Since I use a loss-aversion utility function, this assumption ensures that the agents have incentive to share risk. Facing a shock, it is beneficial to share risk since the consumption will be lower than threshold h.

Lemma 1. *When $\theta > \theta^\star$, a friend will not default.*

Proof: see Appendix. $\theta^\star = \frac{(1-\delta)(m-\kappa)+\alpha\delta m}{(1+\alpha)\delta(m-\kappa)}$. From the condition, when θ is sufficiently large, default is not preferred by a friend. Intuitively, when the emotional cost of defaulting is sufficiently large, the borrower, as a friend, will feel so guilty that it is better to choose not to default. Therefore, the contract is self-enforcing, and players do not have to worry about the default problem if they sign a risk-sharing contract with a friend. The threshold is determined by δ, the parameter to capture altruism. With δ increasing, the threshold is smaller and default is less likely between friends.

By contrast, as a non-friend, if the other player decides to sign contract and share risk with her, she will definitely default. Since a non-friend will never feel guilty, the "emotional collateral" cannot prevent her from defaulting.

3.2.1 First Best for friend

Proposition 1. *If $\theta > \hat{\theta}$. A friend will sign the contract with a friend, and will not sign with a non-friend.*

$\hat{\theta} = \max\left\{\frac{(1-\delta)(m-\kappa)+\alpha\delta m}{(1+\alpha)\delta(m-\kappa)}, \frac{[\alpha-1+(1+\alpha)\delta](m-\kappa)+\alpha m}{(1+\alpha)(m-\kappa)}\right\}$. Given **Lemma 1**, when θ is larger than $\frac{(1-\delta)(m-\kappa)+\alpha\delta m}{(1+\alpha)\delta(m-\kappa)}$, it is beneficial for a friend to sign contract without the concern of being defaulted. When θ is larger than $\frac{[\alpha-1+(1+\alpha)\delta](m-\kappa)+\alpha m}{(1+\alpha)(m-\kappa)}$, the loss of being defaulted is larger than benefits of risk sharing, so a friend prefers not to sign the contract with a non-friend.

As a simple implication of **Proposition 1**,

Corollary 1. *When $\theta > \theta^\star$, $(sign, sign)$ is a Pareto-dominant Nash Equilibrium (NE) if both players are friends.*

Without concerns of being defaulted, a friend prefers to share risk with another friend, so $(sign, sign)$ can form a Nash Equilibrium. There are some other equilibria if one player rejects to sign the contract. In this case, risk cannot be shared, so $(sign, sign)$ is the Pareto-dominant equilibrium. In most cases in previous literature, people are hard to share risk in a non-repeated game setup due to limited commitment, but thanks to "emotional collateral", at least friends can share risk between each other.

3.2.2 First Best for non-friend

Proposition 2. *If $\theta > \tilde{\theta}$, A non-friend will sign the contract with a friend, but will not sign with a non-friend.*

Proof: see Appendix. $\tilde{\theta} = \frac{\alpha(2m-\kappa)}{(1+\alpha)(m-\kappa)}$. Without "emotional collateral", a non-friend can obtain extra benefits by default, but the contract will be rejected by a friend. When θ is sufficiently large, the loss of being defaulted is larger than the benefit of consumption risk sharing, so a non-friend will also reject to sign contract with a non-friend.

Therefore, in the First Best case, friends can overcome the limited commitment problem and share risk with each other. In the non-repeated game setup, only non-friends are hard to share risk.

3.3 Second Best without Gift Exchange

In the First Best case, thanks to complete information, a friend can share risk with a friend, and can avoid being defaulted by a non-friend. In reality, however, information is not always complete, and the type of each player is not common knowledge. Suppose Player 1 only knows her own type, and the probability that Player 2 is a friend, q, her best strategy will accordingly change.

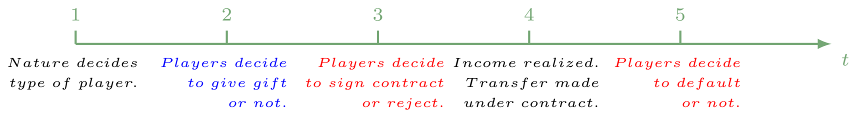
From **Lemma 1**, if $\theta > \theta^\star$, a friend will not default, but a non-friend definitely will. If the share of friends is sufficiently small, it is too risky for a player, no matter a friend or a non-friend, to sign the risk-sharing contract, since it is very likely to be defaulted by a non-friend. So in the Second Best case,

Proposition 3. *When $q < \tilde{q}$, the only NE is $(\text{not sign}, \text{not sign})$ under asymmetric information.*

Proof: see Appendix. $\tilde{q} = \min\left\{\frac{[(1+\alpha)(\theta-\delta)-(\alpha-1)](m-\kappa)-\alpha m}{[(1-\delta)+(1+\alpha)\theta](m-\kappa)-\alpha m}, \frac{[(1+\alpha)(\theta-1)-1](m-\kappa)-\alpha m}{[(1+\alpha)\theta-1](m-\kappa)-\alpha m}\right\}$. When q, the share of friends, is sufficiently small, it is very possible to sign the contract with a non-friend, so both will reject the contract. Compared with the First Best case, apparently friends appear worse off since they cannot share risk. For non-friends, it is indifferent since they cannot share risk in either cases.

3.4 Second Best with Gift Exchange

As illustrated above, type of friend in reality, who is altruistic, is not perfectly observable. So when q is small, people may have concerns with sharing risks. But without any risk sharing, people have to suffer from welfare loss of income shocks. In what follows, I will demonstrate that the problem can be solved by introducing gift expenses to the game. In this case, game structure is changed as follows.



- Stage 1: Nature decides the type of player. The probabilities of friend and non-friend are q and $(1-q)$. Each player has endowment κ.

- Stage 2: With only the information on her own type, Player 1 and Player 2 decide whether or not to give a gift simultaneously.

- Stage 3: Based on the result of the gift exchange and the inferred information, both players decide whether or not to sign a risk-sharing contract of loans simultaneously.

- Stage 4: Nature chooses shocks to both players. For simplicity, all kinds of shocks are abstracted to income shock. So the incomes of both players are realized in Stage 4. This consists of two elements, a certain part, w; and an uncertain part, which is m with probability p, and $-m$ with probability $(1-p)$. The income shock is denoted by ε_i, $i \in \{1, 2\}$,

$$\varepsilon_i = \begin{cases} m, & with\, p \\ -m, & with\, 1-p \end{cases} \tag{7}$$

  Once income is being realized, a loan is made between players if the contract is signed by both players. They must maintain autarky as long as any player refuses to sign.

- Stage 5: Players have a certain income, $(1+r)\,w$ in this stage, assume $rw = m$ which ensures that borrowers have capacity to repay. Meanwhile, players decide to default or repay if the loan was made in Stage 4.

The payoff of Player 1 in each stage is as follows,

$$\begin{cases} z_{11} = w + \varepsilon_1 + \kappa + t_{21} - g_1 + g_2 \\ \begin{cases} z_{12} = (1+r)\,w, & if\, default\, happens \\ z_{12} = (1+r)\,w - t_{21}, & if\, no\, default\, happens \end{cases} \end{cases} \tag{8}$$

g_1 and g_2 are the gifts given by Player 1 and Player 2, respectively. z_{11} is the income of Player 1 before Stage 4, and z_{12} is the income of Player 1 in Stage 5. The payoff of Player 2 is symmetric.

When introducing gift exchange, the game consists of five stages. Using backward induction, players decide to repay or default in Stage 5. Given the results, they decide whether or not to sign the contract in Stage 3. Then in Stage 2, players decide whether or not to offer a gift under informational asymmetry. If friends can be distinguished from non-friends by the gift, players can only sign contract with friends, and keep autarky if meeting a non-friend.

Due to asymmetric information, as shown in **Proposition 3**, players cannot share risk even though they have "emotional collateral" to each other. In this case, gift expenses can facilitate risk sharing by telling friends from non-friends, because gift can play as a signal of friendship (altruism). Since a friend is altruistic, when gifts increase the other player's utility, her own utility also increases. So gifts are always less costly to a friend than a non-friend.

Suppose both players have belief that

$$\begin{gathered}\Pr\left(gift \mid friend\right)=1 \\ \Pr\left(gift \mid non-friend\right)=0\end{gathered} \tag{9}$$

both friends and non-friends will seek to share risk with a player who wish to give a gift. However, when friends wish to give a gift and show their type, non-friends also wish to give gift and pretend to be friends, If the benefits of pretending friends, i.e. the opportunities of risk sharing and defaulting, are sufficiently high.

Fortunately, gifts are always less costly to a friend than to a non-friend. When a gift is sufficiently expensive, only friends will give a gift, and non-friends will offer nothing since the gift is so expensive that the cost of pretending friends cannot be compensated. On equilibrium, the two types of player will have different strategies, and thus separating equilibrium can exist. The equilibrium is consistent with the belief that a friend will give gifts, and a non-friend will not, so the equilibrium is separating Perfect Bayesian Equilibrium (PBE), which ensures the revelation of types of both players. As in the First Best case, friends can form a risk-sharing group with friends, and non-friends have to keep autarky.

Formally, to have the separating equilibrium, the friend sets g, the gift value, so as to maximize the expected utility subject to the non-friend's incentive compatibility constraint. The value of gift has to fulfill the following conditions:

1. IR condition : $E_q\left(U_F\left(c_1,\, c_2,\, g^\star\right)\right) > E_q\left(U_F\left(c_1,\, c_2,\, 0\right)\right)$
2. IC condition: $E_q\left(U_{NF}\left(c_2,\, 0\right)\right) > E_q\left(U_{NF}\left(c_2,\, g^\star\right)\right)$

where friend is denoted as f, and non-friend is denoted as nf. The individual rationality (IR) condition guarantees that it is beneficial for a friend to give a gift and share risk; the incentive compatibility (IC) condition ensures a non-friend will prefer to offer nothing and keep autarky. I then obtain

Proposition 4. *Given* $\theta > \theta^\star$*,* $q \leq q^\star$ *and belief* $\Pr(gift \mid friend) = 1$ *and* $\Pr(gift \mid non-friend) = 0$*, a separating PBE* $\left(\left(g^\star = \frac{qp(1-p)(1+\alpha)(m-\kappa)}{1+(1-p)\alpha} \mid friend\right), (0 \mid non-friend)\right)$ *exists. A friend would like to offer a gift,* $g^\star = \frac{qp(1-p)(1+\alpha)(m-\kappa)}{1+(1-p)\alpha}$ *, while non-friends offer nothing.*

Proof: see Appendix. $q^\star = \frac{(1+(1-p)\alpha)}{p(1-p)(1+\alpha)(m-\kappa)}$. Using Bayes' rule, if $g^\star \geq \frac{qp(1-p)(1+\alpha)(m-\kappa)}{1+(1-p)\alpha}$, the belief about the other player's type can be updated and help in forming a risk-sharing group. The intuition is shown in Figure 1. When the value of gift is equal to or greater than $g^\star$, only friends can benefit from giving gift. It is noteworthy that the equilibrium in **Proposition 4** is not the only equilibrium, but the least-cost one, which is refined by intuitive criterion.

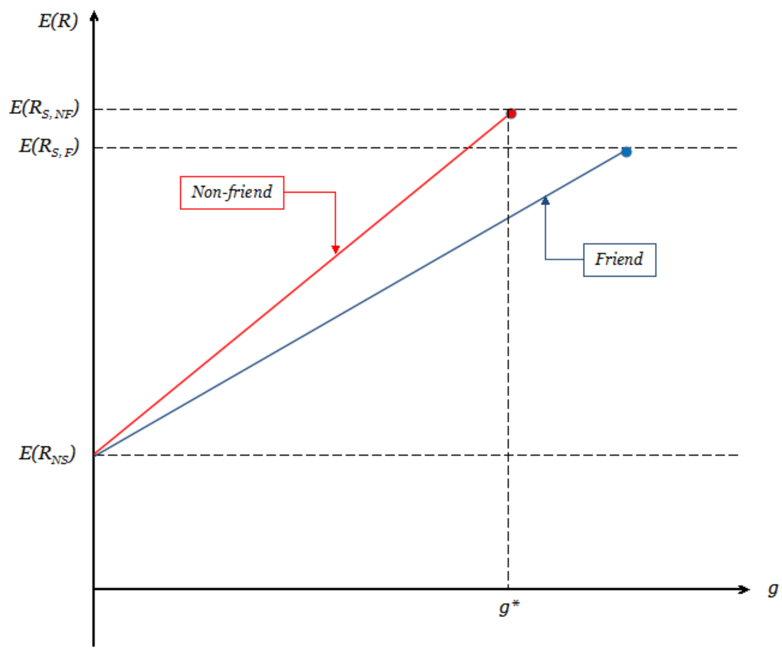


Figure 1: Separating equilibrium in a game of gift

The threshold $g^\star$ is determined by the share of friends. When q is larger, the value of $g^\star$ is higher, since the gift is more likely to be rewarded. However, q has to be smaller than $q^\star$. From IR condition, if q is too large, non-friends have a strong motivation to offer gifts and pretend to be friends. So the gift value, which can distinguish friends from non-friends is too high to afford (bigger than κ). In other words, it may be even better for friends to simply bear the risk of defaulting, which is relatively small.

α also affects the threshold: a non-friend has a greater incentive to spend on gifts when α is larger, since they have to place considerable weight on risk sharing. Gift competition will drive the threshold up.

The effect of κ is ambiguous, on the one hand, as κ increases, non-friends moves away from the subsistence level of consumption, so have lower incentive to pretend to be friends. On the other hands, they become more capable to pretend to be friends, the total effect on $g^\star$ depends on which effect dominates. Due to the form of utility function (kinked form), the extra κ is always preferred to be consumed directly, rather than spent as a gift in a risk-sharing group, so $g^\star$ is decreasing with κ.

As a straightforward implication, in this symmetric case ($w = w_1 = w_2$), if the two players are friends to each other, after gift exchange, there is no actual cost in gifting ex-post. Because the payment of gifts will be compensated by the received gifts, in this model, the cost of gift giving only comes from the uncertainty of giving to a non-friend, who will not give a gift back.

Back to the context of rural China, the model explains why people spend so much money on gifts, in particular, the gifts to a few certain friends. On each ceremony, especially wedding ceremonies and funerals, it is quite easy to compare the gift values and evaluate the closeness of friendship. So ceremonies can be taken as an arena of gift contest where people talk about the values of gifts, and the information is quite open to every one. In fact, the equilibrium of gift expense is easy to reach, as sometimes gift givers will communicate before the ceremony and decide how much to pay.

It is worthy of note that, a gift can be used as a signal only when most people accept and believe it as a signal. In China, gifts play an important role in facilitating risk sharing thanks to the culture of gift exchange. Confucian Culture emphasizes the role of gift exchange in connecting members in society, thus compared to other cultures, it is easier for Chinese to find the possibility of taking gifts as a signal of friendship. When most people realize the benefits of giving gifts, the mechanism becomes more efficient in distinguishing friends from non-friends. Once gift exchange between friends become a social norm, everyone has to join the signaling game, otherwise they have to face all kinds of risks alone.

3.5 Discussion on Efficiency

To evaluate the welfare effect of the mechanism, based on the analysis above, I compare the ex-ante efficiencies of the two cases under asymmetric information in this sub-section. In the case without gift exchange, players have no means to identify friends and non-friends, but in the case with gift, players can signal their types by giving gifts. If the conditions of **Proposition 3** and **Proposition 4** hold, I obtain

Corollary 2. *Compared to the Second Best case without gift exchange, ex-ante efficiencies of both friends and non-friends in the case with gift exchange are improved.*

Proof: see Appendix.

Since gift exchange helps to rule out the possibility of being defaulted, friends will no longer reject sharing risks. Unlike what they choose in the Second Best case without gift exchange, a friend can share risk with another friend in whom she can trust. Therefore, the welfare of the friend definitely gets better off in the Second Best case with gift exchange.

It is surprising that, compared with the Second Best case without gift exchange, non-friends also get better off. Although they still have to maintain autarky in both cases, it is at least possible for them to receive gifts if the other player is a friend, so the efficiency is higher.

Corollary 3. *Compared to the First Best case, the ex-ante efficiency of friends is worse off in the case with gift exchange, but ex-ante efficiency of non-friends is better off.*

Proof: see Appendix.

When comparing the Second Best case with gift exchange with the First Best case, the welfare of the friend is worse off since it is possible for them to give gifts to a non-friend and have no reward. But for non-friends, it is still possible to get better off. Although they cannot share risk with them, it is possible for them to get gifts from friends, and the values of gifts are always considerable.

I conduct further analysis on the ex-post efficiency of the case. If both players are friends, there is no actual cost of gift giving. When a player gives a gift to another, she will get a gift back by the same value. If one player is a friend and the other is a non-friend, there is an actual cost to the friend to signal herself. Therefore, if most friendships are mutual in reality, the actual cost of giving gifts is actually very low.

Even though friendship is not always a mutual relationship, the actual cost can be also very low. In reality, the type of each player can be partially revealed by other approaches, so in many cases, the gift giver knows who is more likely to be her friend. That is why the approach is considered quite cost-effective.

3.6 Costly Signal: Asymmetric Case

Gift expenses, as a signal of friendship, can facilitate risk sharing. In the symmetric case, when incomes of each player are identical, $w_1 = w_2 = w$, the actual cost of the approach can be quite low, the main cost is the probability to offer gifts to non-friends. However, in an asymmetric case, for example, $w_1 > w_2$, the gift values will not be the same any more. Even if between friends, gift expenses are more costly to one player than another.

Suppose Player 1 is richer than Player 2 ($w_1 > w_2$), according to the sharing rule, the income of Player 1 takes a larger share than Player 2 in the income pooling. It indicates that, Player 1 has to lend more to Player 2 than she can borrow. Formally, when Player 1 is in need, she can only borrow

$$\frac{\pi}{2} \cdot (w_2 - w_1 + 2m) \tag{10}$$

However, when Player 2 is in need, she only has to offer

$$\frac{\pi}{2} \cdot (w_1 - w_2 + 2m) \tag{11}$$

Apparently, Player 1 has to lend more but borrow less, so she accordingly has less incentive to signal her type by giving gift. From another perspective, it is not so beneficial to pretend to be a friend of Player 2, so the competition pressure on Player 1 is not heavy. Therefore, Player 1 will not give many gifts.

By contrast, Player 2 can benefit more from the risk sharing. Meanwhile, since everyone wants to be friend with the rich, Player 2 has heavier competition pressure from non-friends, so she has more incentive to give gifts. To summarize,

Proposition 5. *In an unequal risk-sharing group ($w_1 > w_2$), if $q < \frac{1}{2} \cdot \left(1 + \frac{1}{(1-p)\alpha}\right)$, the poor friend has to offer a more valuable gift to the rich friend than she gets back, so $g_1 < g_2$.*

Proof: see Appendix.

Intuitively, for the non-friend with w_1, the benefits of risk sharing and defaulting are lower, but the cost of being defaulted is higher since they have to lend more. Especially when the share of friends, q is small enough, it is more possible to have no gift back. So she has less incentive to pretend to be a friend by giving gift. The pressure on the rich friend is thus less, and she will spend less on gifts.

However, the non-friend with w_2 has a greater incentive to spend in the gift competition, so the poor friend has to spend more to distinguish herself. A straightforward implication is that inequality may force the poor to spend more on gifts than the rich, so the mechanism of gift exchange will mitigate the beneficial effect of risk sharing and worsen inequality in the economy. α is negatively correlated with the threshold, the rich friends may give a more valuable gift than receive, since they place too much weight on risk sharing.

This extension contributes to understanding why in Yan (1996), the author observed that the gift exchange is not always balanced or equal between friends in reality. Poor people give more gifts to the rich or the village cadres than they get back, since the poor have more competitors, who would like to spend more on gifts to pretend to be friends. When the poor host ceremonies, the rich or the cadres may not show up, let alone give gifts. But the poor will not complain, since they have got or will get more help than they can offer.

3.7 Risk Sharing and Favor Exchange

Risk sharing is one case of reciprocal exchange, so following the same mechanism, the model can be applied to analyze other types of reciprocal exchange, such as, favor exchange. In developing areas, the use of cash is limited, and in many other cases, people highly rely on exchanging favors with friends. For example, in busy seasons (planting or harvest seasons), people rely heavily on the help from friends. Mutual help also includes taking care of the sick, irrigating others' fields in drought seasons, overcoming natural disasters and so on. As Coate and Ravallion (1993) illustrated, the limited commitment problem does not only exist in risk sharing, but also in all other kinds of reciprocal exchange. Therefore, by gift exchange, people facilitate not only risk sharing, but also all other reciprocal exchange in general.

A natural question is, if friendship is reflected in providing loans or favors to those in need, why is it necessary to use gifts as a signal? It is because compared with gifts, it might be too costly to signal type of friend by a favor or loans. For example, any delay in seeding or harvesting can cause a substantial loss to peasants, particularly when busy seasons are more or less the same to every household, so it is a big favor to help a friend in busy seasons in expense of their own job. Certainly it is a costly signal to identify a friend from a non-friend, but the cost might be too high to afford. Therefore, compared to some other signals, gift giving is cost effective.

4 Data Source

4.1 Four-Wave Census Survey

The empirical evidence for the model is drawn from the data set of a census conducted in three administrative villages in Guizhou Province, China[13]. It contains four waves of census-type household data collected in 3 administrative villages, 26 natural villages in 2004, 2006, 2009 and 2011. The natural villages are both geographically isolated and ethnically diversified. Local residents know each other well. Most residents' kinship and friendship networks are confined to these natural villages. An administrative village consists of several natural villages. More than 20 ethnic groups are living in the area, including Han, Miao, Buyi, Gelao, and Yi. In total, ethnic minorities comprise about 20 percent of the population.

The four waves of survey cover more than 800 households. All four waves include detailed information on household demographics, income, consumption, and transfers. Transfers include gifts received and extended. Table 1 presents summary statistics for the three administrative villages in 2006, 2009 and 2011 [14], respectively. The rise in income and living expenditure reflects the basic trend of economic growth in rural China. The first administrative village consists of 11 natural villages, but is relatively low in income and expense. The second is smallest, only has 5 natural villages. The third has ten natural villages. Since it is a short walk to the county seat, its economic performance is the best of the three administrative villages.

Records on gift expense in the survey have to be highlighted. Compared to most similar databases, the records on gift spending in this survey are quite detailed and cover every household of the three villages. The variables about gifting behavior are not only total gift expense, times of gift giving, but also average

Table 1 : Summary Statistics of Consumption and Income

Year	2006	2009	2011	2006-2009 (%)	2009-2011 (%)	2006-2011 (%)
Consumption						
Living expense (yuan)	7,728	11,984	18,567	18.35	27.47	28.05
Per capita living expense (yuan)	1,874	2,684	4,250	14.41	29.18	25.36
Food expense(%)	44.96	41.92	39.35	-2.26	-3.06	-2.50
Fuel expense(%)	7.74	7.42	10.25	-1.39	19.07	6.48
Phone expense(%)	1.81	0.87	0.43	-17.28	-25.32	-15.25
Medical expense(%)	10.82	12.45	10.85	5.02	-6.45	0.04
Education expense(%)	7.32	4.88	6.79	-11.10	19.54	-1.45
Gifting expense(%)	11.23	15.03	15.53	11.27	1.68	7.66
Clothing expense(%)	3.78	4.09	4.73	2.76	7.84	5.05
Income						
Income (yuan)	6,657	14,789	31,235	40.71	55.60	73.83
Per capita income (yuan)	1,617	3,264	7,510	33.95	65.02	72.86
Farming income(%)	49.00	46.14	31.76	-1.94	-15.58	-7.03
Remittance income(%)	12.03	8.61	8.76	-9.48	0.86	-5.44
Local non-farm and self-employment(%)	22.13	17.63	18.06	-6.78	1.23	-3.68
Income of land leasing and subsidy(%)	-	1.73	11.44	-	280.93	280.93
Other income(%)	3.94	19.21	25.30	129.39	15.85	108.58
Obs	824	784	882	-	-	-

Table 2 : Summary Statistics of Key Variables

Year	2006		2009		2011		Growth rate		
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	2006-2009 (%)	2009-2011 (%)	2006-2011 (%)
Median of log per capita income (administrative village)	7.00	0.38	7.75	0.28	8.26	0.27	3.56	3.33	3.61
Median of log per capita income (natural village)	6.98	0.42	7.75	0.38	8.29	0.37	3.70	3.49	3.77
Mean of total gift expenses (natural village)	882.49	1,113.28	1,916.88	2,609.78	3,487.50	12,171.69	39.07	40.97	59.04
Mean of times of gift giving (natural village)	2.55	0.93	3.12	2.15	21.92	42.82	7.52	301.30	152.22
Mean of average gift expenses each time (natural village)	291.91	292.18	505.07	555.26	158.13	423.13	24.34	-34.35	-9.17
Total debts that are not repayed	-	-	8,082.81	16,068.88	11,007.11	16,525.09	-	18.09	-
Number of events that cause shortage of cash	-	-	2.08	1.52	1.16	0.85	-	-22.00	-
Number of days offered to help friends in busy season	-	-	3.62	6.60	4.52	9.73	-	12.40	-
Number of days in busy season	65.05	61.33	45.48	44.07	74.41	71.38	-10.03	31.80	2.88
Relative deprivation (natural village)	0.65	0.64	0.65	0.72	0.86	0.94	0.25	15.62	6.44
Gini index (total)	0.48	0.00	0.48	0.00	0.58	0.00	-0.27	10.42	3.97
Gini index (administrative village)	0.45	0.03	0.45	0.05	0.53	0.09	0.01	8.68	3.48
Gini index (natural village)	0.43	0.06	0.42	0.09	0.48	0.12	-0.38	6.87	2.49

gift expenses of each time. Table 2 provides summaries about some key variables in the empirical study.

4.2 Gift-Exchange Records Collection

In addition to this information, the database also offers a sub-sample with records on every single item of gifting behavior in the period 2000 to 2009. From those records, it is easy to identify, in the ten years prior to 2010, how many gifts a household made to another household, and what the gifts were for. Thanks to the emphases on gift exchange in rural China, the households usually keep records of gifts received on major occasions over a long period for several reasons (Yan (1996)). In the survey area in Guizhou, almost all the households kept a gift book, which records the gift exchange on major occasions (i.e. male members' wedding, female members' wedding, funeral, coming-of-age ceremony, child birth ceremony, and house-moving ceremony), the sub-sample consists of 56 households of three natural villages.

5 Empirical Strategy

This section outlines the strategy to the empirical study regarding the theory. The key mechanism of the model is that gift expenses can improve risk sharing by serving as a signal of friendship. So in the following study, I will pay special attention to the empirical patterns of the mechanism. By using the data on both gift giving and gift receiving, I will empirically show the impact of gift expenses on risk sharing, and its signaling function. Moreover, since the association between gift exchange and risk sharing can be also explained by competing hypotheses, by using the same data set, I would like to further test some model predictions which are hardly interpreted by alternative theories.

5.1 Hypothesis I: Gift Giving and Risk Sharing

According to the model, people spend on gifts for better risk sharing. So in this dynamic game model, people who spend more on gifts in the first period, are more likely to get help in the second period, when they face income or consumption shocks. In other words, under income or consumption shock, people certainly have incentive to borrow from friends, in order to share the shock and smooth their consumptions. However, they cannot necessarily obtain any loan, unless they are sufficiently trustworthy. In the model, trustworthiness is signaled by (previous) gift expenses, so if the theory holds, people who give more gifts deserve a higher chance of risk sharing. The hypothesis is summarized as follows.

- ***Hypothesis I***: *Average gift expenses in last period can increase the probability of risk sharing in current period, if one has any consumption shock.*

To empirically test the hypothesis, a few issues have to be addressed. First, who has consumption shock and needs loans? The data set, fortunately, allows me to identify the people who have consumption

[13]The four-round surveys were conducted by International Food Policy Research Institute, the Chinese Academy of Agricultural Science, and Guizhou University in 2004, 2006, 2009 and 2011.

[14]Due to the missing variable problem, I mainly use data from these three rounds.

shocks. In rural China, the following events can cause shortage of cash: holding ceremonies, especially wedding ceremony and funeral; natural disaster; death of livestock; being stolen; tuition and fees for college education and fire hazard. So I calculate the number of consumption shock for each household, and in what follows, I will focus on the borrowing behavior of those who suffer from these shocks.

Second, what is an appropriate measure of gift giving if I attempt to capture the impact of gift expenses? In this study, I measure gift giving of each household by averaging gift expenses of each time, rather than the total gift expenditure. Since only high-value gift expenses can play the role of signal, without controlling the times of gift giving, larger total gift expenses do not necessarily indicate more friends or higher chance of risk sharing.

In fact, I am not the first to argue the association between gift expenses and risk sharing. Fafchamps (1999) and Fafchamps and Lund (2003) have shed light on this association, but consider gift expenses as quasi-credit, which can share risk directly. Unlike their argument, gifts play as a signal in this paper, which can improve risk sharing in future rather than in current stage. Therefore, I use the lagged term of average gift expenses rather than current term as an explanatory variable, so as to highlight the dynamic association between gift expenses and risk sharing.

Third, how to measure the opportunity or capacity of risk sharing? In this study, it is measured as a dummy variable indicating if a household borrows any new loan in the survey year. As defined in Fafchamps and Lund (2003), one has shared her risk if some new loans are made, even if they are not completely[15]. Hence in a binary choice model, the dummy variable helps to estimate the probability of getting risk shared with friends. According to the model I propose, one's (previous) gift expenses can increase the probability of obtaining loans if she has any consumption shock.

I will test the hypothesis by regressing the specification as follows.

$$Debt_{i,t} = \alpha_0 + \alpha_1 AG_{i,t-1} + \delta' \mathbf{X_{i,t}} + \varepsilon_{i,t} \qquad if\ Cashevent_{i,t} > 0 \tag{12}$$

$Debt_{i,t}$ is a dummy variable that indicates if there is any new loan that household i borrowed from friends and relatives in period t. $AG_{i,t-1}$ is average gift expenses of household i for each time, $Cashevent_{i,t}$ is the number of events that can cause shortage of cash for household i in period t. $\mathbf{X_{i,t}}$ is a vector of control variables, including income rank in natural village, household size, per capita household income, share of family member having jobs outside the county, share of family member having odd jobs in the county seat and some demographic characteristics of household head. If the theory holds, gift expenses can signal friendship and improves risk sharing, so that people who gave more gifts in period $t-1$, are more likely to borrow new debt if they are in need in period t. So when I estimate the specification above only for the sub-sample who have consumption shocks in period t ($Cashevent_{i,t} > 0$), α_1 is predicted to be positive and significant.

As a natural concern, there might be endogeneity problem. If people can predict to have consumption

[15]Particularly most loan requires no interest or physical collateral, if the loan can be made, it is very likely based on reciprocal principle, in other words, for the purpose of risk sharing.

shock, they may give more gifts in previous period, then the regression will suffer from mutual causality problem. I will solve the problem by narrowing the definition of consumption shock. As a robustness check, I only focus on those who have funeral; natural disaster; death of livestock; being stolen; and fire hazard and regress the model above again. Apparently all the events are hard to predict and assigned randomly.

5.2 Hypothesis II: Gift Receiving and Risk Sharing

The first hypothesis provides us a chance to test the basic linkage between gift expenses and risk sharing. However, this association can also be interpreted by some competing theories, for example, *Hypothesis of Altruism*. Suppose friends are always mutual, it will be not surprising that people who give more gifts can gain more help. So in what follows, I attempt to provide empirical evidence regarding the signaling function of gift expenses.

In theory, on a separating equilibrium, only friends will signal their type by gifting ("signaling" gift), and non-friends will not. However in rural China, for simply showing politeness or keeping basic harmony in community, people have to exchange some low-value gifts even if the relationship is not so close (Yan (1996)). These "politeness" gifts pushes up the value of "signaling" gift in reality to a even higher level. If an individual wants to distinguish herself from the non-friends, she has to spend much more than the level of "politeness" gift. So in reality, only high-value gifts can improve risk sharing by serving as a signal, while low-value gifts cannot do so and may even squeeze the spending on high-value gifts. If the model holds, given the number of gift giving, those who spend more on high-value gifts can obtain more help if in need. By contrast, the spending on low-value gifts cannot improve risk sharing. This heterogeneous impacts of gift expenses helps us to identify the signaling function.

In the data set, however, we only have detailed records of gifts received rather than gift giving. So in this empirical study, I will test the heterogeneous effects from the perspective of gift receiving. The empirical strategy can simply apply to the case of gift receiver. Given the number of received gift, a larger share of the high-value gifts means more friends, then an individual may wish to provide more help since she knows the help will be rewarded sooner or later. However, a larger share of the low-value gifts may have little or even negative effect on risk sharing, since it may indicate that the household has been isolated from the risk sharing group in community.

As we have shown above, the data set only has the detailed records (every item of received gift from each household in each ceremony) of 55 households for 10 years, so I design the empirical strategy according to the data limitation. First, a household cannot hold ceremony every year, so there might be only a few or even no gift received in some years. Hence, I expand the window of observation to 10 years, in order to completely capture the gifts one can receive from all her friends and accurately calculate the share of high-value gifts. Second, loans are rarely made in rural China. In fact, there is little loan made among the 55 households, so new loan cannot be an appropriate measure of risk sharing. Alternatively, I measure risk sharing with the number of days to help friends in busy seasons. In busy seasons, such as harvesting seasons or seeding seasons, people have to finish their jobs in a very limited time, otherwise it may cause a big loss. So help in busy seasons is an important mean of sharing (potential) risks. However, since the busy season is almost the same to each household, it is hard for people to help a random stranger in expense of their own benefits, and people cannot afford any "limited commitment" problem. Therefore, people will only help friends who are trustworthy, and according to the theory, the number of days will depend on the share of high-value gifts. Fortunately, the variable is available in the data set, among the 55 households, most spend some days to help friends (5.3 days on average) each year.

Following the empirical strategy, I will test the hypothesis as follows to explore the heterogeneous effect of gift receiving on sharing friends' risk.

- ***Hypothesis II****: Given number of received gifts, the share of the high-value gifts has positive effect on help one would like to offer, whereas the share of the low-value gifts has negative effect.*

The prediction can be tested by using following specifications,

$$Days_{i,t} = \alpha_0 + \sum_{n=1}^{N} \alpha_n SG_{n,i} + \theta Time_i + \delta' \mathbf{X_{i,t}} + \beta_i + \eta_t + \varepsilon_{i,t} \tag{13}$$

where $Days_{i,t}$ is the number of days that household i offers to help friends in busy seasons in period t. Since there is no natural criterion to distinguish "signaling" gifts from "politeness" gifts, I equally divide all the gifts received in a natural village to N groups by value (Group 1 is lowest, and N is highest), $SG_{n,i}$ are the share of gifts which belongs to group n over all the gifts received by household i from 2000 to 2009. For example, gifts received in a natural village are equally divided to 5 groups. At least top 20% gifts are quite likely to be high-value gifts which can serve as signal, whereas bottom 20% gifts are more likely to be low-value which has no impact on risk sharing. This empirical exercise will focus on the (heterogeneous) effects of gift received over value groups.

$Time_i$ is the number of received gifts from 2000 to 2009. $\mathbf{X_{i,t}}$ is a vector of control variables, including household size, normalized income rank, log per capita income, days of busy season, share of family member having jobs outside the county, share of family member having odd jobs in the county. If ***Hypothesis II*** holds, at least the coefficient to $SG_{N,i}$ is positive and significant, and the coefficient to $SG_{1,i}$ is either insignificant or negative. To control heterogeneity across households and over time, I include household and year fixed effects into the specification. As robustness check, I will re-estimate by using different grouping methods.

5.3 Hypothesis III: Gift Expenses and Income Status

5.3.1 Prediction and specification

By testing ***Hypothesis I*** and ***II***, I attempt to provide empirical evidence to the signaling function of gift expenses and its impact on risk sharing. To rule out other competing interpretation, I would like to provide a further evidence by testing ***Hypothesis III***.

Most models regarding gift behavior predict that rich people will give more gifts to the poor than they receive (Andreoni (1989), Brown, Bulte, and Zhang (2011) and Ellingsen and Johannesson (2011)), but the model in this paper predicts that in a pair of friends, the poor one has to offer more gifts to the rich to signal herself as a friend, since her competitors, the poor non-friends have more incentive to pretend to be friends. Conversely, it is less beneficial to pretend to be friends with the poor, so the rich one faces less competition and does not have to spend so much on gifting. The empirical pattern will be hardly interpreted by alternative theories, so that provide evidence to the model. The prediction can be summarized as follows.

- ***Hypothesis III:*** *In an unequal risk-sharing group, a low-income member will offer more gifts to a high-income member than the high-income member gives back.*

Since the data set is accessible to detailed records of gift giving and receiving among 55 households from 2000 to 2009, I make a matrix of gift giving and receiving among each other (55×55) for each year, so that I can find the determinants of gift exchange between each pair of households, and explore the role of income gap. In this study, I use the difference of income rank rather than absolute income to measure the income gap, because in reality, the absolute income may not be perfectly observable, while income rank or status of income is easier to observe, particularly when the gap is large.

Following Chen, Kanbur, and Zhang (2011) and Fafchamps and Gubert (2007), I employ the following specification of a dyadic regression.

$$G_{i,j,t} = \gamma_0 + \gamma_1 \left(z_{i,t} - z_{j,t}\right) + \gamma_2 \left(z_{i,t} + z_{j,t}\right) + \delta' \mathbf{X_{i,t}} + \theta' \mathbf{X_{j,t}} + \beta_j + \varepsilon_{i,j,t} \tag{14}$$

where G_{ij} is the accumulated gift flow from i to j. z_i and z_j respectively denote the income status (rank) of the gift giver i and gift receiver j, which is measured by normalized income ranking. γ_1 captures the impact of the gap of income status between giver i and gift receiver j, then γ_2 captures the impact of the level effect of income status. $\mathbf{X_i}$ and $\mathbf{X_j}$ are other control variables of household i and j, including difference effects of per capita income, share of family member having jobs outside the county, share of family member having odd jobs in the county, household size, education, marriage status and age of household head between household i and j and the corresponding level effects.

If the prediction holds, γ_1 should be negative and significant, which indicates that the gifts from the rich to the poor on average will be smaller than that from the poor to the rich.

Since most control variables are only available on 2004, 2006 and 2009, I take data of these three years to test ***Hypothesis III***. Since a higher gift received may be simply because the family hold more on social events, I control for the number of social events held by the gift receiver in 2004, 2006 and 2009. In addition, more gifts may also be due to the heterogeneity of social events, for example, a family holds more wedding ceremonies than others, therefore receives more gifts. Thus I control for the number of wedding ceremony held by a family in the three years.

To control heterogeneity among gift receivers, a fixed effect term is included in specification. Since the auto-correlation must exist in dyadic regression ($\varepsilon_{i,j,t}$ and $\varepsilon_{j,i,t}$), standard errors are clustered in each pair of gift giver and receiver. As a robustness check, I employ the method in Fafchamps and Gubert (2007) to re-estimate the dyadic regression.

6 Estimation Results

6.1 Hypothesis I: Gift Giving and Risk Sharing

Before reporting the estimation results, I first provide a basic pattern regarding the linkage between gift expense and risk sharing by Figure 2. On natural village level, higher average gift expenses of each time are positively correlated with average loans for each consumption shock. The pattern shows a rough relationship between gift expenses and loans, which provides basic support the ***Hypothesis I***.

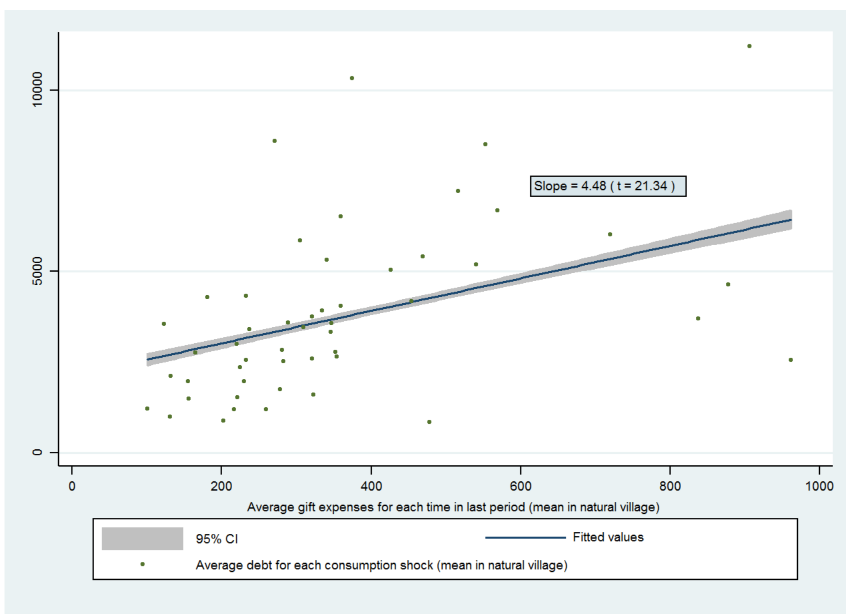


Figure 2: Correlation between gift expenses and loan per consumption shock

Table 3 reports the estimation results to the test on the first hypothesis. In column 1, I run a Probit model with the sample who have consumption shocks without any control variables. The definition of consumption shock includes all kinds of events that lead to shortage of cash. The coefficient to AG_i is 0.204 and significant at 1 percent level. The result indicates that people who give more gifts in period $t-1$ are more likely to gain some new loans to smooth their consumption, apparently it provides empirical support to ***Hypothesis I***.

More control variables are added in Column 2. The coefficient to $AG_{i,t-1}$ is 0.147 and significant at 1 percent level, which provides further empirical support to ***Hypothesis I***. Given the estimated coefficient, when average gift expenses for each time increases by 100 RMB, the chance of obtaining loans will increase by 1 percent.

To solve the endogeneity problem, in column 3, I run a Probit model again with a smaller sample. The definition of $Cashevent_{i,t}$ covers only funeral; natural disaster; death of livestock; being stolen; and fire hazard, which are exogenous. The estimated coefficient to $AG_{i,t-1}$ is 0.168 and significant ($p < 0.05$), which indicates that the people under (exogenous) consumption shock have more incentive to borrow new loan. In line with the model prediction, the coefficient to $AG_{i,t-1}$ is also positive and significant ($p < 0.05$) in Column (4) when more control variables are added.

6.2 Hypothesis II: Gift Receiving and Risk Sharing

Table 4 provides estimation results to the test on ***Hypothesis II***. An individual fixed effect model (Equation (13)) is estimated in Column 1. The coefficient to the share of top 20% gifts is 34.532 and significant at 10 percent level, indicating that high-value gifts received can significantly increase the number of days that one would like to offer to help friends. By contrast, the received gifts in other value groups have little impact on risk sharing, the coefficient to any other $SG_{n,i}$ is significant. Given the estimated coefficient, as the share of top 20% gifts increases by 0.01, the household would like to provide 0.345 days to help friends, given others equal. Consider on average people provide around 5 days to help friends, the impact is quite significant.

The estimation results are robust when a year fixed effect is added in Column (3). Only high-value gifts can increase the number of days one is willing to help friends in busy seasons. Since the dependent variable is lower bounded by zero, a Tobit model is estimated in Column (2) and (4). After correcting the downwards-bias, the coefficient to the share of top 20% gifts increases to 282.356 and is significant at 1 percent level in Column (2). Although the coefficients to the other $SG_{n,i}$ become significant, they are much smaller in size and even negative. The estimation results suggest that the high-value gifts (top 20%) provide more incentive of sharing risk than any other kind of gifts, and the estimation results are robust to the year fixed effect.

As robustness check, I re-estimate the hypothesis by using different grouping methods. In Table 5, I report the estimation results when gifts received are equally divided to four groups. The estimation provides

Table 3: The Effect of Gift Giving on Chance of Risk Sharing

VARIABLES	(1)	(2)	(3)	(4)
Lag term average gift expenses of each household each time	0.198***	0.147***	0.168**	0.101**
	(0.057)	(0.013)	(0.069)	(0.043)
Number of events leading to shortage of cash		0.345***		0.309**
		(0.114)		(0.143)
Household size		-0.029		-0.015
		(0.057)		(0.057)
Per capita income of each household		-0.000		-0.000
		(0.000)		(0.000)
Controls	NO	YES	NO	YES
Village fixed effect	YES	YES	YES	YES
AIC	627.168	522.026	610.719	513.885
Log likelihood	-312.584	-259.013	-304.359	-254.942
Observations	598	519	582	505

Note: 1. Dependent variables are *There is any new debt in* 2011.
2. A Probit model is employed.
3. Control variables are *Normalized per capita income rank*, *Head is a party member*, *Share of family member having job outside county*, *Share of family member having odd job in county*, *Male head of household* (*dummy*), *Head is village cadre*, *Marriage status of household head*, *Share of family member having chronic disease*.
4. The consumption shocks in (1) and (2) consist of ceremonies, natural disasters, accidents and spending for children's high education.
5. The consumption shocks in (3) and (4) consist of funerals, natural disasters and accidents.
6. Standard errors are clustered in administrative village.
7. *** p<0.01, ** p<0.05, * p<0.1

Table 4: The Effect of Gift Receiving on Help Offered (I)

VARIABLES	(1)	(2)	(3)	(4)
Share of highest 20% gifts received in total gifts received	34.532*	282.356***	33.693*	274.668***
	(13.034)	(0.202)	(15.239)	(0.412)
Share of middle high 20% gifts received in total gifts received	3.837	55.591***	4.024	54.365***
	(10.863)	(0.089)	(11.687)	(0.152)
Share of middle 20% gifts received in total gifts received	-17.760	-155.497***	-21.663*	-165.674***
	(9.836)	(0.151)	(9.735)	(0.268)
Share of middle low 20% gifts received in total gifts received	7.156	79.382***	3.574	67.554***
	(16.051)	(0.131)	(22.457)	(0.221)
Number of received gift	0.037	0.290***	0.031	0.263***
	(0.076)	(0.001)	(0.092)	(0.001)
Normalized per capita income rank (natural village)	0.516	2.526***	-0.134	0.907***
	(0.871)	(0.034)	(1.887)	(0.010)
Constant	-1.804	-57.572***	-.818	-52.348***
	(13.165)	(0.041)	(16.341)	(0.081)
Controls	YES	YES	YES	YES
Household fixed effect	YES	YES	YES	YES
Year fixed effect	NO	NO	YES	YES
AIC	607.123	428.618	606.093	425.969
Log likelihood	-	-210.309	-	-208.984
Adjusted R-square	0.237	-	0.227	-
Observations	103	103	103	103

Note: 1. Dependent variable is *Number of days to help friends and relatives in busy season*.

2. The gifts received in the natural village are divided to five groups equally. The household may have more friend if they receive a larger share of high-value gifts.
3. OLS estimations are reported in Column (1) and (3), and Tobit model estimations are reported in Column (2) and (4), since the dependent variable is lower bounded by zero.
4. Control variables are *Per capita income*, *Days of busy season*, *Share of family member having job outside county*, *Share of family member having odd job in county*.
5. Standard errors are clustered in natural village.
6. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

further empirical support to ***Hypothesis II***. Both linear and Tobit model suggest that high-value gifts can significantly improve risk sharing, whereas low-value gifts has either much smaller effects or negative effects.

6.3 Hypothesis III: Gift Expenses and Income Status

To provide further evidence to the model, Table 6 shows the dyadic regression (Equation (13)) results for ***Hypothesis III***. Column 1 presents a basic regression without control variables, and the estimation results are in line with the model prediction. The estimated γ_1 is -1.211 and significant at 1 percent level, which indicates that a rich gift giver will spend less on gifts to a relatively poor gift receiver. In other words, a poor gift giver has to offer more to the rich receiver. When more control variables are added, the results in Column 2 are not substantially changed (1.831 and $p < 0.01$). Since the higher gift income of the rich is perhaps because they held more wedding ceremonies, I control for times of wedding ceremonies in Column 3, where the estimation results are still consistent with the prediction. In Columns 4, the number of other ceremonies and social events are controlled. The estimated coefficients become smaller to -0.896, but still significant at 10 percent level. All the results show support to ***Hypothesis III***.

As a robustness check, I employ the method in Fafchamps and Gubert (2007) to re-estimate. The estimation results are robust, and provide further support for the findings in Table 6[16].

6.4 Discussion

I also consider several competing interpretations to the association between gift expenses and risk sharing. First, gift giving may just build a patron-client relationship. Poor people give gifts to the rich as "insurance fee" and obtain help when they are in need, meanwhile the gifts from the rich can be simply out of altruism. A similar interpretation takes gifts as a fee to gain access to favor or credit of the rich. The interpretation implies that gift expenses will help people to get access to risk sharing, but the empirical findings in the paper suggest only high-value gifts can affect risk sharing, rather than other kinds. The pattern is hardly explained by this interpretation, but in line with the model I propose. Another alternative interpretation is that both gift exchange and risk sharing are just out of altruism or reciprocity. As a natural implication of the hypothesis, if gift expenses are just because of altruism, rich people are supposed to give more to the poor than they receive. However, the empirical pattern I find in data is just opposite. The third competing interpretation argues that the gift expenses and the amount of loan are correlated because people borrow money just for giving gifts (under pressure of social norm). However, the average amount of debt is much larger than gift expenses, for example in 2011, the

[16] The unequal flow of gifts between the rich and the poor has been documented in Weerdt and Fafchamps (2011), where gifts are taken as quasi-credit in their paper. The interpretation in this paper can explain not only the unequal flow, but also other empirical patterns in gift expense and risk sharing.

Table 5: The Effect of Gift Receiving on Help Offered (II)

VARIABLES	(1)	(2)	(3)	(4)
Share of highest 25% gifts received in total gifts received	175.137**	1,057.791***	147.881**	962.175***
	(52.003)	(0.085)	(47.586)	(0.166)
Share of middle high 25% gifts received in total gifts received	239.765**	1,404.408***	199.404**	1,265.285***
	(79.702)	(0.171)	(64.868)	(0.285)
Share of middle low 25% gifts received in total gifts received	92.495**	573.010***	74.376	511.918***
	(32.505)	(0.097)	(39.751)	(0.169)
Number of received gift	1.173**	6.895***	0.988**	6.248***
	(0.358)	(0.001)	(0.313)	(0.001)
Normalized per capita income rank (natural village)	0.516	2.526***	-0.134	0.907***
	(0.871)	(0.033)	(1.887)	(0.011)
Constant	-210.382**	-1275.504***	-175.974**	-1155.298***
	(65.113)	(0.044)	(60.218)	(0.087)
Controls	YES	YES	YES	YES
Village fixed effect	YES	YES	YES	YES
Year fixed effect	NO	NO	YES	YES
AIC	607.123	428.618	606.093	425.969
Log likelihood	-	-210.309	-	-208.984
Adjusted R-square	0.237	-	0.227	-
Observations	103	103	103	103

Note: 1. Dependent variable is *Number of days to help friends and relatives in busy season.*

2. The gifts received in the natural village are divided to four groups equally. The household may have more friend if they receive a larger share of high-value gifts.
3. OLS estimations are reported in Column (1) and (3), and Tobit model estimations are reported in Column (2) and (4), since the dependent variable is lower bounded by zero.
4. Control variables are *Per capita income*, *Days of busy season*, *Share of family member having job outside county*, *Share of family member having odd job in county.*
5. Standard errors are clustered in natural village.
6. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Gift Exchange and Status of Income (Panel Data)

VARIABLES	(1)	(2)	(3)	(4)
Difference of income rank in natural village	-1.211***	-1.831***	-1.514***	-0.896*
	(0.299)	(0.568)	(0.539)	(0.542)
Sum of income rank in natural village	1.096**	1.897***	1.410**	0.775
	(0.445)	(0.598)	(0.604)	(0.550)
Difference in times of wedding ceremonies			7.334***	6.872***
			(1.582)	(1.534)
Sum of times of wedding ceremonies			8.774***	8.983***
			(1.750)	(1.706)
Difference in times of social events				5.422***
				(1.034)
Sum of times of social events				5.597***
				(0.870)
Controls	NO	YES	YES	YES
Fixed effect	YES	YES	YES	YES
AIC	66,186.160	46,783.620	46,729.090	46,647.370
Adjusted R-square	0.004	0.018	0.029	0.045
Observations	7,098	5,012	5,012	5,012

Note: 1. Dependent variable is *Accumulative gifts from giver to receiver in each year*.

2. Control variables are *Difference of household size between gift giver and receiver*,
Difference of marriage status of household head,
Difference of education of household head,
Difference of share of family member having job outside county,
Difference of share of family member having odd job in county,
Sum of household size between gift giver and receiver
Difference of marriage status of household head,
Sum of education of household head,
Sum of share of family member having job outside county,
Sum of share of family member having odd job in county,

3. Standard errors are clustered within a pair of people who exchange gifts.

4. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Gift Exchange and Status of Income (Dyadic Regression)

VARIABLES	(1)	(2)	(3)	(4)
Difference of income rank in natural village	-4.514**	-5.981**	-5.560*	-6.694**
	(1.808)	(2.684)	(2.891)	(3.323)
Sum of income rank in natural village	1.178	-2.436*	-2.058*	-3.415***
	(1.471)	(1.274)	(1.218)	(1.188)
Difference in times of wedding ceremonies			3.547	2.803
			(2.627)	(3.246)
Sum of times of wedding ceremonies			-3.056	-2.166
			(5.960)	(5.309)
Difference in times of social events			3.591	2.155
			(3.181)	(3.967)
Sum of times of social events			-3.399	-1.682
			(5.274)	(4.409)
Difference in social expenses				0.001*
				(0.001)
Sum of social expenses				0.001*
				(0.001)
Observations	1,260	1,260	1,260	1,260

Note: 1. Dyadic Regression is run by the method of Fafchamps and Gubert (2007).

2. Dependent variable is *Accumulative gifts from giver to receiver in* 2004, 2006 *and* 2009.

3. Control variables are *Difference of household size between gift giver and receiver*, *Difference of education of household head*, *Difference of income per capita*, *Difference of share of family member having job outside county*, *Difference of share of family member having odd job in county*, *Sum of household size between gift giver and receiver* *Sum of education of household head*, *Sum of income per capita*, *Sum of share of family member having job outside county*, *Sum of share of family member having odd job in county*, *Median of per capita income of sender's natural village*, *Median of per capita income of receiver's natural village.*

4. Dyadic robust Standard errors are in parenthesis.

5. *** p<0.01, ** p<0.05, * p<0.1

amount of debt on average is more than 11000 RMB, but the average gift expenses are only more than 3000 RMB. Apparently gift spending is not a main use of the loan. There might be some more alternative interpretations, and I never deny the possibility that gift expenses facilitate risk sharing through other channels, but the empirical evidence suggests the signaling function plays an important role.

7 Conclusion

To conclude, this paper makes two contributions. First, it shows how “signaling altruism” can overcome limited commitment problem and facilitate risk sharing between friends. Thanks to the emotional cost of defaulting, people can form self-enforcing risk-sharing groups only between friends, even though effective contract enforcement is lacking. However, this reliable risk sharing is not easily formed in reality, since friendship is not perfectly observable. In this case, gifts can help to distinguish friends from non-friends, since it is less costly to the friends than the non-friends. When gift is sufficiently expensive, non-friends would have little incentive to pretend to be friends. The model offers an interpretation to the high gift expense in China. In the absence of efficient contract enforcement in rural China, gift expenses play an important role in facilitating risk sharing and mutual help. But the efficiency improvement may be offset by increased inequality.

Second, beyond the theoretical analysis, the paper provides empirical evidence for the association between gift expenses and risk sharing. Three hypotheses are tested by using a unique data set from rural China. The estimation results are in line with the predictions of the model, but different from the patterns predicted by alternative interpretations.

These results have potentially relevant implications from a policy perspective. On the one hand, we may re-evaluate the role of gifts in China. As a simple, cost-effective and practical approach, gift exchange helps to facilitate risk sharing and favor exchange in the absence of efficient contract enforcement. The mechanism may also help to share risk and improve welfare in other developing countries with similar cultural backgrounds, such as East or Southeast Asian countries. However, on the other hand, inequality always arises during economic growth. When the poor bear too much burden of gift giving due to inequality, such informal insurance is necessarily replaced by formal insurance to alleviate efficiency losses.

8 Appendix

A Proofs

A.1 Proof of Lemma 1

Lemma 1 is about the condition under which a friend will not default. The return of a friend to default is

$$U_{F,\,D}\left(c_1,\,c_2\right) = 2w + m + \delta\left(2w + 2\kappa + (1+\alpha)\left(m - \theta\left(m - \kappa\right)\right)\right) \tag{15}$$

and when she does not default, the return will be

$$U_{F,\,ND}\left(c_1,\,c_2\right) = 2w + \kappa + \delta\left(2w + 2m + \kappa\right) \tag{16}$$

When $\theta > \frac{(1-\delta)(m-\kappa)+\alpha\delta m}{(1+\alpha)\delta(m-\kappa)}$, $U_{1,\,D}\left(c_1,\,c_2\right) > U_{1,\,ND}\left(c_1,\,c_2\right)$, so a friend will definitely not default[17].

I would like to prove the condition under which a non-friend will default. The return of a non-friend to default is $U_{NF,\,D}\left(c_1,\,c_2\right) = 2w{+}m$, whereas if she does not default, the return is $U_{NF,\,ND}\left(c_1,\,c_2\right) = 2w{+}\kappa$. Since $m > \kappa$, apparently in any case, a non-friend will default.

A.2 Proof of Proposition 1

Proposition 1 is about the best strategy of a friend given the type of the other player. If information is complete, she will share risk with a friend rather than a non-friend. Given **Lemma 1**, when $\theta > \frac{(1-\delta)(m-\kappa)+\alpha\delta m}{(1+\alpha)\delta(m-\kappa)}$, if the type of the other player is a friend, there will be no concern of being defaulted, so she would like to sign contract with a friend and share risk. However, a non-friend will default, so it is quite risky to share risk with a non-friend, even though risk sharing is still beneficial. The expected return of a friend to sign contract with a non-friend is

$$\begin{aligned} E_S\left(U_F\left(c_1,\,c_2\right)\right) = {} & p^2\left(2w + 2m + \kappa\right)(1+\delta) \\ & + (1-p)^2\left(2w + \kappa - \alpha\left(m - \kappa\right)\right)(1+\delta) \\ & + p\,(1-p)\left[2w + 2\kappa + (1+\alpha)\left(m - \theta\left(m - \kappa\right)\right) + \delta\left(2w + m\right)\right] \\ & + p\,(1-p)\left(2w + \kappa + \delta\left(2w + 2m + \kappa\right)\right) \end{aligned} \tag{17}$$

[17] The loss-aversion utility function effectively simplifies the problem. An altruistic player has no motivation to lend money, unless the other player's consumption is lower than subsistence level. An implicit assumption is made here that, α is sufficiently small that a friend's optimal share of income in pooling is smaller than π.

The expected return to not sign is

$$
\begin{aligned}
E_{NS}\left(U_F\left(c_1,\, c_2\right)\right) = & \, p^2\left(2w+2m+\kappa\right)\left(1+\delta\right) \\
& +\left(1-p\right)^2\left(2w+\kappa-\alpha\left(m-\kappa\right)\right)\left(1+\delta\right) \\
& +p\left(1-p\right)\left[2w+m+\kappa+\delta\left(2w+\kappa-\alpha\left(m-\kappa\right)\right)\right] \\
& +p\left(1-p\right)\left(2w+\kappa-\alpha\left(m-\kappa\right)+\delta\left(2w+2m+\kappa\right)\right)
\end{aligned}
\tag{18}
$$

When $\theta > \frac{[\alpha-1+(1+\alpha)\delta](m-\kappa)+\alpha m}{(1+\alpha)(m-\kappa)}$, $E_{NS}\left(U_F\left(c_1,\, c_2\right)\right) > E_S\left(U_F\left(c_1,\, c_2\right)\right)$, that is, the loss of being defaulted is larger than the benefits of risk sharing, so a friend will not sign the contract with a non-friend. To sum up, when $\theta > \max\left\{\frac{(1-\delta)(m-\kappa)+\alpha\delta m}{(1+\alpha)\delta(m-\kappa)},\ \frac{[\alpha-1+(1+\alpha)\delta](m-\kappa)+\alpha m}{(1+\alpha)(m-\kappa)}\right\}$, the best strategy of a friend is to share risk with a friend, and reject a non-friend, under complete information.

A.3 Proof of Proposition 2

Proposition 2 is about the best strategy of a non-friend under complete information. Simply taking Player 1 as an example and given the type of the other player, from **Lemma 1**, she would like to share risk to a friend, since there is only benefits of risk sharing and defaulting, and no concern of being defaulted. Note that, to make sure that non-friends will reject risk sharing due to the risk of being defaulted, I impose an extra cost. Specifically, when player 1 is being defaulted, her loss is not only economic, i.e. t_{12}, but also emotional. For simplicity, we assume the emotional cost is equal to θt_{12}. Therefore, if the other player is a non-friend, the expected return of a non-friend to sign contract is

$$
\begin{aligned}
E_S\left(U_{NF}\left(c_1\right)\right) = & \, p^2\left(2w+2m+\kappa\right) \\
& +\left(1-p\right)^2\left(2w+\kappa-\alpha\left(m-\kappa\right)\right) \\
& +p\left(1-p\right)\left(2w+m\right) \\
& +p\left(1-p\right)\left(2w+2\kappa+\left(1+\alpha\right)\left(m-\theta\left(m-\kappa\right)\right)\right)
\end{aligned}
\tag{19}
$$

The expected return to not sign is

$$
\begin{aligned}
E_{NS}\left(U_{NF}\left(c_1\right)\right) = & \, p^2\left(2w+2m+\kappa\right) \\
& +\left(1-p\right)^2\left(2w+\kappa-\alpha\left(m-\kappa\right)\right) \\
& +p\left(1-p\right)\left(2w+\kappa-\alpha\left(m-\kappa\right)\right) \\
& +p\left(1-p\right)\left(2w+2m+\kappa\right)
\end{aligned}
\tag{20}
$$

When $\theta > \frac{\alpha(2m-\kappa)}{(1+\alpha)(m-\kappa)}$, $E_{NS}\left(U_{NF}\left(c_1\right)\right) > E_S\left(U_{NF}\left(c_1\right)\right)$, that is, the loss of being defaulted is larger than the benefits of risk sharing, so a non-friend will not sign the contract with a non-friend. So the best strategy of a non-friend is to sign contract with a friend, but reject a non-friend.

A.4 Proof of Proposition 3

Proposition 3 is about the best strategy of a friend and a non-friend under incomplete information (Second Best). As a friend, given the share of friends, q, the expected return to sign the contract is

$$\begin{aligned} E_S\left(U_F\left(c_1,\, c_2\right)\right) = & \, p^2\left(2w+2m+\kappa\right)\left(1+\delta\right) \\ & +\left(1-p\right)^2\left(2w+\kappa-\alpha\left(m-\kappa\right)\right)\left(1+\delta\right) \\ & +p\left(1-p\right)q\left(2w+2m+\kappa+\delta\left(2w+\kappa\right)\right) \\ & +p\left(1-p\right)\left(1-q\right)\left(2w+2\kappa+\left(1+\alpha\right)\left(m-\theta\left(m-\kappa\right)\right)+\delta\left(2w+m\right)\right) \\ & +p\left(1-p\right)\left(2w+\kappa+\delta\left(2w+2m+\kappa\right)\right) \end{aligned} \tag{21}$$

The expected return to not sign the contract is

$$\begin{aligned} E_{NS}\left(U_F\left(c_1,\, c_2\right)\right) = & \, p^2\left(2w+2m+\kappa\right)\left(1+\delta\right) \\ & +\left(1-p\right)^2\left(2w+\kappa-\alpha\left(m-\kappa\right)\right)\left(1+\delta\right) \\ & +p\left(1-p\right)\left[2w+m+\kappa+\delta\left(2w+\kappa-\alpha\left(m-\kappa\right)\right)\right] \\ & +p\left(1-p\right)\left(2w+\kappa-\alpha\left(m-\kappa\right)+\delta\left(2w+2m+\kappa\right)\right) \end{aligned} \tag{22}$$

When $q < \frac{[(1+\alpha)(\theta-\delta)-(\alpha-1)](m-\kappa)-\alpha m}{[(1-\delta)+(1+\alpha)\theta](m-\kappa)-\alpha m}$, $E_{NS}\left(U_F\left(c_1,\, c_2\right)\right) > E_S\left(U_F\left(c_1,\, c_2\right)\right)$, so that a friend will reject to share risk under incomplete information.

Similarly, the expected return of a non-friend, simply taking Player 1 as an example, to sign the contract is

$$\begin{aligned} E_S\left(U_{NF}\left(c_1\right)\right) = & \, p^2\left(2w+2m+\kappa\right) \\ & +\left(1-p\right)^2\left(2w+\kappa-\alpha\left(m-\kappa\right)\right) \\ & +p\left(1-p\right)\left(2w+m\right) \\ & +p\left(1-p\right)\left(2w+2m+\kappa+qm\right) \\ & +p\left(1-p\right)\left(1-q\right)\left(\kappa+\alpha m-\left(1+\alpha\right)\theta\left(m-\kappa\right)\right) \end{aligned} \tag{23}$$

The expected return to not sign contract is

$$\begin{aligned} E_{NS}\left(U_{NF}\left(c_1\right)\right) = & \, p^2\left(2w+2m+\kappa\right) \\ & +\left(1-p\right)^2\left(2w+\kappa-\alpha\left(m-\kappa\right)\right) \\ & +p\left(1-p\right)\left(2w+\kappa-\alpha\left(m-\kappa\right)\right) \\ & +p\left(1-p\right)\left(2w+2m+\kappa\right) \end{aligned} \tag{24}$$

When $q < \frac{[(1+\alpha)(\theta-1)-1](m-\kappa)-\alpha m}{[(1+\alpha)\theta-1](m-\kappa)-\alpha m}$, $E_{NS}\left(U_{NF}\left(c_1\right)\right) > E_S\left(U_{NF}\left(c_1\right)\right)$, so that a friend will reject to share risk under incomplete information. Therefore, when

$$q < \min\left\{\frac{\left[\left(1+\alpha\right)\left(\theta-\delta\right)-\left(\alpha-1\right)\right]\left(m-\kappa\right)-\alpha m}{\left[\left(1-\delta\right)+\left(1+\alpha\right)\theta\right]\left(m-\kappa\right)-\alpha m},\, \frac{\left[\left(1+\alpha\right)\left(\theta-1\right)-1\right]\left(m-\kappa\right)-\alpha m}{\left[\left(1+\alpha\right)\theta-1\right]\left(m-\kappa\right)-\alpha m}\right\} \tag{25}$$

, both friend and non-friend will reject to sign the contract and share risk, since it is so easy to be defaulted.

A.5 Proof of Proposition 4

Proposition 4 is about the Incentive Compatibility (IC) condition and IR (Individual Rationality) condition when taking gifts as a signal. The IC condition is based on the decision of a non-friend. The expected return of a non-friend, simply taking Player 1 as an example, to give gift is

$$\begin{aligned} E_G\left(U_{NF}\left(c_1\right)\right) = & p^2\left(2w+2m+\kappa-\left(1-q\right)g\right) \\ & +\left(1-p\right)^2\left(2w+m-\left(1+\alpha\right)\left(m-\kappa\right)-\left(1-q\right)\left(1+\alpha\right)g\right) \\ & +p\left(1-p\right)\left(2w+2m+\kappa-\left(1-q\right)g\right) \\ & +p\left(1-p\right)\left(2w+m-\left(1-q\right)\left(1+\alpha\right)\left(m-\kappa+g\right)\right) \end{aligned} \tag{26}$$

The expected return to give no gift is

$$\begin{aligned} E_{NG}\left(U_{NF}\left(c_1\right)\right) = & p^2\left(2w+2m+\kappa+qg\right) \\ & +\left(1-p\right)^2\left(2w+m-\left(1+\alpha\right)\left(m-\kappa\right)+q\left(1+\alpha\right)g\right) \\ & +p\left(1-p\right)\left(2w+2m+\kappa+qg\right) \\ & +p\left(1-p\right)\left(2w+m-\left(1+\alpha\right)\left(m-\kappa\right)+q\left(1+\alpha\right)g\right) \end{aligned} \tag{27}$$

When $g \geq \frac{qp(1-p)(1+\alpha)(m-\kappa)}{1+(1-p)\alpha}$, $E_{NG}\left(U_{NF}\left(c_1\right)\right) > E_G\left(U_{NF}\left(c_1\right)\right)$, that is, if the gift is expensive enough, a non-friend would like to give no gift. The least-cost equilibrium

$$g^{\star} = \frac{qp\left(1-p\right)\left(1+\alpha\right)\left(m-\kappa\right)}{1+\left(1-p\right)\alpha} \tag{28}$$

Concerning with the IR condition, which ensures it is beneficial for a friend to give a gift rather than not. The expected return of a friend to give a gift is,

$$\begin{aligned} E_G\left(U_F\left(c_1,\, c_2\right)\right) = & p^2\left(\left(1+\delta\right)\left(2w+2m+\kappa\right)-\left(1-q\right)\left(1-\delta\right)g\right) \\ & +\left(1-p\right)^2\left(2w+\kappa-\alpha\left(m-\kappa\right)-\left(1-q\right)\left(1+\alpha\right)g\right) \\ & +\left(1-p\right)^2\delta\left(2w+\kappa-\alpha\left(m-\kappa\right)+\left(1-q\right)\left(1+\alpha\right)g\right) \\ & +p\left(1-p\right)\left(2w+2m+\kappa+\delta\left(2w+\kappa\right)-\left(1-q\right)\left(1-\delta\right)g-\left(1-q\right)\delta\alpha\left(m-\kappa-g\right)\right) \\ & +p\left(1-p\right)\left(2w+\kappa+\delta\left(2w+2m+\kappa\right)-\left(1-q\right)\left(1-\delta\right)g-\left(1-q\right)\alpha\left(m-\kappa+g\right)\right) \end{aligned} \tag{29}$$

The expected return to not give gift is

$$
\begin{aligned}
E_{NG}\left(U_F\left(c_1,\, c_2\right)\right) = {} & p^2\left(\left(1+\delta\right)\left(2w+2m+\kappa\right)+q\left(1-\delta\right)g\right) \\
& +\left(1-p\right)^2\left(\left(1+\delta\right)\left(2w+\kappa-\alpha\left(m-\kappa\right)\right)+q\left(1+\alpha\right)\left(1-\delta\right)g\right) \\
& +p\left(1-p\right)\left(2w+2m+\kappa+\delta\left(2w+\kappa-\alpha\left(m-\kappa\right)\right)+qg-q\delta\left(1+\alpha\right)g\right) \\
& +p\left(1-p\right)\left(2w+\kappa-\alpha\left(m-\kappa\right)+\delta\left(2w+2m+\kappa\right)+q\left(1+\alpha\right)g-q\delta g\right)
\end{aligned}
\tag{30}
$$

When $g < \frac{p(1-p)q(1+\delta)\alpha(m-\kappa)}{(1-\delta)(1+(1-p)\alpha)} = g^{\star\star}$, $E_{NG}\left(U_F\left(c_1,\, c_2\right)\right) > E_G\left(U_F\left(c_1,\, c_2\right)\right)$, that is, a friend would like to give gift than not give. If $\delta > \frac{1}{2\alpha+1}$, $g^{\star\star} > g^{\star}$, so the separating equilibrium, $g^{\star}$ can exist. The intuition is, when δ, the parameter to altruism is not too small, gift is not so costly to a friend, then it can be taken as a signal of friendship.

A.6 Proof of Corollary 2

For a friend, compare the expected return in the Second Best case with gift (Equation (29)) with the Second Best case without gift (Equation (22)), the ex-ante welfare of a friend is better off in the case with gift exchange, since it is possible for them to share risk.

Similarly, for a non-friend, compare the expected return in the case with gift (Equation (27)) to the case without gift (Equation (24)), apparently the expected return in the case with gift is higher than without gift. Although in any case, a non-friend cannot share risk, at least in the case with gift expense, it is possible for them to get a gift from a friend. Therefore, the ex-ante efficiency is higher for both friends and non-friends in the case with gift expense than without.

A.7 Proof of Corollary 3

Similar to **Corollary 2**, by comparing the expected returns of a friend in the Second Best case with gift expense and the First Best case, it is easy to prove that the efficiency in Second Best case with gift expense is lower than the First Best case. The expected return in Second Best case with gift expense is shown in Equation (29), and the expected return in the First Best, given the share of friends, is shown by

$$
\begin{aligned}
E_{FB}\left(U_F\left(c_1,\, c_2\right)\right) = {} & p^2\left(2w+2m+\kappa\right)\left(1+\delta\right) \\
& +\left(1-p\right)^2\left(2w+\kappa-\alpha\left(m-\kappa\right)\right)\left(1+\delta\right) \\
& +p\left(1-p\right)\left[2w+2m+\kappa+\delta\left(2w+\kappa\right)-\left(1-q\right)\alpha\delta\left(m-\kappa\right)\right] \\
& +p\left(1-p\right)\left(2w+\kappa+\delta\left(2w+2m+\kappa\right)-\left(1-q\right)\delta\left(m-\kappa\right)\right)
\end{aligned}
\tag{31}
$$

For non-friends, in both the Second Best case with gift and the First Best case, they cannot share risk and have to maintain autarky, but in the case with gift, it is possible to get gift if the other player is a friend.

Therefore, the ex-ante efficiency of the Second Best case with gift is higher than the First Best.

A.8 Proof of Proposition 5

Proposition 5 is about the IC condition when $w_1 > w_2$. For simplicity and without lack of generality, assume $w_1 = w_2 + \rho = h + \rho$ ($\rho > 0$), and keep the assumption $\pi = \frac{m-\kappa}{m}$. Denote on equilibrium, the gift expenses of Player 1 and Player 2 are g_1 and g_2, respectively.

The expected return of a non-friend with w_1 to give gift is

$$\begin{aligned} E_G\left(U_{NF}\left(c_1\right)\right) = &\, p^2\left(2w_1 + 2m + \kappa - g_1 + qg_2\right) \\ &+ (1-p)^2\left(2w_1 + \kappa - \alpha\left(m-\kappa\right) + \alpha\rho - g_1 + qg_2 - \alpha\left(1-q\right)g_1 - \tfrac{(1+\alpha)q\rho\pi}{2}\right) \\ &+ p\left(1-p\right)\left(2w_1 + 2m + \kappa - g_1 + qg_2\right) \\ &+ p\left(1-p\right)\left(2w_1 + \kappa + \left(1-q\right)\alpha\rho - g_1 + qg_2 + \tfrac{(2m-\rho)q\pi}{2} - \left(1-q\right)\alpha\left(m-\kappa+g_1\right)\right) \end{aligned} \tag{32}$$

If the non-friend does not give a gift, the expected return[18] will be

$$\begin{aligned} E_{NG}\left(U_{NF}\left(c_1\right)\right) = &\, p^2\left(2w_1 + 2m + \kappa + qg_2\right) \\ &+ (1-p)^2\left(2w_1 + m - \left(1+\alpha\right)\left(m-\kappa\right) + \alpha\rho + q\left(1+\alpha\right)g_2\right) \\ &+ p\left(1-p\right)\left(2w_1 + 2m + \kappa + qg_2\right) \\ &+ p\left(1-p\right)\left(2w_1 + m - \left(1+\alpha\right)\left(m-\kappa\right) + \alpha\rho + q\left(1+\alpha\right)g_2\right) \end{aligned} \tag{33}$$

On equilibrium, the gift expense of Player 1, as a friend, is given by $E_G\left(U_{NF}\left(c_1\right)\right) = E_{NG}\left(U_{NF}\left(c_1\right)\right)$, so

$$g_1 = \frac{p\left(1-p\right)\left(1+\alpha\right)q\left(m-\kappa\right) - \frac{(1-p)q\rho\pi((1+\alpha)(1-p)+p)}{2} - \left(1-p\right)q\alpha\left(p\rho + g_2\right)}{1 + \left(1-p\right)\left(1-q\right)\alpha} \tag{34}$$

Similarly, the expected return of a non-friend with w_2 to give gift is

$$\begin{aligned} E_G\left(U_{NF}\left(c_2\right)\right) = &\, p^2\left(2w_2 + 2m + \kappa - g_2 + qg_1 + \tfrac{q\pi\rho}{2}\right) \\ &+ (1-p)^2\left(2w_2 + \kappa - \alpha\left(m-\kappa\right) - g_2 + qg_1 - \alpha\left(1-q\right)g_2 + \tfrac{(1+\alpha)q\rho\pi}{2}\right) \\ &+ p\left(1-p\right)\left(2w_2 + 2m + \kappa - g_2 + qg_1\right) \\ &+ p\left(1-p\right)\left(2w_2 + \kappa - g_2 + qg_1 + \tfrac{(2m+\rho)q\pi}{2} - \left(1-q\right)\alpha\left(m-\kappa+g_2\right)\right) \end{aligned} \tag{35}$$

[18] It is assumed here that the transfer won't drag the consumption level of a player who have positive income shock lower than the subsistence level.

Whereas the expected return of a non-friend with w_2 to not give gift is

$$\begin{aligned}
E_{NG}\left(U_{NF}\left(c_2\right)\right) = & \, p^2\left(2w_2 + 2m + \kappa + qg_1\right) \\
& + (1-p)^2\left(2w_2 + m - (1+\alpha)(m-\kappa) + q(1+\alpha)g_1\right) \\
& + p(1-p)\left(2w_2 + 2m + \kappa + qg_1\right) \\
& + p(1-p)\left(2w_2 + m - (1+\alpha)(m-\kappa) + q(1+\alpha)g_1\right)
\end{aligned} \tag{36}$$

So the equilibrium gift expense of Player 2, as a friend, equals

$$g_2 = \frac{p(1-p)(1+\alpha)q(m-\kappa) - \frac{(1-p)^2 q\rho\pi(1+\alpha)}{2} + \frac{pq\pi\rho}{2} - (1-p)q\alpha g_1}{1 + (1-p)(1-q)\alpha} \tag{37}$$

Therefore,

$$g_1 - g_2 = -\frac{\rho}{\left(1 - \frac{(1-p)q\alpha}{1+(1-p)(1-q)\alpha}\right)} \cdot \left((1-p)pq\alpha + \frac{q\pi\left(2(1-p)^2(1+\alpha) + p^2\right)}{2}\right) \tag{38}$$

When $q < \frac{1}{2} \cdot \left(1 + \frac{1}{(1-p)\alpha}\right)$, $g_1 - g_2$ is negative. So the poor has to give more give to the rich than they get back from the rich. When inequality gets more serious, ρ increases, the gap of gift expenses between the rich and the poor becomes larger.

As a simply extension, if income rise is asymmetric to each player, for example, only the income of Player 1 increases by ρ. The equilibrium gift expense g_1 and g_2 can be solved by taking g_2 in Equation (37) back to g_1 in Equation (34). By using Implicit Function Theorem, I can prove

$$\frac{dg_1}{d\rho} < 0 \tag{39}$$

and

$$\frac{dg_2}{d\rho} > 0 \tag{40}$$

So the income rise of Player 1 will lower the gift expense of Player 1, but raise the gift expense of Player 2, which can be taken as a kind of gift competition.

B Estimation of Dyadic Regression

When I check robustness of the estimation to ***Hypothesis III***, I employ the method developed in Fafchamps and Gubert (2007). Apparently dyadic observations (observations in pair) are not independent, so an auto-correlation problem within a pair of observations has to be solved. Therefore, $E[u_{ij},\, u_{ik}] \neq 0$ for all k and $E[u_{ij},\, u_{kj}] \neq 0$ for all k. Meanwhile $E[u_{ij},\, u_{jk}] \neq 0$ for all k and $E[u_{ij},\, u_{ki}] \neq 0$ for all k.

Given that regressors are exogenous, simple OLS will provide an inconsistent standard error estimation, leading to incorrect inference. Fafchamps and Gubert (2007) extends the method in Conley (1999), the formula for network corrected covariance matrix is of the form:

$$AVar\left(\hat{\beta}\right) = \frac{1}{N-K}\left(X'X\right)^{-1}\left(\sum_{i=1}^{N}\sum_{j=1}^{N}\sum_{k=1}^{N}\sum_{l=1}^{N}\frac{m_{ijkl}}{2N}X_{ij}u_{ij}u'_{kl}X_{kl}\right)\left(X'X\right)^{-1} \tag{41}$$

where β denotes the vector of coefficients, N is the number of dyadic observations, K is the number of regressors, X is the matrix of all regressors, X_{ij} is a vector of regressors for dyadic observation ij, and $m_{ijkl} = 1$ if $i = k$, $j = l$, $i = l$ or $j = k$, and 0 otherwise. Reasonably assume $E\left[u_{ij},\, u_{km}\right] = 0$, the variance computed by Equation (41) corrects for possible auto-correlation and heteroskedasticity.

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