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*Ruixin Wang, Oct 18th, 2015*

# Contents

# 1 Introduction

This dissertation investigates various issues in development economics and public economics. The three chapters cover topics concerning the behavior modes of agents in government, family and community, and attempt to uncover the hidden mechanisms which improve or impede economic efficiency and development.

Although the dissertation covers various topics, the underlying motivation of all these studies is to explore the behavior mode of agents under uncertainty in different circumstances. In Chapter 1, we show that, due to uncertainty of government performance, politicians are able to manipulate their public image by misallocating public resources. The uncertainty of human capital investment, as shown in Chapter 2, can change the fertility decisions of households. Moreover, without an effective insurance market, people in developing countries have to manage uncertainties of income and consumption by forming risk sharing groups. In Chapter 3, I demonstrate that gift exchange can facilitate risk sharing among households. The three chapters all consist of theoretical analysis and empirical studies. Depending on topics, I employ data from the United States, Africa and rural China to conduct empirical studies.

The first chapter considers the "dark" side of fiscal decentralization. We demonstrate in a yardstick competition model, that when fiscal expenditure is decentralized, more public resources might be misallocated between visible public goods and invisible ones. The second chapter investigates the role that income plays in explaining the (heterogeneous) fertility responses to adult mortality risks. Our analysis helps to reconcile the conflicting empirical evidence regarding the impact of HIV/AIDS on fertility found in previous literature. The third chapter considers a mechanism that facilitates risk sharing when effective contract enforcement is lacking. The "emotional collateral" between friends may help regulate the limited commitment problem. I show that the mechanism can work effectively if gift expenses serve as signals that separate friends, who have "emotional collateral", from non-friends.

The first chapter, written jointly with Wendun Wang, was motivated by the finding that the poverty rate can increase as fiscal expenditure is decentralized. To interpret this puzzling pattern, we introduce the concept "dress-up contest" to a yardstick competition model. A "dress-up contest" is a competition for the best public image, and fiscal decentralization can lead to such a contest between the political leaders of each local government. In previous literature, yardstick competition can improve government efficiency by regulating politicians' moral hazard problem (Besley and Coate (1995)). However, in the chapter we show that, when taking visibility of public goods into account, yardstick competition (due to fiscal decentralization) will force local governments to allocate more resources to more visible public goods (such as cash assistance) than to less visible goods (such as vendor payments). The resulting distortion of resource allocation causes a structural bias in public expenditure and hurts social welfare.

To empirically verify our theoretical model, we employ U.S. state-level data from 1992 to 2008, and we estimate the panel data model using various econometric approaches. The empirical results provide strong evidence that fiscal decentralization can lead to distortion in public expenditure arising from dress-up contests. We also find that this distortion increases the poverty rate on the regional level.

The second chapter is jointly written with Yang Zhou and Erwin Bulte. By proposing a portfolio choice model based on a "quantity-quality tradeoff", we explore fertility decisions by taking into account the risk of human capital investment. Our theory highlights the detrimental effect of adult mortality risks on human capital investment, and predicts heterogeneous impacts on fertility choice across income groups. Suppose that rich people are less risk-averse than the poor, and that adult mortality risk increases. Then, rich families may expand their family size and lower their human capital investment on each child, to guarantee their return from children in the future. Conversely, poor families would reduce their family size, since risky investments in children become unaffordable.

As an implication, our model suggests that adult mortality risks have destructive impacts on economic growth, particularly in the context of developing countries, due to the uncertainty of returns to human capital investments. Unlike Voth (2013) and Young (2005), which emphasize that adult mortality risks (e.g. black death or HIV/AIDS) may increase returns to human capital investments by reducing labor supply. In this paper, we highlight its detrimental effect on human capital accumulation. Due to the increased uncertainty, parents are reluctant to invest in their children. This destruction of human capital may particularly drag some relatively rich countries back to a "Malthusian regime" from a "Post Malthusian regime" (cf. "Unified growth theory" in Weil and Galor (1999)).

We take our theory to (African) data. By using the case of HIV/AIDS epidemics, we find empirical evidence to support heterogeneous responses to adult mortality shocks over income groups. Furthermore, we find that human capital investment is decreasing in all the countries, particularly in rich ones, because rich people prefer to lower investments per child in response to the increased adult mortality risks. Our empirical study provides support to our "portfolio" theory of fertility, and also helps reconcile conflicting empirical evidence regarding the effect of HIV/AIDS on fertility in previous research.

In Chapter 3, I analyze gift giving behavior in developing regions. In regions such as rural China, the Philippines and some African countries, people spend a large amount of money on gifts. The share of gift expenses over income is on average more than 10%, even though living standards are only on the edge of subsistence. As a result, individuals may even have to borrow money or sell blood to be able to give gifts (Chen and Zhang (2009)). In this chapter, I study the causes and consequences of gift behavior through both theoretical and empirical approaches.

The chapter studies how gift exchange helps to overcome the limited commitment problem in risk sharing. Due to emotional connection, friends will endure more from emotional or moral cost if they default to one another. As a consequence, friends are more trustworthy and less likely to default in risk sharing. Thus people rely on friends in risk sharing, but friendship is not perfectly identifiable in reality. Gift expenses, however, can serve as a signal of friendship. Due to altruism, giving a gift is less costly for a friend than for a non-friend. As a signal, gift exchange improves the efficiency of risk sharing by identifying friendship. I also demonstrate that the welfare gains due to this improvement may be offset by increased inequality. The model helps to rationalize the high gift expenses in China and other developing countries.

By using a unique data set containing detailed records about gift exchange in rural China, I find empirical evidence to support the association between gift expenses and risk sharing. When facing consumption shocks, people who spend more on gifts can more easily obtain loans and help. By testing more model predictions, I provide additional evidence which helps to identify the model from competing models.

In all three chapters, I conduct both theoretical and empirical research. Although the topics are not closely connected, the three chapters all aim to uncover the hidden determinants of economic efficiency and development, and to inform policies in these areas.

Authorship and contributions

The first chapter is written jointly with Wendung Wang and is completed under the supervision of Prof. Jan Magnus and Prof. Erwin Bulte.

The second chapter is written jointly with Yang Zhou and Erwin Bulte.

The third chapter, as my job market paper, is completed under the supervision of Prof. Erwin Bulte and Prof. Xiaobo Zhang.

# 2 Dress-up Contests: A Dark Side of Fiscal Decentralization[1]

**Abstract:** A "dress-up contest" is a yardstick competition of politicians for the best public images, and fiscal decentralization can lead to such contests. In this paper we model the dress-up contest (due to fiscal decentralization) and investigate how it affects social welfare. We show that as public expenditure is being decentralized, local politicians will allocate more resources to more visible public goods than less visible goods under pressure of dress-up contest. The resulting distortion of resource allocation causes a structural bias of public expenditure and further hurts social welfare. To empirically verify our theoretical model, we employ state-level data of welfare expenditure in the United States from 1992 to 2008, and estimate the panel data model using various econometric approaches. The empirical results provide strong evidence that fiscal decentralization can lead to distortion in public expenditure arising from dress-up contests. We also find that this distortion increases the regional poverty rate.

**JEL classification:** *D72, H75, H77*

**Key words:** Fiscal decentralization; Yardstick competition; Dress-up contest; Functional coefficient model

[1]The paper is jointly written with Wendun Wang, we are grateful to seminar participants in Tilburg University, the V Workshop on Fiscal Federalism in Barcelona, and Asian Meeting of the Econometric Society (AMES) in Singapore; to Erwin Bulte, Federico Revelli, Stephen Calabrese, Daniel Wilson, Rafael Parchet, Albert Solé Ollé, Reyer Gerlagh for useful comments. Remaining errors are our own.

## 2.1 Introduction

During the last three decades, fiscal decentralization and local-government reform have been at the center-stage of policy experiments. This has occurred not only in countries with a traditional tendency to decentralize, such as the United States, but also in a large number of developing and transition economies, such as Africa, Asia, and Latin America (The World Bank (1999)). Fiscal decentralization, which moves the responsibility for decision-making in public expenditure from central to local governments, is widely believed to be an effective tool for improving the efficiency of public expenditure. One of the major mechanism, well documented in the literature, is yardstick competition. The hypothesis of yardstick competition suggests that, "if citizens of a jurisdiction use information about the policies implemented in other jurisdictions to gauge and evaluate the performance of their own government, that process will increase electoral competition at home and thus incite the governing politicians to act in their benefit more than they would otherwise" (Kenyon, Kincaid, and on Intergovernmental Relations (1991)). Since the comparison is made more easily among local governments than central ones, yardstick competition is accordingly intenser among local-level politicians. As a result, the efficiency of public expenditure will be enhanced as it is being decentralized (see Besley and Coate (1995)).

However, as Sobel (1999) points out, yardstick competition does not necessarily improve efficiency of public expenditure but rather provide mis-incentive to agents. In this paper, we explore a negative effect of yardstick competition. When voters evaluate a politician's capacity, some projects may provide more accurate information than the others. Under the pressure of yardstick competition, politician will have incentive to distort the structure of public expenditure, and spend more on these more "visible" projects. As a result, fiscal decentralization does not necessarily improve social welfare, since the structure of public expenditure will be even biased when it is being decentralized.

The objective of this paper is two-fold. First, we develop a simple model to capture the politicians' decisions in a yardstick competition, and show its negative effect on the allocation of public expenditure. Second, by using a data set of welfare expenditure in United States from 1992 to 2008, we test the key predictions of our model, and provide empirical evidence to the dark side of fiscal decentralization.

The intuition of our model is as follows. Incumbent politicians of local governments are involved in a yardstick competition, since voters appraise the politicians at home by comparing them with the peer politicians in similar jurisdictions. Suppose voters can only infer the capacity of politician based on observed outcomes of public projects, the yardstick competition is actually about the politicians' perceived capacities or public images, rather than the "real" capabilities. This kind of yardstick competition is thus named as "dress-up contest" in this paper.

Assume public projects are different in terms of "visibility": a project is defined as "being less visible if it is harder to assess government competence" (Mani and Mukand (2007)). For voters, they will trust more on the assessments based on the outcomes of the more visible projects than those of the less visible ones, since the inferences are more accurate. For politicians, the more visible projects can make a larger contribution to their public images than the less visible ones. Therefore, a politician will have an incentive to allocate more resources to the more visible projects. In terms of building better public image, it is more cost-effective to spend on the more visible projects. As a result, the dress-up contest results in a biased structure of public expenditure toward the more visible projects, and causes a welfare loss of the voters. The impact of fiscal decentralization also becomes negative. As public expenditure is being decentralized, the structure of public expenditure will be distorted due to the dress-up contest among politicians of local-level governments.

We use state-level welfare expenditure data in United States to test two theoretical predictions of the model. First, we test the effect of fiscal decentralization on the structure of public expenditure; second, we test whether fiscal decentralization will result in loss of social welfare by distorting the structure of public expenditure. In United States, welfare expenditure consists of cash assistance and vendor payments. The former one is relatively visible since it is directly spent by government and easily observed by citizens. So in this paper, we propose to use the ratio between the spending on cash assistance and vendor payments program to measure the share of the spending on visible projects. We find that fiscal decentralization causes a flow of public expenditure from the more visible project to the less visible one, which confirms our theoretical finding that fiscal decentralization can cause dress-up contests between local governments. Furthermore, the estimation results suggest that the effect of fiscal decentralization is stronger on the structure of public expenditure where yardstick competition is fiercer. This is another evidence of dress-up contests. To capture how the distorted structure of public expenditure affects poverty, we employ a functional coefficient method, which allows us to capture the possible nonlinear interaction between the cash-vendor-payment (CV) ratio, welfare expenditure, and poverty. We find that the structural distortion can greatly lower the efficiency of welfare expenditure and increases poverty rate. We thus empirically verify our theoretical findings, and provide empirical evidence for the negative side of fiscal decentralization.

To the best of our knowledge, this paper is the first to argue that fiscal decentralization can lower efficiency of public expenditure due to yardstick competition for politicians' public images (dress-up contest). Unlike previous literature, fiscal decentralization adversely affect not by reducing the size of public expenditure, but rather distorting its structure. The paper also provides empirical evidence to the negative side of fiscal decentralization and the underlying mechanism. This paper fits into several strands of literature. First, following Besley and Coate (1995) and Besley and Smart (2007), we study the effect of yardstick competition on the efficiency of public expenditure, but highlight its negative side due to difference of visibility across public projects. Second, by using some results in Dewatripont, Jewitt, and Tirole (1999) and Mani and Mukand (2007), we introduce visibility of public projects to the analysis on yardstick competition, and reveal a dark side of fiscal decentralization both theoretically and empirically. Third, this paper is related to the empirical studies regarding the effect of yardstick competition, such as Revelli (2006), and our empirical findings highlight the effect of yardstick competition on the structure of public expenditure.

The remainder of the paper is organized as follows. In Section 2, we present our theoretical model, and derive key testable implications. Section 3 describe the institutional background and the data. In Section 4, we outline the empirical strategy and present the estimation results. Section 6 concludes.

## 2.2 Conceptual Framework

### 2.2.1 Background

Following Mani and Mukand (2007), we capture the behavior of a politician in a career concern model. Voters will evaluate the capability of a politician and make their voting decisions based on the observed outcome of the public projects she implemented. So politician has an incentive to make her public image of ability as high as possible, under the pressure of yardstick competition.

Assume public projects are different in visibility. The assumption is realistic for two reasons. First, some public project outcomes are intrinsically harder to directly observe or measure, for example, the loss of life in a famine might be easy to observe, but it is relatively hard to observe the occurrence of malnutrition. The second reason for low visibility is the "complexity" of a public project. Many factors can determine the outcome of a project, so that it is hard to isolate the politician's competence, even though the outcome itself is easily observed. For example, among the welfare programs in United States, most cash assistance programs, which help the unemployed, elderly or families with dependent children, are directly implemented by governments, so the outcomes of such programs can effectively reflect the politicians' capacities. By contrast, some other welfare programs are implemented by welfare house, soup kitchen and hospital, the outcomes of these programs do not only depend on the politicians' abilities, but also the performance of the contractors. So voters may feel hard to assess the politician's capacity based on these projects.

For simplicity and without loss of generality, we assume there are two projects, project $a$ and $b$, which are different in terms of visibility. A politician has to decide to allocate resources to each project given budget constraint. In what follows, we will model the yardstick competition in a two-period political game, and demonstrate the dark side of fiscal decentralization when visibility of public project matters.

### 2.2.2 Politicians

Assume there are two jurisdictions, $A$ and $B$. In a two-period game, the incumbent politician in each jurisdiction aims to retain office for the entire two periods, so it is crucial for them to win the election between the first and the second period. While in office she allocates effort and public expenditures to a set of public projects in the first period, in order to maximize the probability of winning election.

Specifically, the objective function of incumbent politician in jurisdiction $i$ (politician $i$ hereafter) is as follows.

$$\max E\left(U_i\right) = R\eta_i - C_i\left(e_{1i,}\ \ldots\ ,\ e_{Ji}\right) \qquad\qquad i \in \{A,\ B\}$$
$$s.t. \qquad I_i = \textstyle\sum_{j=1}^{J} e_{ji} \tag{1}$$

where $R$ is the return from winning the election, and $\eta_i$ is the probability of winning the local election for the politician $i$. Since there is no return if she loses the election, the expected return to win the election is $R\eta_i$ for politician $i$. The incumbent's (opportunity) cost of offering effort and public expenditures is given by $C_i$. We assume that the first- and second-order derivatives of the cost function satisfy $C_i(e)' > 0$ and $C_i''(e) > 0$. The public expenditure she can use is given by $I$, and budget constraint applies.

### 2.2.3 Voters

Voters are willing to support the (more) capable politician in election, but it is costly to evaluate the capacities of the politicians. So as stated in Downs (1957), many voters can only be"rationally ignorant", and merely do a "referendum on the incumbent management". In this model, we assume there are two types of voters: well-informed voters and ill-informed (ignorant) ones. The information cost is assumed to be relatively low for the well-informed voters, so they will evaluate the capacity of a politician based on the observed outcome of public projects. By contrast, the voting decision of an ignorant voter will not be based on inference about capacity, but rather other factors, such as ideology or macroeconomic trends. The behavior is labeled as "retrospective voting". We assume the share of well-informed voters is $k$. If the information cost is lower, the share of well-informed voters are larger, namely, $k$ is larger.

We now sketch out how a well-informed voter evaluates the capacity of a politician. Assume the production function of each public goods is given as follows.

$$z_{j,i} = \tau_i + e_{j,i} + \epsilon_{j,i} \qquad j \in \{a, b\},\ i \in \{A, B\}, \tag{2}$$

where $z_{j,i}$ is the observed outcome of the public good $j$ provided by politician $i$, $\tau_i$ is politician $i$'s capability, $e_{j,i}$ is politician $i$'s expenditure or effort on good $j$, and $\epsilon_{j,i} \sim N\left(0,\ \sigma^2_{j,i}\right)$ captures the exogenous stochastic factors. Public good $a$ being more visible than $b$ implies that there is more noise in the outcome of $b$ than in that of $a$, i.e. $\sigma^2_{a,\,i} < \sigma^2_{b,\,i}$.

Well-informed voters can obtain information regarding the outcome of the public good $z$. The politician's capability $\tau$ and public expenditure $e$ are unobserved. However, voters (with rational expectation) have common knowledge of the prior distribution, $\tau_i \sim N\left(\overline{\tau},\ \sigma^2_\tau\right)$ for $i \in \{A, B\}$. Voters can use the observed outcome $z_i := \{z_{a,i}, z_{b,i}\}$ and the rationally expected expenditure $\mathbf{e_i}^\star := \{e^\star_{a,i}, e^\star_{b,i}\}$ to update their priors of the politician's capability, i.e. from $\overline{\tau}$ to $(z_{j,i} - e^\star_{j,i})$ with associated variance $\sigma^2_{j,i}$. According to Dewatripont, Jewitt, and Tirole (1999) and Mani and Mukand (2007), the mean posterior assessment of the politician's capability can be obtained via

$$\Phi_i = E\left(\tau_i \mid \mathbf{z}_i,\ \mathbf{e}^\star_i\right) = \left[\frac{h_\tau \overline{\tau} + h_a\left(z_{a,i} - e^\star_{a,i}\right) + h_b\left(z_{b,i} - e^\star_{b,i}\right)}{h_\tau + h_a + h_b}\right] \tag{3}$$

where $h_\tau = 1/\sigma^2_\tau$ and $h_j = 1/\sigma^2_j$ $(j = a, b)$ are the precision of the prior and two realizations, respectively. In election, well-informed voters will make their decisions based on the perceived capacities of the politician. When they assess the capacity of a politician, from Equation (3), a larger weight is put on the belief updated from the outcome of the more visible project $a$, since the outcome $z_a$ is less noisy than $z_b$, so the updated information is more reliable.

#### 2.2.4 Yardstick Competition

When voters decide whether to elect the incumbent politician or not, they do not only refer to the ex-ante estimate of the local challenger's competence $\overline{\tau}$, but also the performance of the incumbent politicians in similar jurisdictions. As stated in Besley and Smart (2007), incumbents will be partly judged on their relative performance, since such comparison provides a more accurate estimate of the underlying unobservables. So in a local election, an incumbent politician will not only face local rivals, but also have to compete with the peer politicians in similar jurisdictions. In another word, the competition is not a local competition, but rather a kind of yardstick competition. In what follows, we will capture the key features of yardstick competition by a simple approach.

Assume the probability of winning election for politician $i$, $\eta_i$, depends on three factors: the inferred capacity of politician $i$, $\Phi_i$; the inferred capacity of a politician in another jurisdiction, $\Phi_{-i}$ and the share of well-informed voter. So the function is featured as follows,

$$\eta_i = \eta_i\left(\Phi_i,\ \Phi_{-i},\ k\right) \tag{4}$$

In this yardstick competition, if the inferred capacity of politician $i$ is high, she will be preferred by the well-informed voters, and have more chance to win the election. By the same logic, if the perceived capacities of her peer politicians in other jurisdictions are relatively high, her chance of winning election will be small. Therefore,

$$\frac{\partial \eta_i}{\partial \Phi_i} > 0, \quad \frac{\partial \eta_i}{\partial \Phi_{-i}} < 0 \tag{5}$$

So the politician cannot only care about her own perceived capacity $\Phi_i$, but also the peer politicians in similar jurisdictions. In fact, this competition is not for the "real" capacities, but rather the perceived capacities inferred from the outcomes of public projects, in another word, for the public images. We call this sort of yardstick competition as dress-up contest.

Furthermore, we assume

$$\frac{\partial^2 \eta_i}{\partial \Phi_i^2} < 0, \quad \frac{\partial^2 \eta_i}{\partial \Phi_i \partial \Phi_{-i}} > 0 \tag{6}$$

The marginal contribution of $\Phi_i$ to probability $\eta_i$ is diminishing, so the second-order derivative of the probability function with respect to $\Phi_i$ is negative, and the assumption is reasonable particularly consider $\eta_i$ is upper bounded by one. The cross partial derivative with respect to $\Phi_i$ and $\Phi_{-i}$ is assumed to be positive. As a reference point, if $\Phi_{-i}$ is small, it is hard to tell the capacity of politician $i$ is high or low from the comparison between $\Phi_i$ and $\Phi_{-i}$, so a larger $\Phi_i$ will earn a relatively smaller rise in $\eta_i$. As the reference level $\Phi_{-i}$ gets higher, the comparison turns more accurate, and ${}^{\partial \eta_i}/_{\partial \Phi_i}$ will be accordingly larger.

The share of well-informed voter, $k$ also affects the probability of winning election, since it decides the degree of dress-up contest. Only well-informed voters can make voting decision based on inferred capacity of the politician, apparently there will be no dress-up contest if there is no any well-informed voters. As the share of well-informed voters gets larger, a politician starts to care about her own perceived capacity, and the comparison with the peer politicians. The dress-up contest will accordingly get intense, and the probability of winning election will be more determined by $\Phi_i$. Hence, we assume

$$\frac{\partial^2 \eta_i}{\partial \Phi_i dk} > 0 \tag{7}$$

#### 2.2.5 Equilibrium and Comparative Statics

In the first period of this political game, a politician will choose $e_a$ and $e_b$ to maximize the probability of winning election, given her peer politicians' strategies and the share of the well-informed voters. We first look at the strategy of politician $A$ (The case for politician $B$ is symmetric.). The optimization problem gives the first order condition with respect to $e_{a,A}$,

$$R \cdot \frac{\partial \eta_A \left(\Phi_A,\ \Phi_B,\ k\right)}{\partial \Phi_A} \cdot \frac{h_a}{h_\tau + h_a + h_b} - C'_A \left(e_{a,A},\ e_{b,A}\right) - \lambda = 0 \tag{8}$$

where $\lambda$ is a Lagrangian multiplier. Since we have assumed the budget constraint is binding, $\lambda$ must not be equal to zero. On a rational expectation equilibrium, politician $A$ will spend $e^{\star}_{a,\,A}$ on project $a$, which is given by

$$e^{\star}_{a,\,A} = \arg\max E\left(U_A\right) \tag{9}$$

According to Mani and Mukand (2007), as long as project $a$ and $b$ are substitute, the politician will spend more on project $a$, which is more visible than $b$, so $e^{\star}_{a,\,A} > e^{\star}_{b,\,A}$. The intuition is that the voters find the updated information from the outcome of project $a$ is more reliable, since $z_a$ is less noisy than $z_b$. Then the politician will have an incentive to allocate more resources to making a better outcome of project $a$ than project $b$, so that the politician can make her perceived capacity (public image) as good as possible.

Moreover, in the yardstick competition, $e^{\star}_{a,\,A}$ will not only depend on the visibility of project $a$, i.e. $\sigma^2_a$, but also the expenditure that incumbent politician $B$ allocate to project $a$, i.e. $e^{\star}_{a,\,B}$. Define $F_A := \partial E(U_A)/\partial e_{a,A}$, then we have

$$F_A = R \cdot \frac{\partial \eta_A\left(\Phi_A,\ \Phi_B,\ k\right)}{\partial \Phi_A} \cdot \frac{h_a}{h_\tau + h_a + h_b} - C'_A\left(e_{a,\,A},\ e_{b,\,A}\right) - \lambda \tag{10}$$

Since ${}^{\partial^2\eta_i}/_{\partial\Phi_i^2} < 0$, we have

$$\frac{\partial F_A}{\partial e_{a,\,A}} = R \cdot \frac{\partial^2 \eta_A}{\partial \Phi_A^2} \cdot \left(\frac{h_a}{h_\tau + h_a + h_b}\right)^2 - C''_A\left(e_{a,\,A},\ e_{b,\,A}\right) < 0 \tag{11}$$

Meanwhile, we have

$$\frac{\partial F_A}{\partial e_{a,\,B}} = R \cdot \frac{\partial^2 \eta_A}{\partial \Phi_A \partial \Phi_B} \cdot \left(\frac{h_a}{h_\tau + h_a + h_b}\right)^2 > 0 \tag{12}$$

since ${}^{\partial^2\eta_i}/_{\partial\Phi_i\partial\Phi_{-i}} > 0$. Using the implicit function theorem, therefore, we obtain the following inequality on equilibrium,

$$\frac{\partial e_{a,A}}{\partial e_{a,B}} = -\left(\frac{\partial F_A}{\partial e_{a,B}}\right) / \left(\frac{\partial F_A}{\partial e_{a,A}}\right) > 0. \tag{13}$$

In this yardstick competition, to obtain a better image (perceived capacity), politician $A$ will spend more on project $a$ if the peer politicians do so in other jurisdictions, even though too much resources allocated to project $a$ will cause a biased structure of public expenditure, and result in a loss of social welfare.

### 2.2.6 Fiscal Decentralization

Yardstick competition is founded on the idea that voters are "rationally ignorant", since it is costly for them to acquire information. When the information cost gets lower, more voters can turn to be well-informed, and use relative performance evaluation to make voting decisions. That is why yardstick competition in local election is intenser than state- or even higher level election. Apparently it is easier for voters to observe the outcome of public projects in their local jurisdiction, rather than state or federal. The comparison of performance is also easier to make among local governments than higher-level governments, since they are not only closer, but also more comparable. So in local election, more voters can be well-informed due to lower information cost. As $k$ gets larger, an intenser yardstick competition makes local politicians care more about their public image. They will thus have an incentive to spend more on visible project $a$, and the structure of local-level public expenditure will be more biased than state- or higher level. We show the proof as follows. By using Equation (10), we have proved that

$$\frac{\partial F_A}{\partial e_{a,A}} < 0 \tag{14}$$

Since $\partial^2\eta_i / \partial\Phi_i dk > 0$,

$$\frac{\partial F_A}{\partial k} = R \cdot \frac{\partial^2 \eta_i}{\partial \Phi_i dk} \cdot \frac{h_a}{h_\tau + h_a + h_b} > 0 \tag{15}$$

By using implicit function theorem,

$$\frac{\partial e_{a,A}}{\partial k} = -\left(\frac{\partial F_A}{\partial k}\right) / \left(\frac{\partial F_A}{\partial e_{a,A}}\right) > 0. \tag{16}$$

As a result, fiscal decentralization will cause a biased structure of public expenditure towards more visible projects. As public income is being decentralized to local level governments, more resources are involved in an intenser yardstick competition (in local election). Compared with higher-level politicians, local politicians have more incentive to exploit every dollar creating a good public image, and a natural strategy will be spending more money on the more visible projects. As a result, fiscal decentralization makes more public expenditure biased in structure. Unlike the results in Besley and Coate (1995), fiscal decentralization does not necessarily improve the efficiency of public expenditure. It may cause distortion in the structure of public expenditure and loss of social welfare, when public projects are different in visibility. This distortion is considered as a dark side of fiscal decentralization.

## 2.3 Data and background

Our empirical analysis aims to provide empirical evidence to the model by testing two key predictions. Based on our model, as public expenditure is being decentralized, its structure will turn to be biased towards the more visible projects, and result in welfare loss. So first, we will explore the association between fiscal decentralization and the structure of public expenditure, and the underlying mechanism. Second, we would like to see whether the biased structure, which is made by fiscal decentralization, will result in welfare loss.

A difficulty to test the first prediction is to measure visibility of public projects. In this paper, we employ a data set of state-level welfare expenditure in United States, our sample covers 48 states excluding Alaska and Hawaii with the time span from 1992 to 2008. The data are from Statistical Abstracts of the United States and Census of Government of United States[2].

In the real world, it is difficult to find a strictly visible public goods, because the outcomes of most public goods are either hard to measure or determined by too many factors. We use this data set to conduct empirical research, since the two main categories

[2]Data are provided by United States Census Bureau

of welfare expenditure, cash assistance and vendor payments, are naturally different in visibility. Cash assistance paid directly to needy persons under the categorical programs, such as Old Age Assistance, Aid for Unemployed and Temporary Assistance for Needy Families (TANF). The program directly increases citizens' disposable income and reduces poverty, so its outcome, i.e. poverty reduction, can be observed in the short term. The outcome also primarily depends on the government's expenditure on this service, it can thus effectively reflect the efficiency and capacity of government.

In contrast, vendor payments made directly to private purveyors for medical care, burials, and other commodities and services provided under welfare programs; its provision and operation are mainly by welfare institutions, such as hospitals (old-age assistance, aid to dependent children and to the blind), welfare houses or soup kitchens. The outcome of these payments depends on a large number of factors beyond the government's control, such as the performance of other institutes, and it may not be obvious in the short term. Compared to cash assistance program, people is harder to infer capacity of government from vendor payments program, the voters may even not know whether or how the welfare institutions is funded by government. Therefore, it is reasonable to regard cash assistance as more visible and vendor payments as less visible.

To test the second hypothesis, we have to appropriately measure the loss of social welfare. Given that we focus on welfare expenditure, we use poverty rate as a measure of social welfare. The aim of welfare expenditure is to increase social welfare by lowering poverty rate, but if our theory holds, fiscal decentralization will distort the structure of welfare expenditure, and may adversely affect poverty rate. The key variables are summarized in Table 1. We measure fiscal decentralization by

$$FD := \frac{\text{Local public expenditure}}{\text{Total public expenditure}} \tag{17}$$

where the local expenditure includes the expenditure of the county, city, and town governments, and the total expenditure is the expenditure of the state and local governments. $FD$ is between zero and one. The structure of welfare expenditure is measured by the

Table 1: Descriptive statistics of main variables

| VARIABLES | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| Fiscal decentralization | 0 .0914 | 0 .1334 | 0.0001 | 0.9610 |
| Welfare expenditure | 0 .6914 | 0 .2223 | 0.2021 | 1.5460 |
| Cash-vender-payment ratio | 0 .1137 | 0 .0889 | 0.0013 | 0.7367 |
| Poverty rate (percentage) | 12.559 | 3.5560 | 4.5 | 26.4 |
| Unemployment Rate | 5.2916 | 1.5932 | 2.2 | 14 |
| Gini index | 0.4392 | 0 .0284 | 0 .36 | 0 .52 |

ratio of cash assistance and vendor payment, $RCV$.

Most welfare expenditure is funded by public revenue of state-level government. The local-level governments have autonomy of administrating the expenditures, although they have to follow the guideline of state governments. The decentralization degree of welfare expenditure varies over states and time, from around zero to 0.96. Figure 2 shows the spatial pattern of the decentralization degree in the United States[3].

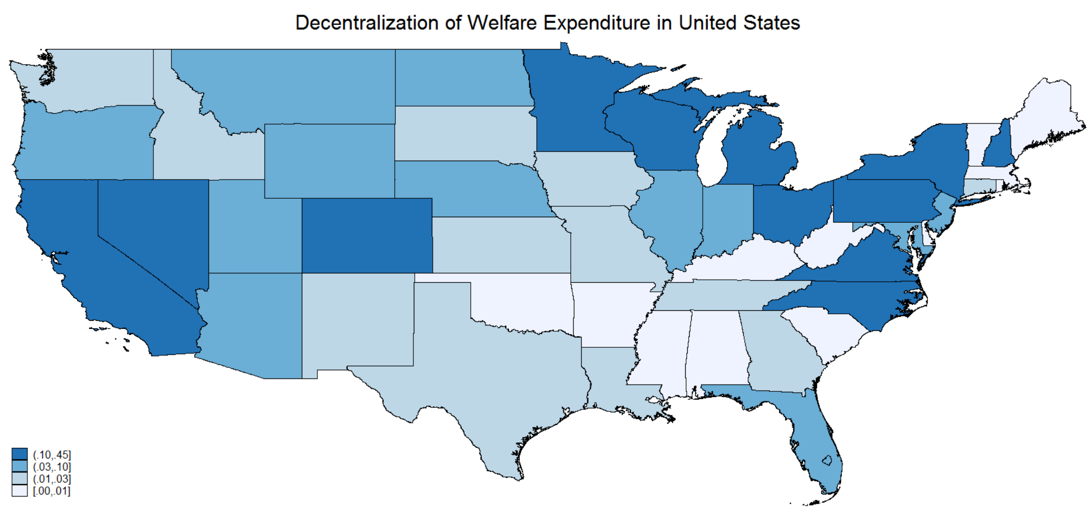


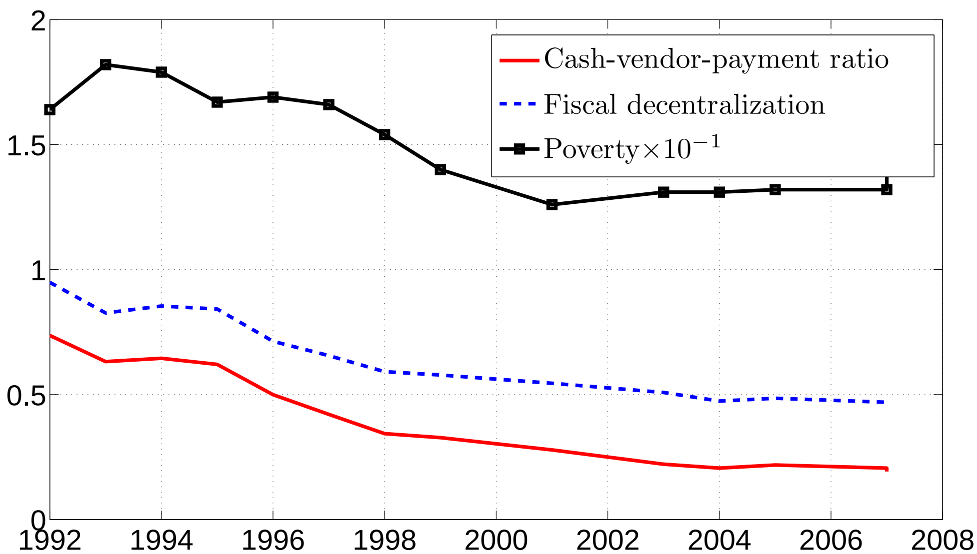

Figure 1: Fiscal Decentralization of welfare expenditure in United States (2008)

According to Boyd (2003), the spending on cash assistance was declining in many states (e.g. Arizona, California, Colorado, Connecticut and so on) since 1995. In the same period, the decentralization degree of welfare expenditure was also decreasing in these

[3]One possible determinant is political ideology, states with highest degree of decentralization are more liberal.

states. When more welfare expenditure is decided by state governments rather than local, less money is spent on cash assistance program, and we find poverty rate is decreasing. In Figure 3, we show the pattern about decentralization, structure of welfare expenditure and poverty rate in California over time, similar pattern can be found in many other states, such as Indiana, Arizona and so on.

Figure 2: Fiscal Decentralization, Structure of Welfare Expenditure and Poverty Rate (California)




The basic pattern is consistent with the empirical findings in Berner (2005). When local governments controlled more welfare expenditure in North Carolina, cash assistance program was expanded, and its efficiency became lower. Both results are in line with our model, and provide basic evidence.

## 2.4 Empirical Strategy and Estimation

### 2.4.1 Hypothesis I

**Effect on Structure of Welfare Expenditure** We first consider a direct test for the effect of fiscal decentralization on structural bias of public expenditure and the underlying mechanism. Based on our model, we have the first hypothesis as follows.

***Hypothesis I***: As welfare expenditure is being decentralized, ratio of cash assistance and vendor payments will increase.

To illustrate the hypothesis and our empirical strategy, we introduce some preliminary notation. Assume that state-level politicians spend $1/v_S$ of the state's welfare expenditure on visible projects (cash assistance program), while local-level politicians spend $1/v_L$ of the local expenditure on such projects. Since yardstick competition is fiercer in local elections than in state elections, we have $v_S > v_L \geq 1$. If we let $\Gamma$ be the total (state + local) public expenditure, then the total expenditure (state and local government) on the cash assistance program, which is denoted by $Cash$, and that on the vendor payments program (less visible project), $Vendor$ are given by

$$\begin{aligned} Cash &= \tfrac{\Gamma}{v_S} + \Gamma \cdot FD\left(\tfrac{1}{v_L} - \tfrac{1}{v_S}\right) \\ Vendor &= \Gamma - \text{Cash} = \Gamma \cdot \left(1 - \tfrac{FD}{v_L} + \tfrac{FD-1}{v_S}\right). \end{aligned} \tag{18}$$

The ratio of $Cash$ to $Vendor$ (hereafter the CV ratio) is

$$RCV = \frac{v_L + FD(v_S - v_L)}{v_L(v_S - 1) - FD(v_S - v_L)} \tag{19}$$

which is a measure of the structure of welfare expenditure in terms of visibility. Note that $RCV$ is a monotonically increasing function of the degree of fiscal decentralization, i.e.

$$\frac{\partial RCV}{\partial FD} = \frac{v_S v_L (v_S - v_L)}{[(v_S - 1)v_L - FD(v_S - v_L)]^2} > 0 \tag{20}$$

Therefore, as the degree of fiscal decentralization increases, the total expenditure on cash assistance program and the CV ratio both increase. Inequality (20) thus allows us to empirically test the direct association between fiscal decentralization and the biased structure of public expenditure due to dress-up contests.

To test this hypothesis, we consider the reduced-form model as follow,

$$RCV_{it} = \alpha_i + \kappa_0 + \kappa_1 FD_{it} + \kappa_2 TWE_{it} + \varepsilon_{it} \tag{21}$$

where the subscript $it$ denotes observation of the $i$th state ($i = 1, \ldots, N$) at year $t$ ($t = 1, \ldots, T$), and $\alpha_i$ is the state-specific fixed effect. $TWE$ is the total (state + local) welfare expenditure.

The fixed-effect estimation results are reported in column (1) of Table 2. It shows that a larger degree of fiscal decentralization causes a larger CV ratio. The estimated coefficient to $FD$ is 0.4850 and significant at 5 percent. To capture the causal effect, in columns (2) and (3), we replace the contemporary fiscal decentralization by its first- and second-order lagged values $FD_{i,t-1}$ and $FD_{i,t-2}$, respectively, since an fiscal decentralization policy may take effect after a period of time. We see that using lagged values gives a more positive and more significant estimate, confirming the causal relationship between $FD$ and the CV ratio. The estimation results suggest that when the welfare expenditure gets decentralized, more spending will flow from vendor payments to cash assistance program.

As a robustness check, we recompute $FD$ using the expenditure from only city and town governments (excluding the county-level governments), and we denote this ratio as $FD_{CT}$. Since yardstick competition is supposed to be even intenser at the city and town level, we expect to observe a stronger association between structural bias and fiscal decentralization, i.e. a more significant and positive estimated coefficient $\kappa_1$. The results in column (4) indeed indicate a stronger and more significant effect, the coefficient turns to be 2.3915 and significant at 1 percent, showing the robustness of this empirical finding.

Table 2: Fiscal decentralization effect on CV ratio

| VARIABLES | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Fiscal decentralization | 0.4850** | | | |
| | (0.200) | | | |
| Fiscal decentralization (first lag) | | 0.5018*** | | |
| | | (0.188) | | |
| Fiscal decentralization (second lag) | | | 0.4888*** | |
| | | | (0.160) | |
| Fiscal decentralization (city and town level) | | | | 2.3915*** |
| | | | | (0.864) |
| Welfare expenditure | −0.246*** | −0.2539*** | −0.2270*** | −0.2760*** |
| | (0.025) | (0.025) | (0.022) | (0.048) |
| Constant | 0.243*** | 0.2484*** | 0.2233*** | 0.2532*** |
| | (0.031) | (0.030) | (0.026) | (0.036) |
| AIC | −2323.83 | −1860.35 | −1936.64 | −385.72 |
| R-square | 0.2734 | 0.2990 | 0.2655 | 0.0084 |
| Observations | 720 | 576 | 576 | 96 |

Note: 1. Dependent variable is *CV ratio*.
2. Standard errors are in parentheses.
3. *** p<0.01, ** p<0.05, * p<0.1

**The role of yardstick competition** Furthermore, we would like to explore the underlying mechanism of the effect. According to our model, fiscal decentralization increases the spending on the more visible projects, since more public expenditures are involved with a fiercer yardstick competition (dress-up contest). Therefore, the variation in yardstick competition can explain the effect of fiscal decentralization on the structure of public expenditure. Therefore, the variation in degree of yardstick competition over local jurisdictions can affect the structural effect of fiscal decentralization on public expenditure. We expect that the stronger the yardstick competition of the local jurisdiction, the stronger the distortion of the public expenditure. More formally, if the local-level yardstick competition is intensified, i.e. $v_L$ is smaller, then the CV ratio increases, because

$$\frac{\partial RCV}{\partial v_L} = -\frac{FDv_S^2}{\left[(v_S-1)v_L - FD(v_S-v_L)\right]^2} < 0 \tag{22}$$

This implies that given the same degree of fiscal decentralization, if the local-level yardstick competition is stronger in a particular state, then the politicians in that state have more incentive to invest in visible projects. This mechanism can be empirically captured by an interaction term between yardstick competition and fiscal decentralization. Thus, we consider the model

$$RCV_{it} = \alpha_i + \kappa_0 + \kappa_1 FD_{it} + \kappa_2 COMP_{it} + \kappa_3 FD_{it} \times COMP_{it} + \kappa_4 TWE_{it} + \beta' \mathbf{X_{it}} + \varepsilon_{it} \quad (23)$$

where $COMP$ is a measure of the yardstick competition, and $\mathbf{X_{it}}$ is a vector of control variables, including the land size of each state, and the share of urban population, both variables are controlled to avoid potential endogeneity problem. Estimating Equation (23) allows us to examine the mechanism described in the model.

Yardstick competition is difficult to measure, to the best of our knowledge, there is no satisfactory measure in literature. We propose two measures based on the comparability of jurisdictions and the competitiveness of local governments. First, we consider the comparability of jurisdictions. This is motivated by the argument of Bodenstein and Ursprung (2005) that yardstick competition emerges when the performance of governments in various jurisdictions becomes sufficiently comparable so that the voters can alleviate the agency problem by making meaningful comparisons between jurisdictions (see also Besley and Coate (1995)). In the United States, most congressional districts consist of several local governments that have similar political and economic situations, such as similar political interests and voters' preferences. Hence, we expect that the yardstick competition between local governments within a congressional district is stronger than that outside the district. This implies that the congressional district demarcates the political boundaries of the yardstick competition. If a given district contains more local governments, then the yardstick competition in this district is intenser because each local government has more comparable rivals. Given this motivation, we propose to measure the yardstick competition by

$$COMP_r := \frac{\text{Number of local governments}}{\text{Number of congressional districts}} \quad (24)$$

As $COMP_r$ gets larger, the yardstick competition is intenser[4]. If our theory holds, a larger $COMP_r$ will lead to a serious structural bias, namely larger CV ratio, therefore, $\kappa_2$ is predicted to be positive.

Next, we consider measuring the yardstick competition by the competitiveness of the local elections, which is computed based on the percentage of votes won by the leading party. We denote this measure as $COMP_c$. The average level of competitiveness is a reasonable measure of the yardstick competition within the state. The competitiveness is higher if the leading party wins a smaller share of the votes, suggesting that the competing parties are well matched or none of the candidates has strong support. In both cases, the yardstick competition can be intense. Due to the lack of county-level data, we use congressional-district data. In the two-party system of the U.S., congressional elections are expected to be highly correlated with local (county, city, or town) elections, and thus the average competitiveness of these elections can be a proxy for the yardstick competition at the local level. As $COMP_c$ gets smaller, the yardstick competition is intenser[5]. If our theory holds, a smaller $COMP_r$ will lead to a serious structural bias, namely larger CV ratio, therefore, $\kappa_2$ is predicted to be negative.

To see how the effect of fiscal decentralization varies at different levels of yardstick competitiveness, we first rank all the states according to their average competitiveness (averaged over time). Then, we estimate the fiscal decentralization effect using the two samples, made up of the most competitive and the least competitive states, respectively. Columns (1) to (4) of Table 3 present the results. It is clear that the fiscal decentralization effect on the structure of welfare expenditure (CV ratio) is much stronger and more significant in the more competitive states. As shown in Column (1), using $COMP_r$ as a measure to rank states, for most competitive states, the coefficient to $FD$ is 0.7432 and significant at 1 percent level; whereas the coefficient to -0.09 and insignificant in Column (3) for least competitive states.

[4]This ratio is unaffected if we control for a state's land size or population since we divide both the numerator and denominator by the land size or population.

[5]This ratio is unaffected if we control for a state's land size or population since we divide both the numerator and denominator by the land size or population.

Table 3: Interaction between FD, yardstick competition, and CV ratio

| VARIABLES | 15 most competitive | | 15 least competitive | | Entire sample | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Fiscal decentralization | 0.7432*** | 0.5789** | −0.0900 | 0.4929 | 0.0727 | | 0.5018*** | |
| | (0.151) | (0.229) | (0.227) | (0.318) | (0.148) | | (0.185) | |
| Fiscal decentralization (first lag) | | | | | | 0.1375 | | 0.5866*** |
| | | | | | | (0.140) | | (0.163) |
| Welfare expenditure | −0.2923*** | −0.2769*** | −0.2804*** | −0.2195*** | −0.2163*** | −0.2220*** | −0.1991*** | −0.2072*** |
| | (0.036) | (0.056) | (0.032) | (0.033) | (0.023) | (0.022) | (0.022) | (0.022) |
| Yardstick competition (comparability of jurisdictions) | √ | | √ | | −0.5779 | −0.8195 | | |
| | | | | | (0.772) | (0.819) | | |
| Yardstick competition (competitiveness of local governments) | | √ | | √ | | | −0.0006 | −0.0006 |
| | | | | | | | (0.001) | (0.001) |
| Fiscal decentralization × Yardstick competition (comparability of jurisdictions) | | | | | 4.1628* | | | |
| | | | | | (1.853) | | | |
| Fiscal decentralization × Yardstick competition (competitiveness of local governments) | | | | | | | −0.0036* | |
| | | | | | | | (0.003) | |
| Fiscal decentralization (first lag) × Yardstick competition (comparability of jurisdictions) | | | | | | 3.5766* | | |
| | | | | | | (1.692) | | |
| Fiscal decentralization (first lag) × Yardstick competition (competitiveness of local governments) | | | | | | | | −0.0048* |
| | | | | | | | | (0.002) |
| Constant | 0.2590*** | 0.2591*** | 0.3086*** | 0.2328*** | 0.8351*** | 0.6654** | 0.7579*** | 0.6296** |
| | (0.032) | (0.070) | (0.035) | (0.026) | (3.59) | (0.269) | (0.003) | (0.260) |
| AIC | −716.43 | −663.79 | −801.608 | −847.628 | −2464.49 | −1962.63 | −2449.87 | −1957.30 |
| R-square | 0.3188 | 0.5877 | 0.0114 | 0.0636 | 0.0445 | 0.0444 | 0.0529 | 0.0511 |
| Observations | 225 | 225 | 225 | 225 | 720 | 576 | 718 | 574 |

Note: 1. Dependent variable is *CV ratio*.

2. Columns (1) and (2) use the 15 most competitive states, based on two measures of yardstick competition, respectively; columns (3) and (4) use the 15 least competitive states based on two measures of yardstick competition; columns (5) to (8) use the entire sample of 48 states.
3. Columns (5) to (8) include population and share of urban population as additional controlled variables.
4. Standard errors are in parentheses.
5. *** p<0.01, ** p<0.05, * p<0.1

Next, we use the entire sample to examine the interactive effect of fiscal decentralization with yardstick competitiveness by estimating the panel data model (23). The results are given in columns (5) to (8) of Table 3. We see that the interaction terms are strongly positive when using $COMP_r$ and strongly negative when using $COMP_c$ in the models with level and lagged terms of $FD$. In Column (5), when using $COMP_r$ as a measure of yardstick competition (dress-up contest), the coefficient to interaction term $COMP_r \times FD$ is 4.1628 and significant at 10 percent level, however, the coefficient to $FD$ becomes insignificant. This result suggests that the variation in yardstick competition explains a large share of the effect of $FD$, if we compare with the estimation in Table 2, the coefficient to $FD$ is quite significant when the interaction term is not introduced. In Column (6) to (8), we find the same pattern, which again confirms that a stronger yardstick competition leads to a stronger fiscal decentralization effect on the CV ratio. The different significance levels suggest that $COMP_r$ and $COMP_c$ measure the yardstick competition from different perspectives. However, the results from the two measures are generally consistent: a larger degree of fiscal decentralization and more intense yardstick competition are associated with a higher CV ratio.

To summarize, the above analysis shows that a high degree of fiscal decentralization is associated with an expenditure flow from the more visible product (cash assistance) to the less visible product (vendor payments), and the association is even stronger in regions with intenser yardstick competition. This is because to achieve a better image and win more votes, politicians tend to allocate more resources to the more visible project. This dress-up contest is intensified by fiscal decentralization through the channel of yardstick competition. These empirical results thus provide support for our theoretical findings.

#### 2.4.2 Hypothesis II:

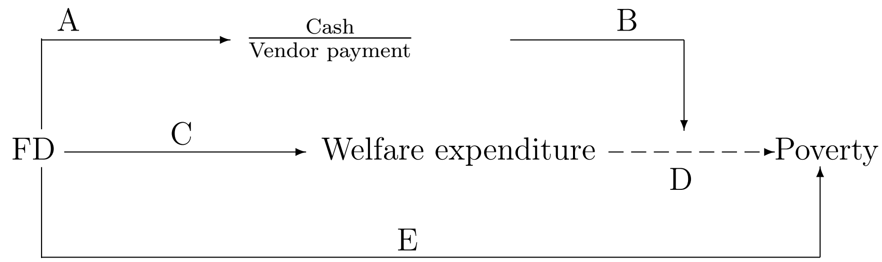
**Effect on Poverty Rate** In this section, we explore the welfare consequences of fiscal decentralization and the underlying mechanism. According to our model, fiscal decentralization causes the structural bias of public expenditure, thus lowers its efficiency and creates social welfare loss. Formally we present the testable prediction as follows.

***Hypothesis II***: As welfare expenditure is being decentralized, the poverty rate will accordingly increase due to distorted expenditure structure.

Poverty rate is defined by the share of people with an income lower than poverty line[6]. We focus on three channels from fiscal decentralization to poverty, which are summarized in Figure 3. First, according to the model, fiscal decentralization can affect poverty by changing the structure of welfare expenditure, i.e. an expenditure flow from less visible goods to more visible goods (Effect A and B). Second, fiscal decentralization can indirectly affect poverty by affecting the size of welfare expenditure (Effect C and D). On the one hand, fiscal decentralization may increase the welfare expenditure due to higher administrative costs; on the other hand, it is likely that welfare expenditure shrinks after fiscal decentralization because the mobility of the poor motivates governments to spend less on welfare to reduce the fiscal burden. It is not clear which effect dominates, and we investigate this in our empirical study. Finally, in addition to the indirect effects, fiscal decentralization can have an impact on poverty through channels other than changing the size and structure of welfare expenditure. We consider other connections between fiscal decentralization and poverty as Effect E. In this section, we focus on the Effect A and B. However, the other channels have to be controlled, not only to avoid omitted variable bias, but also to identify the main channel from the others.

[6]The poverty threshold is calculated and updated by United States Census Bureau each year, consider the basic living standard in each state, county and other geographic division. The standard is based on the Current Population Survey Annual Social and Economic Supplements.

Figure 3: Transmission channels from fiscal decentralization to poverty




**Standard panel data model** To provide empirical evidence to the second hypothesis, we identify the channels separately. We first examine the effect of fiscal decentralization on the size of welfare expenditure (Effect C), then explore the further effect on poverty rate (Effect D and E) and the underlying mechanism (Effect B). To examine the hypothesis, we estimate the following models:

$$TWE_{it} = \alpha_i + \theta_0 + \theta_1 FD_{it} + e_{it} \tag{25}$$

$$p_{it} = \alpha_i + \beta_0 + \beta_1 FD_{it} + \beta_2 TWE_{it} + \beta_3 RCV_{it} + \beta_4 UNEM_{it} + \beta_5 GINI_{it} + \epsilon_{it} \tag{26}$$

where $TWE$ is total welfare expenditure, $p$ is poverty rate, $UNEM$ and $GINI$ represent unemployment rate and Gini index respectively. Model (25) captures the transmission Effect C, while Model (26) captures the direct effect of fiscal decentralization on poverty (Effect E) and the indirect effect through welfare expenditure (Effect D). To examine Effect B, we add $RCV$ as an explanatory variable in regression (26)[7].

Table 4 present the standard fixed-effect estimation results based on Equation (25) and Equation (26). First, we examine the Effect C, D and E, then will focus on Effect B. Column (1) shows that fiscal decentralization has a strongly negative effect on welfare expenditure (Effect C). The estimated coefficient to $FD$ is 1.1031 and significant at 1 percent level.

[7]Effect A has been examined in Section 4.1.

Table 4: Results for separate transmission channels

| VARIABLES | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | Welfare expenditure | Welfare expenditure | Poverty | Poverty | Poverty | Poverty | Poverty |
| Fiscal decentralization | −1.1031*** | | 7.4507*** | 5.4731*** | 4.7246** | 3.3062 | 4.6255* |
| | (0.307) | | (1.642) | (1.570) | (2.061) | (2.147) | (2.537) |
| Fiscal decentralization$_{L1}$ | | −1.0418*** | | | | | |
| | | (0.292) | | | | | |
| Welfare expenditure | | | | −1.7927*** | −2.2731*** | −0.4419 | −2.3902*** |
| | | | | (0.530) | (0.636) | (0.614) | (0.686) |
| Gini index | | | | | −0.1913 | | 0.6650 |
| | | | | | (2.282) | | (2.297) |
| Unemployment rate | | | | | 0.5519 | | 0.5784*** |
| | | | | | (0.091) | | (0.100) |
| Ratio of cash to vender payment | | | | | | 4.5906*** | 0.1824 |
| | | | | | | (1.438) | (1.401) |
| Constant | 0.7922*** | 0.7796*** | 12.037*** | 13.457*** | 10.960*** | 12.142*** | 10.518*** |
| | (0.028) | (0.028) | (0.150) | (0.434) | (1.295) | (0..531) | (1.314) |
| AIC | −857.65 | −634.04 | 3031.54 | 3017.78 | 2656.71 | 2825.66 | 2481.27 |
| R-square | 0.0092 | 0.0146 | 0.0029 | 0.0186 | 0.1357 | 0.0038 | 0.1419 |
| Observations | 768 | 576 | 768 | 768 | 708 | 720 | 660 |

Note: 1. Standard errors are in parentheses.
2. *** p<0.01, ** p<0.05, * p<0.1

Column (2) replaces the contemporary value of $FD$ by its first-order lagged value $FD_{L1}$, and shows a similar result, confirming that a high degree of fiscal decentralization leads to less welfare expenditure. This suggests that the negative effect of fiscal decentralization on welfare expenditure dominates in our case. The empirical finding is consistent with coordination failure model of fiscal decentralization and intergovernmental competition (see Oates (1999)). Since the poor are mobile, an increase of welfare expenditure in one jurisdiction attracts the poor to this region, which adds to the burden of this jurisdiction but reduces the burden of others. Therefore, if most jurisdictions are free riders, then fiscal decentralization leads to a coordination failure and the inefficient provision of public goods.

Column (3) shows a significant and positive overall effect of fiscal decentralization on poverty, challenging the conventional viewpoint that fiscal decentralization improves social welfare. The estimated coefficient to $FD$ is 7.4507 and significant at 1 percent level. This effect is largely reduced (in size and significance) when we include welfare expenditure (column (4)), but remains significant at 1 percent level. Meanwhile the coefficient of welfare expenditure is significantly negative. This suggests that part of the fiscal decentralization effect on poverty is explained by the change of the size of welfare expenditure, and it provides evidence for strong Effect D. These effects are robust when we include the Gini coefficient and unemployment (column (5)).

Columns (6) and (7) show that the fiscal decentralization effect remains positive and significant after we control for welfare expenditure and the CV ratio, and this suggests the existence of Effect E. The strongly positive and robust effect of fiscal decentralization again confirms the dark side of fiscal decentralization on poverty reduction.

After controlling Effect C, D and E, now we focus on Effect B, which is crucial to test Hypothesis II. In Column (6), the CV ratio is positively related to poverty, the estimated coefficient is 4.5906 and significant at 1 percent level. However, this effect becomes insignificant when we add more control variables (Column (7)). This estimation results show that the CV ratio can be positively related to poverty (Effect B), but the delicate coefficient suggests that the standard panel data model may not fully capture the effect of the CV ratio on poverty. Also, we see that including $RCV$ can affect the estimated coefficient of $TWE$, which suggests possible interactions between $RCV$ and $TWE$. As shown in Figure 3, the CV ratio influences poverty by interacting with the effect of welfare expenditure, in another word, CV ratio changes poverty rate by changing the effect of welfare expenditure.

The less significant coefficient in Column (8) does not necessarily indicate that Effect B does not exist. The effect of CV ratio is not monotonic with poverty rate in theory. An excessively large (or small) CV ratio reduces the beneficial effect of welfare expenditure on poverty reduction, while an appropriate value of the ratio can maximize the effect of welfare expenditure. Therefore, Effect B cannot be fully captured by this standard fixed-effect model, and more appropriate methods are required. Another limitation of this panel data model is endogeneity problem. Poverty rate is determined by fiscal decentralization, meanwhile the degree of fiscal decentralization will be also affected by poverty rate, since it has been taken as a policy tool in many states. To estimate Effect B and avoid endogeneity problem, we employ functional coefficient analysis to conduct further research.

**Standard functional coefficient model** Functional coefficient analysis is an effective tool for estimating non-linear model, particularly with an interactive effect (see Fan and Gijbels (1996)). We employ this approach here for three reasons. First, as illustrated above, CV ratio affects poverty rate by changing the effect of welfare expenditure, usually this effect can be captured by an empirical model with interaction term as follows,

$$p_{it} = \alpha_i + \beta_0 + \beta_1 FD_{it} + \beta_2 TWE_{it} + \beta_4 RCV_{it} + \beta_5 TWE_{it} \times RCV_{it} + \sum_{k=1}^{2} \gamma_k x_{it,k} + \epsilon_{it} \quad (27)$$

where $x_{it} = (GINI_{it}, UNEM_{it})$. We argue that this approach does not work here since the effect of CV ratio is supposed to be non-linear. Both extremely large and small values of the CV ratio reflect the distortion of welfare expenditure, and this structural distortion can weaken its effect on poverty reduction. Moreover, the interaction term of $TWE$ and

$RCV$ may result in multi-collinearity, and produce large standard errors[8]. The problem may be even serious if non-linear form of $RCV$ is introduced, e.g. $RCV^2$. Second and importantly, we only know the effect of CV ratio is non-linear, but have no idea about its functional form. By using functional coefficient analysis,we don't have to impose any specific form to the regression. Third, by using functional coefficient analysis, $RCV$ is not an explanatory variable, so the endogeneity concern with $RCV$ is not a problem.

To investigate the impact of each channel and capture the possibly nonlinear relationship between the CV ratio and poverty, we consider the functional coefficient model in which the slope coefficients are allowed to vary over a common variable. Specifically in the following functional coefficient model, we take each coefficient as a function of CV ratio. By estimating the model, we know how CV ratio can affect poverty rate through changing the effects of these variables.

$$p_{it} = \delta_0 + \delta_1 FD_{it} + \delta_2 TWE_{it} + \delta_3 GINI_{it} + \delta_4 UNEM_{it} + \eta_{it} \tag{28}$$

where the slope coefficient $\delta_k$ $(k = 0, 1, \ldots, 4)$ is a continuous function of the CV ratio. The variables $FD$, $TWE$, $GINI$, and $UNEM$ in Equation (28) are the same as in Equation (26)[9]. One advantage of a functional coefficient model is that it allows regressors to be correlated with the smoothing variable $RCV$, and thus avoids the multi-collinearity problem in Equation (27). Moreover, it provides information on how the effect of welfare expenditure varies (possibly nonlinearly) for different values of the CV ratio. The model also allows us to rule out other possible transmission channels from the CV ratio to poverty, if the other functional coefficients ($\delta_1$, $\delta_3$, and $\delta_4$) do not vary over $RCV$ or show no clear trends. For the moment, we consider a standard functional model without an individual-specific effect $\alpha_i$ (pool estimation), and the estimated coefficients are consistent if $\alpha_i$ is assumed to be uncorrelated with the regressors. In next subsection we will allow correlation between $\alpha_i$ and the regressors and estimate a fixed-effect functional coefficient

[8]Actually, estimates of Equation (27) show that $\hat{\beta}_5$ is not significant.

[9]$DINC$ is not included to avoid possible multi-collinearity between $TWE$ and $DINC$, Our robustness check suggests that including $DINC$ does not change the shape of the curves, but just widens the confidence bands.

model.

The parameters in this model are estimated by local linear estimation (Fan and Gijbels (1996); see also Cai, Fan, and Yao (2000)). Thus we specify

$$\delta_k = \delta_{Ck} + \delta_{Sk}(RCV - u_0) \quad (k = 0, 1, \ldots, 4) \tag{29}$$

where $\min(RCV) \leq u_0 \leq \max(RCV)$. The parameters $(\delta_{Ck}, \delta_{Sk})$ are estimated by minimizing the following objective function:

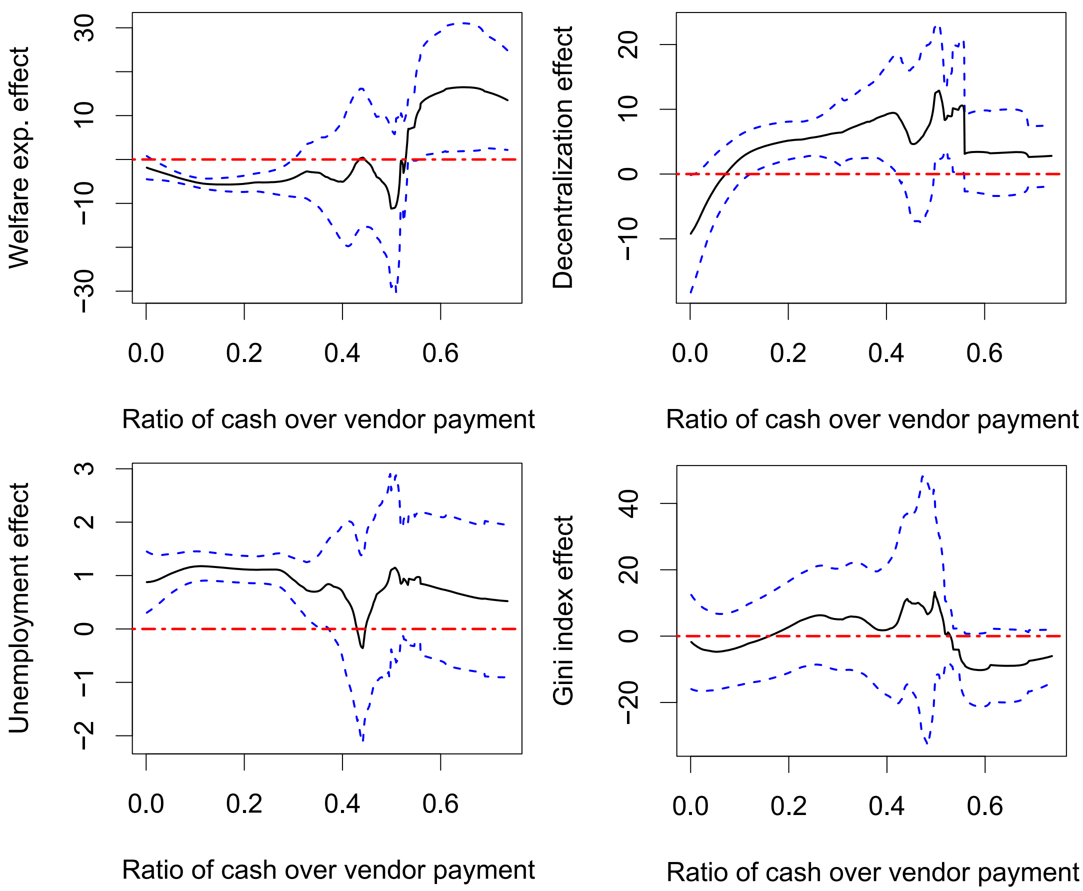
$$\min_{\delta_{Ck}, \delta_{Sk}} \sum_i \sum_t \left( p_{it} - \sum_{k=0}^{4} \{\delta_{Ck} + \delta_{Sk}(RCV_{it} - u_0)\} x_{itk} \right)^2 K_h(RCV_{it} - u_0) \tag{30}$$

where $x_{itk}$ is the $k$th regressor, and $K_h(\cdot) := h^{-1}K(\cdot/h)$ with bandwidth $h$ and kernel function $K(\cdot)$. Various data-driven methods could be used to select the bandwidth, e.g. cross-validation Fan and Gijbels (1996). We choose the bandwidth by minimizing the averaged mean square error, following Cai, Fan, and Yao (2000).

If Hypothesis II holds, the correlation between $RCV$ and the coefficient to welfare expenditure $\delta_2$ is non-linear (Effect B). Above a threshold, the correlation is supposed to be positive, indicating that too much spending on cash assistance program will lower the efficiency of welfare expenditure and increase poverty rate. Since $RCV$ can affect poverty rate only through Effect B, its correlation with other variables are supposed to be insignificant.

Figure 4 shows the slope parameters as a function of the CV ratio. The solid line plots the coefficient estimate, and the dashed lines are $\pm 2 \times$ the bootstrap standard errors (calculated over 200 replications). We see a rough U-shape of the welfare-expenditure effect on poverty (upper-left subfigure). The effect is significantly negative when the proportion of the cash assistance is relatively small, and it becomes stronger (more negative) as the ratio increases to around 0.2. However, when the ratio is more than 0.3, increasing the cash proportion weakens the welfare-expenditure effect on poverty reduction, with wide confidence bands. The effect even becomes weakly positive when the ratio is particularly high. The nonlinear behavior shows that a deviation of the CV ratio from its optimal value, and in particular an increase in its value, can weaken the poverty-reduction effect of welfare expenditure. This provides evidence for Hypothesis II: the efficiency loss caused by an overspending on visible products (Effect B).

Figure 4: Marginal effect of control variables on poverty as function of CV ratio (standard functional coefficient model)




The effect of fiscal decentralization on poverty (upper-right subfigure) is significantly positive for values of $RCV$ from around 0.1 to 0.4, and less significant for larger values. The estimated functional coefficients of the welfare expenditure and $FD$ confirm the results from the standard fixed-effect model, suggesting Effect D and E are both strong. We also see that the curves of fiscal decentralization, unemployment, and the Gini index have no particular shape, suggesting that the CV ratio does not influence poverty through these channels.

**Fixed-effect functional coefficient model** Standard functional coefficient estimation works if the individual-specific effect $\alpha_i$ is independent of the control variables. However, it is possible that an unobserved individual effect $\alpha_i$ is correlated with the control variables, for example, the historical and cultural differences between states (an unobserved individual effect) may affect the government behavior, and thus impact the degree of fiscal decentralization. To allow for possible correlation between the individual-specific effect and the regressors, we estimate a fixed-effect functional coefficient model:

$$p_{it} = \alpha_i + \delta_0 + \delta_1 FD_{it} + \delta_2 TWE_{it} + \delta_3 GINI_{it} + \delta_4 UNEM_{it} + \eta_{it} \tag{31}$$

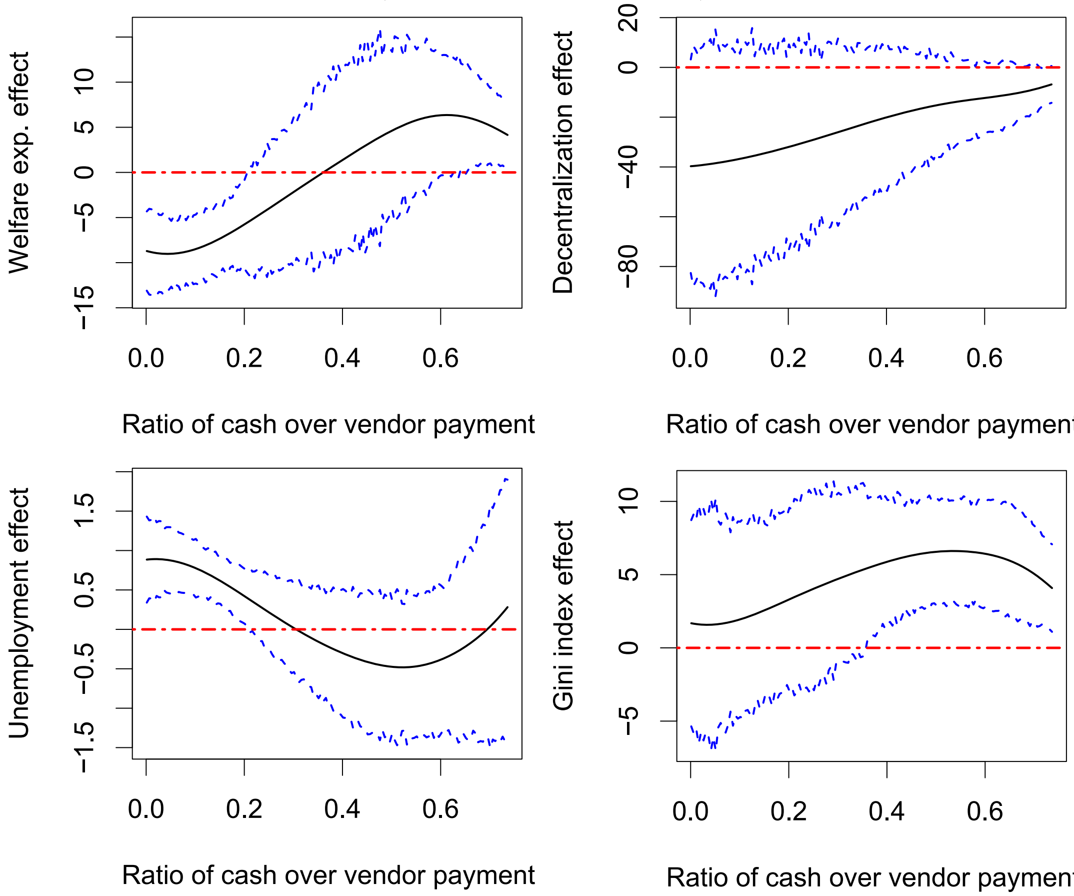
where $\alpha_i$ can be correlated with the regressors in any (unknown) pattern. In a functional coefficient model, the fixed effect cannot be removed by a preliminary step of first-difference or within-transformation of the dependent and independent variables, because the slope coefficients $\delta_k = \delta_k(RCV_{it})$ are no longer constant for all the observations. The transformation based on equations also does not work, because it involves an additive function that impedes kernel-based estimation, and also because it produces an inconsistent estimated coefficient of the time-invariant term (see Sun, Carroll, and Li (2009) for the details). Therefore, we follow Sun, Carroll, and Li (2009) and remove the fixed effects by deducting a smoothed version of the cross-time average from each individual unit. This approach first analytically finds the fixed-effect vector via a weighted least square dummy variable model, and then estimates the functional parameters non-parametrically using a concentrate weighted least square method. To calculate the bootstrap standard error in the panel data model, we follow Kapetanios (2008) and construct bootstrap samples by resampling whole cross-sectional units with replacement (cross-sectional resampling).

Figure 5 presents the fixed-effect functional coefficient estimates for each variable. In general the shape of the curves is similar to those in the standard functional coefficient model. In particular, the trends of the welfare-expenditure effect are consistent with previous finding: welfare expenditure has a significantly negative effect on poverty when the CV ratio is low, but a weakly positive effect when the ratio is high (the U-shaped curve). Also, this effect becomes less significant as the ratio increases. The estimation results provide further evidence to Hypothesis II.

The estimated coefficients of $FD$ are below the zero line; they are much lower than those in the standard panel data model, even though we observe only the upper bound of the confidence interval. Thus, $FD$ has little impact on the poverty rate when we have controlled for the size (Effect C and D) and the structure (Effect A and B) of welfare expenditure. This result suggests that the strong Effect E in standard functional coefficient model can actually be explained by some time-invariant factors in each state. The estimations for unemployment and the Gini index show no particular trends.

To summarize, by using functional coefficient analysis, particularly when we control fixed-effect, the estimation results suggest the structural change of welfare expenditure lowers the efficiency of welfare expenditure, and thus increases poverty rate (Effect B). Meanwhile, the size of welfare expenditure also matters (Effect D). When Effect B and D have been controlled, fiscal decentralization can hardly affect poverty rate (Effect E), in another word, Effect B and D are the main channels through which fiscal decentralization can affect poverty rate. The estimation results do not only provide empirical evidence to Hypothesis II, but also allow us to identify main effect from the rest.

Figure 5: Marginal effect of control variables on poverty as a function of CV ratio (Fixed-effect estimation)




**Robustness check** We investigate the robustness of our results in various ways. First, we focus on the coefficient of $TWE$ and consider different subsets of auxiliary variables $\{FD, UNEM, GINI\}$. The results from both the standard and fixed-effect models show that including different auxiliary variables does not affect the effect of welfare expenditure.

Second, we consider using an alternative data set, namely the local governments' expenditure on cash assistance and vendor payments programs. To ensure that the ratio is well-defined, we assign zero to those observations with no such assistance or payments[10].

[10]Setting these observations to zero cannot distinguish the case with no cash and vendor payments from the case with vendor payments but no cash assistance.

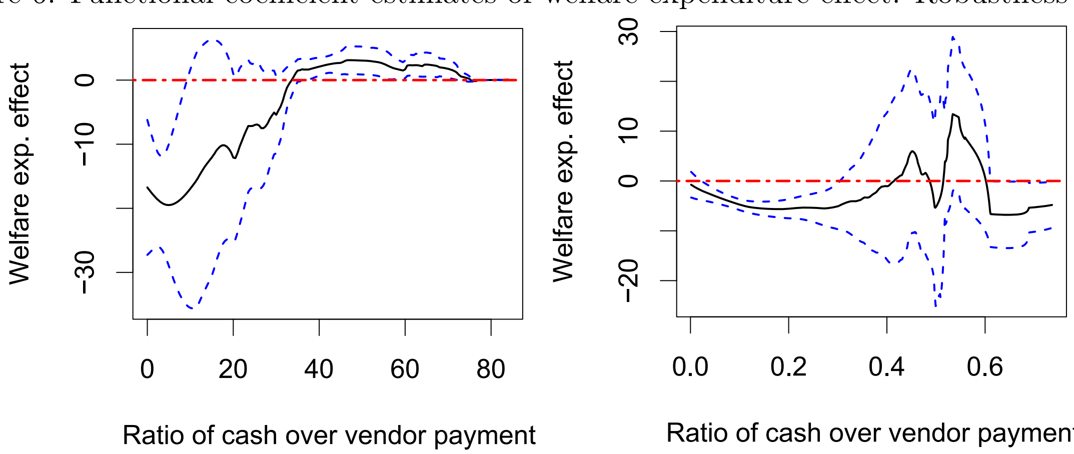
We estimate the functional coefficient model using the local government expenditure. The left panel of Figure 6 shows that the welfare-expenditure effect on poverty is negative when $RCV$ is small but weakly positive when $RCV$ is large. This result is consistent with our previous findings. The larger confidence bands for small values of $RCV$ are partly because we assign zero to those observations with no assistance or payments, which reduces the accuracy.

Finally, we consider the possible effect of lagged variables. This captures the causal effect, and using the lagged value can also reduce the endogeneity to some extent. We consider the following model:

$$p_{it} = \alpha_i + \delta_0 + \delta_1 FD_{i,t-1} + \delta_2 TWE_{i,t-1} + \delta_3 GINI_{it} + \delta_4 UNEM_{it} + \eta_{it} \tag{32}$$

where $\delta_k$ is a function of $RCV_{i,t-1}$. In this model, we take a first-order lag of the control variables $FD$ and $TWE$ together with the smoothing covariate $RCV$, because they are related to the fiscal policies. We estimate Equation (32) using both standard and fixed-effect models, and the right panel of Figure 6 shows that our main results are not affected.

Figure 6: Functional coefficient estimates of welfare-expenditure effect: Robustness check



## 2.5 Conclusion

This paper models and empirically examines the negative side of fiscal decentralization due to dress-up contest. Because of asymmetric information, voters cannot observe politicians' capabilities, but make assessments based on the outcome of public projects. Therefore politicians, under pressure of yardstick competition, are motivated to allocate more resources to more visible projects to improve their public image. We show that the yardstick competition triggered by fiscal decentralization can turn into a competition for a better image, and this contest further causes a structural bias in public expenditure (more expenditure on visible projects) and reduces the efficiency of public expenditure.

Our empirical analysis does not only offer evidence to the distorted structure under fiscal decentralization due to dress-up contest, but also its welfare loss. By testing the first hypothesis, we find that fiscal decentralization significantly reduces the welfare expenditure. In the second part, by using both standard panel data model and functional coefficient model, we find fiscal decentralization further increases poverty as it encourages governments to spend more on visible projects, leading to a higher CV ratio in welfare expenditure. The functional coefficient analysis does not only suggests that an excessively large CV ratio weakens the poverty-reduction effect of welfare expenditure because of the efficiency loss, but also helps to rank the contribution of each channel through which fiscal decentralization can affect poverty rate. Our estimation results provide supporting evidence for the positive effect of fiscal decentralization on poverty, and our results are robust to different model specifications. Unlike previous literature, such as Besley and Coate (1995), both our theoretical and empirical analysis suggests that fiscal decentralization has a dark side that can lead to social welfare loss through a dress-up contest.

Our results have important policy implications. Policymakers, who consider fiscal decentralization to be an efficient policy tool, should also be aware of its dark side. Two methods can help to avoid dress-up contests and their negative effects on social welfare in the course of fiscal decentralization. First, there should be a minimum level of public expenditure on less visible projects, so that the structure of public spending does not become too distorted. Second, an evaluation system could be introduced to increase the visibility of public projects, such as the CPA (comprehensive performance assessment) system used in the UK since 2002. Such an assessment system would allow voters to better evaluate politicians' capabilities.

Further research is needed in several areas. First, endogeneity problem is still a concern when estimating the effect of fiscal decentralization on poverty rate, so a valid instrumental variable is required, meanwhile we will consider functional coefficient estimation in the presence of instrumental variables. Second, there are missing values in the current data set, and a better data set is thus required. Third, better measures of yardstick competition may be required if we attempt to provide further evidence for dress-up contests. Finally, "dress-up contest" will be not only affected by fiscal decentralization, but also many other shocks or policies. For example, the CPA program in UK can significantly affect the "dress-up contest" among local governments; the reform of cadre performance evaluation in China in 2009 can also reshape the dress-up contest in China. In future research, empirical studies can be conducted by using these cases, meanwhile, it will be interesting if the dress-up contest is used to analyze these policies.

# 3 Fertility in Times of AIDS: Adult Mortality, Portfolio Choice and Human Capital Investment[1]

**Abstract:** What happens to fertility decision if adult mortality risk increases? We propose a portfolio choice model based on the "quantity-quality tradeoff" of investing in human capital. Our theory predicts that the impact of such a mortality shock on fertility is heterogeneous across income groups. While rich families expand family size in response to increased adult mortality risks, the reverse is true for poor families. As an implication, we highlight the detrimental effect of adult mortality risks on human capital accumulation and economic growth. We take our theory to (African) data, and find evidence to support key predictions. We hope the model helps to reconcile conflicting empirical evidence regarding the effect of HIV/AIDS on fertility in previous research.

**JEL classification:** *D8, I12, J13*

**Key words:** HIV/AIDS, Fertility, Portfolio, Human Capital Investment

[1]The paper is jointly written by Erwin Bulte and Yang Zhou. We thank German Caruso, Patricio Dalton, Yufeng Huang, Peter Kooreman, Sang Yoon (Tim) Lee, Cezar Santos, Michele Tertilt and Gonzague Vannoorenberghe for some very useful comments and discussions, as well as seminar audiences at Tilburg University, University of Mannheim, ESPE Annual Conference in Braga, RES Conference in Manchester and CSAE Annual Conference in Oxford. Remaining errors are our own.

## 3.1 Introduction

The effect of adult mortality risk on fertility choice is ambiguous from both a theoretical and empirical perspective. While the literature has focused on the effects of adult mortality risk on fertility via changes in life expectancy (Jayachandran and Lleras-Muney (2009) and Zhang and Zhang (2005)) or labor supply (Young (2005)), other potentially important factors such as the return to human capital investment have received only scant attention. The empirical literature tends to focus on the HIV/AIDS epidemic as a case to explore fertility choices under adult mortality risks. However, this literature has not reached a consensus, and the empirical evidence is mixed, or even conflicting[2]. While some studies find that fertility decreases in response to increased mortality risk (Young (2005) and Young (2007)), other studies find no significant effect, or argue that behavioral responses cause an increase in fertility rates (Fortson (2009), Kalemli-Ozcan and Turan (2011) and Juhn, Kalemli-Ozcan, and Turan (2013)).

The objective of this paper is two-fold. First, we develop a tractable portfolio model to study fertility choice under uncertainty of human capital investment. The model replicates the stylized quantity-quality tradeoff, and predicts differential fertility responses across income groups. In the model, we highlight the detrimental effect of adult mortality risks on human capital accumulation and economic growth. Second, we empirically test our model using the case of the HIV/AIDS epidemic in Africa. Based on both country-level and individual-level data, we find empirical support for key model predictions. Importantly, our empirical findings may help reconcile conflicting empirical findings about the effect of HIV/AIDS on fertility in previous literature. As discussed in Kalemli-Ozcan (2012), differences in econometric outcomes in existing studies may be attributed to differences

[2]Most studies use similar empirical strategy and the same data base (The Demographic and Health Surveys, DHS), but the sample countries may be different.

in HIV prevalence data, variation in econometric specifications, and variation in countries included in the sample. In this paper we focus on the latter possibility, and consider the possibility that the relation between HIV/AIDS and fertility is heterogeneous - varying across the African continent in a systematic fashion.

Our model is based on the assumption that children are a risky asset and that investment in children's human capital is not simply driven by parental altruism. Since most developing countries lack effective social security, parents count on transfers from their offspring to secure their old day. They invest in children as part of an overall portfolio consisting of human capital and other assets. When adult mortality risk increases, e.g. due to the diffusion of HIV/AIDS, the expected return to investments in children's human capital goes down. Depending on parental risk preferences, this may have different consequences. We assume risk preferences vary across income groups, and that rich families are better able to tolerate risk than poor families. The result is heterogeneous fertility responses across income groups, so existing (cross-country) studies seeking to tease out average effects may obscure important underlying patterns and relations in the data. While our theory is framed in terms of the HIV/AIDS mortality shock, we emphasize the intuition is more general and may also be used to understand the impact of positive shocks to longevity, such as eventuating from new developments in medicine.

As an implication, our model suggests adult mortality risks have destructive impacts on economic growth, due to uncertainty of human capital investment, particularly in the context of developing countries. Unlike Voth (2013) and Young (2005), which emphasize that adult mortality risks (e.g. black death or HIV/AIDS) may increase return to human capital investment by reducing labor supply, in this paper, we highlight its detrimental effect on human capital accumulation. Due to the increased uncertainty, parents are reluctant to invest in their children. This destruction of human capital may particularly drag some relatively rich countries back to "Malthusian regime" from "Post Malthusian regime" (cf. "Unified growth theory" in Weil and Galor (1999)). As a result, it may slow down economic growth, even trap a country "Malthusian regime".

We use country-level and individual-level data from a sample of African countries to test two theoretical predictions of the model. First, we test whether people in high-income groups tend to increase fertility after the epidemic of HIV/AIDS, and whether people in low income groups tend to shrink their family size. This prediction is supported by the data. Second, we test whether both rich and poor households reduce human capital investment after the shock. This prediction is in line with the estimation results in Fortson (2011), but stands in contrast with predictions in Young (2005). The reduction in fertility caused by HIV/AIDS may not result in higher education levels, as predicted in standard "quantity-quality tradeoff" model, since the enhanced risk implied by higher adult mortality discourages investments in schooling.

This paper fits into the recent literature on the effects of mortality risks on fertility choice, and is related to several other strands of the literature. First, following Jayachandran and Lleras-Muney (2009), Zhang and Zhang (2005) and Young (2005), this paper sheds light on the fertility responses to adult mortality risk (rather than infant mortality risk). While previous papers emphasize the importance of life expectancy or labor supply, the present paper highlights the role of risky human capital investment. Second, the model proposed here builds on the literature studying fertility choice and inter-generational transfers (e.g. Gete and Porchia (2011), Portner (2001) and Chakraborty and Das (2005)). One common feature is to treat children as assets rather than consumption goods. Because we introduce the risk of investing in assets, our model not only derives implications for the mortality-fertility linkage, but also replicates several stylized facts in fertility theory, see De La Croix and Doepke (2003). Third, this paper relates to work on the effect of HIV/AIDS on fertility choice, such as Young (2005), Kalemli-Ozcan and Turan (2011), and Fink and Linnemayr (2008), and employs the empirical strategy in Fortson (2009) and Fortson (2011).

The paper is organized as follows. In section 2 we present our theoretical model, and derive key testable implications. In section 3, we introduce the background of HIV/AIDS epidemic in Africa and argue why it can be used as a case of adult mortality shock. Section 3 also contains our empirical strategy. Section 4 presents the estimation results, and Section 5 concludes.

## 3.2 Model

We start our theoretical analysis with the basic setup of the portfolio model and derive optimal fertility and human capital levels. We then introduce an adult mortality shock, and probe the fertility response of rich and poor households respectively. Next, we aggregate these individual fertility responses, and show the heterogeneous effects of adult mortality risks on the total fertility rate (TFR) over aggregate income levels.

### 3.2.1 Basic Setup: Fertility Choice

Many models of fertility choice view children as a consumption good (e.g. Becker and Lewis (1973), Wolpin (1984) and Conde-Ruiz, GimeNez, and PeRez-Nievas (2009)), but investments in human capital are not simply driven by parental altruism. They also reflect the need to provide security for old age (Neher (1971) and Bental (1989)). As in Defo (2009) and Aboderin (2006), "customarily, in developing countries, families have carried the full responsibility and have been the mainstay of support for older people unable to sustain themselves. The filial obligation of younger generation kin, especially adult children, towards their elders has been enshrined in societies' moral codes and in many African societies is expressed in traditional proverbs." Therefore, following Gete and Porchia (2011), Portner (2001) and Chakraborty and Das (2005), we assume parents invest in a portfolio consisting of children and other kinds of assets, perhaps including stocks, savings, or a salaried job. But the return to investing time and money in children is not risk-less – children may get injured or may even die before providing support to their aged parents. As the risk implied by investing in children goes up, parents will adjust their investment strategy, and increase investment in other assets.

Assume there are two kinds of children —— a "high-quality" child ($H$) and a "low-quality" child ($L$), where quality simply reflects investment in human capital before maturity. The high-quality child requires more investment, and will produce a higher return (in case of success). However, the loss is also higher in case of failure, such as pre-mature death. Therefore the variance of the high child's return is larger. The low-quality child, instead, requires little investment in human capital, and yields a relatively low but stable return.

Following studies on the sheepskin effect (e.g. Jaeger and Page (1996)), we treat human capital investment as a discrete choice, rather than a continuous one. In terms of returns to schooling, it makes relatively little difference to invest in an extra year of schooling, unless a credential is achieved. For example in Africa, most parents only have to decide whether to send their children through primary (or secondary) school, or not. The primary school completion rate in Africa in 2009 was only 67%, and only half these pupils have a chance of transitioning to lower secondary school[3].

[3] Global Education Digest (2011), regional profile: Sub-Saharan Africa. UNESCO Institute of Statistics. http://www.uis.unesco.org/Education/Documents/GED2011_SSA_RP_EN.pdf

Following portfolio theory (see Cochrane (2009)), we capture the fertility decision of an agent and the effect of adult mortality risks in a two-period model. In period $t$, the agent makes investment decision given her expectation of future return, the quantity and quality of children are accordingly decided in this period. In period $t+1$, the agent can obtain return of human capital investment from children, when they've grown up. So in the first period, an agent optimizes the expected utility of an investment portfolio, which consists of human capital investment and other kinds of assets. Specifically, consider an agent with mean-variance utility preferences. For simplicity, and without loss of generality, assume her portfolio consists of two assets: a risky asset, children, and a risk-free asset, possibly a salaried job or accumulated savings. The utility maximization problem is given by:

$$\max_{\alpha_t} \quad \mathbf{E}_t(r_{p,t+1}) - \tfrac{\theta(w_t)}{2}\sigma^2_{p,t+1} \tag{1}$$

where $r_{p,t+1} = \alpha_t r_{t+1} + (1-\alpha)\, r_{f,t+1}(w_t)$, and $w_t$ is initial wealth of the parents, which can be taken as both human and physical capital. $\mathbf{E}_t(r_{p,t+1})$ and $\sigma_{p,t+1}$ are the mean and variance of return to the portfolio; $r_{t+1}$ is the return on raising children; and $r_{f,t+1}(w_t)$ is the risk-free rate, which we treat as an increasing deterministic function of $w_t$ (reflecting that high human capital facilitates access to high-return investment opportunities, or better salaried jobs, c.f. Claessens (2006) and Sahn and Alderman (1988)). The choice variable $\alpha_t$ is the share of investment in children in the asset portfolio, so the share of risk-free assets is given by $(1-\alpha_t)$.

We assume risk attitudes of agents are heterogeneous over income groups, compared with rich people, poor people are more risk averse. Thus the coefficient of relative risk aversion, $\theta$ is assumed to be a decreasing function of wealth. The income-varying risk preference is generated from both $r_{f,t+1}(w_t)$ and $\theta(w_t)$ (i.e. DRRA utility function, cf. Ogaki and Zhang (2001)). We make the assumption based on several empirical studies in developing countries. The field experiments in Ehiopia and West Africa (Yesuf and Bluffstone (2009) and Liebenehm and Waibel (2014)) suggest that the constraints in wealth is associated with greater risk aversion. Based on survey data in Vietnam, Tanaka, Camerer, and Nguyen (2010) shows that people living in wealthy villages are less risk averse than in poor villages.

Assume

$$r_{t+1}|\mathcal{F}_t, \sim N(\mu, \sigma^2). \tag{2}$$

given $r_{p,t+1} = \alpha_t r_{t+1} + (1-\alpha)\, r_{f,t+1}(w_t)$, we have,

$$r_{p,t+1}|\mathcal{F}_t, \sim N(\alpha_t \mu + (1-\alpha)\, r_{f,t+1}(w_t), \quad \alpha_t^2 \sigma^2). \tag{3}$$

where $\mathcal{F}_t$ represents the information set up to time $t$. The distribution of the return on the portfolio allows us to rewrite the optimization problem as:

$$\max_{\alpha_t} \quad (\alpha_t \mu + (1-\alpha)\, r_{f,t+1}(w_t)) - \frac{\theta(w_t)}{2} \cdot (\alpha\sigma)^2 \tag{4}$$

Solving the optimization problem with respect to $\alpha_t$ yields,

$$\alpha_t = \frac{\mu - r_{f,t+1}(w_t)}{\theta(w_t)\sigma^2} = \frac{\mu - r_{f,t+1}(w_t)}{\sigma} \cdot \frac{1}{\theta(w_t)\sigma} = \frac{\lambda(w_t)}{\theta(w_t)\sigma}. \tag{5}$$

where $\lambda = {}^{\mu - r_{f,t+1}(w_t)}/_{\sigma}$ is the so-called Sharpe ratio for investments in (the human capital of) children, measuring the marginal benefits from taking one unit of risk. Reflecting the dependence of the risk free asset on wealth, this ratio is a decreasing function of wealth, so we assume:

$$\begin{aligned} \tfrac{\partial r_{f,t+1}}{\partial w_t} &> 0, \\ \tfrac{\partial \lambda}{\partial w_t} &< 0, \\ \tfrac{\partial \theta}{\partial w_t} &< 0. \end{aligned} \tag{6}$$

Hence, the fraction of wealth allocated to bearing and raising children, $\alpha_t$, increases with the attractiveness of having off-spring, as captured by the Sharpe ratio ($\lambda$), but decreases with its riskiness ($\sigma$) and the agent's degree of risk aversion ($\theta$)[4]. As both $\lambda$ and $\theta$ decrease with wealth levels, it is not evident how wealth affects investments in children.

Once agents choose the optimal investment in each kind of children $\alpha_t w_t$, they have chosen the children number of each kind, given the cost of raising a child, $C_t$. The number of children is given by

$$n_t = \frac{\alpha_t w_t}{C_t} = \frac{w_t \lambda(w_t)}{C_t \theta(w_t)\sigma}. \tag{7}$$

Since there are two kinds of children, high-quality child ($H$) and low-quality child ($L$), the number of children[5] is

$$n_t = n_{H,t} + n_{L,t}. \tag{8}$$

Denote investment costs by $C_t$ where $C_H > C_L$. The return to these kinds is defined as $r_{t+1}$, where $r_{H,t+1} \sim N(\mu_H, \sigma_H)$ and $r_{L,t+1} \sim N(\mu_L, \sigma_L)$, and where $\mu_H > \mu_L$ and $\sigma_H > \sigma_L$[6]. In words, raising high-quality child yields higher expected returns, but also implies incurring higher costs and generating higher risks (for example due to pre-maturity death). As a benchmark model we assume children have to be treated equally, so that a family can have high-quality or low-quality child, but not both[7]. The optimal number of kind-specific child

[4]Given the risk of human capital investment, which is captured by $\sigma$, higher relative return to risk-free asset ($\lambda$) attracts more investment in children. Other things being equal, a higher riskiness ($\sigma$) may disincentive people from investing in children's human capital, a higher sensitivity ($\theta$) to risk plays a similar role.

[5]We (implicitly) assume that the number of children is not necessary to be integer in the model, so a potential problem is that the current result might be deviated from the condition by using integer optimization. However, the deviation will be very limited on the aggregate level. We do not only derive our main results on aggregate level, but also test these predictions by country level data.

[6]Throughout this paper, we use subscript "$L$" to represent variables associated with low-quality children and subscript "$H$" to represent variables associated with high-quality children.

[7]We obtain similar results when we loose the assumption that children are equally treated.

is now given by:

$$\begin{aligned} n_{H,t} &= \frac{w_t \lambda_H(w_t)}{C_{H,t}\theta(w_t)\sigma_H}, \\ n_{L,t} &= \frac{w_t \lambda_L(w_t)}{C_{L,t}\theta(w_t)\sigma_L}. \end{aligned} \tag{9}$$

So there are two kinds of portfolios: the one consisting of $H$- quality child (and the risk-free asset), or $L$ - quality child (and the risk-free asset). Expected utility of these portfolios is given by

$$\begin{aligned} \mathbf{E}_t U_H^* &= r_{f,t+1}(w_t) + \frac{\lambda_H(w_t)^2}{2\theta(w_t)} \\ \mathbf{E}_t U_L^* &= r_{f,t+1}(w_t) + \frac{\lambda_L(w_t)^2}{2\theta(w_t)} \end{aligned} . \tag{10}$$

So kind of child is simply chosen by comparing these expected utilities. **Proposition 1** characterizes the results.

**Proposition 1.** *If $\lambda_H > \lambda_L$, the agent chooses high-quality children; If $\lambda_H < \lambda_L$, she chooses low-quality children; if $\lambda_H = \lambda_L$, she is indifferent between high-quality and low-quality children.*

This proposition states that the decision on the kind of offspring depends on the attractiveness of children as an investment opportunity, as reflected by the Sharpe ratio. Given the kind of child, the optimal number of children is accordingly given by Equation (9).

**Proposition 2.** *If $\lambda_H < \lambda_H^\star$, then $n_L > n_H$. Otherwise, the relationship between $n_L$ and $n_H$ is ambiguous.*

We can prove the proposition by considering Equation (9). $n_L > n_H$ indicates $\lambda_H < \lambda_L \cdot \frac{C_H \sigma_H}{C_L \sigma_L} = \lambda_H^\star$, where $\lambda_H^\star$ is the threshold value of $\lambda_H$. When the relative return of the low-quality child compared to the risk-free asset is sufficiently high, parents choosing the low-quality child will choose to have greater fertility than parents choosing the high-quality child. This implies the quantity-quality tradeoff, but the mechanism is different than provided by Becker and Lewis (1973). Since $C_H > C_L$ and $\sigma_H > \sigma_L$, a simple implication is when parents choose low-quality children ($\lambda_H < \lambda_L$), $n_L > n_H$. However, when the low-quality child is not sufficiently attractive ($\lambda_L$ is "low"), even for $C_H > C_L$, it holds that $n_L$ can be smaller than $n_H$. The reason is that people would rather invest in other assets than in low-quality child. If so, the quantity-quality tradeoff need not hold.

Figure 1 shows how optimal fertility varies with wealth. For low wealth levels, $\lambda_H < \lambda_L$, the agent chooses low-quality offspring. As wealth increases, so does fertility, reflecting greater ability to invest in low-quality children. However, Sharpe ratios also change, as depicted in Figure 2. Specifically, both Sharpe ratios decrease with the wealth level, but the high-quality ratio falls more slowly due to the larger variance of high-quality child's return. Eventually the two curves (may) intersect, so that $\lambda_H = \lambda_L$, and agents switch from low to high-quality offspring. Fertility drops abruptly (in case of a quantity-quality tradeoff). For the rich, who earn a relatively high return on their risk-free assets, only high-quality children are a sufficiently attractive investment opportunity. Further increasing wealth implies that, again, fertility increases. This reflects that wealthier households can afford to invest more in offspring.

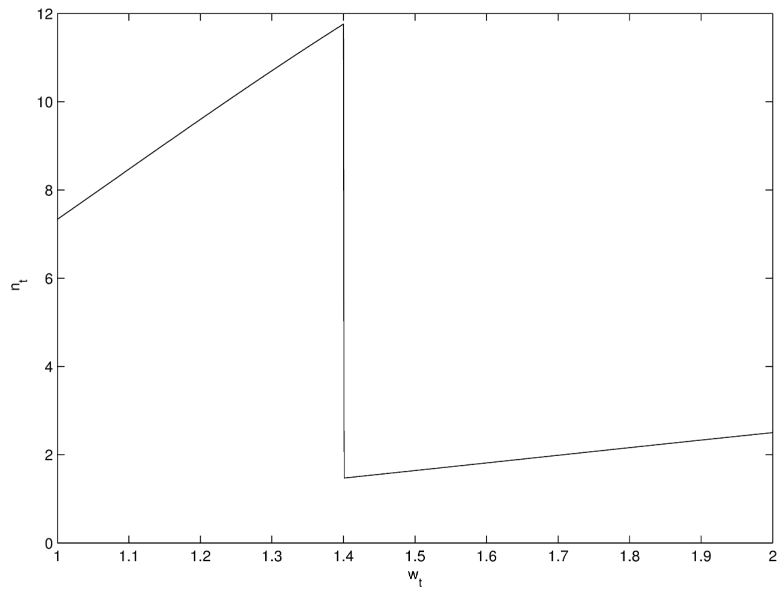



Figure 1: Number of children for agents with different wealth levels.

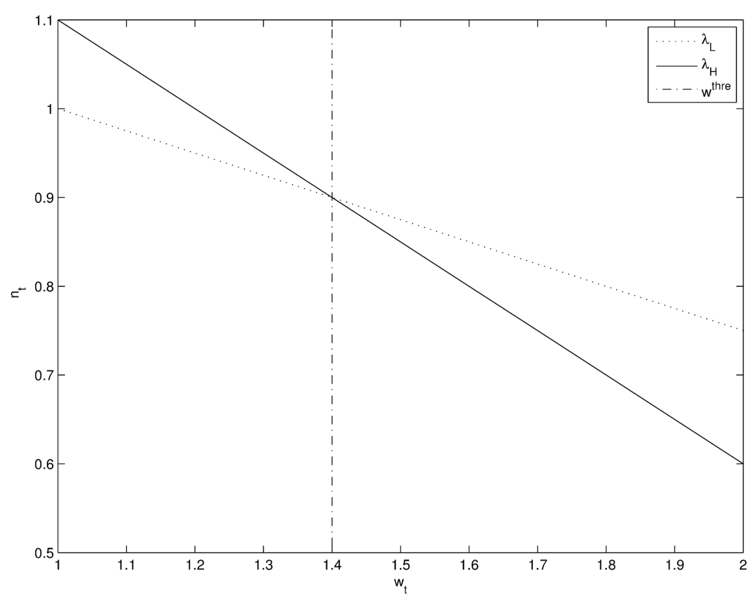



Figure 2: Sharpe ratios for different individual wealth. $\lambda_H$ (dotted line) and $\lambda_L$ (solid line) are Sharpe ratios for high-quality and low-quality children, respectively. $w^{thre}$ is the critical wealth level for kind-switching.

### 3.2.2 Individual Response to a Shock of Adult Mortality Risks

Before exploring the fertility response to an adult mortality shock, we first probe the effect of such a shock on human capital formation. The adult mortality rate directly reduces the survival rate of adults, lowering the probability of high-return events and increasing the probability of low-return events. Assume the adult mortality shock shifts the entire distribution to the left[8]. Suppose the reduction in probability of surviving is the same for high-quality and low-quality children after the shock, then

$$\triangle \Pr(H) = \triangle \Pr(L). \tag{11}$$

We can prove that, since

$$\sigma_H > \sigma_L. \tag{12}$$

the reduction in the mean of high-quality children's return, $m_H$ must be larger than the low-quality child $m_L$, so that,

$$m_H > m_L. \tag{13}$$

The proof is in the Appendix. The intuition is that a larger variance indicates a bigger loss in case of pre-mature mortality. When the shock increases the probability of such a "bad" outcome, the reduction of expected returns must be larger. In this paper we focus on the case that $\triangle \Pr(H) = \triangle \Pr(L)$, which appears consistent with the HIV/AIDS epi-

[8]The shock changes the location rather than scale of the distribution of the return of human capital investment

demic which does not seem to discriminate across education levels. de Walque (2009) and Gregson, Waddell, and Chandiwana (2001)) show that the effect of HIV/AIDS epidemic on adult mortality rate of well-educated people is close to that of poor-educated ones. In Fortson (2008), educated people are actually more likely to be infected. Although low-educated people suffer from poor protection and cure of HIV infection, well-educated have better access to risky sexual behavior (e.g. drug abuse or prostitution). Mishra et al (2007) suggests that HIV infection is not strongly correlated with status of wealth. Even if the survival rate is higher for the rich than the poor (e.g., due to access to better treatment), the costs of cure and care will reduce the return to earlier human capital investment[9].

Next, we assume that[10]

$$m_H = cm_L \ , \tag{14}$$

and

$$\begin{array}{c} r_f(w) = a + bw \\ \theta(w) = \frac{d}{w} \end{array} \ . \tag{15}$$

where $a > 0$, $b > 0$, $c > 1$, and $d > 0$. The Sharpe ratios before and after the mortality shock for both kinds are given by:

$$\begin{array}{cc} \lambda_H^B(w) = \frac{\mu_H - a - bw}{\sigma_H}, & \lambda_L^B(w) = \frac{\mu_L - a - bw}{\sigma_L}; \\ \lambda_H^A(w) = \frac{\mu_H - cm_L - a - bw}{\sigma_H}, & \lambda_L^A(w) = \frac{\mu_L - m_L - a - bw}{\sigma_L}. \end{array} \tag{16}$$

[9]The conclusions will hold in many cases when $\triangle \Pr(H) < \triangle \Pr(L)$.

[10]To ease the notation, we suppress the time representation "$t$" in what follows.

where $\lambda_H^B$ and $\lambda_L^B$ represent the before-shock Sharpe ratios for the high and low-quality kinds, and where $\lambda_H^A$ and $\lambda_L^A$ denote the after-shock Sharpe ratios. In what follows we will consistently use the superscript $B$ ($A$) to denote before (after) mortality shock variables. The critical wealth level where parents "switch" from the low to the high-quality offspring is obtained by equating $\lambda_H^B$ and $\lambda_L^B$ ($\lambda_H^A$ and $\lambda_L^A$ after the shock), so we get:

$$\begin{array}{c} \hat{w}^B = \frac{\sigma_H\mu_L - \sigma_L\mu_H}{b(\sigma_H - \sigma_L)} - \frac{a}{b} \\ \hat{w}^A = \frac{\sigma_H\mu_L - \sigma_L\mu_H + (c\sigma_L - \sigma_H)m_L}{b(\sigma_H - \sigma_L)} - \frac{a}{b} \end{array} . \tag{17}$$

When $\triangle \Pr(H) = \triangle \Pr(L)$, we can prove that $c\sigma_L - \sigma_H > 0$, so $\hat{w}^B < \hat{w}^A$, which ensures that after the mortality shock some parents switch from the high to the low-quality child but not the other way around. The result is summarized as follows,

**Proposition 3.** *When $\triangle \Pr(H) = \triangle \Pr(L)$, the mortality shock will cause poor households to reduce their fertility ($w < \hat{w}^B$), and increase fertility of rich households ($w < \left[\hat{w}^B,\ \hat{w}^A\right]$).*

The kind-switching region induced by mortality shocks is $\left[\hat{w}^B,\ \hat{w}^A\right]$ and the width of the region, $I$, is given by,

$$I = \frac{(c\sigma_L - \sigma_H)m_L}{b(\sigma_H - \sigma_L)} = \frac{(c-1)\sigma_L m_L}{bD_\sigma} - \frac{m_L}{b}. \tag{18}$$

where $D_\sigma = \sigma_H - \sigma_L$. It is easy to verify $I$ is increasing in $c$ and decreasing in both $D_\sigma$ and $b$. The intuition is straight-forward. When a shock diminishes the attractiveness of high-quality children, some parents will switch from high to low-quality offspring. They will re-allocate their investment among risky and risk-free assets.

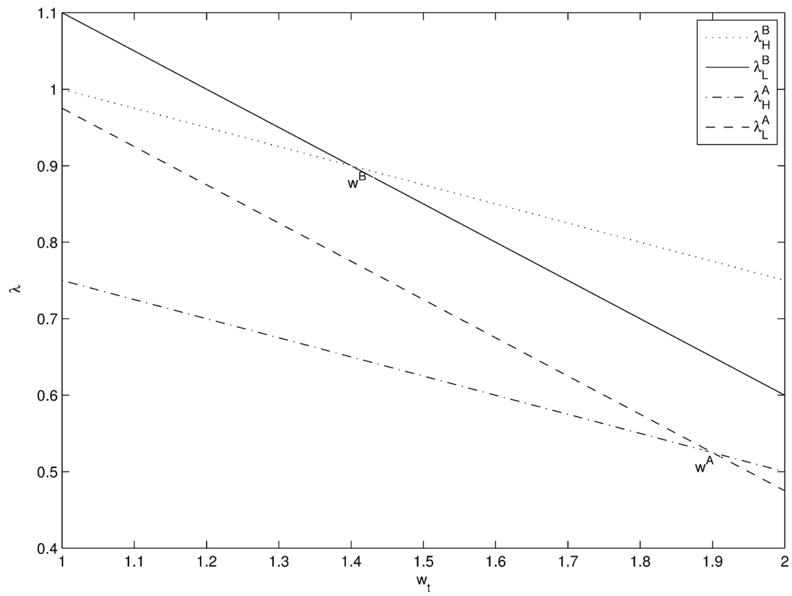



Figure 3: Sharpe ratios for different individual wealth and effect of mortality shock. $\lambda_H^B$ (dotted line) and $\lambda_L^B$ (solid line) are the Sharpe ratios for high-quality and low-quality children before the mortality shock. $\lambda_H^A$ (dash-dotted line) and $\lambda_L^A$ (dashed line) are the Sharpe ratios for high-quality and low-quality children after the mortality shock. $w^B$ ($w^A$) is the critical individual wealth level for kind-switching before (after) the mortality shock.

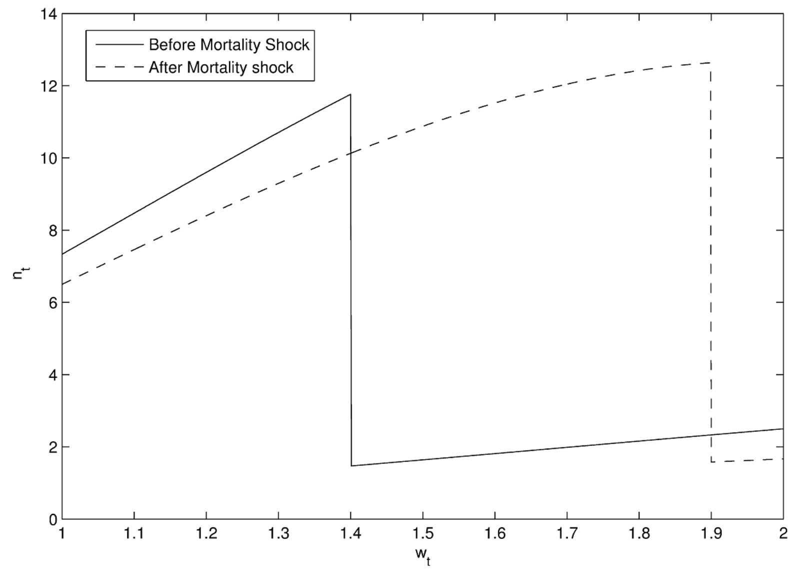



Figure 4: Fertility responses to adult mortality shock. The solid line represents the fertility choice before the shock, the case after shock is shown by the dash-dotted line. The poor and rich families will keep their choice of children's quality but reduce number. The intermediate families will switch kind from high to low, then expand family size given quantity-quality tradeoff.

Figure 3 illustrates how kind-switching is affected by the mortality shock. The kind-switching point (or intersection of the two Sharpe ratios) moves to the right following the mortality shock, occurring at a greater level of wealth. Hence, after the shock, poor people will reduce their fertility (reflecting lower attractiveness of investing in children), and instead invest more in the risk-free asset. Rich people will adopt a similar strategy in response to the lower expected return of high-quality children. However, as shown in Figure 4, an intermediately wealthy fraction of the population, who is (almost) indifferent between kinds, switches its investment strategy in response to the mortality shock and opts for low-quality offspring rather than the high-quality child. These households will actually increase their fertility to guarantee the return of their human capital investment[11].

[11]We are aware that in reality, people may be hard to make fertility decision by perfectly following portfolio theory. So in this paper, we borrow portfolio model only attempting to capture the investment decision about (risky) human capital, and the responses when people face the rising uncertainty in spending on children.

#### 3.2.3 Aggregating Responses to a Shock of Adult Mortality Risks

We now turn to the aggregate fertility response to a mortality shock, paying special attention to the pivotal role of wealth as a determinant of investments in human capital. For simplicity, assume wealth in a country is uniformly distributed; $w \in [\underline{w}, \bar{w}]$. In our empirical study below, we will measure wealth by income per capita, so country size does not matter. We can therefore normalize $\bar{w} - \underline{w}$ to one, so that aggregate wealth of a country with upper bound $\bar{w}$ is given by,

$$W(\bar{w}) = \int_{\bar{w}-1}^{\bar{w}} w\mathbf{d}w = \bar{w} - \frac{1}{2}. \tag{19}$$

Hence, there is a one to one correspondence between the upper bound, $\bar{w}$ and the total wealth of the country, $W$. Given the specific functional form in Equation (14) and (15), we can aggregate total fertility number in a country by integrating number of children in each family (Equation (9)), so that we have

$$N = \begin{cases} \frac{1}{dC_L\sigma_L^2}\int_{\bar{w}-1}^{\bar{w}} w^2(\mu_L - a - bw)\mathbf{d}w, & \text{if} \quad \bar{w} \le \hat{w}^B; \\ \begin{array}{l} \frac{1}{dC_L\sigma_L^2}\int_{\bar{w}-1}^{\hat{w}^B} w^2(\mu_L - a - bw)\mathbf{d}w \\ \qquad +\frac{1}{dC_H\sigma_H^2}\int_{\hat{w}^B}^{\bar{w}} w^2(\mu_H - a - bw)\mathbf{d}w \end{array}, & \text{if} \quad \hat{w}^B < \bar{w} \le \hat{w}^B + 1; \\ \frac{1}{dC_H\sigma_H^2}\int_{\bar{w}-1}^{\bar{w}} w^2(\mu_H - a - bw)\mathbf{d}w, & \text{if} \quad \bar{w} > \hat{w}^B + 1. \end{cases} \tag{20}$$

This outcome is graphically depicted in Figure 5. Similar to the pattern of fertility choice at the individual level, we find that as aggregate wealth levels increase, the total fertility rate (TFR) first increases. All the children are of the low-quality, reflecting that the high-quality child is too risky to invest in. However, eventually TFR decreases, as more and more families switch to high-quality offspring. Given their budget constraint, those families will reduce their fertility. Finally, for wealthy countries, almost all people are sufficiently rich to afford high-quality children, and the TFR rises again with aggregate wealth. These dynamics capture the interplay between the direct income effect (raising demand for offspring) as well as the indirect effect via kind-switching.

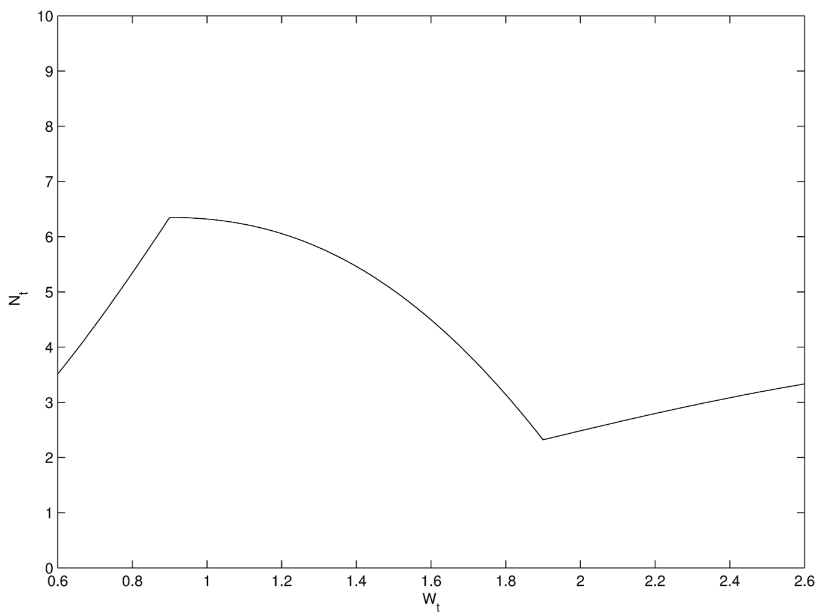



Figure 5: Aggregate fertility for countries with different wealth.

We next consider how an adult mortality shock, such as the HIV/AIDS epidemic, affects fertility accounting for heterogeneous effects over aggregate wealth levels. Figure 6 shows aggregate fertility for countries with different levels of wealth, before and after the mortality shock. $N^B$ and $N^A$, are the TFR of countries before and after the mortality shock. $\hat{W}^B$ and $\hat{W}^A$ mark the countries where the TFR starts to fall because of the quantity-quality tradeoff before and after the shock, respectively.

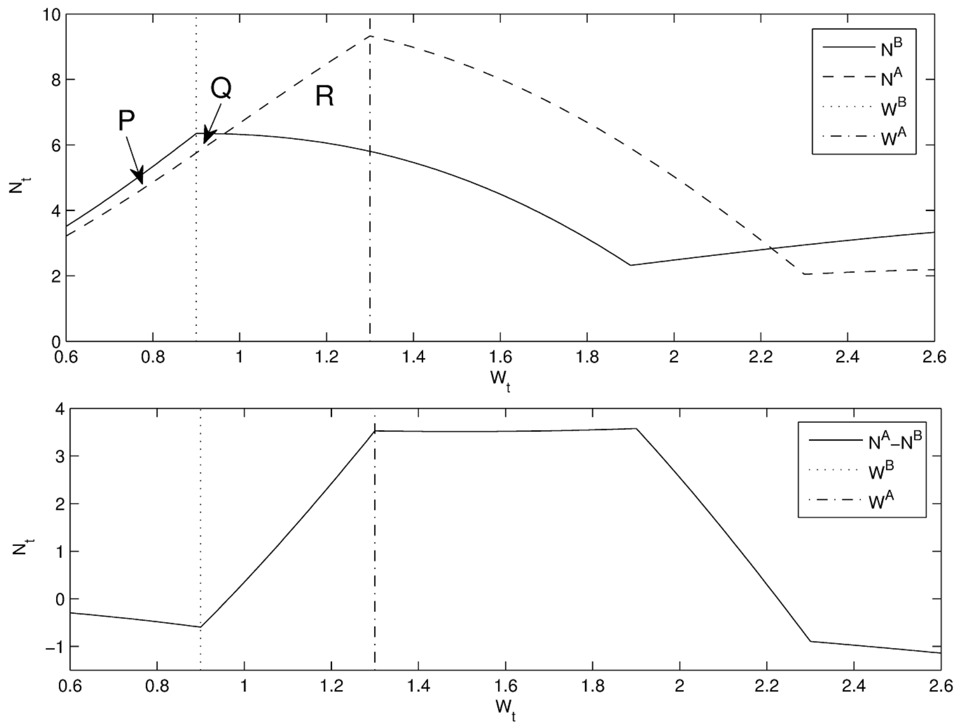



Figure 6: Aggregate fertility for countries with different wealth before and after the mortality shock. $N^B$ (solid line) and $N^A$ (dashed line) are the aggregate fertility before and after the mortality shock. $W^B$ (dotted line) and $W^A$ (dash-dotted line) are the critical aggregate wealth levels for kind-switching before and after the mortality shock.

As shown in the top panel, an adult mortality shock moves the entire fertility distribution to the right. In the bottom panel we summarize the implications in terms of changes in fertility (i.e., fertility after the shock minus fertility before the shock). In Sectors P and Q, people reduce fertility after the shock, reflecting that human capital investment is less profitable. But in Sector R, fertility increases because of kind-switching. The net effect, as shown in the bottom panel, may be positive or negative, depending on wealth levels.

**Proposition 4.** *When $m_l^{thre} < m_L < m_u^{thre}$, the mortality shock decreases TFR of low-income countries ($W_t < W^T$), while increases TFR of high-income countries ($W_t \in \left[W^T, \hat{W}^A\right]$).*

$W^T$ is the turning point, or the intersection point of the TFR curves before and after the shock in Figure 6. Note $m_L$ captures the size of the mortality shock.

The proof of the proposition is in the Appendix. The intuition is that most families in low-income countries are so poor (and, hence, risk-averse) that they cannot afford the risk of human capital investment after the shock, so they will reduce their fertility. Families in richer countries also suffer from the mortality shock, but prefer to increase their fertility to ensure the return of investment in human capital (which has gone down for each child). Heterogeneous effects can exist as long as $m_l^{thre} < m_L < m_u^{thre}$, or that mortality shocks are neither too small nor too large. If mortality shocks are "too big", even kind-switching agents will not increase their number of children as income increases because of the extremely low return on offspring. In contrast, if the shocks are "too small", every agent only slightly reduces her offspring, regardless of the kind, and kind-switching does not occur.

Based on **Proposition 4**, we predict the impact of HIV/AIDS on fertility is heterogeneous, and varies across samples (when different samples contain countries with different income levels). Specifically, in samples dominated by lowest-income countries, the mortality shocks lowers the TFR. For example, Durevall and Lindskog (2011) find a negative association between HIV and fertility in Malawi[12]. When a more mixed sample is employed,

[12]Durevall and Lindskog (2011) suggest that the epidemic increases the probability that a young woman

such as Juhn, Kalemli-Ozcan, and Turan (2013), Kalemli-Ozcan (2012) and Fortson (2008), the estimation results are either ambiguous or weak. However, samples containing sufficient intermediate income countries may display a positive average treatment effect. For example, Kalemli-Ozcan and Turan (2011) consider a relatively rich country, South Africa, and finds a positive effect of HIV prevalence on fertility.

Other models linking mortality to fertility produce ambiguous but no heterogeneous effects. For example, in Zhang and Zhang (2005), adult mortality risk affects fertility by reducing life expectancy. Expected life-time consumption is lower after the shock, lowering parental investment in human capital and fertility. But lower expected consumption also reduces the motivation to save, freeing up family resources for childbearing (considering children as consumption goods). Hence, the fertility rate may increase or decrease after the shock, but neither channel generates heterogeneous effects of mortality on fertility[13].

### 3.2.4 Implications on Economic Growth

Our model helps to understand the impacts of adult mortality on economic transition and growth. We are not the first to discuss this association. Voth (2013) demonstrate the role that black death, as a mortality shock, played in triggering industrial revolution and economic growth. Young (2005) argues that HIV/AIDS epidemic may create a long-term economic growth, so HIV/AIDS is only a humanitarian disaster, rather than economic

gives birth to her first child, while it decreases the probability to give birth of older women and of women who have already given birth. However, we think the increased probability of the first child only can be interpreted as an eagerness to have a child under the threat of HIV/AIDS, as pointed out in Trinitapoli and Yeatman (2011), rather than an intention to expand family size. Therefore, we take the negative effect on the fertility of the woman who have given birth as the main result.

[13]Young (2005) suggests another channel linking mortality to fertility. When adult mortality risks increase, labor supply falls short of demand, and wage level rises. The opportunity cost of childbearing is accordingly increasing, so parents prefer to reduce number of children after shock. Note this channel also does not generate heterogeneous effects.

disaster. Both papers emphasize that the mortality shock reduces labor supply, and causes a higher wage level. As a consequences, the shock increases the return to human capital investment, which guarantees a sustainable economic growth. In this paper, we highlight another channel through which mortality shock can affect economic growth. While disease can raise wage level, it also increases uncertainty of investment in children. If children die from the disease when they grow up, parents will lose all investment but earn nothing. Therefore, the shock will impede human capital accumulation. This prediction is different from Young (2005), since poor families will only reduce number of children rather than switch kind, human capital per child will not be driven up. In the framework of "Unified growth theory" (Weil and Galor (1999)), the shock may even drag a relatively rich country back from "Post Malthusian regime" to "Malthusian regime", which is featured as high population and low human capital investment. In fact, the association between mortality risk and economic growth will be clear only when we take both impacts into account.

## 3.3 Background, Data and Identification

### 3.3.1 A case of adult mortality shock: The HIV/AIDS epidemic in Africa

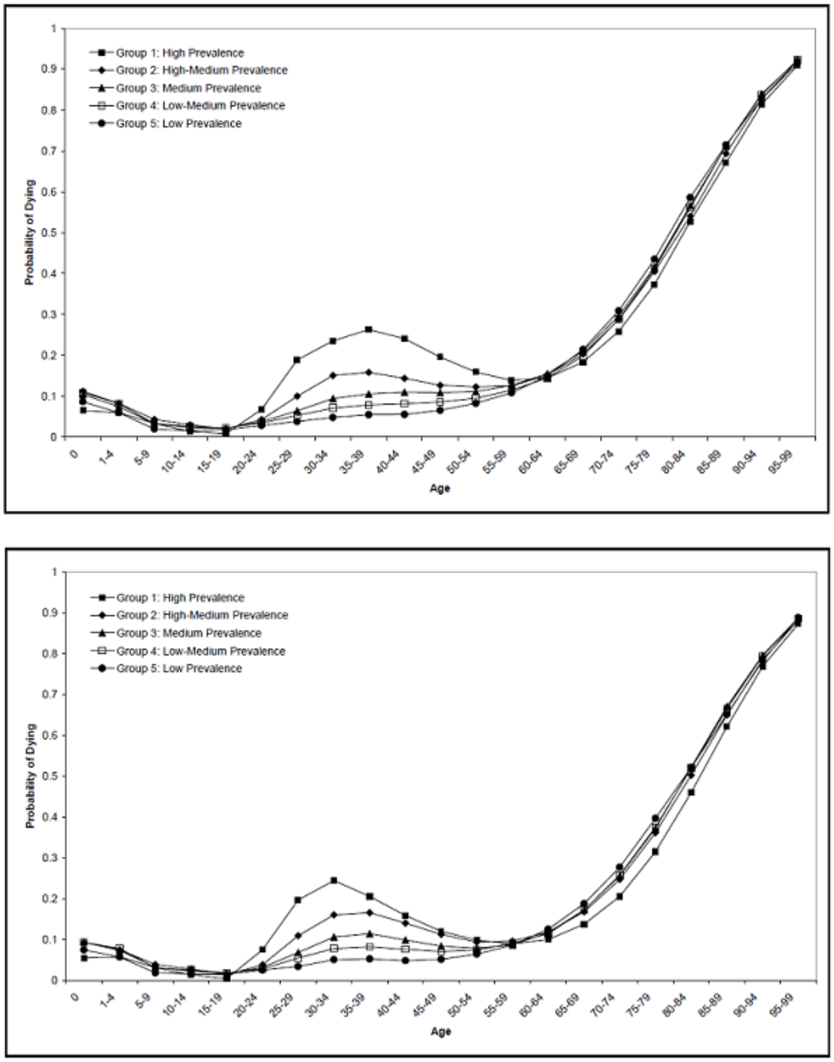



Figure 7: Top panel: Median UN projected male age-specific probability of dying 2000-2005 by HIV prevalence group for 35 countries in Africa with HIV prevalence estimates of 1 percent or greater. Bottom panel: Median UN projected female age-specific probability of dying 2000-2005 by HIV prevalence group for 35 countries in Africa with HIV prevalence estimates of 1 percent or greater.

We now test a few important predictions of the model. The HIV/AIDS epidemic in Africa is used to capture the adult mortality shock. HIV/AIDS not only significantly increased adult mortality risks (Timaus and Jasseh (2004)), more importantly, it increased "morbidity and mortality at those ages where normal levels of morbidity and mortality are very low" (Barnett and Whiteside (2002)). As shown in Figure 7, HIV/AIDS especially increases the mortality rate of people from twenty to sixty. The HIV/AIDS crisis is so severe in many Sub-Saharan African countries that we believe it can affect people's fertility choice. Worldwide, more than 30 million people are infected with HIV, and Sub Saharan Africa is home to about two-thirds of these infected people. The prevalence rate among prime age workers is high in many African countries. It is estimated that HIV/AIDS killed about 2 million Africans in 2005, and that HIV/AIDS-related mortality has driven a decline in life expectancy to pre-1970 levels (US Census Bureau, 2005). Third, the HIV/AIDS epidemic significantly threatens the expected return of human capital investment. As suggested in Ardington et al (2010), "the deaths (of prime-aged people) have in turn affected both the children and the parents of those who died... Parents of those infected with HIV are affected in many ways, including providing care during illness, absorbing direct financial costs of illness and death, losing financial support, and providing care for orphaned children".

### 3.3.2 Data Source and Summary Statistics

Our empirical study is based on data sets of Africa at the country and individual level. The country-level data cover 44 countries[14] in Sub-Saharan Africa from 1975 to 2007. Table 1 summarizes these data. Data on HIV prevalence are from UNData[15]. Total fertility rate

[14]They are Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Kinshasa). Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

[15]http://data.un.org/Default.aspx

Table 1: Summary Statistics of Key Variables (Aggregate)

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Total fertility rate | 1,452 | 5.87 | 1.17 | 1.66 | 8.29 |
| Prevalence of HIV, total (% of population ages 15-49) | 792 | 5.08 | 6.25 | 0.10 | 27.30 |
| GNI per capita, PPP (constant 2005, 1,000 international $) | 843 | 2.56 | 3.14 | 0.29 | 18.36 |
| School enrollment, primary | 1,161 | 80.74 | 32.91 | 13.36 | 207.73 |
| School enrollment, secondary | 907 | 24.50 | 18.55 | 1.65 | 95.70 |
| School enrollment, primary, female | 1,106 | 73.92 | 35.18 | 10.13 | 168.01 |
| School enrollment, primary, male | 1,106 | 86.55 | 31.09 | 16.49 | 176.91 |
| Mortality rate, under 5 (per 1,000 live births) | 1,342 | 153.42 | 63.45 | 15.60 | 339.20 |
| Mortality rate, infant (per 1,000 live births) | 1,342 | 92.64 | 32.09 | 13.40 | 178.80 |
| Urban population (% of total) | 1,353 | 30.83 | 15.61 | 4.00 | 84.43 |
| Life expectancy at birth, total (years) | 1,353 | 51.24 | 7.07 | 26.82 | 73.01 |
| Mortality rate, adult, female (per 1,000 female adults) | 456 | 356.97 | 116.84 | 77.54 | 688.84 |
| Mortality rate, adult, male (per 1,000 male adults) | 456 | 402.52 | 99.75 | 162.71 | 681.97 |

and control variables (education[16], income and other demographic variables) are from the World Bank Database[17]. The mean of total fertility rate is around 6, and the gross income per capita is less than $3000 on average.

The individual level data are from the Demographic and Health Surveys (DHS). Descriptive statistics are reported in Table 2. The data set covers more than 120 thousand people from 11 countries[18]. We only employ data collected in DHS V and DHS VI, for

[16]School enrollment rate can exceed 100% due to the inclusion of over-aged and under-aged students because of early or late school entrance and grade repetition.

[17]http://data.worldbank.org/indicator

[18]They are Congo (Kinshasa), Cameroon, Ethiopia, Kenya, Lesotho, Malawi, Rwanda, Swaziland, Tanzania, Zambia and Zimbabwe.

Table 2: Summary Statistics of Key Variables (Individual)

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Total number of births in the past year | 122,488 | 0.16 | 0.38 | 0.00 | 4.00 |
| Total number of births in the last five years | 122,488 | 0.72 | 0.86 | 0.00 | 8.00 |
| Prevalence of HIV in the region, total (% of population ages 15-49) | 118,239 | 8.50 | 7.44 | 0.30 | 29.00 |
| Wealth Index | 122,483 | 1.21 | 10.93 | -30.96 | 87.60 |
| Age | 122,488 | 28.06 | 9.53 | 15.00 | 49.00 |
| Highest year of education | 97,949 | 4.35 | 2.35 | 0.00 | 99.00 |
| Type of place of residence (dummy for urban) | 122,488 | 1.70 | 0.46 | 1.00 | 2.00 |
| Knows someone who has or died of AIDS | 61,119 | 0.50 | 0.58 | 0.00 | 9.00 |
| Knowledge of any contraceptive method | 106,170 | 2.78 | 0.78 | 0.00 | 3.00 |
| Ever use any contraceptive method | 106,170 | 1.50 | 1.51 | 0.00 | 4.00 |
| Knowledge of any method to avoid AIDS | 34,128 | 1.60 | 2.13 | 0.00 | 9.00 |
| Total number of sons who have died | 122,488 | 0.21 | 0.57 | 0.00 | 10.00 |
| Total number of daughters who have died | 122,488 | 0.18 | 0.52 | 0.00 | 8.00 |

which a wealth index is available. This index is a composite measure of a household's cumulative living standard, and is calculated using easy-to-collect data on household ownership of selected assets (e.g., television and bicycles; materials used for housing construction; and types of water access and sanitation facilities)[19]. Other variables include fertility choice in the past year, past five years, HIV prevalence, some demographic variables, and other HIV/AIDS-related variables, including knowledge about contraceptive methods and about persons who have died of AIDS, etc.

### 3.3.3 Empirical Strategy

Our model's main prediction is that the effect of HIV/AIDS on fertility is heterogeneous across income groups. The model also predicts a negative association between adult mortality risk and human capital accumulation. We will test both predictions.

[19]Details of the index can be found in DHS Comparative Reports (http://www.dhsprogram.com/pubs/pdf/CR6/CR6.pdf).

Our model predicts the (intermediate) rich will expand the size of their family in response to a mortality shock, whereas the poor reduce their number of children.

**Hypothesis 1**: *The effect of HIV/AIDS epidemic is non-monotonic on fertility choice: while low-income households reduce their fertility, high-income households prefer to have more children.*

We test this hypothesis using country-level data and individual level data. At the aggregate level, fertility choice is captured by the TFR. The outbreak of HIV was around 1980, but since most HIV-infected people will develop AIDS after about ten years of infection, we assume the onset of the mortality shock was in 1990 (see also Young (2005)). As a benchmark, we first estimate the effect of HIV/AIDS on fertility and its association with income in the following specification,

$$tft_{it} = \beta_0 + \beta_1 Inc_{it} \times Post_t + \beta_2 Post_t + \beta_3 Inc_{it} + \gamma' \mathbf{X_{it}} + \beta_i + \eta_{it} + \varepsilon_{it} \tag{21}$$

where $tft_{it}$ is the total fertility rate in country $i$ and year $t$, $Post_t$ is the time dummy that indicates year $t$ is after 1990, $Inc_{it}$ is the income level (GNI, per capita). According to our model, fertility effects of HIV/AIDS are heterogeneous depending on wealth level rather than income. Due to lack of data of wealth on aggregate level, we have to use income as a proxy variable to wealth, since in reality, especially on aggregate level, income level is closely correlated with wealth accumulation.

We assume that HIV affected fertility after 1990, but no earlier. However, because the effect may only materialize after some delay (or vary over time), we also use a time dummy for 1995 as a robustness check. $\mathbf{X_{it}}$ is a vector of control variables, such as education (school enrollment, primary and secondary), mortality rate (infant and 5-year)[20], residence (urban or rural) and life expectancy. To control the effect of time trend and heterogeneity across countries, we introduce countrywide fixed-effect term ($\beta_i$) and country specific time trend ($\eta_{it}$).

The specification can be easily transformed to

$$tft_{it} = \beta_0 + (\beta_1 Inc_{it} + \beta_2) \times Post_t + \beta_3 Inc_{it} + \gamma' \mathbf{X_{it}} + \beta_i + \eta_{it} + \varepsilon_{it} \tag{22}$$

where $(\beta_1 Inc_{it} + \beta_2)$ captures the effect of HIV/AIDS on fertility rate. From **Hypothesis 1**, we expect $\beta_2 < 0$, since poor families want to reduce the number of children after the shock, but as income levels rise, the fall in fertility rate is smaller, or even reversed (so $\beta_1 > 0$).

As suggested by Kalemli-Ozcan and Turan (2011) and Kalemli-Ozcan (2012), a measurement error problem may emerge when we simply use a time dummy to capture the impact of the mortality shock. Hence, as an extension, we employ a "generalized" difference-in-difference approach, leveraging not only the before-after effect but also controlling for regional differences in HIV prevalence[21]. Following Fortson (2009), the effect of the HIV/AIDS epidemic on fertility and the mediating role of income are estimated as follows,

$$\begin{aligned} tft_{it} = {} & \beta_0 + \beta_1 Inc_{it} \times HIV_{it} \times Post_t + \beta_2 HIV_{it} \times Post_t + \beta_3 HIV_{it} \\ & + \beta_4 Post_t + \beta_5 Inc_{it} + \gamma' \mathbf{X_{it}} + \beta_i + \eta_{it} + \varepsilon_{it} \end{aligned} \tag{23}$$

where $HIV_{it}$ is the HIV prevalence in country $i$ and year $t$, HIV prevalence is defined as percentage of total population aged from 15 to 49. Prevalence of HIV, total (% of

[20] According to Zhang (1990), Doepke (2005) and others, infant-child mortality rate controls for the replacement effect, which can lead to high fertility rates if infant mortality is high.

[21] Following Fortson (2009), we define the method as a "generalized" difference-in-difference. Although it is not in a standard form, it keeps the spirit of difference-in-difference approach. $Post_t$ controls time trend before and after 1990, $HIV_{it}$ controls regional differences, and the interaction term captures the treatment effect.

population ages 15-49) . The effect of HIV/AIDS on fertility is captured by the coefficient to the interaction term $HIV_{it} \times Post_t$. Similarly, the specification can be transformed to

$$\begin{aligned} tft_{it} = \beta_0 + (\beta_1 Inc_{it} + \beta_2) \times HIV_{it} \times Post_t + \beta_3 HIV_{it} + \beta_4 Post_t \\ + \beta_5 Inc_{it} + \gamma' \mathbf{X_{it}} + \beta_i + \eta_{it} + \varepsilon_{it} \end{aligned} \tag{24}$$

so $(\beta_1 Inc_{it} + \beta_2)$ captures the effect of HIV/AIDS on fertility rate, $\beta_2 < 0$, while $\beta_1 > 0$. We cluster standard errors at regional level[22]. Since the fertility rate is lower bounded by zero, we use log form of the dependent variable, and estimate a Tobit model to avoid potential bias due to censoring. In the specification, countrywide fixed effect and country specific time trend are both controlled.

Since at aggregate level we cannot control for all relevant factors[23], we also use individual-level data to test **Hypothesis 1.** Since we do not have data on wealth before 2005, we can only use cross-section data and estimate the following model,

$$fertility_{irc} = \kappa_0 + \kappa_1 hiv_{rc} \times wealth_{irc} + \kappa_2 hiv_{rc} + \kappa_3 wealth_{irc} + \phi' \mathbf{x_{irc}} + D_c + \mu_{irc} \tag{25}$$

where $fertility_{irc}$ is the number of births of woman $i$ in region $r$ and country $c$ in the last year (or in the last five years); $hiv_{rc}$ is the HIV prevalence in region $r$ and country $c$; *wealth* is the wealth-index; and $\mathbf{x_{irc}}$ is a vector of control variables, including some

[22]Because there may be serial correlation in fertility, a difference-in-differences model may have a tendency to over-reject the null hypothesis of no effect. Clustering the standard errors on the region is one solution proposed by Bertrand, Duflo, and Mullainathan (2004).

[23]The measurement error and other problems of TFR are discussed in Bongaarts and Feeney (1998). Furthermore, the composition of aggregate variables is so complex that it may cause ambiguous estimated results. For instance, the estimation might be biased downward due to high inequality in most African countries. So we also test the hypothesis by individual-level data.

demographic variables such as age, highest year of education, type of residence; and other HIV/AIDS related variables[24]. $D_c$ represents regional dummies. We use the HIV prevalence as a measure of adult mortality risks, and $(\kappa_1 wealth_{irc} + \kappa_2)$ captures the effect of HIV prevalence on fertility choice. Our model predicts $\kappa_2 < 0$ and $\kappa_1 > 0$.

As robustness check, we cluster standard errors at the regional level, and also estimate the effect by income group,

$$fertility_{irc} = \kappa_0 + \kappa_1 hiv_{rc} + \phi' \mathbf{x_{irc}} + D_c + \mu_{irc} \tag{26}$$

We use different approaches to classify households by wealth level. The effect of HIV prevalence is predicted to be negative for low-income groups, but positive (or at least less negative) for richer individuals.

#### 3.3.4 Human Capital Investment

We now turn to mortality shocks and investments in human capital. Our model predicts the poor will reduce their fertility without increasing human capital investment per child. The relatively rich will reduce human capital investment (the quantity-quality tradeoff). At the country level, consider the inequality in Africa, we expect a net decrease in human capital accumulation across all countries, and perhaps particularly in richer countries.

**Hypothesis 2**: *The effect of HIV/AIDS epidemic is negative on the human capital investment of rich families due to kind-switching, but insignificant for poor families.*

[24]Such as knowledge about any method to avoid AIDS, knowledge about any contraceptive method and knowledge about someone who has or died of AIDS and ever use any contraceptive method.

Data limitations imply we cannot test this hypothesis at the individual level. However, Fortson (2011) provides some evidence at the regional level, and finds that "areas with higher levels of HIV experienced relatively larger declines in schooling." This is consistent with our prediction.

We use school enrollment rate (primary and secondary) as a measure of human capital investment at the country level. Our model predicts school enrollment will fall in all countries (but in particular in rich countries). We use a difference-in-difference approach to explore this issue. Since it takes time for parents to realize the long term effect of HIV/AIDS epidemic on the returns to human capital, and adjust their fertility, we take 1995 as the time of shock. Following Fortson (2011), we estimate the effect on school enrollment rate by the following specification.

$$School_{it} = \beta_0 + \beta_1 HIV_{i,t-5} \times Post_{t-5} + \beta_2 HIV_{i,t-5} + \beta_3 Post_{t-5} + \gamma' \mathbf{X_{it}} + \beta_i + \eta_{it} + \varepsilon_{it} \quad (27)$$

where $School_{it}$ is the primary school enrollment rate in country $i$ and year $t$. Since we mainly use primary school enrollment rate, we expect the change in fertility choice will take around 5 years to impact school enrollment. We use 5-year lagged term of $HIV_{it}$ and $Post_{it}$. $\beta_1$ captures the effect the epidemic on school enrollment. Both fixed effect and country specific time trends are controlled. As robustness check, we would like to test the effect on school enrollment by income groups.

The association between the effect and income level can be accordingly estimated by the following specification,

$$
\begin{aligned}
School_{it} = \beta_0 + \beta_1 Inc_{it} \times HIV_{i,t-5} \times Post_{t-5} + \beta_2 HIV_{i,t-5} \times Post_{t-5} \\
+\beta_3 HIV_{it-5} + \beta_4 Post_{t-5} + \beta_5 Inc_{it} + \gamma' \mathbf{X_{it}} + \beta_i + \eta_{it} + \varepsilon_{it}
\end{aligned} \tag{28}
$$

where $\beta_1 Inc_{it} + \beta_2$ captures the effect of the epidemic on school enrollment. According to **Hypothesis 2**, $\beta_2$ should be insignificant, and $\beta_1 < 0$. The impact should become larger for higher incomes.

## 3.4 Estimation results

### 3.4.1 Fertility results

Table 3 reports the results of our benchmark specification (Equation (21)). Consistent with our predictions, $\beta_1$ enters significantly positive and $\beta_2$ is also significant but negative. As estimated in Column (1), $\beta_2 = -0.386$, and $\beta_1 = 0.026$, both are significant at least in 5 percent level. When evaluated against the standard deviation of the total fertility rate variable, which is only 1.17, these are "large coefficients." Taken together, these estimates indicates a fall in TFR after the mortality shock for most poor countries, but this fall is attenuated (and eventually reversed) as incomes rise. While the shock's effect on TFR is negative for most countries, it turns positive for rich countries such as South Africa, Mauritius, Gabon, Equatorial Guinea or Botswana. Our estimate of the aggregate TFR effect is likely an underestimate of the true effect for the relatively rich as within-country inequality implies that the poor share of the population will reduce their fertility (driving the aggregate fertility response down). Countrywide fixed-effect term is controlled in Column (2). Fixed effects and country-specific time trends are both controlled in Column (3). The estimation results are both robust. The estimation results are robust when clustering standard errors (Column (4)). The Tobit model in Column (5) suggests a similar result.

In Table 4 we use a difference-in-difference approach (Equation (23)). The coefficient of the interaction term $Inc_{it} \times HIV_{it} \times Post_t$ is now estimated to be positive. The estimation is robust to clustering and other correction approaches (Model with fixed effect and country-specific time trends, and Tobit model). As pointed by Kalemli-Ozcan and Turan (2011), data on HIV prevalence are missing before 1990, so we cannot estimate the coefficient to the interaction term $HIV_{it} \times Post_t$ ($\beta_2$) due to co-linearity.

Considering it takes time for people to realize the threat of AIDS to adults and human capital investment, we next employ an alternative year dummy as a robustness check ($Post_t$). Specifically, we now use 1995 to capture the impact of the mortality shock. Table 5 contains the results of our difference-in-differences approach. Consistent with the results in Table 4, the estimate of $\beta_1$, the coefficient to the interaction term $Inc_{it} \times HIV_{it} \times Post_t$, is around 0.005, still positive and significant at the 1 percent level (Column (1)). The coefficient to $HIV_{it} \times Post_t$, $\beta_2$ is estimated to be -0.058 (significant and negative). Both estimations support **Hypothesis 1**.

We did several additional robustness checks. For example, since both income and education can be endogenous regressors, we also use lagged terms of both variables as instrumental variables. The 2SLS estimates provide further robust evidence.

Next we turn to the results of the individual-level regressions based on DHS data. Table 6 reports the estimation results of Equation (25), where the dependent variable is

Table 3: Heterogeneous Effects of Mortality Risks on Fertility Choices (Aggregate)

| VARIABLES | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| GNI per capita × Year after 1990 (dummy) | 0.026** | 0.025*** | 0.044*** | 0.044* | 0.044*** |
| | (0.013) | (0.008) | (0.012) | (0.024) | (0.011) |
| GNI per capita, PPP (constant 2005, 1,000 international $) | -0.028** | 0.111*** | 0.005 | 0.005 | 0.005 |
| | (0.011) | (0.016) | (0.032) | (0.035) | (0.030) |
| Year after 1990 (dummy) | -0.386*** | -0.289*** | -0.304*** | -0.304** | -0.304*** |
| | (0.051) | (0.034) | (0.037) | (0.116) | (0.035) |
| Death rate, crude (per 1,000 people) | 0.045*** | 0.002 | -0.035** | -0.035 | -0.035** |
| | (0.015) | (0.014) | (0.016) | (0.035) | (0.015) |
| School enrollment, secondary (% gross) | -0.011*** | -0.006*** | -0.009*** | -0.009* | -0.009*** |
| | (0.002) | (0.002) | (0.002) | (0.005) | (0.002) |
| Mortality rate, infant (per 1,000 live births) | 0.008*** | 0.014*** | 0.008*** | 0.008 | 0.008*** |
| | (0.001) | (0.001) | (0.002) | (0.005) | (0.002) |
| Urban population (% of total) | 0.003* | -0.020*** | -0.036*** | -0.036** | -0.036*** |
| | (0.001) | (0.004) | (0.006) | (0.016) | (0.006) |
| Life expectancy at birth, total (years) | 0.017* | 0.011 | -0.017 | -0.017 | -0.017 |
| | (0.009) | (0.010) | (0.012) | (0.023) | (0.012) |
| Dependence Ratio | 0.066*** | 0.064*** | 0.059*** | 0.059*** | 0.059*** |
| | (0.002) | (0.002) | (0.003) | (0.011) | (0.003) |
| Country Fixed-effect | NO | YES | YES | YES | YES |
| Country-Specific Time Trend | NO | NO | YES | YES | YES |
| AIC | 638.288 | -173.194 | -389.107 | -441.107 | -309.107 |
| Adjusted R-square | 0.899 | 0.893 | 0.929 | 0.934 | - |
| Log likelihood | - | - | - | - | 229.553 |
| Observations | 573 | 573 | 573 | 573 | 573 |

Note: 1. Dependent variables are *Total fertility rate*.
2. Since dependent variable is bounded by zero, a Tobit model is employed in Column (5).
3. Standard errors are clustered in country level in Column (4).
4. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Heterogeneous Effects of Mortality Risks on Fertility Choices (Diff-in-Diff)

| VARIABLES | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| GNI per capita × Prevalence of HIV × Year after 1990 (dummy) | 0.005*** | 0.003*** | 0.005*** | 0.005* | 0.005*** |
| | (0.001) | (0.001) | (0.001) | (0.003) | (0.001) |
| GNI per capita, PPP (constant 2005, 1,000 international $) | -0.010 | 0.048* | -0.078** | -0.078 | -0.078** |
| | (0.011) | (0.025) | (0.036) | (0.061) | (0.032) |
| Prevalence of HIV, total (% of population ages 15-49) | -0.068*** | -0.022*** | -0.013** | -0.013 | -0.013** |
| | (0.005) | (0.006) | (0.006) | (0.011) | (0.005) |
| Death rate, crude (per 1,000 people) | 0.003 | 0.070*** | 0.137*** | 0.137*** | 0.137*** |
| | (0.015) | (0.018) | (0.016) | (0.042) | (0.014) |
| School enrollment, secondary (% gross) | -0.011*** | -0.018*** | -0.011*** | -0.011 | -0.011*** |
| | (0.002) | (0.002) | (0.002) | (0.007) | (0.002) |
| Mortality rate, infant (per 1,000 live births) | 0.003** | 0.013*** | 0.007*** | 0.007 | 0.007*** |
| | (0.002) | (0.002) | (0.002) | (0.005) | (0.001) |
| Urban population (% of total) | -0.004*** | 0.017** | -0.033*** | -0.033 | -0.033*** |
| | (0.001) | (0.008) | (0.011) | (0.031) | (0.009) |
| Life expectancy at birth, total (years) | -0.036*** | 0.050*** | 0.095*** | 0.095** | 0.095*** |
| | (0.011) | (0.016) | (0.014) | (0.035) | (0.013) |
| Dependence Ratio | 0.052*** | 0.053*** | 0.059*** | 0.059*** | 0.059*** |
| | (0.002) | (0.004) | (0.003) | (0.010) | (0.003) |
| Country Fixed-effect | NO | YES | YES | YES | YES |
| Country-Specific Time Trend | NO | NO | YES | YES | YES |
| AIC | 187.115 | -280.579 | -671.658 | -723.658 | -591.658 |
| Adjusted R-square | 0.938 | 0.842 | 0.948 | 0.954 | - |
| Log likelihood | - | - | - | - | 370.829 |
| Observations | 370 | 370 | 370 | 370 | 370 |

Note: 1. Dependent variables are *Total fertility rate*.

2. Since dependent variable is bounded by zero, a Tobit model is employed in Column (5).
3. Standard errors are clustered in country level in Column (4).
4. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5: Heterogeneous Effects of Mortality Risks on Fertility Choices

(Diff-in-Diff, Robustness)

| VARIABLES | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| GNI per capita × Prevalence of HIV × Year after 1995 (dummy) | 0.005*** | 0.001** | 0.003*** | 0.003 | 0.003*** |
| | (0.001) | (0.001) | (0.001) | (0.002) | (0.001) |
| GNI per capita, PPP (constant 2005, 1,000 international $) | -0.010 | 0.042* | -0.056* | -0.056 | -0.056* |
| | (0.010) | (0.023) | (0.033) | (0.056) | (0.029) |
| Year after 1995 (dummy) | 0.123*** | -0.215*** | -0.114*** | -0.114* | -0.114*** |
| | (0.047) | (0.040) | (0.030) | (0.065) | (0.027) |
| Prevalence of HIV, total (% of population ages 15-49) | -0.022*** | -0.017** | 0.007 | 0.007 | 0.007 |
| | (0.007) | (0.006) | (0.005) | (0.012) | (0.005) |
| Prevalence of HIV × Year after 1995 (dummy) | -0.058*** | 0.005 | -0.007 | -0.007 | -0.007 |
| | (0.008) | (0.007) | (0.005) | (0.013) | (0.005) |
| Death rate, crude (per 1,000 people) | -0.015 | 0.054*** | 0.085*** | 0.085 | 0.085*** |
| | (0.014) | (0.020) | (0.019) | (0.060) | (0.017) |
| School enrollment, secondary (% gross) | -0.010*** | -0.015*** | -0.011*** | -0.011 | -0.011*** |
| | (0.002) | (0.002) | (0.002) | (0.007) | (0.002) |
| Mortality rate, infant (per 1,000 live births) | 0.003** | 0.010*** | 0.002 | 0.002 | 0.002 |
| | (0.002) | (0.002) | (0.002) | (0.006) | (0.002) |
| Urban population (% of total) | -0.004*** | 0.020** | -0.013 | -0.013 | -0.013 |
| | (0.001) | (0.008) | (0.010) | (0.029) | (0.009) |
| Life expectancy at birth, total (years) | -0.052*** | 0.040** | 0.052*** | 0.052 | 0.052*** |
| | (0.011) | (0.017) | (0.016) | (0.043) | (0.014) |
| Dependence Ratio | 0.050*** | 0.049*** | 0.060*** | 0.060*** | 0.060*** |
| | (0.002) | (0.004) | (0.003) | (0.009) | (0.003) |
| Country Fixed-effect | NO | YES | YES | YES | YES |
| Country-Specific Time Trend | NO | NO | YES | YES | YES |
| AIC | 151.845 | -316.724 | -690.763 | -742.763 | -610.763 |
| Adjusted R-square | 0.944 | 0.858 | 0.951 | 0.956 | - |
| Log likelihood | - | - | - | - | 382.381 |
| Observations | 370 | 370 | 370 | 370 | 370 |

Note: 1. Dependent variables are $Total\ fertility\ rate$.
2. Since dependent variable is bounded by zero, a Tobit model is employed in Column (5).
3. Standard errors are clustered in country level in Column (4).
4. *** p<0.01, ** p<0.05, * p<0.1

the number of births in the last five years. In Column (1), we use OLS to estimate the effect of HIV prevalence on fertility and its association with wealth. In line with our predictions, $\kappa_1$ is positive and $\kappa_2$ is negative, and both are significant at 1 percent level. Most families reduce fertility in the presence of the mortality risk imposed by HIV/AIDS, but some rich families do the opposite. In Column (2) we estimate a Tobit model to avoid censoring bias, and find the results are consistent. Following Kalemli-Ozcan and Turan (2011), in Column (3), we estimate a Count Data Model (Poisson distribution), and again the results confirm our hypotheses. To avoid omitted variable problems and control for inter-region heterogeneity, we include country dummies in Columns (4-6).

Table 7 shows estimation results by income group. We divide the whole sample into four groups of equal size. The dependent variable is the number of births in the last year. The estimated coefficient $\kappa_1 = -0.010$ for middle-low income group ($p < 0.05$). For the middle-high income group, $\kappa_1 = -0.009$ ($p < 0.01$). By contrast, $\kappa_1 = 0.005$ for the top income group ($p < 0.10$). The positive coefficient helps to rule out the concern that the effect of HIV/AIDS is biological, rather than economic. According to Gray et al (1998), "pregnancy prevalence is greatly reduced in HIV-1-infected women", so the biological channel cannot explain the increase in fertility rate when the prevalence of HIV in the community is higher. The estimated coefficient for the bottom income group is of the right sign but not significant.

As a robustness check, we replace the dependent variable with the number of births in the last five years (Table 8). The estimation results are rather consistent with predictions. Although the effect for the top-income group is not positive, the estimated coefficient is significantly smaller than coefficients for the other groups. Threatened by the HIV/AIDS epidemic, therefore, the rich do not increase fertility but appear to adjust the investment in human capital per child (see below). Most estimates of individual level are robust to clustering standard errors at the regional level. But a caveat is important. Data limitations hinder us from addressing potential endogeneity problems when estimating with the household level data, so the interpretation of the estimated coefficients requires care.

### 3.4.2 Effect on Human capital accumulation

In Table 9, we regress Equation (28) to test **Hypothesis 2**. Without controls, in Column (1), $\beta_1 = -0.301$ ($p < 0.01$) and $\beta_2 = 0.921$ (positive but not significant). Both estimated coefficients are consistent with our hypotheses. School enrollment in high-income countries goes down, and the impact in low-income countries is less significant. This empirical pattern does not follow from competing theoretical models. A possible alternative interpretation for the fall in school enrollment may be the fact that HIV/AIDS induced mortality has made orphans out of many children. The epidemic has altered family structures in some regions in Africa — turning grandparents in care-givers for their grandchildren after their adult children have died. In Column (2), we control for the rate of dependency and other factors, and we found the same pattern with Column (1). Another potential concern threatening our interpretation of the empirical findings is policy changes around 1990s in the domains of fiscal policy or education. To address this concern, we include public expenditures on education, countrywide fixed effects as well as country specific time trend in the model in Column (3) to (5). In Column (4), standard errors are clustered in country level, and a Tobit model is estimated in Column (5). All these can not change the signs and significance of $\beta_1$ or $\beta_2$, so the estimation results are quite robust and support our model predictions on human capital.

Table 6: Heterogeneous Effects of Mortality Risks on Fertility Choices (Individual)

| VARIABLES | OLS | Tobit | Poisson | OLS | Tobit | Poisson |
|---|---|---|---|---|---|---|
| Prevalence of HIV in the region, | | | | | | |
| total (% of population ages 15-49) | -0.028*** | -0.059*** | -0.041*** | -0.022*** | -0.048*** | -0.034*** |
| | (0.004) | (0.008) | (0.005) | (0.005) | (0.010) | (0.007) |
| Prevalence of HIV in the region | | | | | | |
| × Wealth Index | 0.001*** | 0.003*** | 0.001*** | 0.001*** | 0.002*** | 0.001** |
| | (0.000) | (0.001) | (0.001) | (0.000) | (0.001) | (0.001) |
| Wealth Index | -0.014*** | -0.038*** | -0.026*** | -0.013*** | -0.036*** | -0.024*** |
| | (0.002) | (0.004) | (0.003) | (0.002) | (0.004) | (0.003) |
| Country Dummy | NO | NO | NO | YES | YES | YES |
| AIC | 42,644.520 | - | - | 42,583.930 | - | - |
| Adjusted R-square | 0.122 | - | - | 0.125 | - | - |
| Log likelihood | - | -20,423.031 | -18,529.533 | - | -20,395.018 | -18,500.224 |
| Observations | 17,272 | 17,272 | 17,272 | 17,272 | 17,272 | 17,272 |

Note: 1. Dependent variable is *Total number of births in the last five years*.
2. Other control variables are *Age*, *Highest year of education*,
*Type of place of residence* (*dummy for urban*), *Knows someone who has or died of AIDS*,
*Knowledge of any contraceptive method*, *Ever use any contraceptive method*,
*Knowledge of any method to avoid AIDS*,
*Total number of sons who have died*, *Total number of daughters who have died*.
3. Standard errors in parentheses.
4. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Heterogeneous Effects of Mortality Risks on Fertility Choices
(Individual, by income group)

| VARIABLES | Bottom | Middle low | Middle high | Top |
|---|---|---|---|---|
| Prevalence of HIV in the region, total (% of population ages 15-49) | -0.001 | -0.010** | -0.009*** | 0.005* |
| | (0.005) | (0.004) | (0.003) | (0.003) |
| Age | -0.006*** | -0.000 | -0.002** | -0.002*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Highest year of education | 0.008 | 0.006*** | 0.004** | 0.000 |
| | (0.005) | (0.002) | (0.002) | (0.002) |
| Type of place of residence (dummy for urban) | 0.020 | 0.002 | 0.037*** | 0.031* |
| | (0.028) | (0.016) | (0.012) | (0.018) |
| Knows someone who has or died of AIDS | 0.015 | -0.006 | 0.013 | 0.007 |
| | (0.017) | (0.008) | (0.011) | (0.009) |
| Knowledge of any contraceptive method | 0.006 | 0.030*** | 0.037*** | 0.016 |
| | (0.013) | (0.008) | (0.011) | (0.014) |
| Ever use any contraceptive method | 0.017** | 0.024*** | 0.029*** | 0.029*** |
| | (0.007) | (0.005) | (0.004) | (0.004) |
| Knowledge of any method to avoid AIDS | 0.010*** | -0.001 | 0.002 | -0.002 |
| | (0.004) | (0.003) | (0.004) | (0.005) |
| Total number of sons who have died | 0.039** | 0.039*** | 0.010 | 0.008 |
| | (0.016) | (0.010) | (0.011) | (0.014) |
| Total number of daughters who have died | 0.035** | 0.028** | 0.033*** | 0.055*** |
| | (0.017) | (0.011) | (0.012) | (0.017) |
| AIC | 2412.443 | 5303.903 | 4628.258 | 2256.521 |
| Adjusted R-square | 0.017 | 0.016 | 0.015 | 0.018 |
| Observations | 2,241 | 5,664 | 5,058 | 4,309 |

Note: 1. Dependent variable is *Total number of births in last year*.
2. The sample is divided into four groups based on wealth index.
3. Standard errors in parentheses.
4. *** p<0.01, ** p<0.05, * p<0.1

Table 8: Heterogeneous Effects of Mortality Risks on Fertility Choices

(Individual, Robustness Check)

| VARIABLES | Bottom | Middle low | Middle high | Top |
|---|---|---|---|---|
| Prevalence of HIV in the region, total (% of population ages 15-49) | -0.024** | -0.035*** | -0.041*** | -0.012** |
| | (0.010) | (0.008) | (0.007) | (0.006) |
| Age | -0.005** | 0.010*** | 0.004*** | 0.004*** |
| | (0.002) | (0.001) | (0.002) | (0.001) |
| Highest year of education | 0.012 | 0.024*** | 0.018*** | 0.003 |
| | (0.010) | (0.005) | (0.004) | (0.004) |
| Type of place of residence (dummy for urban) | 0.060 | 0.060* | 0.118*** | 0.101** |
| | (0.061) | (0.034) | (0.026) | (0.040) |
| Knows someone who has or died of AIDS | 0.051 | 0.001 | 0.080*** | 0.053*** |
| | (0.038) | (0.017) | (0.025) | (0.020) |
| Knowledge of any contraceptive method | 0.063** | 0.115*** | 0.106*** | 0.052 |
| | (0.029) | (0.018) | (0.023) | (0.032) |
| Ever use any contraceptive method | 0.091*** | 0.147*** | 0.148*** | 0.132*** |
| | (0.016) | (0.010) | (0.010) | (0.008) |
| Knowledge of any method to avoid AIDS | 0.019** | 0.009 | -0.004 | 0.008 |
| | (0.008) | (0.007) | (0.008) | (0.011) |
| Total number of sons who have died | 0.211*** | 0.198*** | 0.189*** | 0.120*** |
| | (0.035) | (0.021) | (0.026) | (0.032) |
| Total number of daughters who have died | 0.173*** | 0.133*** | 0.214*** | 0.263*** |
| | (0.038) | (0.024) | (0.027) | (0.039) |
| AIC | 5981.801 | 14,206.930 | 12,751.130 | 9,389.890 |
| Adjusted R-square | 0.047 | 0.132 | 0.112 | 0.100 |
| Observations | 2,241 | 5,664 | 5,058 | 4,309 |

Note: 1. Dependent variable is *Total number of births in the last five years*.

2. The sample is divided into four groups based on wealth index.

3. Standard errors in parentheses.

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

In Table 10 we split the sample by income group, attempting to explore the mediating impact of income. The results indicate that the reduction in school enrollment is observed for both high-income and low-income groups. No income-group has increased its school enrollment rate after the shock.

## 3.5 Conclusion

The inter-twined issues of mortality, fertility and human capital accumulation have been a prime research area in (development) economics for a long time. In this paper, we seek to advance this literature by emphasizing the complex effects of a shock in adult mortality risk on fertility choice and investment in human capital. We approach fertility and human capital as an optimal investment issue, and focus on the portfolio of assets held by different types of households. Since adult mortality risks affect the expected return on investments in human capital, a mortality shock will invite a re-arrangement of the optimal portfolio. A key result is that the nature of this adjustment process is different for poor and rich households. Specifically, while enhanced adult mortality will always reduce investment in human capital for all types of households, we find that the fertility impact depends on wealth-varying risk attitude. The poor will reduce fertility, and the rich will increase fertility (substituting high-quality offspring for low-quality but more numerous offspring). As a consequence, people will lower their spending on childbearing and education due to increased uncertainty of human capital investment. Possibly adult mortality shock may slow down economic growth, and even trap an economy in a “Malthusian regime”.

We use cross-country and household data to empirically test these two predictions. Following previous studies, we use the case of HIV/AIDS in Africa as the relevant mortality shock. We consistently find (strong) support for our theory: human capital accumulation

Table 9: The Effect of Mortality Risks on Human Capital Accumulation (Role of Income)

| VARIABLES | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| GNI per capita × Prevalence of HIV × Year after 1995 (dummy, 5-year lagged) | -0.301*** | -0.241*** | -0.148* | -0.148* | -0.148** |
| | (0.053) | (0.070) | (0.079) | (0.080) | (0.065) |
| Prevalence of HIV × Year after 1995 (dummy, 5-year lagged) | 0.921 | -0.103 | 0.306 | 0.306 | 0.306 |
| | (0.586) | (0.700) | (0.257) | (0.332) | (0.212) |
| GNI per capita, PPP (constant 2005, 1,000 international $) | 4.533*** | 2.161** | -1.244 | -1.244 | -1.244 |
| | (0.518) | (0.884) | (1.955) | (5.158) | (1.607) |
| Year after 1995 (dummy, 5-year lagged) | 12.002*** | 9.264** | 0.612 | 0.612 | 0.612 |
| | (3.399) | (4.155) | (1.587) | (2.047) | (1.304) |
| Prevalence of HIV (5-year lagged) | 1.203*** | 1.889** | 2.433*** | 2.433*** | 2.433*** |
| | (0.453) | (0.726) | (0.757) | (0.776) | (0.622) |
| Public spending on education, total (% of GDP) | | -2.616*** | -0.724 | -0.724 | -0.724 |
| | | (0.747) | (0.610) | (0.526) | (0.502) |
| Urban population (% of total) | | -0.331*** | -0.297 | -0.297 | -0.297 |
| | | (0.114) | (1.055) | (2.394) | (0.866) |
| Death rate, crude (per 1,000 people) | | 6.453*** | -8.263** | -8.263 | -8.263** |
| | | (1.619) | (4.009) | (10.307) | (3.294) |
| Total fertility rate | | -17.486*** | 28.759*** | 28.759 | 28.759*** |
| | | (4.474) | (10.027) | (17.864) | (8.239) |
| Life expectancy at birth, total (years) | | 3.701*** | -2.735 | -2.735 | -2.735 |
| | | (0.965) | (2.385) | (5.197) | (1.960) |
| Mortality rate, infant (per 1,000 live births) | | -0.296* | -0.809*** | -0.809*** | -0.809*** |
| | | (0.176) | (0.177) | (0.186) | (0.145) |
| Dependence Ratio | | 0.963*** | -1.499** | -1.499 | -1.499*** |
| | | (0.349) | (0.693) | (0.932) | (0.570) |
| Country-Specific Time Trend | NO | NO | YES | YES | YES |
| Country Fixed-effect | NO | NO | YES | YES | YES |
| AIC | 3286.254 | 1717.751 | 1122.684 | 1078.684 | 1184.684 |
| Adjusted R-square | 0.279 | 0.438 | 0.789 | 0.828 | - |
| Log likelihood | - | - | - | - | -527.341 |
| Observations | 361 | 197 | 197 | 197 | 197 |

Note: 1. Dependent variable is *Primary school enrollment*.
2. Since dependent variable is bounded by zero, a Tobit model is employed in Column (5).
3. Standard errors are clustered in country level in Column (4).
4. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 10: The Effect of Mortality Risks on Human Capital Accumulation

(by income group)

| VARIABLES | Bottom | Middle Low | Middle | Middle high | Top |
|---|---|---|---|---|---|
| Prevalence of HIV × | | | | | |
| Year after 1995 (dummy, 5-year lagged) | -4.778** | -0.114 | 0.200 | -2.225** | -1.294* |
| | (2.314) | (1.482) | (0.629) | (0.823) | (0.618) |
| Year after 1995 (dummy, 5-year lagged) | 9.153 | 3.702 | 11.647*** | 9.402* | 11.871* |
| | (7.970) | (7.669) | (4.020) | (4.712) | (6.065) |
| Prevalence of HIV (5-year lagged) | 7.144*** | -3.563 | 1.755 | 1.272 | 2.100*** |
| | (1.952) | (3.488) | (2.323) | (0.884) | (0.630) |
| GNI per capita, PPP (constant 2005, | | | | | |
| 1,000 international $) | 94.459*** | -87.179** | -76.067*** | -3.279 | -0.534 |
| | (27.586) | (31.751) | (19.278) | (5.453) | (2.707) |
| Public spending on education, | | | | | |
| total (% of GDP) | 2.188 | 1.091 | 2.489 | -2.842*** | 5.332*** |
| | (3.347) | (3.419) | (1.975) | (0.603) | (0.994) |
| Urban population (% of total) | 0.280 | 0.415 | 0.740 | -1.045*** | 0.898* |
| | (0.560) | (0.825) | (0.464) | (0.092) | (0.461) |
| Total fertility rate | -21.003*** | -12.359 | -11.363 | 6.171 | 3.272 |
| | (6.167) | (9.479) | (12.592) | (6.319) | (4.979) |
| Life expectancy at birth, total (years) | -4.061 | -5.875 | 3.793 | -5.726*** | 3.706*** |
| | (2.551) | (4.210) | (3.226) | (0.649) | (0.599) |
| Mortality rate, infant | | | | | |
| (per 1,000 live births) | -0.610 | -2.280** | 0.638** | -2.922*** | 0.997*** |
| | (0.492) | (1.016) | (0.273) | (0.330) | (0.151) |
| AIC | 277.289 | 311.215 | 314.458 | 334.297 | 154.848 |
| Adjusted R-square | 0.772 | 0.711 | 0.694 | 0.927 | 0.879 |
| Observations | 34 | 37 | 43 | 48 | 28 |

Note: 1. Dependent variable is *Primary school enrollment*.
2. The sample is divided into five groups based on GNI.
3. Standard errors in parentheses.
4. *** p<0.01, ** p<0.05, * p<0.1

falls in both rich and poor countries in response to the shock, and we find heterogeneous effects of adult mortality risk on fertility choice across income groups.

We postulate that this heterogeneous treatment effect explains why existing empirical work has produced mixed evidence regarding the impact of adult mortality risk on fertility. Specifically, while some studies find that the HIV/AIDS epidemic has reduced fertility, others find no significant effect, and yet other studies find that fertility has increased. These outcomes are consistent with our theoretical predictions, as we would expect the estimated outcomes of a mortality shock to critically depend on (average) income/wealth of respondents in the sample that is studied. Samples dominated by rich respondents produce opposite estimates than samples dominated by low income respondents. Samples containing both rich and poor respondents are unlikely to produce significant net results either way.

We believe these context-specific comparative statics speak against a uniform policy response across the African continent. Taking the income position of specific social groups into account is a first step towards developing policies that effectively help households to cope with enhanced mortality risks. Consider the discouraging effect of HIV/AIDS on human capital accumulation, we also highlight the necessity of more public spending on education. Lowering the (private) cost of education is one approach to make investment in high-quality children "less risky".

## 3.6 Appendix: proofs

### 3.6.1 Proof of $m_H > m_L$

Assume here are two projects (i.e. kinds of children), and the payoffs follow each normal distribution respectively. The probability density function (pdf) of the high risk project is

$$f_H(x) = \frac{1}{\sigma_H\sqrt{2\pi}} e^{-\frac{1}{2}\cdot\left(\frac{x}{\sigma_H}\right)^2}. \tag{29}$$

with mean $\mu_H = 0$ and variance $\sigma_H$. Similarly, the pdf of the low risk project is

$$f_H(x) = \frac{1}{\sigma_L\sqrt{2\pi}} e^{-\frac{1}{2}\cdot\left(\frac{x}{\sigma_L}\right)^2}. \tag{30}$$

with mean $\mu_L = 0$ and variance $\sigma_L$. Assume $\sigma_H > \sigma_L$. Define the outcome as "good" when the payoff is positive. Before the shock, the probability of good outcome is $\frac{1}{2}$ (halfway of the distribution). After the shock, assume the reduction in probability of good outcomes for the high risk project is equal to the reduction for the low risk one, and the shock only reduces the means, rather than variances (the shape) of the distributions. We expect the fall in the mean of the high risk project, $m_H$ to be bigger than $m_L$. We prove this as follows.

The reduction in probability of good outcome can be defined as

$$\triangle \Pr(i) = (1 - \Phi_{iB}(0)) - (1 - \Phi_{iA}(0)) \qquad i \in \{H,\ L\}. \tag{31}$$

where outcomes before and after shock are denoted by $B$ and $A$, respectively. Since

$$\Phi_i(0) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{0} e^{-\frac{1}{2}\left(\frac{x-\mu_i}{\sigma_i}\right)^2} dx. \tag{32}$$

then

$$\Phi_{iB}(0) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{0} e^{-\frac{1}{2}\left(\frac{x-0}{\sigma_i}\right)^2} dx. \tag{33}$$

$$\Phi_{iA}(0) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{0} e^{-\frac{1}{2}\left(\frac{x-(0-m_i)}{\sigma_i}\right)^2} dx = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{0} e^{-\frac{1}{2}\left(\frac{x+m_i}{\sigma_i}\right)^2} dx. \tag{34}$$

Since

$$\triangle \Pr(H) = \triangle \Pr(L). \tag{35}$$

then

$$(1-\Phi_{HB}(0)) - (1-\Phi_{HA}(0)) = (1-\Phi_{LB}(0)) - (1-\Phi_{LA}(0)). \tag{36}$$

therefore

$$\Phi_{HA}(0) = \Phi_{LA}(0). \tag{37}$$

that is

$$\frac{1}{\sqrt{2\pi}} \int_{-\infty}^{0} e^{-\frac{1}{2}\left(\frac{x+m_H}{\sigma_H}\right)^2} dx = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{0} e^{-\frac{1}{2}\left(\frac{x+m_L}{\sigma_L}\right)^2} dx. \tag{38}$$

Given

$$\sigma_H > \sigma_L. \tag{39}$$

so that

$$m_H > m_L. \tag{40}$$

### 3.6.2 Existence of Heterogeneous effects

From the top panel of Figure 6, the "transition region" (Q and R) generates the heterogeneous effects of the mortality shock. The region also holds the key to empirically test our model. We now show the condition that the "transition region" and the intersection point of TFR curves, $W^T$ exist.

Define the "transition region" at the aggregate level as the region between the two critical wealth levels, $\hat{W}^B$ and $\hat{W}^A$, where countries switch from only investing in the low-quality child to having both kinds of children. We can prove that, as long as the cost of raising a high-quality child is sufficiently large (relative to low-quality child), $\bar{w} = \hat{w}^B$. This implies that the threshold country, before the shock, is the country where the richest family just prefers high-quality offspring. The proof is as follows.

We first derive the condition for local maxima at $\bar{w} = \hat{w}^B$ before mortality. The number of children associated with the aggregate wealth level of $\hat{W}^B$, $N^{B,thre}$, is given by,

$$N^{B,thre} = \frac{1}{dC_L\sigma_L^2}\int_{\hat{w}^B-1}^{\hat{w}^B} w^2(\mu_L - a - bw)\mathbf{d}w. \tag{41}$$

As any country wealthier than $\hat{W}^B$ has both kinds of children, the number of children associated with $\hat{W}^B + \Delta w$ is,

$$\begin{aligned} N^B(\hat{W}^B + \Delta w) = & \tfrac{1}{dC_L\sigma_L^2}\int_{\hat{w}^B-1+\Delta w}^{\hat{w}^B} w^2(\mu_L - a - bw)\mathbf{d}w \\ & + \tfrac{1}{dC_H\sigma_H^2}\int_{\hat{w}^B}^{\hat{w}^B+\Delta w} w^2(\mu_H - a - bw)\mathbf{d}w \end{aligned}. \tag{42}$$

To ensure the local maxima is obtained at $\bar{w} = \hat{w}^B$, the difference between $N^{B,thre}$ and $N^B(\hat{W}^B + \Delta w)$ must be negative,

$$\begin{aligned} N^{B,thre} - N^B(\hat{W}^B + \Delta w) = & \tfrac{1}{dC_L\sigma_L^2}\int_{\hat{w}^B-1}^{\hat{w}^B-1+\Delta w} w^2(\mu_L - a - bw)\mathbf{d}w \\ & - \tfrac{1}{dC_H\sigma_H^2}\int_{\hat{w}^B}^{\hat{w}^B+\Delta w} w^2(\mu_H - a - bw)\mathbf{d}w > 0 \end{aligned}. \tag{43}$$

From the equation above, we have,

$$C_H > l_1 C_L. \tag{44}$$

where

$$
\begin{aligned}
l_1 &= \lim_{\Delta w \to 0} \frac{\sigma_L^2}{\sigma_H^2} \frac{\int_{\hat{w}^B}^{\hat{w}^B+\Delta w} w^2(\mu_H - a - bw)\mathbf{d}w}{\int_{\hat{w}^B-1}^{\hat{w}^B-1+\Delta w} w^2(\mu_L - a - bw)\mathbf{d}w} \\
&= \frac{\sigma_L^2}{\sigma_H^2} \frac{(\hat{w}^B)^2(\mu_H - a - bw^B)}{(\hat{w}^B - 1)^2(\mu_L - a - bw^B + b)}
\end{aligned}
. \tag{45}
$$

In a similar fashion, one can derive the condition for local maxima at $\bar{w} = \hat{w}^A$ after the mortality shock:

$$
C_H > l_2 C_L. \tag{46}
$$

where

$$
\begin{aligned}
l_2 &= \lim_{\Delta w \to 0} \frac{\sigma_L^2}{\sigma_H^2} \frac{\int_{\hat{w}^A}^{\hat{w}^A+\Delta w} w^2(\mu_H - a - bw - cm_L)\mathbf{d}w}{\int_{\hat{w}^B-1}^{\hat{w}^B-1+\Delta w} w^2(\mu_L - a - bw - m_L)\mathbf{d}w} \\
&= \frac{\sigma_L^2}{\sigma_H^2} \frac{(\hat{w}^A)^2(\mu_H - a - b\hat{w}^A - cm_L)}{(\hat{w}^A - 1)^2(\mu_L - a - b\hat{w}^A + b - m_L)}
\end{aligned}
. \tag{47}
$$

Obviously both $l_1$ and $l_2$ are exogenously given. Hence, we impose $C_H = lC_L$, where $l > \max(l_1, l_2)$.

Therefore, as long as

$$
C_H > lC_L. \tag{48}
$$

where $l = \frac{\sigma_L^2}{\sigma_H^2} \frac{(\mu_H - a)(\hat{w}^B)^2 - b(\hat{w}^B)^3}{(\mu_L - a)(\hat{w}^B - 1)^2 - b(\hat{w}^B - 1)^3}$, $\bar{w} = \hat{w}^B$ and $\bar{w} = \hat{w}^A$.

The one-to-one correspondence between the upper bound $\bar{w}$ and aggregate wealth of the country $W$ implies the threshold before the mortality shock is given by,

$$
\hat{W}^B = \int_{\hat{w}^B - 1}^{\hat{w}^B} x\mathbf{d}x = \hat{w}^B - \frac{1}{2}. \tag{49}
$$

Similarly, the threshold after the mortality shock is given by,

$$\hat{W}^A = \int_{\hat{w}^A-1}^{\hat{w}^A} x\mathbf{d}x = \hat{w}^A - \frac{1}{2}. \tag{50}$$

Since $\hat{w}^A > \hat{w}^B$, then $\hat{W}^A > \hat{W}^B$, which ensures the "transition region" between $\hat{W}^B$ and $\hat{W}^A$ in Figure 6 always exists.

While $\hat{W}^A > \hat{W}^B$ ensures the existence of a "transition region", we only find heterogeneous fertility effects if $N^B$ intersects $N^A$ in the "transition region"[25]. To guarantee the intersection point $W^T$ exists, as shown in Figure 6, a condition should be satisfied. For the threshold country after the shock, its TFR before the mortality shock (denoted by $N^{B,A}$) must be smaller than that after the mortality shock (denoted by $N^{A,thre}$).

$N^{A,thre}$ is given by,

$$\begin{aligned} N^{A,thre} &= \tfrac{1}{dC_L\sigma_L^2}\int_{\hat{w}^A-1}^{\hat{w}^A} w^2(\mu_L - a - bw - m_L)\mathbf{d}w \\ &= \tfrac{1}{dC_L\sigma_L^2}\left[\tfrac{\mu_L-m_L-a}{3}((\hat{w}^A)^3 - (\hat{w}^A-1)^3) - \tfrac{b}{4}((\hat{w}^A)^4 - (\hat{w}^A-1)^4)\right] \end{aligned}. \tag{51}$$

The value of $N^{B,A}$ depends on the relation between $\hat{w}^B$ and $\hat{w}^A - 1$. We can prove that only if $m_l^{thre} < m_L < m_u^{thre}$, then $N^{B,A} < N^{A,thre}$, therefore the intersection of $N^B$ and $N^A$ in the "transition region" between $\hat{W}^B$ and $\hat{W}^A$ can exist. In what follows, we prove the condition in two cases: $\hat{w}^B > \hat{w}^A - 1$ and $\hat{w}^B \leq \hat{w}^A - 1$.

*Case* 1. $\hat{w}^B > \hat{w}^A - 1$. There exist $m_l^{thre}$ and $m_u^{thre}$ such that $m_l^{thre} < m_L < m_u^{thre}$, which implies that, to ensure the existence of transition, mortality shocks cannot be

[25](As shown in the top panel of Figure 6, TFR before the mortality shock decreases over the interval $[W^B,\ W^A]$, while after the mortality shock fertility increases)

too small nor too large. We prove this as follows. In this case, the country with wealth of $\hat{W}^A$ has both kinds of children. Therefore, $N^{B,A}$ is given by,

$$\begin{aligned} N^{B,A} &= \tfrac{1}{dC_L\sigma_L^2}\int_{\hat{w}^A-1}^{\hat{w}^B} w^2(\mu_L - a - bw)\mathbf{d}w + \tfrac{1}{dC_H\sigma_H^2}\int_{\hat{w}^B}^{\hat{w}^A} w^2(\mu_H - a - bw)\mathbf{d}w \\ &= \tfrac{1}{dC_L\sigma_L^2}\left[\tfrac{\mu_L-a}{3}((\hat{w}^B)^3 - (\hat{w}^A-1)^3) - \tfrac{b}{4}((\hat{w}^B)^4 - (\hat{w}^A-1)^4)\right] \\ &\quad + \tfrac{1}{dC_H\sigma_H^2}\left[\tfrac{\mu_H-a}{3}((\hat{w}^A)^3 - (\hat{w}^B)^3) - \tfrac{b}{4}((\hat{w}^A)^4 - (\hat{w}^B)^4)\right] \end{aligned} . \quad (52)$$

From Equation 17, we have:

$$m_L = e\hat{w}^A + f. \quad (53)$$

where

$$e = \frac{b(\sigma_H - \sigma_L)}{c\sigma_L - \sigma_H} > 0. \quad (54)$$

$$f = \frac{a(\sigma_H - \sigma_L) - \sigma_H\mu_L + \sigma_L\mu_H}{c\sigma_L - \sigma_H}. \quad (55)$$

The equation above implies that $m_L$ can be expressed as an increasing linear function of $\hat{w}^A$. Using this relation and the condition $N^{A,thre} > N^{B,A}$, we obtain:

$$g_1(\hat{w}^A)^4 + h_1(\hat{w}^A)^3 + i_1(\hat{w}^A)^2 + j_1\hat{w}^A + k_1 > 0. \quad (56)$$

where

$$
\begin{gathered}
g_1 = -\tfrac{3b}{4}\left(1 - \tfrac{C_L\sigma_L^2}{C_H\sigma_H^2}\right) < 0 \\
h_1 = (\mu_L - a) - \tfrac{C_L\sigma_L^2}{C_H\sigma_H^2}(\mu_H - a) - 3e \\
i_1 = 3(e - f) \\
j_1 = 3f - e \\
k_1 = -f + \left[\tfrac{C_L\sigma_L^2}{C_H\sigma_H^2}(\mu_H - a) - (\mu_L - a)\right](\hat{w}^B)^3 + \left[\tfrac{3b}{4}\left(1 - \tfrac{C_L\sigma_L^2}{C_H\sigma_H^2}\right)\right](\hat{w}^B)^4
\end{gathered} \quad . \tag{57}
$$

The equation above is a quartic inequality with a negative coefficient of the highest order term and has a discriminant given by,

$$
\begin{aligned}
\Delta = {} & 256g_1^3k_1^3 - 192g_1^2h_1j_1k_1^2 - 128g_1^2i_1^2k_1 + 144g_1^2i_1j_1^2k_1 - 27g_1^2j_1^4 + 144g_1h_1^2i_1k_1^2 \\
& -6g_1h_1^2j_1^2k_1 - 80g_1h_1i_1^2j_1k_1 + 18g_1h_1i_1j_1^3 + 16g_1i_1^4k_1 - 4g_1i_1^3j_1^2 - 27h_1^4k_1^2 \\
& +18h_1^3i_1j_1k_1 - 4h_1^3j_1^3 - 4h_1^2i_1^3k_1 + h_1^2i_1^2j_1^2
\end{aligned} \quad . \tag{58}
$$

We assume $\Delta < 0$, which implies that the associated equation has two real roots and two complex conjugate roots. Thus, we have:

$$
w_l^{thre} < \hat{w}^A < w_u^{thre}. \tag{59}
$$

where $w_l^{thre}$ and $w_u^{thre}$ are the two real roots. The linear relationship between $\hat{w}^A$ and $m_L$ ensures that there exist $m_l^{thre}$ and $m_u^{thre}$ such that,

$$
m_l^{thre} < m_L < m_u^{thre}. \tag{60}
$$

*Case* 2. $\hat{w}^B \leq \hat{w}^A - 1$. There exists$m^{thre}$ such that $m_L < m^{thre}$. Since $\hat{w}^B \leq \hat{w}^A - 1$ ensures that shocks cannot be very small, we only have to rule out that mortality shocks are too large. If mortality shocks are "too big", even kind-switching agents are not willing to increase their offspring due to the low expected return. We prove as follows. In this case, the country with wealth $W^A$ only has high-quality child. Therefore, $N^{B,A}$ is given by,

$$\begin{aligned} N^{B,A} &= \frac{1}{dC_H\sigma_H^2}\int_{\hat{w}^A-1}^{\hat{w}^A} w^2(\mu_H - a - bw)\mathbf{d}w \\ &= \frac{1}{dC_H\sigma_H^2}\left[\frac{\mu_H-a}{3}((\hat{w}^A)^3 - (\hat{w}^A-1)^3) - \frac{b}{4}((\hat{w}^A)^4 - (\hat{w}^A-1)^4)\right] \end{aligned}. \tag{61}$$

Once again, using the linear relation between $m_L$ and $\hat{w}^A$ and the condition $N^{A,thre} > N^{B,A}$, we obtain:

$$g_2(\hat{w}^A)^3 + h_2(\hat{w}^A)^2 + i_2(\hat{w}^A) + j_2 > 0. \tag{62}$$

where

$$\begin{aligned} g_2 &= -3b\left(1 - \frac{C_L\sigma_L^2}{C_H\sigma_H^2}\right) - 3e < 0 \\ h_2 &= 3\left[(\mu_L - a) - \frac{C_L\sigma_L^2}{C_H\sigma_H^2}(\mu_H - a)\right] + \frac{9b}{2}\left(1 - \frac{C_L\sigma_L^2}{C_H\sigma_H^2}\right) - 3(f-e) \\ i_2 &= -3\left[(\mu_L - a) - \frac{C_L\sigma_L^2}{C_H\sigma_H^2}(\mu_H - a)\right] - 3b\left(1 - \frac{C_L\sigma_L^2}{C_H\sigma_H^2}\right) - (e-3f) \\ j_2 &= \left[(\mu_L - a) - \frac{C_L\sigma_L^2}{C_H\sigma_H^2}(\mu_H - a)\right] - \frac{3b}{4}\left(1 - \frac{C_L\sigma_L^2}{C_H\sigma_H^2}\right) - f \end{aligned}. \tag{63}$$

The equation is a cubic inequality with a negative coefficient of the highest order term and has a discriminant given by,

$$\Delta = 18g_2h_2i_2j_2 - 4h_2^3j_2 + h_2^2i_2^2 - 4g_2i_2^3 - 27g_2^2j_2^2. \tag{64}$$

We assume $\Delta < 0$, which implies that the associated equation has one real roots and two complex conjugate roots. Thus, we obtain:

$$\hat{w}^A < w^{thre}. \tag{65}$$

where $w^{thre}$ is only one real root. The linear relation between $\hat{w}^A$ and $m_L$ ensures that there exists $m^{thre}$ such that

$$m_L < m^{thre}. \tag{66}$$

### 3.6.3 The dynamic in change of TFR before and after shock

For poor countries ($W_t < \hat{W}^B$), aggregate fertility increases monotonically with aggregate wealth irrespective of whether there are mortality shocks, or not. Moreover, as shown in the bottom panel, the difference between the number of children after and before the mortality shock decreases because of the direct mortality effect. The proof is as follows.

If $\bar{w} \leq \hat{w}^B$, $N^B$ and $N^A$ are given by,

$$\begin{array}{c} N^B = \frac{1}{dC_L\sigma_L^2}\int_{\bar{w}-1}^{\bar{w}} w^2(\mu_L - a - bw)\mathbf{d}w \\ N^A = \frac{1}{dC_L\sigma_L^2}\int_{\bar{w}-1}^{\bar{w}} w^2(\mu_L - a - bw - m_L)\mathbf{d}w \end{array}. \tag{67}$$

Thus, the difference between $N^B$ and $N^A$ is,

$$N^B - N^A = \frac{m_L}{3dC_L\sigma_L^2}(3\bar{w}^2 - 3\bar{w} + 1). \tag{68}$$

It can be easily verified that $(N^B - N^A)$ is an increasing function of $\bar{w}$ for $\bar{w} \in (0, \hat{w}^B]$. The difference between $N^B$ and $N^A$ is not only non-monotonic with wealth, but can be also (roughly) captured by a quadratic function of wealth.

# 4 Who Should I Share Risk with? Gifts Can Tell: Theory and Evidence from Rural China[1]

**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

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*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*)**

## 4.1 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[2]. Similar to other less developed regions[3], 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[4]. However, to highlight the friendship or social distance

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

[3]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.

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

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" rural financial investigation data, in which the gift-income ratio is 8.69%[5]. Among the gift giving, a large share is directed to close friends (or relatives) who they count on if in need[6].

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

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

[6] 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.

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 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[7].

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.

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

## 4.2 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.

## 4.3 The Model

### 4.3.1 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[8], 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.

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[9] to another player $-i$, so the

[8] 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.

[9] 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.

utility function of Player 1, for example, is

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

where $\mu$ is the coefficient of altruism, which equals $\delta \in (0,\ 1)$ if Player 1 is a friend, otherwise zero. $u(c_1)$ is the self-interest part of Player 1's utility function, the rest is the altruism part[10]. The utility function of Player 2 is symmetric. Friendship is assumed to be not necessarily mutual or symmetric[11], 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.

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

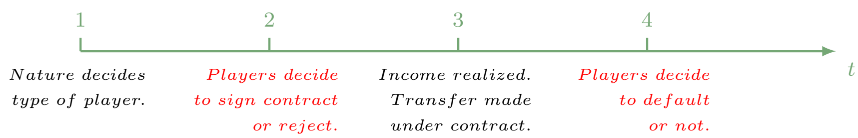
$$u_1(c_1) = \begin{cases} c_1, & if\ c_1 \geq h \\ c_1 + \alpha(c_1 - h), & if\ c_1 < h \end{cases} \tag{2}$$

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.

[10]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.

[11]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.

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 $\kappa$.

- 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 $\varepsilon_i$, $i \in \{1,\ 2\}$,

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

  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.

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, $\pi$ 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.

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.

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, $\delta$ 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"[12], 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

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

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, $\delta$ is the parameter to altruism, when it is larger, people may feel more guilty, and the emotional cost of defaulting is higher. $\theta$ decides the level of guilt-aversion, when it is larger, the emotional cost is higher, so $\theta$ is defined as the parameter to guilt-aversion.

#### 4.3.2 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[13]

**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 $\theta$ is sufficiently

[13]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 $h$.

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 $\delta$, the parameter to capture altruism. With $\delta$ 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.

**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 $\theta$ 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 $\theta$ 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.

**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 $\theta$ 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.

### 4.3.3 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.

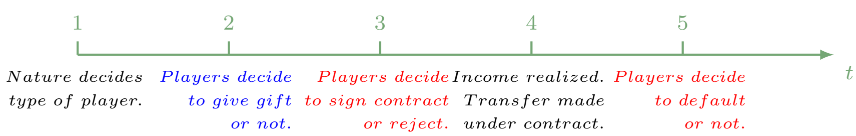
From **Lemma 1**, if $\theta > \theta^{\star}$, a friend will not default, but a non-friend definitely will. If the share of friends is sufficiently small, it is too risky for a player, no matter a friend or a non-friend, to sign the risk-sharing contract, since it is very likely to be defaulted by a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

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

#### 4.3.4 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 $\kappa$.
- 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 $\varepsilon_i$, $i \in \{1, 2\}$,

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

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

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

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*
$\Pr(gift \mid friend) = 1$
$\Pr(gift \mid non - friend) = 0,$
*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.

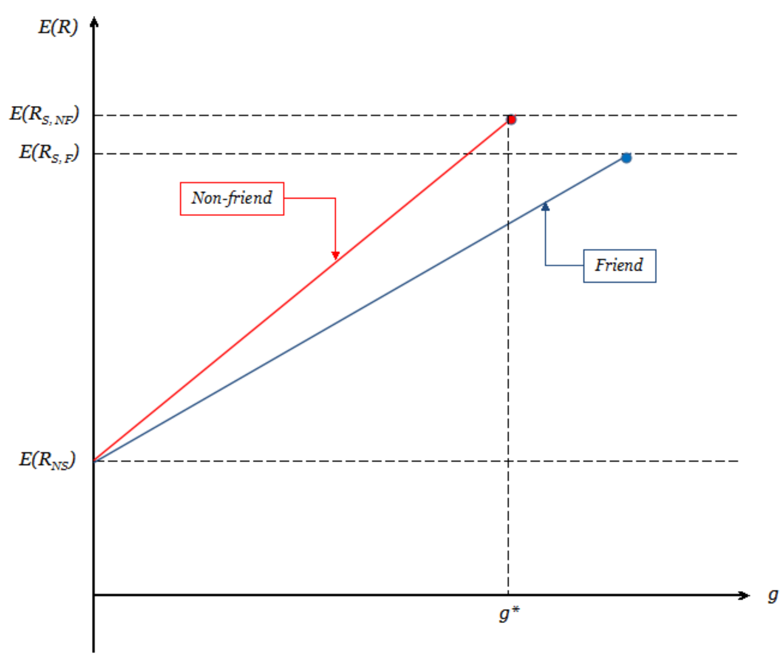



Figure 1: Separating equilibrium in a game of gift

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 $\kappa$). In other words, it may be even better for friends to simply bear the risk of defaulting, which is relatively small.

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

The effect of $\kappa$ is ambiguous, on the one hand, as $\kappa$ 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 $\kappa$ is always preferred to be consumed directly, rather than spent as a gift in a risk-sharing group, so $g^\star$ is decreasing with $\kappa$.

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.

### 4.3.5 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.

### 4.3.6 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. $\alpha$ 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.

### 4.3.7 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.

## 4.4 Data Source

### 4.4.1 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[14]. 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 [15], 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 gift expenses of each time. Table 2 provides summaries about some key variables in the empirical study.

### 4.4.2 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

[14]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.

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

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 |

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.

## 4.5 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.

### 4.5.1 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 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[16]. 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.

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

[16]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.

$Debt_{i,t}$ 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 $t$ ($Cashevent_{i,t} > 0$ ), $\alpha_1$ is predicted to be positive and significant.

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

### 4.5.2 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.

### 4.5.3 Hypothesis III: Gift Expenses and Income Status

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 ($55 \times 55$) 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.

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

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. $\gamma_1$ captures the impact of the gap of income status between giver $i$ and gift receiver $j$, then $\gamma_2$ 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, $\gamma_1$ 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.

## 4.6 Estimation Results

### 4.6.1 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***.

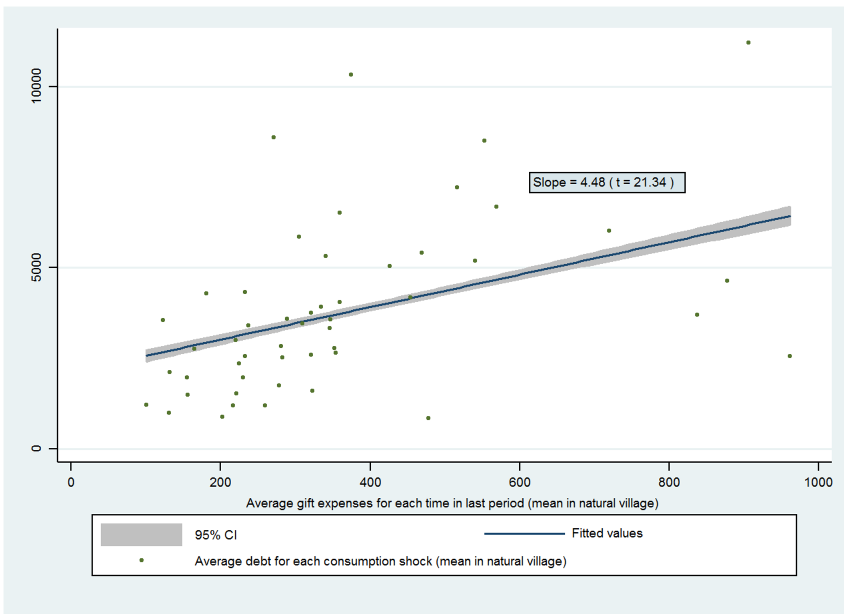



Figure 2: Correlation between gift expenses and loan per consumption shock

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.

### 4.6.2 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

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

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 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.

### 4.6.3 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 $\gamma_1$ 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[17].

[17] The unequal flow of gifts between the rich and the poor has been documented in Weerdt and Fafchamps

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

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

### 4.6.4 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 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.

(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 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

## 4.7 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.

## 4.8 Appendix

### 4.8.1 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[18].

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.

### 4.8.2 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

[18] 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, $\alpha$ is sufficiently small that a friend's optimal share of income in pooling is smaller than $\pi$.

with a non-friend is

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

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.

### 4.8.3 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 $\theta t_{12}$. 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.

### 4.8.4 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.

#### 4.8.5 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

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

The expected return to give no gift is

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

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,

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

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 $\delta$, 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.

### 4.8.6 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.

### 4.8.7 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.

#### 4.8.8 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

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

If the non-friend does not give a gift, the expected return[19] will be

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

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

[19]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.

$E_{NG}\left(U_{NF}\left(c_1\right)\right)$, 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

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

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

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

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

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

Therefore,

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

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, $\rho$ 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 $\rho$. 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.

### 4.8.9 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, $E\left[u_{ij},\, u_{ik}\right] \neq 0$ for all $k$ and $E\left[u_{ij},\, u_{kj}\right] \neq 0$ for all $k$. Meanwhile $E\left[u_{ij},\, u_{jk}\right] \neq 0$ for all $k$ and $E\left[u_{ij},\, u_{ki}\right] \neq 0$ 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 $\beta$ 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.

# 5 Conclusion

The three chapters in this thesis all aim to uncover the mechanisms that matter for social welfare in a world full of uncertainty, but are ignored in literature. As these hidden mechanisms are being revealed, we show that fiscal decentralization can actually reduce social welfare rather than increase in Chapter 1; we also find the empirical studies regarding the association between HIV/AIDS and fertility are actually not conflicting if we take people's risk attitude into account in Chapter 2; furthermore in Chapter 3, we demonstrate that the high gift expenses in rural China is not simply a burden: people can form risk sharing by exchanging gifts, if contract enforcement is lacking in these areas. The analysis helps us to understand how people behave when they face risk and uncertainty. The implications of these chapters also help to improve policy design and implementation.

All three papers have contribution to development economics. The second chapter uses the case of HIV/AIDS prevalence in Africa to study the effect of adult mortality risks. Both theoretical and empirical analysis in Chapter 3 are about the behavioral pattern of gift expenses in rural China. Although the empirical study in Chapter 1 is based on data from the United States, the analysis has important implication for developing countries. As Mani and Mukand (2007) states, the visibility issue is more serious in developing countries, since "voter illiteracy, corruption and a lack of transparency are rife there". Hence, policy makers should be aware of the negative side of fiscal decentralization. In fact, fiscal decentralization has been taken as an effective policy tool to improve government efficiency by many developing countries, but few of them have noticed the structural bias that fiscal decentralization may cause. As shown in Caldeira (2012), fiscal decentralization in China has triggered an intergovernmental competition, and the imbalanced structure of public expenditure in China has attracted more and more attention in recent research (e.g. Henglong and Xian (2007)).

Following the three papers, I will continue my study on public economics and development economics in the future. By using data from China, I will apply the model in Chapter 1 to developing countries, and explore the effect of fiscal decentralization when the "dress-up contest" is not "from the bottom", but "from the top". We will also apply the theory in Chapter 2 to the case of One Child Policy in China, studying its effect on human capital accumulation and financial investment. By using the same data set cited with the third chapter, we explore in a work-in-progress paper, the welfare consequences of gift exchange, particularly to poor people both theoretically and empirically.

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