Vulnerability of Microfinance to Strategic Default and Covariate Shocks: Evidence from Pakistan*

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Abstract

This paper investigates the repayment behavior of microfinance borrowers in Pakistan. In early 2005, the microfinance institution that provided the loans adopted a new system with strict enforcement of punishment against repayment problems. This reform resulted in a healthy situation with almost zero default rates, overcoming the previous problem of frequent defaults. We hypothesize that strategic default under the joint liability mechanism (i.e., if one group member is hit by a negative shock and faces the difficulty in repayment, the other members who are able to repay may decide to default themselves as well, instead of helping the unlucky person), which was encouraged by weak enforcement of dynamic incentives, was responsible for the earlier failure. Using a unique dataset of about 45,000 installments/repayments covering 2,950 micro-borrower households and over a period of 1998-2006, we investigate the dynamics of repayment at the installment level. We find that the repayment delay of each installment was correlated with other members' repayment delay, beyond the level explained by possible correlation of project failures due to locally covariate shocks. We therefore interpret this as evidence for the existence and seriousness of the strategic default. The relative success after the system change in early 2005 can be explained similarly — the new system was successful in suppressing the strategic behavior and inducing cooperation among the group members. The study area was hit by a disastrous earthquake in October 2005, but the new system does not seem to be affected adversely as far as the repayment is concerned, although our conclusion is tentative because of the smaller number of observations after the earthquake.

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1 Introduction

This paper empirically analyzes the repayment behavior of microfinance borrowers who were subject to high levels of idiosyncratic and covariate shocks and experienced a reform in contract design regarding repayment installments and dynamic aspects. In the literature on microfinance, mechanisms that led to the success of the Grameen Bank in maintaining high repayment rates have been the focus of research (Armendariz de Aghion and Morduch, 2005). The first generation studies emphasized the role of joint liability in group lending, such as peer selection (Ghatak, 1999; 2000), peer monitoring (Stiglitz, 1990; Varian, 1990; Banerjee et al., 1994), and peer enforcement (Besley and Coate, 1995). In the second generation studies, the emphasis has been shifted. Armendariz de Aghion and Morduch (2005) argue that joint liability is only one element in successful microfinance schemes but other aspects are also important, such as sequential financing (group-loans that are staggered within the same round), dynamic incentives (exclusion of defaulting borrowers from future access to loans [contingent renewal], while providing larger loans to borrowers who successfully repaid [dynamic incentives in the narrow sense]), frequent repayment installments, and public repayments (loan officers come to villages to meet the borrowers and borrowers repay to them in the presence of others). Chowdhury (2005) theoretically shows that without sequential financing, group-lending schemes may suffer from under-monitoring with borrowers investing in risky projects. In another theoretical paper, Chowdhury (2007) shows that contingent renewal alone can resolve the moral hazard problem only when the discount rate is relatively low but the combination of sequential financing and contingent renewal may be able to resolve the problem even when the discount rate is relatively high.

Nevertheless, the empirical evidence on the effectiveness of each theoretical mechanism is still limited,[1] though burgeoning recently (Hermes and Lensink, 2007). Among the few empirical studies, Kono (2006) reports the experiment result in Vietnam with microfinance games varying in their contract designs and shows that joint liability *per se* leads to more

[1]The focus here is on studies that attempt an explicit link to theories. There are a huge number of empirical and insightful studies that estimate the reduced-form determinants of group repayment behavior among microfinance borrowers (e.g., Al-Azzam and Sarangi, 2006; Hermes et al., 2005; Kritikos and Vigenina, 2005; Godquin, 2004; Paxton et al., 2000; Wydick, 1999; Sharma and Zeller, 1997). Among them, the study by Wydick (1999) has been one of the most influential ones, because it employs the most extensive list of proxy variables to measure screening, monitoring, and enforcement within groups.

frequent occurrence of strategic default. Using the field experiment approach, Gine and Karlan (2007) evaluate the impact of removing group liability in the Philippines and found no adverse impact on repayment as long as public and frequent repayment systems were maintained. See Cassar et al.(2007), McIntosh (2008), and Field and Pande (2008) for other applications of the experiment approach to analyze the mechanism underlying the repayment behavior. On the other hand, empirical studies using non-experimental data but attempting an explicit link to theories are not many. Using data from Peru, Karlan (2007) finds evidence for the existence of peer monitoring under joint liability. Using data from Thailand, Ahlin and Townsend (2007) test across theoretical models of joint liability lending, showing that the joint liability rate negatively affects repayment while the strength of local sanctions positively affects repayment. Interestingly, they show that the Besley and Coate model of strategic default has low explanatory power in general but its explanatory power increases in poor, low-infrastructure areas. These studies mostly support the view that mechanisms such as sequential financing, contingent renewal, dynamic incentives, frequent repayment, and public repayments are more important than joint liability. However, they do not provide detailed empirical evidence for each theoretical mechanism regarding the intra-group dynamics of repayment.

To fill this gap in the literature, this paper investigates a unique dataset of about 45,000 installments/repayments covering 2,950 micro-borrower households and over a period of 1998-2006 in Pakistan, in order to show empirical evidence that strategic default is a serious problem for microfinance and contingent renewal is a prerequisite for joint liability to prevent strategic default. In Pakistan, where the modern-style microfinance began in the late 1990s, several examples of failed schemes were found in spite that they adopted a group lending design following the prototype of the Grameen Bank in Bangladesh. Our dataset is unique not only in its level of disaggregation but also in its time coverage that includes two important breaks. First, from early 2005, contract designs were changed with improved enforcement of contingent renewal and more frequent repayment installments, resulting in a drastic decrease of default rates. Therefore, our dataset enables us to analyze the impacts of contract designs on the repayment behavior. The second time break was October 2005, when a disastrous earthquake with the size of 7.6 magnitude hit Pakistan, killing more than 70,000 people. An earthquake is indeed a very covariate and unexpected natural shock. Sample borrowers in our dataset lived in the distance between 40 and 110 km from the earthquake epicenter. Therefore, our dataset enables us to analyze the impacts of such covariate shocks, whose impact on microfinance is not examined much in the literature (Shoji, 2008; Becchetti and Castriota, 2008).

Our analysis of the installment-level dynamics of repayment delays shows that one type of strategic default under the joint liability mechanism (i.e., if one group member is hit by a negative shock and faces the difficulty in repayment, the other members who are able to repay may decide to default themselves as well, instead of helping the unlucky person), which was encouraged by weak enforcement of the contingent renewal rule, was responsible for the earlier failure. The repayment delay of each installment was correlated with other members' repayment delay, beyond the level explained by possible correlation of project failures due to locally covariate shocks. This type of strategic default is shown to exist theoretically (e.g., Besley and Coate, 1995) but the empirical evidence for its existence is lacking.

The rest of the paper is organized as follow. Section 2 provides a theoretical model to guide our empirical investigation. Section 3 describes the dataset and its background, providing the empirical definition of default and repayment delay adopted in this paper. Section 4 investigates the determinants of loan default and repayment delay under the old system at the borrower level to show that the 2005 reform was in the right direction. Section 5 is the main part of our empirical analysis, in which the dynamics of repayment at the installment level is examined for loans made under the old system. Section 6 extends the analyses to loans made under the new system to show that the extent of strategic default declined and the impact of the earthquake was not discernible. Section 7 concludes the paper.

2 A Theoretical Model of Group Lending with Imperfect Joint Liability

2.1 Overview

Joint liability or group liability (i.e., all group members are jointly liable for the loans made to group members so that all non-default members lose their future loan access if at least one borrower in the borrowers' group fails to repay the current loan) was once regarded as the main mechanism that led to the success of the Grameen Bank. Theoretical predictions show that by adopting a joint liability rule, peer selection (Ghatak, 1999; 2000), peer monitoring of project choice or efforts (Stiglitz, 1990; Varian, 1990; Banerjee et al., 1994), or peer enforcement to avoid strategic default (Besley and Coate, 1995) may contribute to improvement in repayment rates among poor and collateral-less borrowers. At the same time, theoretical predictions are sometimes ambiguous and suggest a possibility that joint liability may lead to high default rates, depending on structural parameters.

By construction, these studies allow only two states: all members' dues are repaid or all members default. To explain the field reality that even under joint liability some members default while others in the same group repay their dues (but do not repay the dues of the defaulting peers), the assumption of perfect joint liability need to be abandoned. We therefore extend a version (without social sanctions) of the repayment game proposed by Besley and Coate (1995), hereinafter the BC model, in order to allow an option for a member of the group to repay her due only. The BC model shows that borrowers who would repay under individual liability may not do so under group liability if members realize that they cannot repay as a group.

In this section, we sketch the extended model of repayment under imperfect joint liability to show that "peer correlation," which is the focus of the empirical part of this paper, reflects the intra-group interaction of borrowers. Models in the existing literature on group lending, however, cannot show this because the enforcement of joint liability is assumed to be perfect, which implies that repayment delay or default within a borrowers' group should be perfectly correlated. By assuming imperfect joint liability, we can investigate the comparative statics of "peer correlation" with respect to the degree of enforcement of the contingent renewal rule as well as the joint liability rule. The extended model predicts that strategic default may occur under the imperfect joint liability. What is worse, under the imperfect joint liability, when the rule of joint liability is not strong enough, "within-group cooperation" — a borrower who would not repay under individual liability is helped by another member to repay the debt — rarely occurs.

2.2 The model

There are two *ex ante* identical borrowers, each of whom has a project that requires one unit of capital. The project yields θ units of income. Before undertaking the project, the borrowers do not know θ but know that θ is distributed on $[\underline{\theta}, \bar{\theta}]$ according to the distribution function $F(\theta)$. If the two borrowers form a borrowers' group, a bank lends each borrower one unit of capital, which is due at the end of the period with the amount to be repaid at $r(> 1)$, inclusive of interest. If both borrowers repay, each obtains the payoff of $\theta_i - r, i = 1, 2$ (the borrowers are assumed to be risk-neutral). These are exactly the same assumptions as those of the BC model.

If both borrowers do not repay, each obtains the payoff of $\theta_i - \pi p(\theta_i)$, where $p(.)$ is the penalty on the default borrowers, which is assumed to be increasing in θ. One way of justifying $p'(.) > 0$ is that the main penalty is the loss of future access to microfinance loans and the net gain from having microfinance access is increasing in the realized value of θ. As in the BC model, the inverse of the penalty function $p(.)$ is denoted by a function $\phi(.)(\equiv p^{-1}(.))$. There is an additional parameter π, which is not included in the BC model. It is a fixed parameter in the range of $[0, 1]$, capturing the level of enforcement of the contingent renewal rule. By the "contingent renewal rule," we mean the mechanism analyzed by Chowdhury (2007), i.e., a rule that borrowers maintain their future loan access contingent on full repayment of the current loan. This rule is prerequisite for the dynamic incentives in the narrow sense (borrowers who successfully repaid will be given a larger amount of credit) to function. In reality, this rule may not be enforced strictly. We thus assume that with probability $1 - \pi$, the defaulters may maintain their future loan access.

If borrower i repays her due (but does not repay her partner's due) while borrower j defaults, the payoff of the former is $\theta_i - r - \gamma\pi p(\theta_i)$ and that of the latter is $\theta_j - \pi p(\theta_j)$, where γ is a fixed parameter in the range of $[0, 1]$, capturing the level of enforcement of the joint liability rule. By the "joint liability rule," we mean the rule that all non-default members lose their future loan access if at least one borrower in the borrowers' group fails to repay the current loan. In reality, this rule may not be enforced strictly. We assume that with probability $1 - \gamma$, the peer of the default borrower may maintain her future loan access.

Following the BC model, we consider the extensive form game depicted in Figure 1. At the time the game is played, the returns from both borrowers' projects are assumed to have been realized. These returns are denoted by θ_1 and θ_2 and are assumed to be common knowledge. At the first stage of the game, each borrower decides simultaneously whether or not to contribute his share, r. The two options are labeled as c (contribute) and n (not contribute). If the two borrowers make the same decisions, then the outcome is straightforward: both members repay their individual dues or both members default.

If the borrowers choose different strategies at the first stage, then the borrower who has played c now chooses from three options: GR (repay the total group dues), IR (repay her due only), and D (default). The second choice of IR is our original addition to the BC model. In Figure 1, payoffs are shown in the bottom rows when the borrowers choose different strategies at the first stage. For example, if borrower 1 chooses to play n and borrower 2 chooses c at the first stage, borrower 2 chooses from the three options, resulting in her payoff of $\theta_2 - 2r$ (if GR is chosen), $\theta_2 - r - \gamma\pi p(\theta_2)$ (if IR is chosen), or $\theta_2 - \pi p(\theta_2)$ (if D is chosen).

Depending upon the realization of (θ_1, θ_2) and the level of enforcing the rules characterized by (π, γ), the choice of each borrower will change. As in the BC model, the extensive form of Figure 1 has many Nash equilibria. Therefore, following the BC model, we use subgame perfection to refine these and assume that the borrowers can achieve the Pareto superior equilibrium if there are two equilibria of mutual contribution and mutual non-contribution.

2.3 Characterization of the solution

Using Figure 1, we search for the Pareto-superior subgame perfect equilibria. Our model is a generalization of the BC model in the sense that it becomes an individual lending model if $\gamma = 0$ and it becomes a joint liability model if $\gamma = 1$, analyzed by Besley and Coate (1995). To see this, if $\gamma = 0$, the player who chooses c at the first stage never chooses GR at the second stage, since the payoff under GR is always smaller than that under IR. In other words, when $\gamma = 0$, the choice of GR is always dominated by the choice of IR. Therefore, this situation is equivalent to the individual lending model analyzed by Besley and Coate (1995). The resulting pattern of equilibria is shown in Figure 2. In the north-east quadrangle, both repay; in the south-west, both default; in the north-west, borrower 1 defaults; and in the south-east, borrower 2 defaults.

Similarly, if $\gamma = 1$, the player who chooses c at the first stage never chooses IR at the second stage, since the payoff under IR is always smaller than that under D. In other words, when $\gamma = 1$, the choice of IR is always dominated by the choice of D. Therefore, this situation is equivalent to the case analyzed by Besley and Coate (1995) without social sanctions. It turns out that when $\gamma > 1/2$, the pattern of equilibria is exactly the same as that of the BC model. The resulting pattern of equilibria is shown in Figure 3. In the most north-east portion with $\theta_i > \phi(2r/\pi), i = 1, 2$, we observe that the group dues are repaid successfully. However, this is achieved by non-symmetric equilibria of either $\{(c, GR), n\}$ or $\{n, (c, GR)\}$. As explained by Besley and Coate (1995), since both borrowers have lucrative projects, so lucrative in fact that either is prepared to repay the group loan unilaterally, $\{c, c\}$ cannot be an equilibrium. When $\{(c, GR), n\}$ is achieved as the equilibrium, for instance, borrower 2 free-rides on borrower 1's decision to repay all group dues. This is one case of strategic default predicted by the BC model. In contrast, in the middle portion with $\phi(r/\pi) < \theta_i < \phi(2r/\pi), i = 1, 2$, loans are successfully repaid as in the most north-east portion but there is no free riding. Both borrowers repay their due. Another case of strategic default predicted by the BC model occurs when $\theta_1 < \phi(r/\pi)$ and $\phi(r/\pi) < \theta_2 < \phi(2r/\pi)$ or when $\theta_2 < \phi(r/\pi)$ and $\phi(r/\pi) < \theta_1 < \phi(2r/\pi)$. In this case, under individual liability, the relatively favored borrower repays while the another defaults, but the joint liability drives the relatively favored borrower to default as well.[2]

When $\gamma < 1/2$, it is possible to observe a situation shown in Figure 4. In four portions in the north-east, i.e., $\theta_i > \phi(r/\pi), i = 1, 2$, loans are repaid successfully as a group. Since the rule of joint liability is not strong enough, in no case one borrower repays the total group dues while the another repays nothing. This is in sharp contrast to the BC model's prediction. For instance, when $\theta_1 < \phi(r/\pi)$ and $\theta_2 > \phi(2r/\pi)$ or when $\theta_2 < \phi(r/\pi)$ and $\theta_1 > \phi(2r/\pi)$, the BC model predicts "within-group cooperation" (a borrower who would not repay under individual liability is helped by another member to repay the debt), while our model predicts that the cooperation cannot be achieved because γ is not large enough. On

[2]This may be avoided if informal social sanctions are effective. See Besley and Coate (1995).

the other hand, the second case of strategic default predicted by the BC model remains in our model. See the two portions in Figure 4 where $\theta_1 < \phi(r/\pi)$ and $\phi(r/\pi) < \theta_2 < \phi(2r/\pi)$ or when $\theta_2 < \phi(r/\pi)$ and $\phi(r/\pi) < \theta_1 < \phi(2r/\pi)$. The incomplete joint liability model predicts group default ($\{n, n\}$). This is the type of strategic default we focus on in this paper — a borrower who would repay under individual liability do not do so under group liability if members realize that they cannot repay as a group.

When γ is sufficiently small, the above situation with strategic default but without group cooperation disappears and the pure individual liability mechanism prevails. The threshold value is determined by an equality $\gamma = 1 - r/\{\pi p(\theta_i)\}$, which is increasing with π.

2.4 Comparative statics analysis of "peer correlation" with respect to the degree of rule enforcement

Figure 5 shows the possible regimes under different combinations of (π, γ), the parameters characterizing the degree of enforcing the rules of contingent renewal and joint liability. There are four segments in the figure. The left segment is characterized by very low values of π, resulting in a situation that loans are never repaid. In this area, "peer correlation" is not defined.

The lower right segment is characterized by low values of γ, resulting in a situation where the pure individual liability mechanism prevails. Borrower 1 defaults if $\theta_1 < \phi(r)$ and borrower 2 defaults if $\theta_2 < \phi(r)$, as shown in Figure 2. Therefore, if individual projects in the same borrowers' group are independent, the "peer correlation" coefficient is zero. If individual project risks are locally covariate, then "peer correlation" purely reflects this covariance.[3]

The upper right segment is characterized by high values of γ, resulting in a situation where IR is never chosen in the second stage of the repayment game. Under this regime, we observe two cases depending on the realization of (θ_1, θ_2): Both loans are repaid or both loans are not repaid, as shown in Figure 3. Therefore, regardless of the correlation of individual projects in the same borrowers' group, the "peer correlation" coefficient is unity.

The middle right segment characterized by middle values of γ is the area of interest.

[3] See Ahlin and Townsend (2008) for an example of modeling the covariance of microfinance returns.

In this case, we never come across a situation where the whole group dues are repaid by one of the two group members. When group dues are repaid successfully, both borrowers repay their individual due. On the other hand, if we look at situations where loans are not repaid at all, we find cases in which a borrower who would repay under individual liability does not do so because of the weak but non-negligible group liability. In Figure 5, this segment is denoted "GR-IR mixed region," by which we mean that when repaid, the individual repayment behavior dominates, while when defaulted, the group repayment behavior exists. Because of the latter effect, the "peer correlation" coefficient is strictly between zero and one when individual project risks are independent. The level of "peer correlation" reflects the frequency of strategic defaults.

From this argument, it is expected that the "peer correlation" coefficient increases with γ. This expectation is confirmed by a numerical example in which θ_1 and θ_2 are jointly distributed as an independent uniform distribution in the range of $[\underline{\theta}, \bar{\theta}]$.

The impact of π on the "peer correlation" coefficient is less clear. It depends on the level of γ. We investigate the case when θ_1 and θ_2 are jointly distributed as an independent uniform distribution in the range of $[\underline{\theta}, \bar{\theta}]$. If γ is low enough for the initial situation to be situated in the middle right segment while the new situation moves to a point in the lower right segment (a move from point A to A' in Figure 5), the "peer correlation" coefficient should decline. On the other hand, if both the initial and new points are located in the middle right segment (a move from point B to B' in Figure 5), the sign of the change in the "peer correlation" coefficient is indeterminate. Our numerical results indicate that the change in the coefficient is negative when γ is low and there is a threshold value of γ, above which the change is positive.

The change in Pakistan we investigate below seems consistent with an increase of π with γ remaining almost constant at a low level. Our model predicts that the improvement in enforcing the contingent renewal rule will result in lower default rates and a lower level of peer correlation due to the less frequent occurrence of strategic defaults.

3 Data and Background

3.1 Microfinance in Pakistan

Pakistan is one of the low income countries in South Asia where income poverty is prevalent and the majority of the poor have difficulty in their access to efficient sources of credit (World Bank, 2002). Microfinance is still relatively new to Pakistan, both from a conceptual and a practical point of view. The country is among the largest potential microfinance markets in the world with potential borrowers of 10 million adults. This conservative estimate is likely to expand dramatically with Pakistan's high population growth rates.

The country has been in the business of microcredit on a limited basis for many decades but the modern style microfinance began in the late 1990s. The main providers of microfinance at that time were NGOs and government-supported rural support networks.

Micro finance was declared a priority in the official Poverty Alleviation Strategy in 1999 and a regulatory framework for the promotion of microfinance was established in 2001. The result was a massive investment of at least US$400 million from 1999 to 2005, largely funded by multilateral resources such as the World Bank and the Asian Development Bank. Among various microfinance providers today, the Khushhali Bank, the flagship institution established by the government in 2000, serves over 175,000 active clients in 2005, more than the total number of clients reached by all the NGOs and rural support programs before 2001 (Montgomery, 2005). Microfinance institutions in Pakistan now comprise a voluntary network called Pakistan Microfinance Network (PMN). With the passage of time, the country not only moved forward its own way but also benefited from the experience of those who were way ahead and much before in the business. The impact of the microfinance services in Pakistan is estimated to be positive, although their outreach is not to the expected level, leaving many of the poor untouched (Montgomery, 2005).

The economy of Pakistan had shown a moderate growth during the 1990s, but due to economic reforms and structural adjustments supervised by the IMF and the World Bank, the poverty and the income inequality continued to rise (World Bank, 2002). The macroeconomic scene in the country over the last six years (2000/01-05/06) has changed drastically by an average annual rate growth of 6% since 2000/01. Besides, the debt-to-GDP ratio fell from almost 100% to 60% and exports have also been doubled. Despite this economic turnaround accompanied with macroeconomic improvements, the absolute level of real income per capita is still very low, standing at US$632 in 2004 evaluated at the official exchange rate and at US$2,225 after the PPP adjustment (UNDP, 2006). The challenge also remains to transfer the benefit of growth equitably across the board and especially to the poor.

3.2 Primary data of microcredit borrowers and their repayment

We utilize a micro-level information maintained for the purpose of financial monitoring of micro credit intervention. The information is obtained from a member of PMN. The names and identities of the participating households are replaced by computer-generated numbers for the sake of privacy. The sample is taken from a district in the North-West Frontier Province (NWFP), Pakistan, which was severely affected by the earthquake. Four primary datasets were collected in August 2006 and they were converted into a pooled cross-section dataset for empirical analysis.

(1) Borrowers' Data: There are 2,950 borrowers in this dataset, ranging from borrowers who borrowed on May 1, 1998, to borrowers who borrowed on July 8, 2006. 29.8% of the borrowers were females. Information of the household to which the borrower belonged was collected and comprised the part of the borrower dataset.

(2) Data on Borrowers' Community Organizations: To be eligible for microfinance loans in the study area, borrowers need to form a community organization (CO) with joint liability. Information of COs to which the above borrowers belonged was collected. There are 870 COs in the CO dataset, ranging from those established on March 11, 1997, to those established on April 10, 2006. Female borrowers usually belonged to COs designated as "female community organization," which accounted for 22.4% of the sample COs. COs keep their own savings account, with its average of Rs.6,348, ranging from 0 to Rs.99,000.[4]

(3) Data on Installments: For each borrower, records were kept for each installment, such as when it was due, how much was due for the principal and as service charges or process fee,[5] how much was repaid for the installment, outstanding debt after the repayment, etc.

[4]In this paper, "Rs." means the nominal Pakistani Rupees. The exchange rate between Pakistani Rupees and US dollars was stable at around Rs.60/$ during the study period. The government estimates for inflation rates inside Pakistan were in the range from 3.1 to 7.9% per annum.

[5]Under the Islamic influence, no interest is charged on microfinance loans but borrowers have to pay

For the 2,950 borrowers in the borrower dataset, there are 44,991 installment records. Their due dates range from June 1, 1998 to October 2, 2007.

(4) Data on Repayment Receipts: When a borrower repays, a receipt is issued and its information, such as the timing and amount of repayment, the amount of penalty, etc., is recorded in this dataset. To the 2,950 borrowers in the borrower dataset, 28,916 receipts were issued. Their receipt dates range from June 5, 1998 (even the first repayment in our sample was four days later than the due date) to June 29, 2006.

The number of receipt-level observations is much smaller than that of installment-level observations for three reasons. First, some due installments were never repaid. This is a default problem. Second, when the borrowers paid the amount more than the amount due in each installment, one receipt was issued. To reduce transaction costs of monthly repayment, many borrowers preferred to repay the amount worth several months' due. On the other hand, when the borrower could not repay a due amount for a month, she/he often repaid the amount worth two months' due in the next month. Third, many of our installment dues were in the future when we collected the data in August 2006. In other words, the right censoring is the third reason why the number of receipt-level observations is smaller than that of installment-level observations.

There are two important time breaks in our data. First, from January 2, 2005, the MFI began to provide microcredit under a new system with improved accountability. The last loan under the old system was issued on October 4, 2003. There was a gap of more than thirteen months without new loans, during which the MFI continued to collect dues from old loans while it prepared a new system. The second time break is October 8, 2005, when the earthquake hit the country.

3.3 Reforms in January 2005

Contract characteristics of microfinance loans are different between two periods demarcated by the first time break (Table 1). First, the average size of loans were almost halved. The average size was Rs.16,300 (about US$270) under the old system and Rs.9,000 (about US$150) under the new system. This reflects the rule change in which the minimum amount of a

"service charges" or "process fee" in addition to repaying the principal. In effect, they are equivalent to interests (the interest rate charged on these loans was 20% per annum under the old system).

standard loan was reduced from Rs.10,000 to Rs.5,000, and large loans exceeding Rs.15,000 were abolished under the new system.

Second, the number of installments and the length of credit duration decreased by 25%. Under the old system, there were many varieties of loans. The most common was a 19 month-loan to be repaid in 18 monthly installments (42.3% of the sample), followed by a 31 month-loan to be repaid in 30 monthly installments (18.3%). About 8.3% of the sample loans were not to be re-paid monthly but only in one installment for the whole loan period of 6, 9, 12, or 18 months. Under the new system, only two standard types are offered: a 12 month-loan repaid in 12 monthly installments or a 15 month-loan repaid in 15 monthly installments. The first type accounted for 92.3% of the sample and the second type accounted for 7.2% (there are three exceptional cases which were repaid after one month in one installment).

The third change was that interests (service charges) for all loans were collected in advance as a processing fee under the new system. Under the old system, service charges were collected over the repayment period along with the principal in each installment. In addition, under the old system, the first installment in a monthly repayment schedule was in many cases two months after the issue of a loan, implying a grace period of one month. The one month grace period was abandoned under the new system.

The fourth change was the enforcement of punishment against repayment problems. Under the old system, there was a rule that no new loans were advanced to a borrower if the borrower group failed to repay. However, the rule was not enforced in a strict way. Under the new system, accountability was strengthened, by which the rule was to be enforced more strictly. In Table 1, the ratio of borrowers with a national identity information record (NIC information), for instance, was 100% under the new system, reflecting this change. The ratio of female borrowers also increased recently.

The fifth change was to link development projects at the community level with repayment rates of COs in the region. In Pakistan, several initiatives were introduced in the 2000s to strengthen community-based development (Kurosaki, 2005). Under the new system, the implementation of infrastructure or human resource development projects became contingent on the good repayment record of the community. This change is another example of improved dynamic incentives for repayment.

3.4 Earthquake in October 2005

The second time break in our dataset is October 8, 2005. On this day, an earthquake with the size of 7.6 magnitude occurred in Kashmir. The earthquake left widespread destruction, killing at least 73,000 people, severely injuring another 70,000, and leaving 2.8 million people without shelter. The affected areas suffered an extensive damage to economic assets and infrastructure, with social service delivery, commerce, and communications either severely weakened or destroyed. Beyond the human toll, the overall cost associated with the earthquake is significant. A Joint Damage and Needs Assessment by a group of experts from the World Bank and the Government of Pakistan put the value of the direct damage due to the earthquake at US$2.3 billion while resulting indirect losses estimated at US$576 million. The estimated costs for relief, livelihood support for victims, and reconstruction cost are estimated at approximately US$5.2 billion.

The earthquake has also adversely affected the macroeconomy, especially the fiscal deficit. Fiscal deficits during the three years following the earthquake are expected to increase by 0.5 to 0.9% of GDP per year. These pressures could pose difficulties for Pakistan's macroeconomic balances and have the potential to compromise the achievement of its long-term development goals. Given the magnitude of resources needed for rehabilitation of earthquake-affected areas, it is unlikely that the government will be able to fully absorb the fiscal impact of the earthquake without significantly affecting public sector development activities. Moreover, it is important that the poor in areas not affected by the disaster (i.e., the vast majority of the poor in Pakistan) may have adversely affected as well due to increased allocation of public resources to the earthquake-affected areas at the expense of the rest of the country.

Contract characteristics of microcredit under the new system reported in Table 1 were re-calculated, distinguishing the borrowers whose loans were issued before and those after the earthquake. They were very similar and none of the variables in Table 1 had a difference with statistical significance.

3.5 Data compilation for loan default and repayment delay

From the primary data described above, we compile several variables for loan default and repayment delay, since these two are the major concerns of MFIs. Table 2 reports the results. Among the 2,950 borrowers, 555 borrowers who obtained the credit under the new system were still in the scheduled repayment process (the due date of the last installment was not yet reached at the time of our survey).

Among the remaining 2,395 borrowers, 120 were under the new system while 2,275 were under the old system. Counting the number of cases where the loan was repaid completely at the time of our survey, we obtain the borrower-level variable, $Default$, which is plotted in Figure 6. As can be seen clearly from the figure, all of the 120 borrowers under the new system repaid fully ($Default = 0$).

In contrast, out of the 2,275 old borrowers, only 1,119 completed the repayment by the time of our survey, implying a default rate at 50.8% (Table 2).[6] In Figure 6, the predicted probability from a probit model is also plotted for samples under the old system, in which $Default$ was regressed on the date of loan issue and its polynomials. The higher order polynomials than the fourth were not statistically significant. The default rates show a highly nonlinear pattern over the period.

The default rate for the old loans nevertheless underestimates the cost for the MFI because some bad loans were repaid very late after the last due date. For instance in our sample, a borrower who obtained a credit of Rs.25,000 on May 7, 1998, paid only about two thirds of their due by November 7, 1999 (the due date of the last installment) and paid the rest on July 19, 2001. Variable $Default$ counts such a case as non-default.

Therefore, for those 1,119 borrowers with $Default = 0$, to measure the quality of repayment, a variable named Avg_delay, i.e., the average delay in days of repayment relative to the due date for each installment, was calculated. Table 2 shows that the average of Avg_delay for the 1,119 borrowers was 100.0 days, ranging from -552.0 to 1014.0 (standard deviation [S.D.] at 145). If we exclude 5 outliers in early repayment ($Avg\_delay < -200$)

[6] Regarding loans provided under the old system, the due date of the last installment for the 2,275 borrowers ranges from July 7, 1999 to October 4, 2004. Since it was more than 22 months since the latest day of these due dates at the time of our data collection, it is safe to ignore the possible repayment in the future. Therefore, the right-censoring problem for the old loans can be ignored.

and 4 outliers in very late repayment ($Avg\_delay > 1000$), the average of Avg_delay became 98.5 (S.D.= 131.6).[7]

Similar variables can be defined at the installment level. The first one, No_repay, is a dummy variable that takes the value of one when the installment was not repaid. For those installments that were re-paid, another variable *Delay* (the delay in days of repayment relative to the due date for the installment) is compiled. In addition to these two, the third variable, $Problem$, is created which is a dummy variable taking one if the installment was not repaid within 31 days from the due date of the installment. Since early repayment is not a problem for MFIs, the third variable $Problem$ ignores the early repayments. Since late repayment as well as no repayment are the problem for MFIs, $Problem$ aggregates the late and no repayment information into one variable. As shown in Table 2, all of the three variables were very high on average for loans provided under the old system. About 21% of all installments were never repaid, the average delay of repaid installments was about 101 days, and 65% of all installments suffered from late repayment or non-repayment.

In sharp contrast, for all of the 120 borrowers who completed their scheduled repayment process under the new system, $Default = 0$ and $No\_repay = 0$ (Table 2).[8] We can calculate Avg_delay, *Delay*, and $Problem$ for these borrowers as well. The average of Avg_delay and that of *Delay* are slightly negative, and $Problem$ was zero for all installments, confirming the absence of a serious delay.

The situation is similar for the 555 borrowers who were still in the repayment schedule at the time of our survey. All of 2637 installments that were due at the time of our survey were already repaid. The range of *Delay* for this subsample is similar to its range for the subsample corresponding to the 120 borrowers. When the 555 borrowers are divided by the credit issue date falling before or after the earthquake, it is found that the mean and the standard deviation of *Delay* are very similar between the two subsets, with no statistically significant difference.

[7]The sample with $Avg\_delay = -552$ was a borrower who borrowed Rs.20,000 on September 2, 2002, which was to be repaid on April 2, 2004 in a lump sum. He repaid the whole money on September 28, 2002, so that his Avg_delay is -552 days.

[8]Because of the right-censoring problem, which could be potentially severe for new loans, for an installment that was already due at the time of our survey, we can assign $No\_repay = 0$ if we observe its repayment but we cannot assign $No\_repay = 1$ even if we observe that the installment was not repaid at the time of our survey. Fortunately, at the time of our survey, all due installments were already paid.

4 Why Did the Old System Fail? A Borrower-Level Analysis

4.1 Empirical models

As a starting point of our analysis, we investigate the determinants of loan default and repayment delay during the old system period. Dependent variables are $Default$ and Avg_delay. Four types of explanatory variables are employed.

(1) Borrowers' characteristics including those of the household to which the borrower belonged: Gender, family type, income sources, house structure, status in the borrowers' group, etc.

(2) Credit characteristics: Amount of credit, number of installments, period of credit in months, etc.

(3) Community organization (CO) characteristics: Number of CO members, amount of CO savings, age of the CO when the loan was issued, etc.

(4) Location and time effects: Unobservable heterogeneity that is specific to a region is controlled by Union fixed effects.[9] Unobservable macro effects are controlled by the date of issue of each loan. In one specification, D_issue (the number of days elapsed since the beginning of the New Style calendar) and its higher order polynomials are adopted. In another specification, year dummies corresponding to the date of issue are included. As shown in Figure 6, no monotonic trend is found between $Default$ and D_issue during the period under the old system but some fluctuations exist over time. Therefore, controlling macro effects in a flexible manner is important.

There are several selection problems in investigating the reduced-form determinants focusing on these explanatory variables. First, Avg_delay is defined only when $Default = 0$. Heckman's two step procedure is adopted to control for this selection bias.

Second, the choice of contract type is not purely random but partially selected by borrowers themselves. Therefore, if we do not control for this self-selection, the coefficients on the credit characteristics listed above cannot be interpreted as showing causal effects

[9] A Union is the smallest administrative unit in Pakistan, under the jurisdiction of the Union Council. Usually, ten to twenty natural villages are under one Union Council. Although there are 47 Union Councils in the dataset, only nine had multiple borrowers' groups. Therefore, we compiled Union dummies for these nine councils and merge the remaining councils as one category of "small Unions". "Union fixed effects" in the regression analyses below correspond to these ten dummies.

of contract designs on repayment (Armendariz de Aghion and Morduch, 2005: 101-102). One way to control for the self-selection is to adopt the matching approach employed by Gomez and Santor (2003) in the context of microfinance. Instead of correcting the self-selection bias regarding the contract type, we report non-corrected results with explanatory variables of (2) and (4) only. The motivation of this exercise is to capture net effects on repayment including both the causal effects of contract designs and the selection effects. This specification is informative in characterizing the problems that occurred under the old system. We then estimate a more reduced-form model with explanatory variables of (1), (3), and (4) only. In this specification, the choice of contract type is treated as endogenous so that variables (2) are excluded.

4.2 Estimation results

(a) Default/delay and credit contract design

Table 3 reports estimation results with $Default$ (dummy for the borrower-level default) or Avg_delay (average of delays in days among installments for a borrower with $Default = 0$) as dependent variables. Explanatory variables are contract types, Union fixed effects, and time effects.

In the $Default$ regression results, the period of credit duration and the dummy for non-monthly installments have positive and statistically significant coefficients. For instance in Model 1, the probability of default would increase by 18.5% if the credit duration becomes six months longer and the probability would increase by 20.8% if monthly installments are replaced by installments with a longer interval. In the Avg_delay regression results, the effect of the dummy for non-monthly installments is very strong, indicating that the delay would be 84 days longer if monthly installments are replaced by installments with a longer interval. These results demonstrate the appropriateness of the reforms introduced in early 2005 to make all installments monthly and to reduce the maximum loan duration to 15 months. As predicted by the estimation results in Table 3, these reforms successfully reduced repayment delays, resulting in zero default rates under the new system (Table 2). The positive impact of frequent repayment on avoiding default and delay has been found from other microfinance schemes in the world and interpreted as the early warning system, the lender's capture of non-microfinance income flow of the borrower, or the borrower's commitment to save regularly (Armendariz de Aghion and Morduch, 2005: 130-134). On the other hand, a recent study based on a clean experiment in India by Field and Pande (2008) shows no difference between weekly versus monthly repayment frequency. Combining these findings, it seems that monthly repayment is the best frequency to avoid repayment delays.

On the other hand, contrary to our expectation, the coefficient on the dummy for loan size larger than Rs.15,000 is not positive.[10] The coefficient is negative in all four models reported in Table 3, and that on *Avg_delay* is statistically significant. This seems to reflect the selection bias. Only those borrowers who have characteristics that are associated with higher probability of on-time repayment applied to large loans and were provided with such loans. Because the selection effect is strong, the potential harm of the loan size on repayment could not be observed in Table 3.

Significantly positive coefficients of the period of credit duration and the dummy for non-monthly installments could also reflect such selection effects. The regression results show that longer loans and less frequent installments are harmful to repayment both through the causal detrimental effects on repayment behavior and through the selection effects that such contracts attract risky borrowers more.

In all specifications, Union fixed effects are jointly significant at the 1% level and time effects are jointly significant at the 1% level. Whether the time effects are controlled by *D_issue* and its higher order polynomials or by year dummies makes little difference qualitatively (compare Model 1 and Model 2 in Table 3). This applies to other regression results as well. Therefore, in tables below, only those using *D_issue* and its higher order polynomials are reported.

(b) Default/delay and borrowers' characteristics

As a more reduced-form approach, $Default$ or *Avg_delay* are regressed on explanatory variables including borrowers' individual characteristics, borrower households' characteristics, CO characteristics, and region/time effects (Table 4). The explanatory variables are jointly

[10] We employ this variable rather than including the size of loan directly for two reasons. First, the size of loan is highly correlated with the loan duration. Therefore, to avoid the multicollinearity problem, we employ the dummy variable. Second, in the 2005 reforms, loan contracts larger than Rs.15,000 were abandoned. To examine the appropriateness of this change, we employ the dummy variable.

significant and those with statistical significance individually are with expected signs.

First, borrowers who reported their NIC information and female borrowers were less likely to default. They also repaid on time when they repaid the loan. The finding of the higher repayment rate by female borrowers is consistent with other empirical studies on microfinance in South Asia (Armendariz de Aghion and Morduch, 2005). This may reflect the difference in preferences and in alternative credit availability. The impact of NIC information shows that the NIC information made more difficult for a defaulted borrower to re-apply to a loan in the future. In other words, the significant effect of this variable shows that the enforcement of the contingent renewal rule was imperfect under the old system. The dummy for chairman or secretary of the CO has a negative coefficient, as expected if these borrowers are more credible, but the coefficients are not statistically significant.

Second, to control the resource availability of a borrower, several household-level variables characterizing household income sources are included and they have significant coefficients. Households with more income sources and households with income originating outside their residential areas were less likely to default and they repaid on time when they repaid the loan. This shows the importance of income diversification to avoid default.

Third, the dummy variable for a female-headed household has a negative coefficient and the negative coefficient is statistically significant for the $Default$ regression. If this variable mainly captures the income and wealth effects, we expect the opposite sign since female-headed households in Pakistan tend to be poorer than male-headed households. The negative coefficient implies that female-headed households have fewer alternative credit sources so that they tend to default less.

Fourth, several variables characterizing the CO to which the borrower belonged have significant effects on repayment. CO's savings have a negative coefficient, implying either the saving accumulated at the CO serves as the buffer to avoid default or borrowers in COs with higher savings tend to be more safe investor. COs with incomplete records were more likely to default. The age of the CO at the time when the loan was issued has a positive coefficient, suggesting that older COs were less successful in repayment, suggesting a group fatigue (Sharma and Zeller, 1997). Among the CO characteristics, the number of CO members has a positive coefficient and it is statistically significant in the Ave_delay

regression. We interpret this as the difficulty faced by larger COs to coordinate within the group and to avoid the free rider problem.[11]

The regression results in Table 4 thus seem to indicate a limited role played by COs to prevent default and repayment delay. Instead, our field observations indicate that COs functioned as a forum to collude under the old system. This impression will be further investigated in the next section.

5 Repayment Dynamics and Intra-Group Interactions under the Failed System: An Installment-Level Analysis

5.1 An example

Figure 7 plots the pattern of repayment for five sample borrowers who belonged to the same CO and borrowed under the same condition. They borrowed Rs.20,000 on November 7, 2000, which was to be repaid in 18 monthly installments after a grace period of one month. In the figure, the cumulated amount of repayment is plotted, with that of scheduled repayment in a blue line with solid diamond dots. Each dot on a zigzag line for each borrower represents the cumulated amount after repayment from the borrower.

If a zigzag line lies below the scheduled line, it implies a delay in repayment. Borrowers No.401, 403, and 405 thus created the delay problem for the MFI, while borrowers No.402 and 404 paid due amounts before due dates (Avg_delay for these two borrowers is negative). If a zigzag line stops to rise before reaching the level of Rs.23,490 (the total amount that should be repaid), it implies that the loan was defaulted. Therefore, borrowers No.401, 403, and 405 defaulted ($Default$ for these three borrowers is 1 so that Avg_delay is not defined). Borrower No.405 repaid the amount corresponding to the first ten installments although with delays. Therefore, installment-level variables for No.405 are calculated as: $No\_repay = 0$ and $Delay > 0$ for the first ten installments; $No\_repay = 1$ and $Delay$ is not defined for the last eight installments.

Looking at the shapes of zigzag lines in Figure 7, we notice two interesting points.

[11] In a different context in Pakistan, Kurosaki (2005) reports a positive effect of the size and diversity of a community-based organization (CBO) on the level of collective action. His interpretation is that larger and more diverse CBOs may have difficulty in coordinating within the group and avoiding the free rider problem but they have advantage in technical skills required for the particular type of collective action he analyzed, and the advantage dominated the difficulty.

First, for borrowers with repayment problems, the zigzag lines seem to be linear or slightly concave. This implies that once repayment is delayed for a borrower, then it is very difficult for the borrower to catch up by the next installment date but is likely to be late again with a similar or longer delay. In other words, *Delay* seems to be positively auto-correlated.

Second, the shapes of zigzag lines are very similar among some of the borrowers. For instance, when borrower No.402 repaid more than required for the third installment, borrower No.404 did the same thing. Meanwhile, borrowers No.401 and 405 did not repay anything for the first two due dates but paid the amount due for one installment when the third installment was due, and they repaid some money when the fourth installment was due but not enough to make up for the outstanding dues. In other words, *Delay* seems to be positively correlated among the CO members (we call this "peer correlation" below).

Since members of a CO reside in the same village, they are subject to village-level covariate shocks. If No.401 and 405 suffered from such covariate negative shocks, it is no wonder that we observe "peer correlation." If this is the case, we expect that No.402 and 404 invested the microfinance loan in similar projects and so did No.401 and 405. To our surprise, No.402 invested in a small grocery shop while No.404 invested in buffaloes. No.401 invested in buffaloes while No.405 invested in another small grocery shop.

Examining more examples as well as discussing with program participants and MFI officers in the field, we came to suspect that there existed a kind of strategic default. Because the dynamic incentives were weak under the old system, if one group member was hit by a negative shock and faced the difficulty in repayment, the other members who were able to repay might have decided to default themselves as well, instead of helping the unlucky person. As shown in Section 2, the "peer correlation" coefficient should be 1 if joint liability is perfectly enforced but it is less than one under imperfect joint liability. The coefficient then increases with the frequency of strategic default. Using our detail dataset at the installment level, we investigate whether this hypothesis is supported empirically.

5.2 Empirical strategy

We begin with an installment-level model for *Delay*, because most of the cases of $No\_repay =$ 1 came after several instances of repayment delay. By definition, for each borrower, $No\_repay =$

1 for installments later than an installment with $No\_repay = 1$. Therefore, after analyzing the determinants of $Delay$, we analyze the determinants of transition probability from $No\_repay = 0$ to $No\_repay = 1$.

To focus on the installment-level dynamics and to avoid the additional complication due to differences in repayment schedules, we use the subset of our installment-level data with 18 monthly installments. Out of 36,777 installments under the old system (see Table 2), 17,316 installments comprise the subset used in the analysis below. A larger subset is used in the robustness check. Each credit contract is denoted by subscript i and the order of its monthly installment is denoted by subscript t ($t = 1, 2, ..., 18$). The following model is estimated to investigate the determinants of $Delay_{it}$:

$$Delay_{it} = a_1 Delay_{i,t-1} + a_2 Delay^C_{it} + u_i + u_t + e_{it}, \tag{1}$$

where $Delay^C_{it}$ is the average over j of $Delay_{jt}$ for borrower j who belongs to the same CO as borrower i but excluding i and whose due date is the same as $Delay_{it}$. Variable $Delay^C_{it}$ is meant to capture the extent of peer correlation. u_i is a borrower-specific unobservable factor, u_t is an unobservable factor specific to the installment order, e_{it} is an i.i.d. error term, and a_1 and a_2 are parameters to be estimated.

Equation (1) is estimated by a two-way fixed effect (FE) panel regression model, with individual credit contract as "group" and the installment number as "time" for the fixed effect. The borrower-level determinants of repayment such as the gender, NIC information, income sources, CO characteristics, etc., which have already been investigated in the previous section, are jointly controlled by u_i. In addition, u_i also controls the macroeconomic factors because each credit contract is associated with the date of the credit issue so that the i-fixed effect controls unobserved factors associated with the date. The common dynamics in a repayment cycle (e.g., a borrower may have a higher motivation to repay on time for the first and the last installment, but her motivations may be lower in between) is controlled by u_t.

Since $Delay^C_{it}$ does not reflect the information of No_repay_{jt}, a variant of equation (1) is also estimated:

$$Delay_{it} = a_1 Delay_{i,t-1} + a_2 Problem^C_{it} + u_i + u_t + e_{it}, \tag{2}$$

where $Problem^C_{it}$ is defined in a way similar to $Delay^C_{it}$, but using $Problem_{jt}$ (dummy for non-repayment until 31 days after the due date: see Table 2). To investigate the determinants of transition probability from the status $No\_repay = 0$ to $No\_repay = 1$, we compile a variable $No\_repay^C_{it}$, which is calculated from No_repay_{jt} in a way similar to $Delay^C_{it}$. We then estimate:

$$No\_repay_{it} = a_1 Delay_{i,t-1} + a_2 No\_repay^C_{it} + u_i + u_t + e_{it}, \tag{3}$$

for the subsample with $No\_repay_{i,t-1} = 0$.

Equations (2) and (3) are also estimated by a two-way FE model, with individual credit contract as "group" and the installment number as "time." In all three equations, parameter a_1 captures the extent of auto correlation and parameter a_2 captures the extent of peer correlation. The robustness of our results to other econometric specifications is discussed in a separate subsection.

If the estimate for a_2 is significantly positive, it implies the existence of peer correlation, which is consistent with predictions of the imperfect joint liability model discussed in the theoretical section. It is possible, however, that the peer correlation simply reflects the ill-effects of covariate shocks that fall on microenterprise projects run by microcredit borrowers. To examine this possibility, we divide the sample observations into those belonging to a CO with very homogeneous microenterprise projects and those belonging to a CO with heterogeneous microenterprise projects. If the main reason for the significance of a_2 is the covariance of microenterprise project returns, we expect the estimate for a_2 among homogeneous groups be larger than that among heterogeneous groups. If the estimate for a_2 is similar regardless of the homogeneity of microenterprise projects within a CO, we interpret that the peer correlation is mainly due to strategic default under imperfect joint liability.

For this investigation, we compile a CO-level variable, *Homogeneity*, which is a dummy variable for the same project purpose.[12] It is an indicator of the homogeneity of microenterprise projects. If $Homogeneity = 1$, the borrowers are presumably subject to more covariate risk in microenterprises than the case with $Homogeneity = 0$. We split the sample depend-

[12] To compile this variable, project purposes are classified into 34 categories. For instance, the category of "Livestock" as the purpose of borrowing shown in Table 1 is disaggregated into four categories of buffalo, cow, goats & sheep, and poultry.

ing on $Homogeneity$ and estimate equations (1), (2), and (3) using the smaller subsamples. We then compare the estimates for a_2, testing the statistical significance of the difference using regression based on the pooled sample with a full set of cross-terms of explanatory variables with $Homogeneity$.

5.3 Estimation results

The FE estimation results for equations (1), (2), and (3) are reported in Table 5. Regarding the determinants of $Delay_{it}$, its lagged value has a significantly positive coefficient a_1 in all three equations. Therefore, the existence of auto-correlation in repayment delay is confirmed quantitatively. The size of the coefficient in (1) and (2) is smaller than unity with statistical significance at the 1% level so that the dynamic path is stable.

Coefficient a_2 on the peer-average variable is also positive and significant in all three equations. Thus the peer correlation exists. The size of these coefficients are quite large: a ten-day delay among the peer led to a delay of 3.19 days; a 10 percentage-point increase of the ratio of non-repaying fellows until 31 days after the due date led to a delay of 3.06 days; and a 10 percentage-point increase of the ratio of fellows with $No\_repay = 1$ increased the probability for the borrower to enter the status of $No\_repay = 1$ by 4.89 percentage points.

The regression results thus confirm the existence of strong auto- and peer correlation. The size of the peer correlation parameter can give the upper limit of the positive correlation among delay/default due to covariate shocks that occurred to these borrowers. To examine the extent to which the positive peer correlation can be attributed to strategic default, we split the sample by the value of $Homogeneity$ and re-estimate the three equations using the smaller subsamples.

The summary regression results in Table 6 show that the estimates for a_2 are statistically significant in all specifications and their coefficients are very similar regardless of the choice of the sample. Coefficient a_2 in equation (1) is 0.320 in heterogeneous COs where some members invested in projects different from others while it is 0.337 in homogeneous COs where all members invested in the same project. The difference is so small that the statistical test accepts the null hypothesis that they are the same. Similarly, coefficient a_2 in equation (2) is 29.7 in heterogeneous COs while it is 30.7 in homogeneous COs. The difference is again statistically insignificant. In the No_repay_{it} regression (equation (3)), a_2 is 0.455 in heterogeneous COs while it is 0.526 in homogeneous COs and the difference is statistically significant. Nevertheless, the absolute size of the difference is very small so that we cannot say the difference is economically significant.

Therefore, the results in Table 6 do not support the view that the observed peer correlation was mainly due to covariate shocks that occurred to the borrowers. They instead seem to support the view that strategic default was (at least partially) responsible for the peer correlation. In Section 6 of this paper, we estimate equation (1) using installment-level data under the new system. The results in Table 10 show that the estimate for a_2 in homogeneous COs are significantly larger than that for a_2 in heterogeneous COs. With this contrast, we are confident that the results in Table 6 support the view that the strategic default under the imperfect joint liability was a serious problem under the old system.

5.4 Robustness check

To check the robustness of the results in Table 6, we attempted four different specifications. First, instead of splitting the sample by the value of $Homogeneity$, we compiled the Herfindahl index for the project purposes (the sum of shares squared) and add its cross-terms with the peer average variables to the three equations. The Herfindahl index takes the maximum value of 1 and if all borrowers in a CO invest in a different project, the index takes the minimum value of $1/n$, where n is the number of members. If the peer correlation is due to covariate shocks to microenterprises, we expect the coefficient on the cross-term to be positive. The regression results in Table 7 show that this is not the case. The cross-term has a negative and insignificant coefficient when the dependent variable is $Delay_{it}$. The cross-term has a positive and marginally significant coefficient when the dependent variable is No_repay_{it}, but its magnitude is economically small.

Second, instead of limiting the sample to observations associated with 18 monthly installments, a larger subset of observations associated with monthly installments more than 5 was employed. Out of 36,777 installments under the old system (see Table 2), 36,306 installments are now included. The analysis may suffer from specification errors due to differences in repayment schedules, but it can gain in statistical efficiency from a larger number of observations. The results in Table 7 show qualitatively the same results as those in Table 6: Coefficient a_2 is slightly larger when observations associated with homogeneous COs are used than when those associated with heterogeneous COs are used, but the difference is not economically significant. The statistical significance level improved in the case of equation (1), possibly reflecting the larger number of observations used, but it deteriorated in the case of equation (3).

Third, we re-estimated (1) and (2) using a system GMM approach proposed by Blundell and Bond (1998). In these two equations, the lagged variable $Delay_{i,t-1}$ is included in the right-hand-side, creating a dynamic panel data (DPD) structure. To avoid the potential endogeneity bias due to the DPD structure, we attempted Blundell and Bond's system GMM estimation method. The system GMM results in Table 7 show that coefficient a_2 is smaller (not larger) when observations associated with homogeneous COs are used than when those associated with heterogeneous COs are used, and the difference is statistically significant. It is difficult to interpret the results but at least they do not support the view that the observed peer correlation was mainly due to covariate shocks that occurred to microenterprises run by the borrowers.

Fourth, we re-estimated the three equations using lagged values of the peer average variables. Three variables proxying the peer effects, i.e., $Delay_{it}^C$, $Problem_{it}^C$, and $No\_repay_{it}^C$, could be simultaneously determined with the left-hand-side variables. Especially when all members in a CO behave strategically when they decide about repayment, the simultaneity bias is a real concern. From our dataset, however, it is difficult to find suitable instrumental variables to control for the simultaneity bias. Therefore, we replaced $Delay_{it}^C$, $Problem_{it}^C$, and $No\_repay_{it}^C$ by $Delay_{i,t-1}^C$, $Problem_{i,t-1}^C$, and $No\_repay_{i,t-1}^C$, as crude proxies for valid instrumental variables. The regression results in Table 7 show that the extent of peer correlation is reduced but still statistically significant for equations (1) and (3). In all three equations, the difference in a_2 across the two subsamples distinguished by $Homogeneity$ is insignificant. Therefore, the view that strategic default contributed to the peer correlation was confirmed again.

The results so far show that the repayment delay of each installment was correlated with other members' repayment delay, beyond the level explained by possible correlation of project failures due to locally covariate shocks. We therefore interpret this as evidence for the existence and seriousness of the strategic default. The nature of the Pakistani society characterized by limited historical experience in community-based cooperation in development and by the existence of strong local elites (e.g., see Kurosaki, 2005) seems to underlie the limited success of community-based group lending. Whether the relative success after the system change in early 2005 can be explained similarly is investigated in the next section.

6 Repayment Delays under the New System and the Impact of the Earthquake

6.1 Empirical models

As shown in Table 2, no case of $Default = 1$ or $No\_repay = 1$ is reported after the new system was adopted in early 2005. Therefore, we first estimate borrower-level determinants of Avg_delay for the 120 borrowers who completed the repayment schedule, using a specification similar to the one reported in Table 4.

Since the 2005 Earthquake was devastating, it is of interest to see whether repayment patterns were affected by the earthquake. To identify the earthquake impact, a difference-in-difference (DID) approach is adopted. First, information about the distance between the locality of each borrower and the epicenter of the earthquake is obtained from the website of the Earthquake Reconstruction and Rehabilitation Agency (ERRA) and a dummy variable D_eq is created, which takes the value of 1 if the household was located within a distance of 75 km from the epicenter of the earthquake, and the value of 0 otherwise. The threshold value of 75km is chosen after consultation with specialists on earthquakes as a useful line to divide regions into those affected more severely by the earthquake and those affected less severely.[13] All of the 120 borrowers obtained the loan before the earthquake. Some of their installments were due after the earthquake. Therefore, we compile a borrower-level variable $Time\_eq$, which is the ratio of installments due after the earthquake. Needless to say, variable D_eq captures a region-specific effect while $Time\_eq$ captures an effect of any macroeconomic factor, so that their coefficients cannot be attributed to the earthquake. However, by adding

[13]In the empirical analysis, we check the robustness of empirical results with respect to the choice of D_eq including the use of the reciprocal of the distance. We found that the results reported in this paper regarding the earthquake impact are very robust to this choice.

their cross term, $D\_eq * Time\_eq$, we can identify the impact of the earthquake, as far as our identification assumption is correct that the region-specific effect affects only the level, not the growth rate, and the macro factors are homogeneous across regions.

One problem of the borrower-level regression is the small number of observations. By estimating an installment-level model (1) by a FE specification, this problem becomes less serious. In addition, we estimate an extended version of model (1) with borrower-level variables included as explanatory variables. The coefficients on these variables are identified only by a random effect (RE) specification. The sample for this exercise is 1,407 installments of the 120 borrowers who completed the repayment schedule or 4,040 installments which were already due and repaid at the time of our survey, including the installments that were repaid by borrowers who were still in the repayment schedule at the time of our survey (Table 2).

To test whether the earthquake affected the installment-level repayment, we add two dummy variables. First, D_t1, which is a dummy variable for an installment due after the earthquake. This is an installment-level variable so that its cross term $D\_eq * D\_t1$ enables us to identify the DID impact of the earthquake in all regression models for installments under the new system. The second dummy variable is D_t2, which is a dummy for the loan made after the earthquake. This is a borrower-level variable taking the value of zero for the 120 borrowers who completed the repayment schedule. Therefore, the cross term $D\_eq * D\_t2$ can identify the DID impact of the earthquake only under the RE specification applied to the expanded sample including more recent installments.

6.2 Estimation results

Table 8 reports the estimation results for the borrower-level determinants of Avg_delay using the 120 borrowers.[14] Although the model is jointly significant at the 1% level, most of the significant regressors are Union fixed effects and time controls. The only variable that is statistically significant and has the same sign as in Table 4 is the "Number of income sources of the household," which tended to decrease the repayment delay, possibly showing the diversification advantage. Unexpectedly, "The dummy for income sources outside the region" has a significantly positive coefficient but this is not robust (see Table 9).

[14] Some of the explanatory variables are dropped since they have no variation among the 120 borrowers.

The impact of the earthquake is not discernible from our sample using the borrower-level regression (Table 8). The coefficient on $D\_eq * Time\_eq$ is insignificant with a negative sign.

Table 9 reports the estimation results for the installment-level determinants of $Delay$.[15] First, all variables capturing the auto- and peer correlation have positive and statistically-significant coefficients. Second, the impact of the earthquake is not discernible in the installment-level analyses, either. The coefficients on $D\_eq * D\_t1$ are insignificant in all four models. The coefficient on $D\_eq * D\_t2$, which is identified in the RE specification only, is positive but its magnitude is very small and statistically insignificant. Third, most of the borrower-level variables, whose effects are identified only in the RE specification, are insignificant in explaining $Delay$. Therefore, results in Table 8 regarding the insignificant effects of these variables are confirmed.

As far as the statistical significance is concerned, a_2 (the coefficient capturing the peer correlation) remains highly significant under the new system (Table 9), as was the case under the old system (Table 5). Does this mean that the tendency to default strategically remains unaffected under the new system? To investigate this question, Table 10 is prepared, in which we re-estimate equation (1), splitting the sample depending on $Homogeneity$, and examine the statistical and economic significance of the difference in a_2.

A striking result is that a_2 is much larger when observations associated with homogeneous COs are used than when those associated with heterogeneous COs are used. The difference is not only statistically significant (the significance level is 1%), but also economically significant. During the new system period including the latest observations, coefficient a_2 is 0.422 in COs where some members invested in projects different from others and it is 0.667 in COs where all members invested in the same project. This contrast is exactly what we expected if the main reason of peer correlation in $Delay$ is covariate shocks to microenterprises. From our field observations, we could not obtain an indication that there occurred a substantial change in the covariance among microenterprises implemented by microcredit borrowers after early 2005. We therefore interpret this as evidence that the tendency

[15] We use the subset of our installment-level data corresponding to those observations with 12 monthly installments. Out of 4,044 installments under the new system (Table 2), 3,992 installments comprising the subset.

to default strategically has been weakened under the new system with improved dynamic incentives and more frequent repayment schedules.

7 Conclusion

This paper analyzed an interesting case of microfinance in Pakistan, in which the MFI successfully overcame the problem of frequent default by adopting in early 2005 a new system with strict enforcement of punishment against repayment problems. We hypothesized that strategic default under the joint liability mechanism, which was encouraged by weak enforcement of dynamic incentives, was responsible for the earlier failure. Using a unique dataset of about 45,000 repayment installments covering 2,950 micro-borrower households and over a period of 1998-2006, we investigated the dynamics of repayment at the installment level. We found that the repayment delay of each installment was correlated with other members' repayment delay, beyond the level explained by possible correlation of project failures due to locally covariate shocks. The peer correlation remained under the new system but it can be better explained by covariate shocks to microenterprises. Therefore, our interpretation is that strategic default occurred frequently and was serious under the old system, while the new system was successful in suppressing the collusion and inducing cooperation among the group members.

Although the study area was hit by a disastrous earthquake in October 2005, the new system seems to be robust as far as the repayment delay is concerned. This does not necessarily imply that the earthquake was not a threat to microfinance. It may reflect a change in the lending strategy that the MFI became more selective about the clients[16] and monitored the borrowers more intensively after the earthquake, thereby avoiding the delay/default problem. If this is the case, borrowers in the earthquake-hit region suffered not only from the natural disaster but also from the punctual (inflexible) repayment requirement of MFI, a finding similar to the one reported by Shoji (2008) for the case of Bangladesh's flood. This is an issue worth further investigation, after collecting more observations after

[16]Comparing borrowers' observable characteristics of those screened *before* the earthquake and *after* the earthquake, we found that most of the characteristics were similar with no statistical difference. One exception was the dummy variable for households with income originating outside their residential areas. Before the earthquake, its average was 0.21 while after the earthquake, its average was 1, suggesting that the MFI lend only to those households with outside income after the earthquake.

the earthquake.

A new implication from these findings to the understanding of microfinance is on the concept of covariate shocks. Even when shocks to microenterprises implemented by borrowers belonging to the same borrower group are purely idiosyncratic from the viewpoint of an individual borrower, such shocks may affect the MFI as if they are covariate shocks falling on these borrowers if the tendency to default strategically exists. This paper shows that if the strategic default is rampant, it affects the sustainability of microfinance more adversely than a purely covariate, negative shock such as the 2005 Pakistan earthquake.

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Table 1. Characteristics of Microfinance Loans

	Old system	New system
Characteristics of credit		
First date of credit issued	01-May-98	02-Jan-05
Last date of credit issued	04-Oct-03	08-Jul-06
Amount of credit in Rs.		
Average	16,324	8,993
Std.Dev.	9,427	2,768
Minimum	500	5,000
Maximum	50,000	15,000
Number of installments		
Average	16.17	12.17
Std.Dev.	8.98	1.08
Minimum	1	1
Maximum	30	15
Credit duration in months		
Average	17.63	12.17
Std.Dev.	7.99	1.08
Minimum	1	1
Maximum	31	15
Characteristics of borrowers		
Ratio of borrowers with NIC* information recorded	78.5%	100.0%
Ratio of female borrowers	24.2%	48.7%
Purpose of borrowing (total=100%)		
Crop agriculture	5.3%	0.3%
Livestock	61.4%	6.8%
Shops, business, workshops	30.4%	55.6%
Others	0.6%	0.7%
Domestic needs (consumption, education, housing, etc.)	2.3%	36.6%
Number of sample borrowers	2275	675

Note *: NIC stands for the "National Identity Card" issued by the Government of Pakistan.

Table 2. Defaults and Delays in Repayment of Microcredit

	Old system	New system: Borrowers who completed the repayment schedule	New system: Borrowers who were still in the repayment schedule
Borrower-level variables			
Total number of observations	2275	120	555
Default (dummy for non-repayment)			
NOB: Number of obs.for which this variable can be defined	2275	120	0
Average (ratio of defaults)	0.5081	0	
Avg_delay (average delay in repayment)			
NOB	1119	120	0
Average (in days)	100.0	-1.9	
Std.Dev.	144.8	9.3	
Minimum	-552.0	-54.9	
Maximum	1014.0	13.0	
Installment-level variables			
Total number of observations	36777	1407	2637
No_repay (dummy for non-repayment)			
NOB	36777	1407	2637
Average (ratio of non-repayments)	0.2078	0	0
Delay (delay in repayment)			
NOB	29134	1407	2637
Average (in days)	101.1	-2.2	0.9
Std.Dev.	176.1	14.7	11.3
Minimum	-552.0	-181.0	-188.0
Maximum	1560.0	26.0	27.0
Problem (dummy for non-repayment until 31 days after the due date)			
NOB	36777	1407	2637
Average	0.6549	0	0

Table 3. Borrower-level Defaults/Delays and Credit Contract Types

	Probit: *Default*			2-stage Heckman: *Avg_delay*	
	Coef.		dF/dx	Coef.	
Model 1.					
Dummy for loan size larger than Rs.15,000	-0.0182		-0.0073	-24.19	*
	(0.0952)			(12.76)	
Credit duration in months	0.0774	***	0.0309	0.63	
	(0.0072)			(1.01)	
Dummy for non-monthly installments	0.5414	***	0.2079	84.16	***
	(0.1340)			(18.83)	
Inverse Mills ratio				53.09	***
				(16.31)	
Union fixed effects	Yes			Yes	
Date of credit issued: linear, quad., cubic, fourth	Yes			Yes	
Number of observations used in the estimation	2275			1119/2275	
chi2(16), chi2(26) for zero slope	394.5	***		408.0	***
Pseudo R2	0.1251				
Model 2.					
Dummy for loan size larger than Rs.15,000	-0.0403		-0.0161	-31.46	**
	(0.1007)			(13.03)	
Credit duration in months	0.0697	***	0.0278	0.57	
	(0.0072)			(1.02)	
Dummy for non-monthly installments	0.3639	**	0.1424	74.29	***
	(0.1523)			(20.32)	
Inverse Mills ratio				48.04	***
				(17.50)	
Union fixed effects	Yes			Yes	
Year fixed effects	Yes			Yes	
Number of observations used in the estimation	2275			1119/2275	
chi2(17), chi2(31) for zero slope	443.2	***		448.2	***
Pseudo R2	0.1406				

Notes: (1) The average of the "Dummy for loan size larger than Rs.15,000" is 0.592 and that of the "Dummy for non-monthly installments" is 0.129. For other variables, see Tables 1 and 2 for their summary statistics.

(2) Coefficient estimates are statistically significant at 1% (***), 5% (**) or 10% (*). Standard errors are in parenthesis.

(3) For the 2-stage Heckman estimation, the first-stage model is the one reported in Table 4 for *Default* using 2275 observations. In other words, borrowers' and community organizations' characteristics are used as identifying instrumental variables. The number of uncensored observations is 1119.

Table 4. Borrower-level Defaults/Delays and Borrowers' Characteristics

	Mean (Std.Dev) of the explanatory variables	Probit: *Default* Coef.	Probit: *Default* dF/dx	2-stage Heckman: *Avg_delay*
Borrowers' individual characteristics				
Dummy for the availability of NIC info.	0.785	-0.6548 ***	-0.2513	-142.41 ***
	(0.411)	(0.0901)		(36.15)
Dummy for a female borrower	0.242	-0.4779 ***	-0.1879	-78.40 ***
	(0.429)	(0.0772)		(25.86)
Dummy for chairman or secretary of the CO	0.045	-0.1922	-0.0764	-3.52
	(0.208)	(0.1383)		(26.72)
Borrower households' characteristics				
Number of income sources of the household	1.622	-0.3898 ***	-0.1555	-49.82 ***
	(0.861)	(0.0464)		(17.32)
Dummy for income sources outside the region	0.185	-0.3664 ***	-0.1447	-47.51 *
	(0.389)	(0.1154)		(27.49)
Dummy for a female-headed household	0.080	-0.8122 ***	-0.3004	-7.66
	(0.271)	(0.1757)		(49.25)
Dummy for a joint family	0.476	-0.0632	-0.0252	19.76
	(0.500)	(0.0714)		(14.72)
Community Organization (CO) characteristics				
CO's savings (in Rs.100000)#	0.173	-0.4560 *	-0.1818	-40.51
	(0.175)	(0.2430)		(51.90)
Number of CO members#	36.0	0.0010	0.0004	1.57 ***
	(13.6)	(0.0027)		(0.51)
Dummy for missing CO records#	0.165	0.2393 **	0.0948	29.48
	(0.372)	(0.1026)		(23.74)
CO's age in days at the time of the loan issue	496.1	0.00064 ***	0.00026	0.080 **
	(418.3)	(0.00010)		(0.038)
Inverse Mills ratio				-212.31 **
				(82.86)
Union fixed effects		Yes		Yes
Date of credit issued: linear, quad., cubic, fourth		Yes		Yes
Number of observations used in the estimation	2275	2275		1119/2275
chi2(26), chi2(49) for zero slope		531.4 ***		603.2 ***
Pseudo R2		0.1685		

Notes: (1) # "Savings" and "Number of CO members" were not reported from about 15% of the sample CO's. In such a case, "Dummy for missing CO records" takes the value of one, and the means of COs' savings and the number of members were included. The reported standard deviations for "Savings" and "Number of CO members" are based on the subsample for which these two variables were available.
(2) Coefficient estimates are statistically significant at 1% (***), 5% (**) or 10% (*). Standard errors are in parenthesis.
(3) For the 2-stage Heckman estimation, the first-stage model is the one reported in this table for *Default* . In other words, the model is identified only through the non-linearity of the inverse mills ratio.

Table 5. Installment-level Dynamics of Delays and Defaults

	Determinants of *Delay* :		Probability of transition from *No_repay* =0 to *No_repay* =1: Equation (3)
	Equation (1)	Equation (2)	
Lagged value of *Delay* : Parameter a_1	0.736 ***	0.842 ***	0.00019 ***
	(0.007)	(0.006)	(0.00001)
Peer effects: Parameter a_2			
Peer average of *Delay*	0.319 ***		
	(0.008)		
Peer average of *Problem*		30.571 ***	
		(2.133)	
Peer average of *No_repay*			0.4886 ***
			(0.0091)
Total number of observations	12630	12630	13092
Total number of borrowers	898	898	917
R2 within	0.712	0.681	0.260
R2 between	0.914	0.946	0.384
R2 overall	0.817	0.813	0.219
F statistics for zero slope	1607.88 ***	1389.62 ***	237.02 ***
F statistics for all u_i =0	2.48 ***	1.88 ***	2.39 ***
F statistics for all u_t =0	1.35	5.57 ***	2.21 ***

Notes: (1) All of the three models are estimated by a two-way fixed effect panel regression model, with individual credit contract as "group" and the installment number as "time" for the fixed effect.
(2) F statistics for zero slope have degrees of freedom (d.o.f.) at F(18,11714) for the determinants of *Delay* and F(18,12157) for the probability of transition. F statistics for all u_i =0 have d.o.f. at F(897, 11714) for the determinants of *Delay* and F(916,12157) for the probability of transition. F statistics for all u_t =0 have d.o.f. at F(16, 11714) for the determinants of *Delay* and F(16,12157) for the probability of transition.
(3) Coefficient estimates are statistically significant at 1% (***), 5% (**) or 10% (*). Standard errors are in parenthesis.
(4) The subsample of installment-level data of borrowers associated with 18 monthly installments is used.

Table 6. Peer Effects at the Installment-level and Homogeneity of Microenterprise Projects

	Coefficient a_2 (the extent of "peer correlation") or its difference (the addition for the homogeneous groups)		
	Separate regression results using two subsamples		Regression results using pooled sample with cross-terms of all explanatory variables with *Homogeneity*
	Borrowers in a CO with less homogeneous projects (*Homogeneity* =0)	Borrowers in a CO with more homogeneous projects (*Homogeneity* =1)	
Delay on *Delay^c* (equation (1))	0.320 ***	0.337 ***	0.018
	(0.011)	(0.013)	(0.019)
Delay on *Problem^c* (equation (2))	29.684 ***	30.706 ***	1.022
	(2.788)	(3.126)	(4.591)
No_repay on *No_repay^c* (equation (3))	0.455 ***	0.526 ***	0.071 ***
	(0.012)	(0.015)	(0.019)
Number of observations	8493	4137	12630

Notes: (1) All of the nine models are estimated by a two-way fixed effect panel regression model, similar to the one in Table 5.
(2) Coefficient estimates are statistically significant at 1% (***), 5% (**) or 10% (*). Standard errors are in parenthesis.

Table 7. Robustness of the Estimation Results regarding the Peer Effects

	Coefficient a_2 (the extent of "peer correlation")		Test for the hypothesis that a_2 is the same#
	Homogeneity =0	*Homogeneity* =1	
0. Default (see Table 6)			
Delay on *Delay^c* (equation (1))	0.320	0.337	n.s.
Delay on *Problem^c* (equation (2))	29.684	30.706	n.s.
No_repay on *No_repay^c* (equation (3))	0.455	0.526	***
1. Cross-term with Herfindahl to identify the difference in coefficient a_2			
Delay on *Delay^c* (equation (1))	0.338	-0.021	(n.s.)
Delay on *Problem^c* (equation (2))	30.832	-1.223	(n.s.)
No_repay on *No_repay^c* (equation (3))	0.379	0.146	*
2. Larger sample whose installment number is more than 5			
Delay on *Delay^c* (equation (1))	0.318	0.331	*
Delay on *Problem^c* (equation (2))	30.456	33.989	n.s.
No_repay on *No_repay^c* (equation (3))	0.459	0.471	**
3. System-GMM estimates treating lagged *Delay* as endogenous			
Delay on *Delay^c* (equation (1))	0.250	0.209	(**)
Delay on *Problem^c* (equation (2))	128.613	79.677	(**)
4. Using lagged values of the peer variables			
Delay on *Delay^c* [*t*-1] (equation (1))	0.087	0.090	n.s.
Delay on *Problem^c* [*t*-1] (equation (2))	2.214	-2.997	(n.s.)
No_repay on *No_repay^c* [*t*-1] (equation (3))	0.352	0.341	(n.s.)

Notes: All models include the lagged value of delay, borrower fixed effects, and time controls (time fixed effects for 1., 2., and 4) as explanatory variables additional to the peer variable.

1. Coefficient in the first column shows the one corresponding to the mean level of Herfindahl. Coefficient in the second column shows the one on the cross-term. The average of Herfindahl is 0.697 and its standard deviation is 0.297.

2. The total number of observations is 25818 (eq.(1) or (2)) and 26787 (eq.(3)). The total number of borrowers is 1836 (eq.(1) or (2)) and 1881 (eq.(3)).

3. Estimated by a system GMM methodology by Blundell and Bond (1998). Because of memory problem, the full list of time fixed effects were not included. Instead, the relative position of the installment and its higher order polynomials (to the fourth order) were included. This replacement did not affect the structural parameters for Case 1 and Case 2 reported in this table. In all specifications, the Hansen *J* test indicates that the overidentifying restrictions implied by this GMM procedure are not rejected. The AR(2) test for autocorrelation of order 2 indicates that the null hypothesis of no autocorrelation is not rejected.

4. The peer variables in the default model are replaced by their lagged values to avoid the simultaneity bias within a borrowers group.

The null hypothesis is rejected at 1%=***, 5%=**, 10%=*, and not rejected at 10%="n.s." When a_2 is larger in homogeneous COs than in heterogeneous COs, these are shown without parenthesis. When a_2 is smaller in homogeneous COs, these are shown in parenthesis.

Table 8. Borrower-level Delays under the New System and the Impact of the Earthquake

	Mean (Std.Dev) of the explanatory variables	OLS: *Avg_delay*
Controls to identify the earthquake impact		
D_eq : Dummy for the location close to the epicenter	0.483	-2.52
	(0.502)	(6.87)
Time_eq : Ratio of installments due after the earthquake	0.518	-13.89
	(0.178)	(9.43)
D_eq * *Time_eq* : Cross term to identify the earthquake impact	0.238	-4.30
	(0.270)	(12.98)
Borrowers' individual characteristics		
Dummy for a female borrower	0.600	-1.18
	(0.492)	(2.84)
Dummy for chairman or secretary of the CO	0.150	2.29
	(0.359)	(2.19)
Borrower households' characteristics		
Number of income sources of the household	3.308	-1.52 **
	(1.549)	(0.65)
Dummy for income sources outside the region	0.183	9.21 **
	(0.389)	(3.54)
Community Organization (CO) characteristics		
CO's savings (in Rs.100000)	0.070	7.92
	(0.119)	(13.22)
Number of CO members	25.7	-0.09
	(8.8)	(0.17)
CO's age in days at the time of the loan issue	1255.6	-0.001
	(628.5)	(0.002)
Union fixed effects		Yes
Date of credit issued: linear, quad., cubic, fourth		Yes
Number of observations used in the estimation	120	120
F(15,104) for zero slope		3.2 ***
R2		0.3148

Notes: (1) See Table 2 for the statistics of *Avg_delay* . The sample is the borrowers under the new system who completed the repayment schedule.
(2) Coefficient estimates are statistically significant at 1% (***), 5% (**) or 10% (*). Standard errors are in parenthesis.

Table 9. Installment-level Dynamics of Delays under the New System and the Impact of the Earthquake

	Fixed effect estimation		Random effect estimation	
	Completed the repayment schedule	Including those still in the repayment schedule	Completed the repayment schedule	Including those still in the repayment schedule
Controls to identify the earthquake impact				
D_eq			0.748	0.268
			(0.776)	(0.640)
D_t1 : Dummy for an installment due after the quake	-0.200	-0.188	-0.298	-0.301
	(0.945)	(0.631)	(0.871)	(0.534)
*D_eq * D_t1*	0.060	-0.257	0.184	-0.265
	(0.931)	(0.755)	(0.939)	(0.718)
D_t2 : Dummy for the loan made after the earthquake				0.451
				(0.651)
*D_eq * D_t2*				0.052
				(0.826)
Own and peer effects				
Lagged value of *Delay*	0.615 ***	0.605 ***	0.795 ***	0.819 ***
	(0.024)	(0.016)	(0.022)	(0.013)
Peer average of *Delay*	0.558 ***	0.516 ***	0.418 ***	0.337 ***
	(0.025)	(0.018)	(0.022)	(0.015)
Borrowers' characteristics				
Dummy for a female borrower			0.048	-0.288
			(0.729)	(0.329)
Dummy for chairman or secretary of the CO			-0.296	-0.482
			(0.628)	(0.341)
Number of income sources of the household			-0.430 **	-0.080
			(0.186)	(0.096)
Dummy for income sources outside the region			-0.930	0.221
			(0.784)	(0.413)
CO's savings (in Rs.100000)			2.258	2.119
			(2.798)	(1.671)
Number of CO members			0.013	0.007
			(0.027)	(0.017)
CO's age in days at the time of the loan issue			-0.0004	-0.0005
			(0.0006)	(0.0003)
Total number of observations	1287	3451	1287	3451
Total number of borrowers	117	502	117	502
R2 within	0.653	0.538	0.636	0.510
R2 between	0.827	0.760	0.898	0.860
R2 overall	0.724	0.653	0.741	0.680
Statistics for zero slope	155.08 ***	243.92 ***	3620.31 ***	7275.15 ***
F statistics for all u_i =0	2.81 ***	1.96 ***		
F statistics for all u_t =0	2.27 **	3.65 ***	34.52 ***	65.77 ***

Notes: (1) All of the four models are estimated by a fixed or random effect panel regression model, with individual borrower as a "group" for the fixed (random) effect and with the installment number as the fixed time effect.

(2) The effects of borrower-level variables including *D_eq* , *D_t2* and *D_eq*D_t2* are identified in the random effect specifications only.

(3) "Statistics for zero slope" are F(14,1156), F(14,2935), Gaussian Wald chi2(23), and Gaussian Wald chi2(25). "F statistics for all u_i =0" are F(116,1156) and F(501,2935). F statistics for all u_t =0 are F(10,1156), F(10,2935), chi2(10), and chi2(10).

(4) The subsample of installment-level data of borrowers associated with 12 monthly installments is used.

Table 10. Peer Effects and Homogeneity of Microenterprise Projects under the New System

Equation (1) estimated using different subsamples	Coefficient a_2 (the extent of "peer correlation")		Test for the hypothesis that a_2 is the same[(2)]
	Homogeneity = 0	*Homogeneity* = 1	
Subsample of borrowers who already completed the repayment schedule			
	0.480	0.693	***
Subsample of borrowers who already completed the repayment schedule			
	0.422	0.667	***

Notes: (1) All of the six models are estimated by a two-way fixed effect panel regression model, similar to the one in Table 9.
(2) A pooled sample of 1287 (the first row) and 3451 (the second row) is used in regression with cross-terms of all explanatory variables with *Homogeneity* included to test the hypothesis.

Figure 1. The Repayment Game with Imperfect Joint Liability

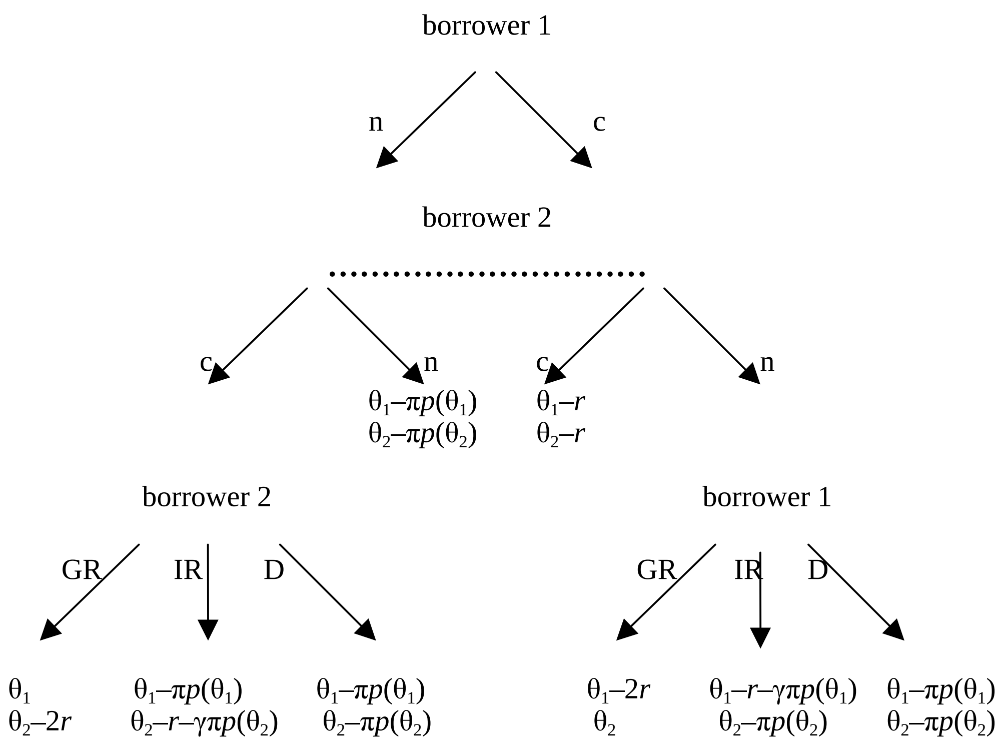


Figure 2. The Equilibria Pattern and Project Returns: Individual Liability (γ=0)

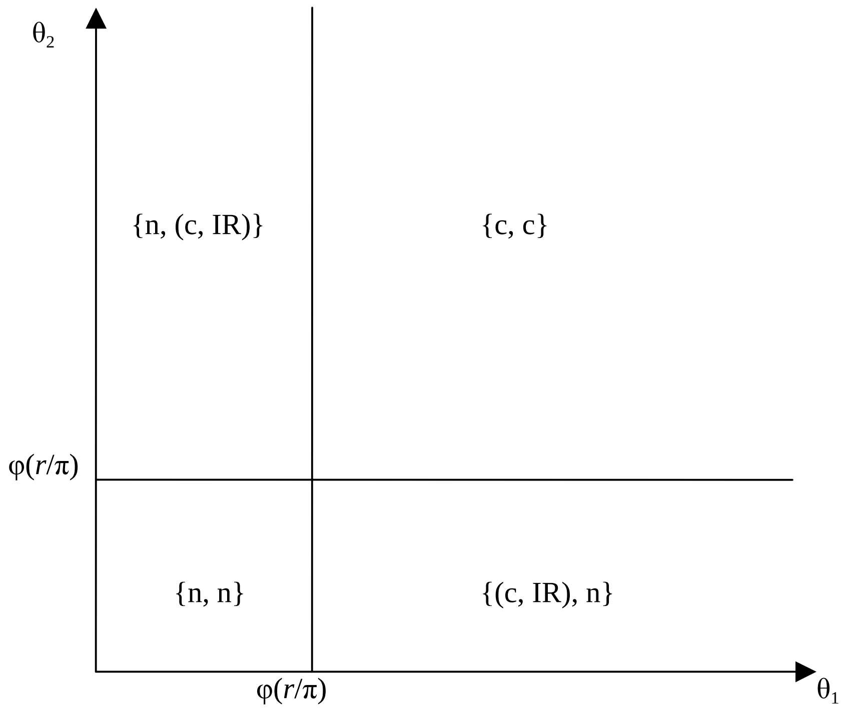


Figure 3. The Equilibria Pattern and Project Returns: Perfect Joint Liability (γ>1/2)

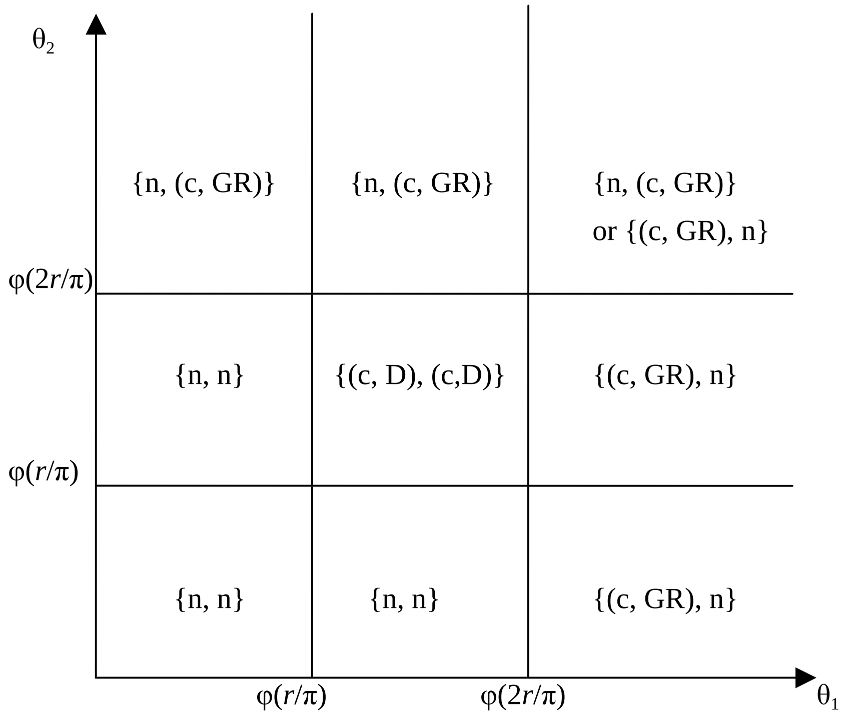
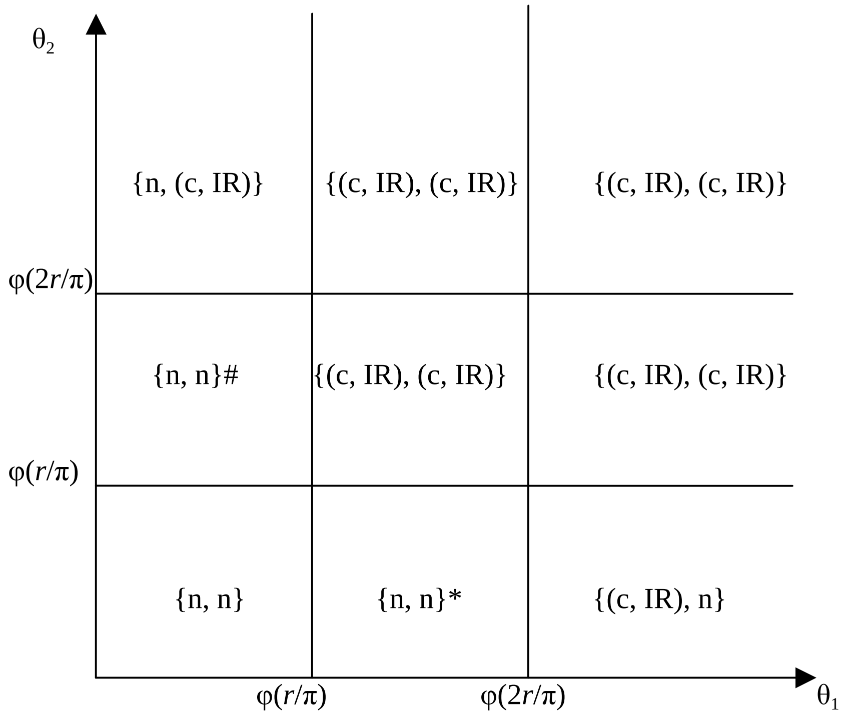


Figure 4. The Equilibria Pattern and Project Returns: Imperfect Joint Liability (γ<1/2)



Notes: # We assume that $1\text{-}r/\{\pi p(\theta_1)\} < \gamma < 1/2$. Otherwise, {n, (c, IR)} is the equilibrium.
* We assume that $1\text{-}r/\{\pi p(\theta_2)\} < \gamma < 1/2$. Otherwise, {(c, IR), n} is the equilibrium.

Figure 5. The Equilibria Pattern and the Rule Enforcement Parameters

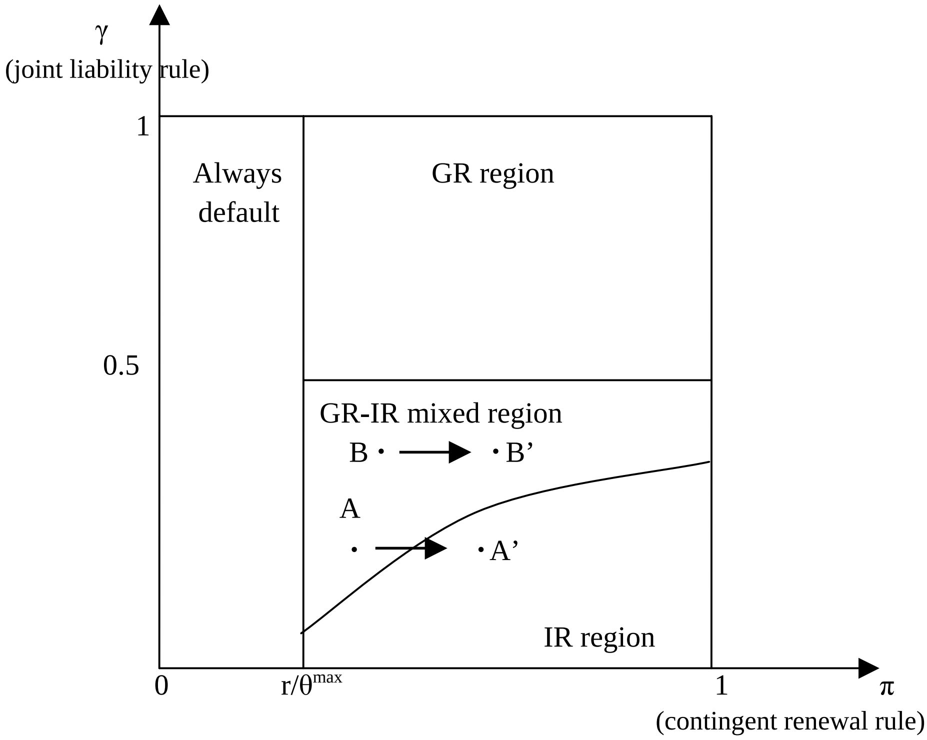


Figure 6. Borrower-Level Default Rates

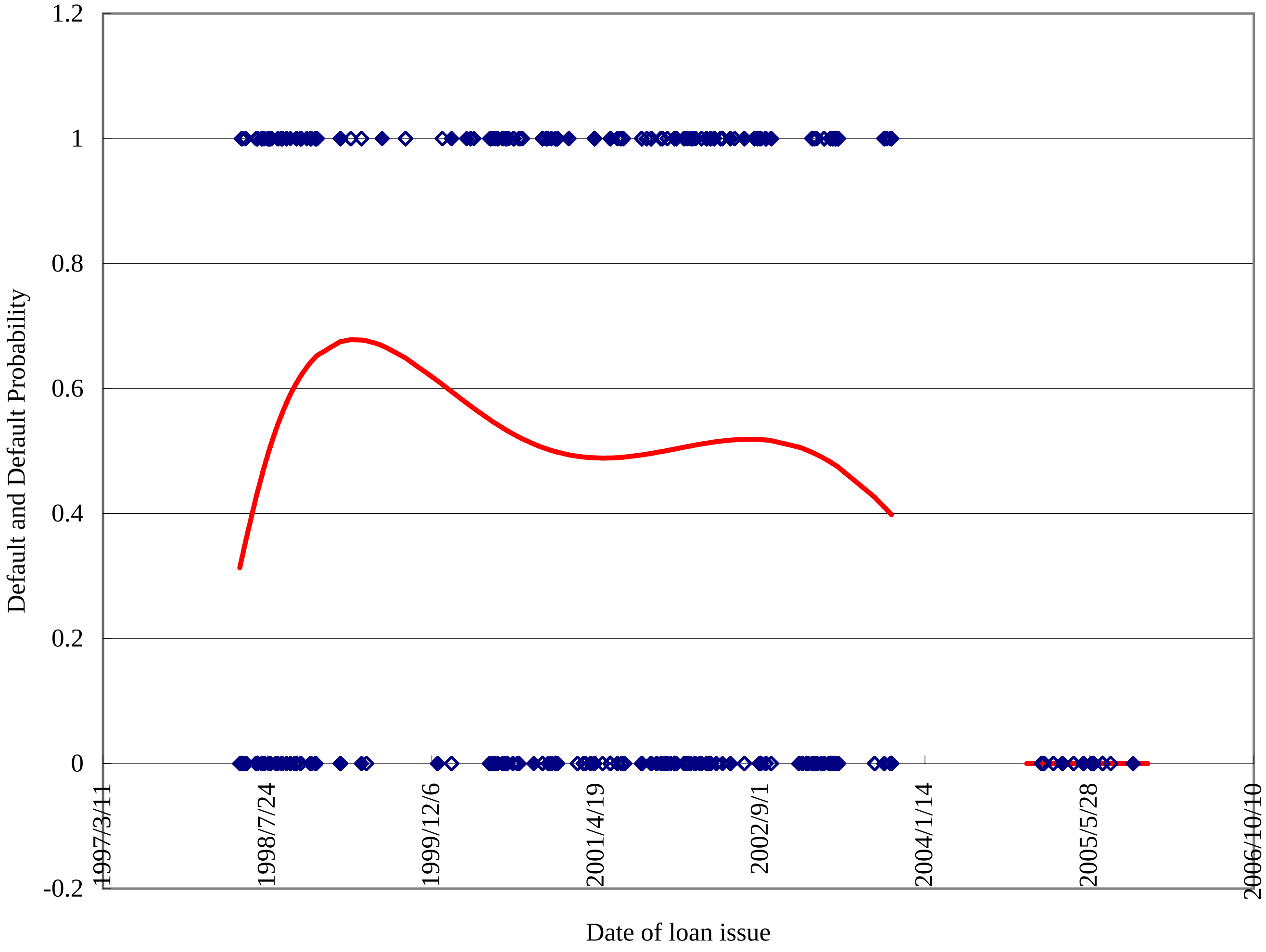


Figure 7. Examples of Repayment Dynamics in a CO (#415)