Learning from Visa®? Incorporating Insurance Provisions in Microfinance Contracts

Loïc Sadoulet*

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*ECARES, Free University of Brussels, sadoulet@ulb.ac.be. I am deeply grateful to Stefan Dercon and Ian Shelding for extensive and insightful comments on a previous version, and to the participants of the Helsinki WIDER conference, the Workshop on Theoretical and Empirical Research on Microfinance at the University of Heidelberg, and seminar participants at the Free University of Amsterdam, ECARES, Toulouse, and the National University of Singapore for interesting comments and discussions. This paper uses data from a survey in Guatemala which was generously funded by the Mellon and the Ford Foundations and by the Financial Research Center at Princeton University. The usual disclaimer applies.

Abstract

We examine a simple extension to existing credit contracts for the poor ("microfinance contracts"), that would allow financial institutions to provide repayment insurance to their clients. The proposed contract uses the repeated nature of loans to build credit records that borrowers in good standing can use to insure themselves against default in case of adverse income shocks. After documenting borrowers' desire for insurance, we derive sufficient conditions for the proposed contract to reduce borrower vulnerability while improving repayment rates. These conditions are quite similar to those that credit-card and automobile-insurance companies seem to apply to deter moral hazard and adverse selection among their subscribers. We close the paper with a discussion on why institutions lending to the poor may face particular implementation problems because of the history of past failures of credit programs for the poor.

Keywords: Microfinance, insurance, reputation

JEL classification codes: 017, G20, G22, D82

1 Introduction

One of the important distinguishing characteristics of poor is their exposure and vulnerability to risk. The prevalence of agriculture and accompanying activities (such as seasonal work), the under-supply and poor quality of transportation and communication infrastructures, and the unreliability of the macroeconomic environment tend to create strong fluctuations in income. Furthermore, low-income households, due to their higher consumption requirement as a proportion of their income and their limited capacity to buffer the effects of shocks, find themselves less able to absorb risk without falling below binding subsistence-level consumption constraints [Rosenzweig and Binswanger, 93]. Low-income households are thus very *vulnerable* to risk: income shocks have a significant impact on household consumption.

In order to reduce the effect of shocks on their consumption patterns, households engage in strategies to mitigate their exposure to risk and lower the impact of shocks. However, these strategies often induce a reduction in future income growth opportunities. Risk-management strategies reduce household exposure to risk by the choice of less variable activities, but at the expense of more profitable ones [Reardon et al, 94]. Risk-coping strategies remedy the lack in income through (often disadvantageous) changes in asset position and resources [Alderman and Paxson, 94; Dercon, 00].[1] By reducing households' productive capacity, these risk-management and risk-coping strategies can impart severe and often long-term consequences to even temporary downturns.

In complete information settings, optimal contracts would involve payments contingent on the states of the world and private actions. In the non-anonymous settings of local or "village" economies, informational asymmetries are small enough to see such (at least partially contingent) contracts exist. This is the case for quasi-credit contracts, in which the repayment conditions of the contract depend on the relative outcome of the contracting parties (Lund and Fafchamps [97] report evidence for the Philippines, Grimard [97] for Côte d'Ivoire, and Udry [90] for Nigeria). This is also the case for remittances [Jensen, 98; de la Brière et al, 98; Lucas and Stark, 85] and informal insurance arrangements [Coate and Ravallion, 93; Morduch, 99]. However, these risk-sharing arrangements are incomplete even

[1] Examples include pulling children out of schooling [Jacoby and Skoufias, 97], cancelling or postponing investments [Morduch, 99], over-exploitation of local resources [Platteau, 00], diminishing nutritional intake [Deaton, 88; Dercon and Krishnan, 00], and running down relationship-based insurance benefits [Goldstein et al., 01].

when agents have good information, and households – particularly poor households – remain subjected to substantial uninsured risk [Deaton, 92; Paxson, 93; Townsend, 94; Jalan and Ravallion, 99].

Furthermore, when one moves to settings in which agents have substantial private information, contracts with full contingencies become difficult to implement. Arrangements must thus rely on non-manipulable signals of performance, letting rise to long-term contracting and financial instruments in well developed markets; and to share-cropping [Ackerberg and Botticini, 98], interlinked contracts [Besley, 1995], and other such arrangements in less developed countries.

In a classic paper, Townsend [82] makes the case for the feasibility of risk-sharing contracts even under private information. These contracts involve several periods with payments based on past reports to induce truthful revelation of private information. While these schemes may require complicated payments in a real-world situations,[2] they still suggest that optimal lending contracts under private information probably involve some mixture of credit and insurance.

In this paper, we argue that the repeated nature of microcredit contracts can allow the lending institution to set up insurance contracts through the creation of a reputation mechanism. Indeed, the success of microcredit institutions at successfully extending credit to the poor, while maintaining high repayment rates, is widely attributed to the particularities of the contracts offered [Morduch, 99]: the loans are uncollateralized (thus favoring outreach);[3] and incentives to repay are created by granting borrowers access to larger future loans only upon successful fulfillment of current contracts [Stiglitz, 90; Ghatak and Guinnane, 99; Sadoulet, 99a].[4] The idea in this paper is to use the repeated interaction between the banks and clients to allow borrowers to build a credit record, which they can use to insure themselves in case of temporary liquidity shocks. We derive the conditions for the evolution of reputation, of premia, and of the sanctions in case of claims, to protect the financial institutions against

[2] Townsend's [82] payment scheme has to induce truthful reporting of two possible states of the world. Allowing for more states would induce an exponential increase in the number of incentive-compatibility conditions.

[3] There has been a debate as what types of poor microcredit actually reaches. In particular, there is increasing evidence that it does not directly help the poorest of the poor [Alexander, 01; Navajas et al., 01].

[4] To reinforce these dynamic repayment incentives, loans tend to be small short-term loans with frequent payments (to minimize the benefits of deviation from repayment) and display a sharp growth upon repayment (to increase the benefits from repayment of the current loan) [Varian, 90; Jain and Mansuri, 01].

adverse selection, moral hazard behavior and fraudulent claims. These conditions are very reminiscent of the types of conditions put on credit-card contracts in the United States, or car insurance contracts. The caveat is that the contract we propose is not an optimal contract, since we derive sufficient conditions for the insurance contract to satisfy the participation and incentive constraints for borrowers and the financial institution. However, it is a simple and implementable contract that improves the ones currently offered.[5]

Very recently, the microfinance industry has developed an interest in providing insurance products to their clients. The benefit is two-fold: reduce borrower vulnerability, and improve the financial sustainability of institutions through a positive impact on repayment rates [Del Conte, 00]. While clients are clearly demanding insurance products, the challenge is to understand what types of products are best fitted to their needs. Recently, Brown and Churchill [00] have detailed insurance contracts in 32 institutions (out of the 60 institutions that have been identified world-wide as offering some type of microinsurance product). Their focus has been on the advantages and disadvantages of microcredit institutions at providing insurance products. The advantages such institutions carry are their experience at the grassroot level, having a client base they know, and their clients know and trust them. Their disadvantages lie in the capacity of the institution to provide insurance, because of the technicality of insurance products (actuarial analysis), and because of the insurability of highly covariate shocks. The solution proposed are alliances with specialized insurance companies, in which the insurer devises the products and the microcredit institution distributes them (referred to as "Partner-Agent model" in Brown and Churchill). However, most of these initiatives have been cantoned to life, property, health, disability, and catastrophe insurance – insurance for large and verifiable shocks [McCord, 01].[6] The range of insurance product offered remains relatively limited.

The remainder of the paper is organized as follows. In the next section, we describe microcredit contracts and illustrate the empirical importance of insurance for borrowers using survey data from Guatemala. Section 3 presents a basic model which aims to capture the salient features of the observed microcredit contracts, namely individual loans and group

[5] The reason we do not derive the less restrictive necessary condition is due to a lack of closed for solutions. Necessary conditions for particular examples, however, would be relatively simple to simulate from the expressions we provide.

[6] Even in case programs that provide loan-payment insurance, the insurance payment is made only upon verification of an identifiable shock (e.g. Canadian Cooperative Association (CCA) in China [Del Conte, 2000]).

loans in which members are jointly-liable. This model is used to demonstrate the incentive mechanisms behind microfinance contracts, and how insurance is an important by-product of joint-liability loans. Section 4 extends the contracts to include insurance provision. The main contribution of the paper is to show the contractual conditions that allow these contracts to be sustainable for the institution and for the borrowers. We close the paper by discussing the historical and regulatory limitations on the implementation of these contracts, and point towards the importance of establishing transparent accounting practices.

2 Microcredit and Insurance

Microcredit contracts were introduced in the late 1970s by Muhammad Yunus, founder of the now-famous Grameen Bank in Bangladesh. The idea was to provide working capital for poor entrepreneurs to generate higher incomes and thus break the cycle of poverty that they faced. While many programs have emerged over the past 30 years[7] and have adapted the original Grameen methodology, all rely on the same two basic principles: (1) poor borrowers need credit and are credit-constrained; (2) institutions can thus use conditional access to future loans as an incentive mechanism for repayment. As described in the introduction, borrowers are offered a sequence of (generally) uncollateralized loans, which grow overtime. Loan repayment grants a borrower access to a further loan; any default, however, is punished by a loss of access to these further loans.

Loan contracts have been offered in two general forms: individual loans, in which borrowers are individually responsible for their loans; and group loans, in which borrowers are asked to form groups (typically between 3 and 8 people[8]), each member receives a loan, and members are jointly liable for the entirety of the group loan: if *any* part of a group loan is not repaid, *all* members of the group are considered in default.

There has been a long debate in the literature on the relative benefits of individual versus group loans. Authors have argued that the joint liability in group loans can have positive effect on repayment rates by inducing borrowers to coordinate on safer projects [Stiglitz, 90; Wydick, 95], pressuring each other to repay [Armendáriz, 99], or providing a mechanism for institutions to charge different effective interest rates for different types of borrowers,

[7] The Microcredit Summit Campaign Report [2000] reports 1,065 programs serving13.8 million clients in the world.

[8] Although some "village banking" models use larger groups.

thus diminishing the adverse selection inherent in contracts with asymmetric information [Ghatak, 99]. Others have pointed out that joint liability can actually lead to lower repayment rates both due to voluntary defaults and the (positive) covariance between incomes of group members [Besley and Coate, 95]. Furthermore, despite possible improvements in repayment rates, joint liability may lead to inefficiencies. Group members may over-monitor [Varian, 90] or put pressure on partners to take excessively safe and low return projects [Banerjee, Besley, and Guinnane, 94]. Nonetheless, implicitly or explicitly, all these papers recognize the importance of the repeated loans in creating dynamic incentives for borrowers to repay.

Unlike most of the academic work, practitioners have long focused on the "mutual help" aspect of group lending. Jointly-liable borrowers will scrutinize each others' projects and actions, but will also come together and repay loans in case of trouble. As reported on the Grameen Trust's website: "The Group Model's basic philosophy lies in the fact that shortcomings and weaknesses at the individual level are overcome by the collective responsibility and security afforded by the formation of a group of such individuals." In this paper, we concentrate on the insurance aspect of this mutual help in credit groups.

To illustrate the importance of this insurance provision, we turn to evidence from a 1995 survey that we conducted in Guatemala. We interviewed the 782 members of 210 credit groups that were clients of *Génesis Empresarial*, a Guatemalan Non-Governmental Organization (Table 1 provides descriptive statistics). They were small informal market sellers, very typical vendors found in markets in low and middle-income countries, characterized by low sales ($400-$500 in good weeks) which were quite variable (sales in a bad weeks were around 40% lower on average). They kept low stocks of merchandise and had a high rate of capital turnover as demonstrated by nearly half the sample buying merchandise more frequently than 2-3 times a week. Their activity was confined to one business, although a large proportion of households had other sources of income (only 40% of the surveyed entrepreneurs were the sole source of household income).

Their access to credit was limited, with only 4% having access to formal banks. Their main credit sources were money lenders and wholesale credit, although these tended to charge very high interest rates (15-25% over the loan). Family and friends were also possible sources of credit, but for small and short-term amounts.

Loans offered by *Génesis Empresarial* were two-month loans for working capital, with regular payment schedules (weekly, fortnightly, or monthly). Loans started off relatively small ($60) but grew rapidly upon successful repayment, typically by 10 to 30 percent. On average, loans represented around two weeks worth of inventory. Repayment problems were met with penalties: one late payment resulted in no increase in loan size; two late payments reduced the loan size; and three late payments in a year resulted in permanent exclusion from any further loan. Since payments start after the first week of the loan, a fair share of borrowers (19%) put part of the loan aside in order to make the first one or two payments, to reduce the chance of going into default.

While all borrowers surveyed were in groups – which *Génesis* requires to be between three and eight members – all borrowers (in principle) have access to both groups and individual loans. Both type of loans carried the same monthly interest rate (2.5%, as in the formal banking sector in 1995[9]) and had exactly the same growth paths and other terms. Yet, two thirds of borrowers *chose* group loans.[10]

A question thus naturally arises: why would borrowers ever choose group loans? The individual and group contracts are similar in every aspect except for the extra joint liability. Part of the answer, we want to suggest, stems from insurance that emerges in these credit groups.

The insurance-need measure we use records the number of times a borrower in a group declares having had difficulties making a payment in the previous year. As reported in Table 2, over 60% of groups report a need for insurance over the past year. Typically, shortfalls in income arise because of low sales or bad planning (74%), or of shocks such as robbery and family illness (23%) – shocks that can be classified as idiosyncratic (although not necessarily exogenous).[11] In 69% of the cases, help came from someone within the group. For 23% of cases, the help came from personal resources: either friends or family outside the group, or from personal savings or borrowing from a money lender. The help is for non-trivial amounts

[9] This amounts to a real monthy interest rate of 1.65 percent [International Finance Statistics, 1998].

[10] While there is some differential screening in practice, borrowers can opt for an individual loan easily after just a few rounds of group lending. People in older groups who remain in group loans therefore reveal their preference for those groups over individual loans (switching costs are negligeable).

[11] While it is probable that the risk of robbery and family illness varies little from group member to group member, repayment ability being affected by low sales or bad planning is typically the result of borrowers' choices of liquidity strategy. Borrowers who save earlier for the purpose of making the payment encounter fewer problems in case of bad sales the last days before the payment is due. However, this is at a high opportunity cost considering the high turnover of capital (payments represent 2-3 days of merchandise purchases, with half of the borrowers buying merchandise at least 2-3 times a week – see Table 1). The trade-off for borrowers is thus between risk and return.

since it covers around 20% of the payment due by the person who cannot repay.[12]

The evidence from the Guatemalan data suggests that the need for insurance is important and relatively frequent in credit groups. The next section examines how groups contracts are instrumental in the provision of insurance between borrowers. In section 4, we will propose a new contract that improves on the insurance sustained by joint-liability contracts.

3 Joint liability and insurance

In order to understand why some borrowers choose group loans over individual loans, we present a simple model (inspired from Sadoulet, 99a) which aims at capturing the most important features of microfinance contracts: the repeated loans, the informational advantage that borrowers have over the lending institution, and the sanctions in case of default. While the economic and social environments are somewhat stylized, the simplifying assumptions allow us to clearly identify the precise role joint liability plays in the establishment and sustaining of insurance arrangements.[13] With these results, we will then be able to analyze how to improve the current microfinance contracts by incorporating an explicit institutional insurance aspect to them in Section 4.

Assume a continuum of individuals, each born with a sequence of one-period projects requiring a unit of capital in every period. Each project in every period has two states of nature: it can succeed and yield a positive return X, or fail and yield a return of zero.

Individuals are distinguished by their exogenous probability of success: in every period, i's project succeeds with an exogenous probability P_i. There is no moral hazard in effort or choice of projects (there will be moral hazard in the choice of repayment). Individuals have no assets or other sources of income, and cannot save between periods.[14] Projects must therefore be financed by a loan in every period.

Loans are provided by a unique financial institution. The objective of the lending institution is to maximize the number of *repaid* loans, subject to a break-even constraint. It, however, has no information on borrower type or on project returns. It can therefore not

[12] We refer to this "mutual help" as insurance because we have strong annecdotal evidence that suggest that members of groups pay each other risk premia to compensate for differential risks in the credit groups.

[13] For a complete analysis of repayment strategies and of equilibrium behavior in this model, the interested reader is referred to Sadoulet [99a].

[14] Alternatively, we could have assumed that the sequence of loans grow faster than the returns on individual projects. It limits individuals' incentive to default on the current loan and self-finance from then on with the amount they did not repay.

price-discriminate across borrowers or provide state-contingent contracts.

The financial institution offers two type of loans: individual loans, and group loans. Both types of loans have the same modalities – same interest rate, same term (1 period), and same amount – and operate on the same following principle: if a borrower fulfills the repayment requirements towards the financial institution, she is granted a future loan. However, any default is punished by the exclusion of the borrower from access to either types of loan from then on.[15] The only difference between individual loans and group loans is a joint-liability requirement. In group loans, borrowers are asked to form a group; each partner receives a loan; and the members are jointly liable: if *any* part of the group loan is not repaid, *all* members of the group is considered in default.[16] Once borrowers lose access to loans from the financial institution, they have no other source of credit and their future present discounted value is (normalized to) zero.[17]

Repayment strategies are governed by borrowers' ability and willingness to repay. When a borrower's project fails, she is unable repay her loan; she thus has no choice but to default. When her project succeeds, however, she is faced with a choice of actions: she is able to repay, but is she *willing?* In individual loans, willingness to repay has straight-forward consequences: if she chooses to repay, she gets access to future loans; if she chooses not to repay, she'll be considered in default. In the group loan, her (simplified) repayment strategies are similar: she can choose never to repay her share, irrespective of what her partners do; repay her share only if her partners repay their share; or repay not only her share but also her partners' share if necessary. We will refer to this third strategy as "insurance."[18]

To illustrate why people might choose group loans, we assume that borrowers have perfect

[15]It is clear that this permanent exclusion does not look optimal. However, this is the rule announced clearly by all microfinance projects we are aware of, and it is precisely a modification of this rule that the contract in section IV will call for.

[16]The equality of interest rates on group loans and individual loans is a characteristic that we adopt to replicate what is done in practice. It is clear that since individual loans and group loans are different products, they should carry a different "price." In personal communication, the financial manager of Accion International, an organization which provides a microlending methodology to institutions, evoked simplicity and fear of selection effects if each contrat was priced differently.

[17]Alternatively, borrowers' fallback option could be to turn to a money lender. Money lenders typically have information on borrower types and on projects, and are a monopoly source of credit. Moreover, they have recourse to severe punishments to control moral hazard. Evidence from the literature on informal money lenders is that they can extract much of borrower surplus. We could therefore normalize the present discounted value to borrowers of borrowing from this fallback option to zero.

[18]The repayment strategies in the group loan are in fact slightly more general than the ones we present in that individuals do not simply repay necessarily their own share but a proportion of the total group loan (see Sadoulet, 99a).

information on types and actions of all potential partners, that they have no external sanctioning mechanism, and that borrowers carry a non-verifiable reputation (observable only by other borrowers, but not by the financial institution). These assumptions are extreme but provide stark results as to the benefits of group loans. A weakening of these assumptions simply diminish the benefits of group loans as compared to individual loans.[19]

A few more unimportant technical assumptions are made for simplicity. Borrowers are risk neutral. We restrict our attention to groups of 2 to avoid the trade-off between group size and quality of partners. We assume that $X \geq 2L$ so that borrowers are always *able* to provide insurance when their project is successful. This assumption, while seemingly strong if taken literally (requiring 200% return on projects), is effectively not very restrictive since it is a direct consequence of our assumption that projects yield zero when they fail. In practice, projects rarely fail completely; the assumption is essentially that group members, when successful, are always able to cover the amount by which their partners fall short. When they cannot, it is as if their project had failed. A third assumption is that borrowers can only participate in one loan in each period, to avoid a possibility of self-insurance through investment in several projects. The probabilities of success are assumed to be independent over time and across borrowers to circumvent the potential trade-off between partner quality and covariance of returns. Borrowers are assumed to be infinitely lived (or to face an exogenous probability of dying). They share the same discount factor $\delta \in (0, 1)$. The borrower types are distributed according to some (discrete or continuous) distribution F and there is a unit mass of borrowers of every type (so that the equilibrium displays equal treatment within each type).[20] Since projects are identically and independently distributed over time, we restrict strategies to be stationary over time.

Under these assumptions, Sadoulet [99a] shows that all borrowers who are "safe enough" have an incentive to maintain access to future loans, where "safe enough" borrowers are

[19] Imperfect information between borrowers entail that intragroup contracts provide less than full insurance, thus diminishing the relative benefits of group lending as compared to individual loans. Similarly, outside sanctions could allow individuals to set up insurance arrangements without joint-liability, thus diminishing the role for joint-liability loans. If borrowers could become anonymous again after the group dissolve, in the sense that past actions are not remembered, groups would provide less than full insurance, as in the imperfect information case above.

[20] Formally, each borrower is denoted by a pair $\{i, n\} \in [0, 1] \times [0, 1]$ where the first coordinate represents their type and is distributed on $[0, 1]$ according to F. See Sadoulet [99b].

defined by

$$P_i \geq \frac{L}{\delta X}. \tag{1}$$

For individual loans, this condition is straight forward: given that the project succeeds and the borrower *can* repay, as long as the discounted expected value of getting another loan next period and defaulting on it ($\delta P_i X$) is greater than the cost of repaying the current loan (L), then the borrower *will* repay his current loan:

$$X - L + \delta \left(P_i X\right) \geq X \Longleftrightarrow P_i \geq \frac{L}{\delta X}.$$

A strategy of repaying loans when successful leads to the same condition. Repaying the current loan and maintaining access to future loans as long as projects are successful outweighs the one period benefit of not repaying a loan (and losing access to future loans) as long as P_i is safe enough:

$$X - L + \sum_{s=1}^{\infty} \left(\delta P_i\right)^s \left(X - L\right) \geq X \Longleftrightarrow P_i \geq \frac{L}{\delta X}. \tag{2}$$

Similarly, for group loans, borrowers will repay their loans and provide insurance if they are safe enough that the benefit of maintaining access to future loans is worth the cost of repaying. More importantly, group loans provide a forum through which borrowers can set up an insurance agreement in an environment in which they have no other existing insurance opportunity (because of lack of external sanctioning mechanisms to enforce insurance agreements). The new technology allowing the enforcement of insurance agreements is precisely the joint liability: it prevents borrowers from reneging ex post on insurance promises, since the borrower not fulfilling the insurance agreement would be considered in default too. In essence, the financial institution, despite being uninformed, provides a punishment for borrowers who do not conform with the insurance arrangement.

This new insurance opportunity through group loans offers a valuable service to borrowers who want to maintain access to future loans. This insurance is so valuable, in fact, that borrowers may voluntarily form in groups which are heterogeneous in risk in equilibrium [Sadoulet, 99b]: safe members join groups with riskier partners and “sell” them insurance. Both safe and riskier types are better off than in separate homogeneous group since the riskier member increases his inherent ability to repay the loan, while the safer member extracts more surplus from the trade than she loses from having a riskier partner .

Sadoulet [99a] shows that the condition for borrowers to repay their loans and insure their partners when necessary is exactly the same as the condition for individual loans (1). No borrower riskier than $\frac{L}{\delta X}$ would ever be accepted as a partner in a group loan. Furthermore, borrowers satisfying (1) either repay their loans and insure if the risk differential is not too high in their group, or opt for individual loans (which they repay) rather than group loans if they cannot find an acceptable partner.

Tables 3 and 4 look at the risk composition of groups and insurance flows within these groups.[21] As we see in Table 3, not all groups are homogeneous in risk. In fact, groups homogeneous in risk are relatively scarce (18 groups out of 210). Furthermore, there exist a significant amount of extremely heterogeneous groups, with members in the two extreme risk quantiles (33 groups) or separated by 3 risk quantiles (43 groups). While matching frictions may prevent borrowers from finding their optimal partner, it would be difficult to argue that such pronounced heterogeneity would emerge from a homogeneous matching equilibrium, particularly considering how under-served the credit market was in Guatemala.[22]

Moreover (Table 4), within groups, insurance flows from the safer part of the risk *distribution* to the risky part (not only from the safer borrowers to the riskier partners in a group). Groups are very heterogeneous in risk, and insurance is provided within these heterogeneous group. Unfortunately, the data does not contain information on the payments from the riskier members to their safer partners. Anecdotal evidence, nonetheless, does confirm the existence of such payments.[23]

The evidence from the Guatemalan data suggests that insurance is important and rela-

[21] Borrowers' risk is measured by their liquidity strategy. The interested reader is referred to Sadoulet and Carpenter [00] for details.

[22] Choice of heterogeneity to benefit from negative covariance does not seem to be an issue in this data. Covariance in sales did not appear to be an important feature in these urban markets, despite our prior intuition that they would be. The major shocks – rain and seasonal variation in buying patterns – tended to be perfectly covariate across activities and thus uninsurable within the group; and the patterns of sales do not differ greatly according to the products sold (except in case of durable goods).

[23] In Sadoulet [99a], we report the case of a group composed of four borrowers. The leader of the group was a 50 year-old man with a well-established cloth business, stocked with several rolls of cloth (over $2,500 worth). He had been selling in this market for 26 years and was a well-respected figure in that section of the market. The other 3 members of the group were shoe sellers, around 25 years old, all in their second year of business. Each of them had no more than 30 pairs of shoes on hand, making them very vulnerable to the fluctuations of the market. It rapidly became clear, in talking to each member of the group, that the younger members of the group were repaying part (if not all) of the group leader's loan at every payment. He essentially repaid only when the younger members needed assistance to repay the group loan. The younger borrowers were therefore ready to pay more than 35% extra in interest in exchange for insurance (they were free to disband the group and form a group between the three of them).

tively frequent, and that borrowers form groups to maximize gains from trading insurance. Yet, a financial institution is much better able than these small credit groups of absorbing credit risk. Transferring the credit risk from a lending institution to the (certainly more risk averse) borrowers has efficiency and welfare costs.

Furthermore, contracts offered by the lending institution do not take into account borrowers' repayment history. For example, a particular group that had been working with *Génesis* for seven years and suddenly faced repayment difficulties for the first time was evicted from the program. While the loan officer would have liked to keep the group for future loans, she recognized that making an exception would weaken the credibility of rules and could start an avalanche of defaults. Yet, *Génesis* clearly had more information on them than on first-time borrowers. Not using this information in the loan contract suggests an important loss in efficiency. In the next section, we propose a remedy by adding insurance clauses to credit contracts.

4 Insurance provisions in credit contracts

The environment is as described in section 3: individuals need one unit of capital to invest; projects yield an amount X when successful and 0 when they fail; borrowers are only able to repay their loan when their projects succeed. The projects outcome are independent and identically distributed over time for each borrower.

The financial institution introduces an insurance contract tied to the individual loan. The basic idea of the contract is that, since the institution has no information on the actual outcome of projects in any particular period, insurance will be awarded conditional on a measure of borrowers' reputation. Through their repayment behavior, individual borrowers build up a credit record and, as long as borrowers are in good standing with the financial institution, their insurance claims will be honored, thus protecting them from default.

The timing is as depicted in Figure 1. In each period, borrowers in good standing receive a loan. If they qualify for insurance, they choose whether to subscribe to the insurance contract or not, and pay the according premium out of the loan they just received. They invest the remainder of the money and their project succeeds or not. They then take the repayment decision. The stage game then ends and the game moves to period $t + 1$.

The financial institution starts with some prior distribution of types. Since the institution

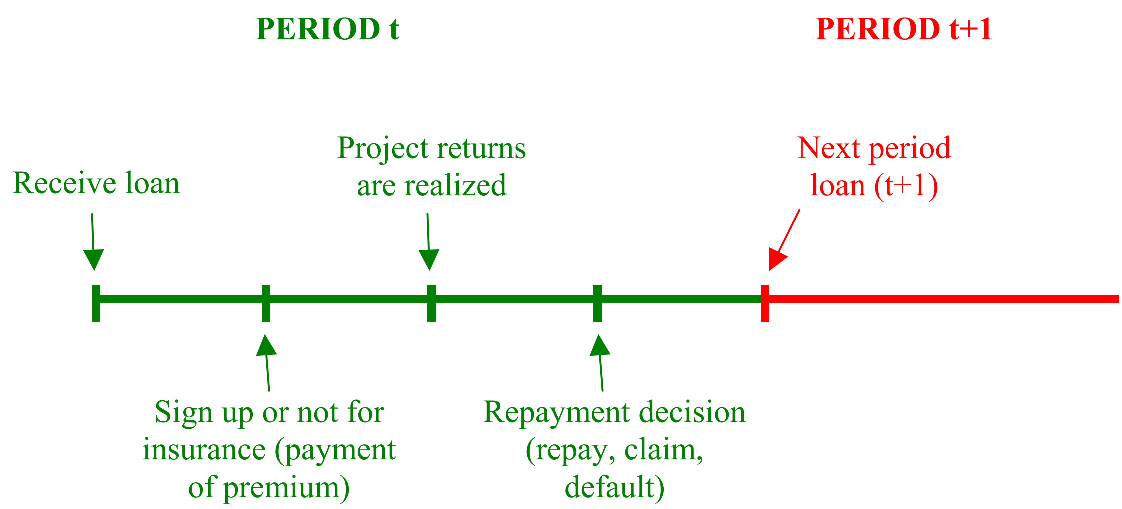

Figure 1: Timing of Loan and Insurance contract

initially has no information on any particular borrower, all borrowers start at the same reputation, say the mean of the institution's prior on distribution the distribution of types:[24]

$$\mu_i^{[1]} = E^{[1]}(P_i) = \mu^{[1]}$$

where $E^{[t]}$ denotes the expectation taken by the financial institution at the beginning of period t (i.e. before observing i's repayment outcome in time t).[25] As time passes, the institution updates individual borrowers' reputation according to observations of repayment or not. Borrower i's reputation based on her repayment behavior after t loans is thus given by

$$\mu_i^{[t]} = E_t\left(P_i \mid c_i^{[t]}\right) \tag{3}$$

where $c_i^{[t]}$ represents the number of claims i has made up to the beginning of loan t.[26] An example is depicted in Figure 2. Repayment of a loan increases i's reputation; a claim decreases her reputation.

In order to finance the insurance, the financial institution fixes an insurance premium. The

[24] Recall, borrowers have no assets or other sources of income. They are thus unable to signal their type by any type of investment or bond posting.

[25] The square brackets are used to distinguish the notion of "at the beginning of time t" from exponential powers.

[26] Note that, since the returns for individuals are independent and identically distributed over time, the order of claims does not matter. More generally, this could be written as conditional on the history of repayment $h_i^{[t]}$.

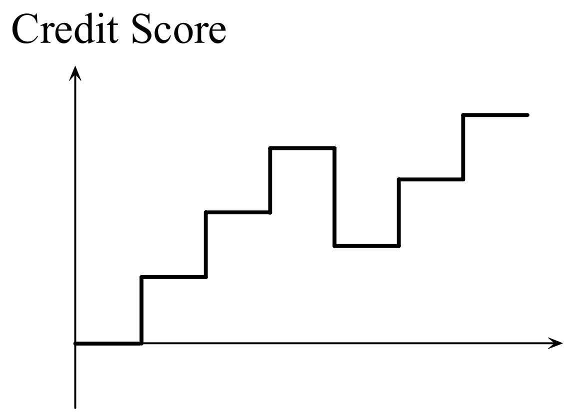

Figure 2: Evolution of borrower reputation

premium is charged at the time the loan is disbursed. We constrain the financial institution to charge actuarially fair premia to each subscriber (up to incentive constraints that will emerge below). The premium $\psi_i^{[t]}$ for borrower i in time t depends therefore on her reputation $\mu_i^{[t]}$ in time t :

$$\psi_i^{[t]} = \left(1 - \mu_i^{[t]}\right) L \tag{4}$$

From period to period, the premium is updated according to (3) as more information becomes available.

The financial institution has to protect itself from two sources of abuse. The first one stems from the borrowers who never repay any loan participating in the insurance scheme; the second one from borrowers filing false claims. We examine each in turn.

4.1 Excluding undesirable borrowers

As we saw in section 3 (equation (1)), borrowers of type $P_i < L\,(\delta X)^{-1}$ are such the cost of repaying a loan outweighs the benefit of maintaining access to future loans. If granted a loan without insurance, they would default after one period. The new possibility of insurance could allow them to default several periods before being evicted from the program. These risky borrowers would sign up for the insurance contract in order to benefit from a second loan on which to default, as long as the premium is not too large of a cost:

$$\begin{aligned} & -\psi_i^{[1]} + P_i X + \delta\left(P_i X\right) > P_i X \\ \Longleftrightarrow \quad & \psi_i^{[1]} = \left(1-\mu^{[1]}\right) L < \delta P_i X \\ \Longleftrightarrow \quad & P_i > \left(1-\mu^{[1]}\right) \tfrac{L}{\delta X}. \end{aligned} \tag{5}$$

Any borrower in $\left[\left(1-\mu^{[1]}\right)\frac{L}{\delta X}, \frac{L}{\delta X}\right]$ will thus sign up for the insurance contract and never repay, for any first-period estimate of mean risk $\mu^{[1]}$.[27]

One way to avert this adverse selection is for the financial institution to deny insurance coverage to any borrower who does not have a reputation above a certain threshold $\widetilde{\mu}$. As long as the threshold is such that it takes sufficient rounds of successful loan repayment to reach it (say T), the institution can weed out borrowers wanting to strategically default on the insurance contract:

$$P_i\left(X-L\right) + P_i\delta\left[P_i\left(X-L\right) + P_i\delta\left[... + P_i\delta\left[-\psi_i^{[T]} + P_i X + \delta\left[P_i X\right]\right]\right]\right] < P_i X.$$

The longer the waiting period, the fewer the borrowers that will undertake the waiting period rather than default immediately. Note that since the contracts are one-period contracts, borrowers have no incentive to sign up to the insurance until they have repaid sufficient number of loans to reach the threshold reputation $\mu^{[T]}$, where $\mu^{[T]}$ denotes the reputation the financial institution ascribes at the beginning of period T to a borrower who repaid all the previous $T-1$ loans.

The insurance contract must thus provide some incentive mechanism encouraging borrowers to only claim insurance when they need it, and allow the financial institution to deny claims from borrowers it views as opportunistic. The insurance contract will therefore display the following two properties:

Proposition 1 ***Limiting Adverse Selection***

To protect itself against adverse selection, the financial institution provides incomplete insurance in the sense that:

- ▶ *No borrower with reputation below some cutoff $\mu^{[T]}$ is insured;*

[27] Futhermore, there exist type distributions such that charging a premium corresponding to the average risk $\mu^{[1]}$ discourages participation of the safer types, leading to participation of only the high-risk borrowers.

▶ *There is no insurance in the first round of loans:*

$$\mu^{[T]} > \mu^{[1]}$$

The proof of Proposition 1 is detailed in appendix A. The intuition behind the result is that, in order to keep undesirable borrowers from participating, the financial institution must put an entry cost to the insurance contract. This entry cost, as demonstrated above, can take the form of several preliminary rounds of successful repayment . Equivalently, it can take the form of a series of discouragingly high premia – until borrowers establish their reputation as willing repayers.

How long is the waiting period? The following result shows that a waiting period sufficient to discourage borrowers of a particular risk level will also discourage any borrower with higher risks:

Corollary 2 *For any prior the institution holds on the distribution of types, and for any* $P_i < \frac{L}{\delta X}$*, there exists a threshold waiting period* $T^{NoAS}\left(\mu^{[T]} \mid P_i\right)$ *such that any longer waiting period discourages all borrowers riskier than* P_i *from participating.*

The threshold waiting period is given by:

$$T^{NoAS}\left(\mu^{[T]} \mid P_i\right) \equiv 1 + \frac{\ln \frac{P_i(L-\delta P_i X)}{(P_i(1+\delta)-1)(L-\delta P_i X)+(1-\delta P_i)\mu^{[T]}L}}{\ln \delta P_i}$$

The corollary insures that picking any particular waiting period eliminates participation in the insurance program of all borrowers below the one just willing to undertake the waiting in order to default twice in a row.

However, the problem is that to eliminate all borrowers below $P_i = \frac{L}{\delta X}$, it would take an infinite waiting period:

$$\lim_{P_i \to \frac{L}{\delta X}^-} T^{NoAS}\left(\mu^{[T]} \mid P_i\right) = \infty$$

The financial institution will always have to face *some* adverse selection.

Nonetheless, while the financial institution cannot eliminate adverse selection completely, by offering an insurance contract with a waiting period it can reduce the cost of adverse selection as compared to the no insurance case, as we show in the next proposition.

Proposition 3 *If the waiting period before borrowers can sign up for insurance T is such that*

$$T > T^{NoAS}\left(\mu^{[T]} \mid P_i = \frac{L}{X}\right)$$

then the costs of adverse selection are lower if the financial institution offers insurance than if it does not.

The proof is in Appendix C, but the intuition is as follows. If the waiting period T is such that all borrowers $P_i \leq \frac{L}{X}$ are discouraged from participation, the cost of the adverse selection coming from these borrowers in $\left[0, \frac{L}{X}\right]$ is the same as in the no-insurance case: they simply default on their first loan. However, the borrowers in $\left[\frac{L}{X}, \frac{L}{\delta X}\right]$ repay $T-1$ loans before defaulting on two loans in a row. For T large enough, the (present discounted) value of losses in the insurance case is smaller than in the no-insurance case since they repay a few loans before defaulting on two.[28]

The waiting period and the premium allows the financial to screen out some of the bad risks from participating in the insurance contract. Do good types participate, however? Ignoring fraudulent claims for an instant, if the financial institution had perfect information on borrower types, the insurance contract would be priced such that the premium is exactly the expected cost of insurance, namely

$$\mu_i^{[t]} = (1 - P_i)\, L.$$

Borrowers' discounted expected return in the insurance contract would thus be given by:

$$\sum_{t=1}^{\infty} \delta^{t-1}\left(-\left(1-P_i\right)L + P_i\left(X-L\right)\right) = \frac{P_i X - L}{1-\delta}$$

which, compared to the expected returns without insurance:

$$\frac{P_i\left(X-L\right)}{1-\delta P_i} \tag{6}$$

insures that all borrowers with $P_i \in \left[\dfrac{L}{\delta X}, 1\right]$ would participate if the institution had perfect information:

$$\frac{P_i X - L}{1-\delta} > \frac{P_i\left(X-L\right)}{1-\delta P_i} \Longleftrightarrow P_i > \frac{L}{\delta X} \text{ and } P_i < 1 \tag{7}$$

[28] Note that repayment rates always increase if there is one period of waiting, since the repayment rate was zero from these borrowers when no insurance was offered. However, repayment rate, in this case, is not an appropriate measure of performance.

However, the institution does not have perfect information on types. Nonetheless, as long as the financial institution's assessment of a borrower risk is not too high compared to her actual risk, the borrower will participate. To see this, we examine the returns under the insurance contract if the financial institution estimated correctly a borrower's probability of failure, and compare them to the returns without insurance. Suppose that from period $T(i)$ onwards, the financial institution correctly estimates borrower i's riskiness. Take the period before the one in which the financial institution has perfect information, $T(i)-1$. A borrower i satisfying (7) will sign up for an insurance contract in $T(i)-1$ and pay the premium $\psi_i^{[T(i)-1]}$ if the expected return of doing so is greater than the expected return of waiting for one more period before getting insurance (and running the risk of losing access to future loans):

$$-\psi_i^{[T(i)-1]} + P_i(X-L) + \delta\left(\frac{P_iX-L}{1-\delta}\right) \geq P_i\left(X-L+\delta\frac{P_iX-L}{1-\delta}\right).$$

This holds as long as the premium does not outweigh the benefit of insurance:

$$\psi_i^{[T(i)-1]} \leq \delta(1-P_i)\frac{P_iX-L}{1-\delta}.$$

Working backwards, we show in appendix $D.1$ that borrower i will sign up for insurance in period n as long as the premium $\psi_i^{[n]}$ is less than an upper bound $\psi_i^{[n]\max}$, where $\psi_i^{[n]\max}$ is given by:

$$\psi_i^{[n]\max} \equiv (1-P_i)\,\delta\frac{P_iX-L}{1-\delta} - (1-P_i)\sum_{s=1}^{T(i)-n-1}\delta^s E^{[n]}\left(\psi_i^{[n+s]} \mid F \text{ in } n\right) \tag{8}$$

$\psi_i^{[n]\max}$ is the largest premium a borrower of type P_i is willing to sign up for insurance in period n.

We further show in appendix $D.2$ that this maximum premium $\psi_i^{[n]\max}$ is increasing with n : the better the information the financial institution has on borrower i's type, the larger the (temporary) deviation from the perfect-information premium the borrower is willing to accept.

Furthermore, by virtue of the fact that borrowers must have been successful in *all* periods before signing up for insurance for the first time, the premium that borrowers face before signing up for the first time is decreasing over time and tends to zero.

Therefore, there exists for, each $P_i > \frac{L}{\delta X}$, a unique number of waiting periods $n(i)$ such that a borrower i will sign up for insurance in period $n(i)$ and not before:

$$\forall P_i \in \left[\frac{L}{\delta X}, 1\right], \quad \exists! n(i) > 1 \ni \psi_i^{[t]\max} < \psi_i^{[t]} \quad \forall t < n(i) \text{ and } \psi_i^{[n(i)]\max} \geq \psi_i^{[n(i)]}$$

Since the premium $\psi_i^{[t]}$ tends to zero as the number of waiting periods becomes large, and that there are strictly positive net benefits from insurance for all $P_i \in \left(\frac{L}{\delta X}, 1\right)$, all "good types" – the borrowers with projects which are socially beneficial – will eventually participate in the insurance scheme.

Note that the benefit from insurance is zero for borrowers whose project never fails (i.e. $P_i = 1$). Similarly, the benefit of insurance is zero for borrowers' whose project never succeeds (i.e. $P_i = 0$). The benefit increases with type and then decreases as borrowers become safer. The initial premium these borrowers are thus willing to pay is thus decrease with type as borrowers become safe enough: the safest borrowers will wait the longest before undertaking any insurance.

We now turn to the second source of abuse: fraudulent claims.

4.2 Deterring fraudulent claims

Since the financial institution has very little information on borrowers in the first rounds of the loans, the gains and losses in reputation for borrowers are greatest in those rounds. Each repayment or insurance claim represents a large proportion of the information that the institution has at its disposal to assess individuals. However, as the number of loan rounds gets large, this difference in reputation from an extra observation shrinks to the point that it becomes negligible. The effectiveness of the drop in reputation as a deterrent for false insurance claims thus diminishes over time. The insurance contract thus has to rely on additional sanctions to deter false insurance claims.

Proposition 4 *The institution must impose costs beyond simple loss of reputation after insurance claims in order to deter fraudulent claims.*

The formal argument is given in Appendix E. The intuition is easy to follow on Figure 3, which represents borrowers reputation as a function on the numbers of loans repaid. The top curve is a borrower's reputation with no defaults; the second is a borrowers' reputation after one default; and so on. Any default drops the borrower down one curve.

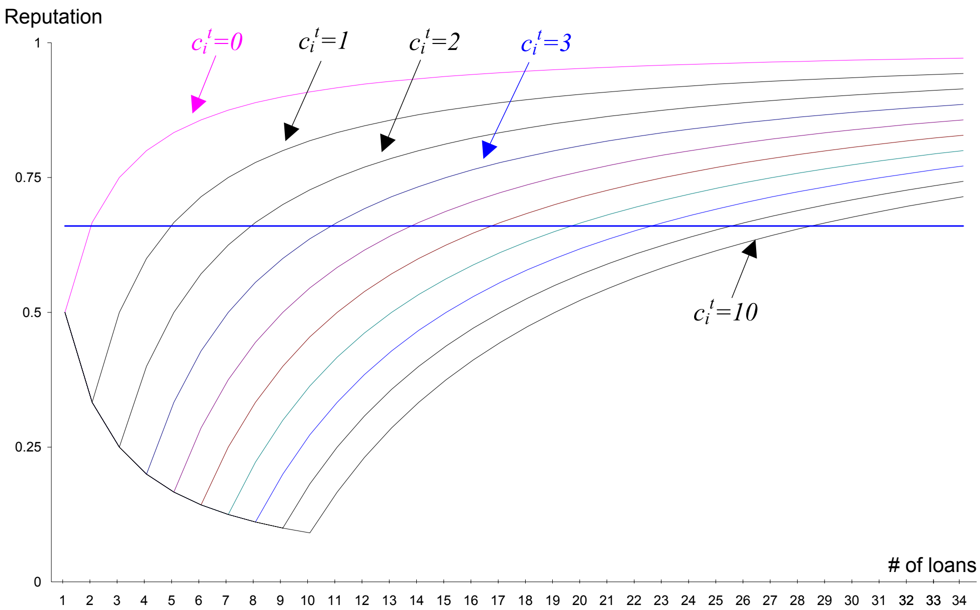

Figure 3: Evolution of Borrower reputation $\mu_i^{[t]}$

By filing a false claim, the borrower gains the fact of not repaying the current loan and the insurance premium. The costs are an increase in the future premia due to a loss of reputation, and an increase in the probability of falling below the reputation cutoff after repeated failures. However, after enough loan repetitions, these two losses effects become infinitesimal. An extra cost of claiming insurance must thus be imposed to discourage borrowers from filing false claims.

One possible form this extra cost could take is one inspired by US-style credit-card contracts. Banks issue credit cards to customers who have stable incomes[29] and a credit record without great blemishes. If a customer were to miss payments early in the relationship, the issuing bank would severely restrict (and even stop) that customer's use of that card. However, over time, responsible use and timely payments is met with increases in credit limits and a willingness from the issuing bank to accept late payments. Credit-card holders are therefore able to use their credit record (i.e. reputation as good payers) to smooth temporary shortfalls in income. The costs to the holder are a late-payment fee and, if the late payments are recurrent, negative entries in the holder's record at various credit rating agencies.[30] These

[29] or to college students with co-signers with stable incomes. Thanks mom!

[30] The idea of sharp important negative effects from reputation upon claims and slow rebuilding of reputation during periods of no claims is also prevalent in auto-insurance contracts. Accidents, speeding tickets, and other

negative entries in the credit record have a sufficient impact that after relatively few missed payments, the financial institution will deny the card holder any further services and the card holder will find it difficult to get access to any other financial services due to the ensuing bad credit record. It takes a long time for a person with a bad credit record to "rebuild her credit."

While the parallel to US credit-card contracts is not quite exact – credit cards allow *late* payments, not defaults[31] – the reputation and sanctioning mechanisms proposed in this paper are quite similar to the ones apparently applied in these contracts. Formally, the sanctioning to prevent moral hazard behavior is equivalent in our model to downgrading a borrower's reputation *and* reducing her acquired "experience" (by which we mean the number of loans she participated in). Reducing a borrower's reputation by more than dictated by the Bayesian updating rule (3) pushes the defaulting borrower closer to the cutoff below which she'll be denied insurance; stripping away experience and considering her as a newer borrower than she actually is (i.e. using a lower t to calculate updates on her reputation) increases the risk that she will actually reach the cutoff due to repeated failures. Financial institutions can customize these losses in reputation and in experience in order to achieve exactly the punishment they intend. The argument in Appendix F proves the following proposition.

Proposition 5 *There exits a cutoff, a sequence of insurance premia, and a sequence of costs in case of insurance claims such that the insurance contract is a Nash Equilibrium.*

The proof verifies that the contract modalities are sufficient to cover the financial institution's costs, do not exceed the benefits of insurance for participating borrowers, and induce truthful reporting from the part of the participating borrowers.

5 Conclusion

As documented in section 2, insurance is an important by-product of group-lending contracts. However, by the virtue of transferring risk to groups of borrowers less able to absorb it than the lending institution, these contracts entail an important loss in efficiency.

signs of hazardous driving are punished by large immediate losses of points that drivers typically need several years of faultless records to erase.

[31] In essence, credit-card companies provide temporary loans to borrowers in good standing to make up income shortfalls.

In this paper, we show that there exists simple credit-with-insurance contracts that financial institutions could implement in environments in which insurance mechanisms are incomplete. No new information is required; the contract is simple to implement; it is certainly welfare improving since building reputation is less costly than building savings. And furthermore, it maintains some borrowers who would have dropped out after a failure in the system.

The question is then understanding why institutions do not implement such contracts. In one sense, institutions have started to. Brown and Churchill [00] document insurance contracts in a number of institutions worldwide which are experimenting with life, health, and property insurance. Furthermore, implicit insurance arrangements exist, whereby institutions are more flexible on the terms of repayment with older groups.

Nevertheless, explicit repayment insurance has three important hurdles to clear. For microcredit programs, providing repayment insurance can impact institutional credibility. These programs are often located in areas in which public targeted credit programs have failed in the past due to their lax enforcement of rules. If the current institutions are seen as "soft" on the rules due to the provision of insurance, they may be faced with waves of default, like their predecessors. Furthermore, many of these institutions, in order to increase their credibility and their access to funds, are preparing for an eventual transition to becoming formal banks. Repayment insurance could be viewed by regulators as a "creative accounting" way to make their portfolio look in good standing, and thus derail the process of formalization. Third, institutions must be able to cover potential large-scale shocks. Since microfinance institutions operate in relatively small geographical areas, they are not immune to a large fraction of their loan portfolio suffering bad outcomes (floods, fire in a market, earthquakes...). While large covaried shocks are easily observable, the ability of the institution to provide insurance is then in question. Institutions must then be able to reinsure these risks.

This suggests a very important direction for policy regarding accounting practices. For institutions to successfully manage loans and insurance, strict accounting rules are needed to separate true instances of insurance from non-performing loans. As we have seen in recent banking sector crises, even developed countries are far from adhering to the standards advocated by the Basel Accords. Transparency, however, is crucial for institutions to gain credibility: in the eyes of their clients, of their national regulatory agency, as well as with potential reinsurers.

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Appendix

A Proof of Proposition 1

We first want to show that offering insurance in period 1 leads to some borrowers signing up for insurance, despite no intention of repaying the loan, simply in order to get an extra loan.

At time $T = 1$, the financial has no information about any borrowers. It can therefore not discriminate between borrowers and all borrowers have the same reputation $\mu^{[1]}$:

$$\mu^{[1]} = E(P_i), \quad \forall i.$$

However, from equation (5), we saw that all borrowers in $\left[\left(1-\mu^{[1]}\right)\frac{L}{\delta X}, \frac{L}{\delta X}\right]$ sign up for the insurance contract even though they never intend to repay any loan. Indeed, the cost of signing up for the loan ($\psi_i^{[1]}$) is outweighed by the benefit of maintain access to one more loan in $T = 2$ despite the (strategic) default in $T = 1$ for borrowers in that segment:

$$\begin{aligned} & -\psi_i^{[1]} + P_iX + \delta(P_iX) > P_iX \\ \iff \quad & \psi_i^{[1]} = \left(1-\mu^{[1]}\right)L < \delta P_i X \\ \iff \quad & P_i > \left(1-\mu^{[1]}\right)\tfrac{L}{\delta X}. \end{aligned}$$

Note that as long as $\mu^{[1]} \neq 0$, then there is some adverse selection if the financial institution provides insurance in $T = 1$.

In order to keep as many P_i below $\frac{L}{\delta X}$ from participating, the financial institution thus can impose a waiting period. Offering insurance in time $T = 2$ after one period of waiting imposes a cost. Nonetheless, some people might still repay the first loan and sign up for insurance, only to strategically default in $T = 2$ and get an extra loan in $T = 3$:

$$\begin{aligned} & P_i(X-L) + P_i\delta\left(-\psi_i^{[2]} + P_iX + \delta(P_iX)\right) > P_iX \\ \iff \quad & \forall P_i \in \left[\frac{1+\delta\left(1-\mu^{[2]}\right)}{1+\delta}\frac{L}{\delta X}, \frac{L}{\delta X}\right). \end{aligned}$$

where $\mu^{[2]}$ denotes a borrower's reputation at the beginning of time t when she has repaid all her loans, i.e.

$$\mu^{[2]} \equiv E^{[2]}\left(P_i \mid c_i^{[2]} = 0\right).$$

Note that whether a one-period wait increases or decreases the range of potential adverse selection depends on the updating from period 1 to 2:

$$\frac{1+\delta\left(1-\mu^{[2]}\right)}{1+\delta}\frac{L}{\delta X} \geq \left(1-\mu^{[1]}\right)\frac{L}{\delta X} \iff \frac{\mu^{[2]}}{\mu^{[1]}} \leq 1 + \frac{1}{\delta}.$$

If there is a big decrease in reputation from repaying in period 1, it might be worth for some P_i to do so, in order to qualify for insurance in period 2 (even though it would not have been worth signing up for insurance and strategically defaulting in period 1).

The issue is then to impose a longer waiting period, in order to keep as many $P_i < \frac{L}{\delta X}$ as possible out. If insurance is first offered at time $t = T$, the set of borrowers who benefit more from waiting until time T to default twice rather than defaulting in the first period is implicitly given by:

$$\sum_{t=1}^{T-1} \delta^{t-1} (P_i)^t (X - L) + (\delta P_i)^{T-1} \left(- \left(1 - \mu^{[T]}\right) L + P_i X + \delta P_i X \right) > P_i X.$$

Take a borrower with $P_i < \frac{L}{\delta X}$. If the waiting time T is such that

$$T < 1 + \frac{\ln \frac{P_i (L - \delta P_i X)}{(P_i (1+\delta) - 1)(L - \delta P_i X) + (1 - \delta P_i) \mu^{[T]} L}}{\ln \delta P_i} \tag{9}$$

then i will repay for the $T - 1$ periods and subscribe to insurance in period T in order to default in T and $T + 1$. We denote the right-hand side of (9) by $T^{NoAS}\left(\mu^{[T]} \mid P_i\right)$:

$$T^{NoAS}\left(\mu^{[T]} \mid P_i\right) \equiv 1 + \frac{\ln \frac{P_i (L - \delta P_i X)}{(P_i (1+\delta) - 1)(L - \delta P_i X) + (1 - \delta P_i) \mu^{[T]} L}}{\ln \delta P_i}$$

To discourage the participation of i, the waiting period has to be such that $T > T^{NoAS}\left(\mu^{[T]} \mid P_i\right)$. By concavity $T^{NoAS}\left(\mu^{[T]} \mid P_i\right)$ in $\mu^{[T]}$,[32] and by concavity of $\mu^{[T]}$ in T,[33] if $T > T^{NoAS}\left(\mu^{[T]} \mid P_i\right)$ then $T + n > T^{NoAS}\left(\mu^{[T+n]} \mid P_i\right)$ for any $n \geq 0$. A borrower who will not wait $T - 1$ periods to participate in period T will not wait $T + n - 1$ periods to participate in $T + n$ either. The first T such that $T > T^{NoAS}\left(\mu^{[T]} \mid P_i\right)$ is sufficient to deter participation by P_i, which proves Proposition 1.■

Figure 4 helps illustrate the argument.[34] The condition $T^{\min AS}\left(\mu^{[T]} \mid P_i\right)$ is represented for four values of P_i. The evolution of the reputation $\mu^{[T]}$ before the borrower signs up for insurance is depicted by the dotted line. As long as the combinations $\left(T, \mu^{[T]}\right)$ are below the condition $T^{\min AS}\left(\mu^{[T]} \mid P_i\right)$, borrower i wants to mimic repaying in order to qualify for

[32] By concavity of the log function, and because δP_i is less than 1 thus rendering the denominator negative.

[33] Since $\mu^{[T]}$ denotes the reputation of a borrower after $T - 1$ successful repayments and no defaults, each success has a smaller marginal contribution to the reputation; $\mu^{[T]}$ is thus a concave function of T

[34] The case illustrated is for parameter values of $\frac{X}{L} = 2$, $\delta = .9$ and a beta$(2, 6)$ prior, skewed towards a higher mass of risky types to reflect a "pessimistic" or cautious prior.

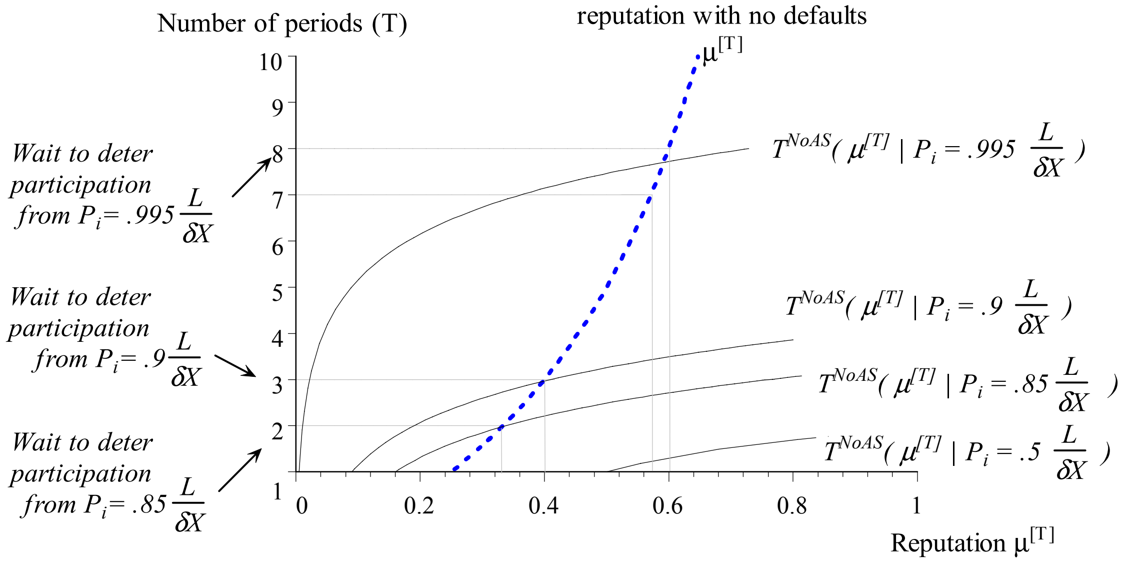

Figure 4: Minimal Waiting Periods to deter Adverse Selection

insurance in period T and default on two loans. For example, first offering insurance in period 2 is sufficient to deter participation from any borrower with $P_i < .85\frac{L}{\delta X}$. All borrowers with $P_i \in \left[.85\frac{L}{\delta X}, \frac{L}{\delta X}\right]$ will, however, repay their first period loan in order to qualify for insurance in $T = 2$ and the default twice. If the waiting is augmented to 2 periods, then the only adverse selection remaining is borrowers in $\left[.9\frac{L}{\delta X}, \frac{L}{\delta X}\right]$. Seven waiting periods is sufficient to discourage any borrower below $.995\frac{L}{\delta X}$ to participate.

B Proof of Corollary 2

To prove that a waiting period $T = T^{NoAS}\left(\mu^{[T]} \mid P_i\right)$ discourages all $P_j < P_i$ from participating in the insurance program, it is sufficient to show that the threshold waiting period $T^{NoAS}\left(\mu^{[T]} \mid P_i\right)$ is increasing in P_i, since all waiting periods $T > T^{NoAS}\left(\mu^{[T]} \mid P_i\right)$ still discourage P_i from participating by Proposition 1.

For our purposes, however, it is easier to work with the inverse of $T^{NoAS}\left(\mu^{[T]} \mid P_i\right)$, namely:

$$\mu(T \mid P_i) = \frac{P_i^2\delta + \delta^T P_i^T (1 - P_i(1+\delta))}{L(1-\delta P_i)(\delta P_i)^T}(L - \delta P_i X).$$

Taking partials with respect to P_i :

$$\begin{aligned}\frac{\partial \mu (T \mid P_i)}{\partial P_i} &= -\frac{\delta (1 + P_i (1+\delta)(\delta P_i - 2)) X + L}{L(-1+\delta P_i)^2} \\ &\quad -\frac{((1-\delta P_i)(T-1)-1)(L-\delta P_i X) + (1-\delta P_i)\delta P_i X}{L(-1+\delta P_i)^2 (\delta P_i)^{T-1}}\end{aligned}$$

we are going to show that

$$\frac{\partial \mu (T \mid P_i)}{\partial P_i} < 0 \qquad \forall T > 1 \quad \text{and} \quad P_i \leq \frac{L}{\delta X}. \tag{10}$$

Equation (10) states that, at a given T, any increase in P_i reduces the threshold of μ. In (μ, T) space, the $T^{NoAS}\left(\mu^{[T]} \mid P_i\right)$ condition thus lies above the $T^{NoAS}\left(\mu^{[T]} \mid P_j\right)$ condition for all $P_i > P_j$. This then proves that the threshold waiting period $T^{NoAS}\left(\mu^{[T]} \mid P_i\right)$ is increasing in P_i, as stated in corollary 2.

To prove equation (10), we proceed by induction on T. At $T = 1$, any increase in P_i reduces the threshold μ :

$$\left.\frac{\partial \mu (T \mid P_i)}{\partial P_i}\right|_{T=1} = -\delta \frac{X}{L} < 0.$$

Assume that at time $T = N$, the derivative of the threshold reputation is negative:

$$\left.\frac{\partial \mu (T \mid P_i)}{\partial P_i}\right|_{T=N} < 0. \tag{11}$$

Then, at $T = N + 1$, the difference between the derivatives of the threshold reputations at $T = N + 1$ and at $T = N$ is given by:

$$\left.\frac{\partial \mu (T \mid P_i)}{\partial P_i}\right|_{T=N+1} - \left.\frac{\partial \mu (T \mid P_i)}{\partial P_i}\right|_{T=N} = \frac{\delta^{-N} P_i^{-N} (1-\delta P_i)^2 ((\delta P_i X - L)(N-1) - \delta P_i X)}{L(1-\delta P_i)^2}.$$

Since $P_i \leq \frac{L}{\delta X}$, is negative, this difference is negative. This implies that the derivative of the threshold reputation at $T = N+1$ is smaller than the derivative of the threshold reputation at $T = N$; which in turn, by equation (11), implies that $\left.\frac{\partial \mu(T|P_i)}{\partial P_i}\right|_{T=N+1}$ is negative. We thus have that the derivative of the threshold reputation is negative for all T and at any value of $P_i \leq \frac{L}{\delta X}$, as stated in equation (10), which completes the proof of the corollary.■

C Proof of Proposition 3

Institutions face the problem is that the required time to discourage *all* borrowers below $P_i < \frac{L}{\delta X}$ from participating in the insurance scheme is infinite:

$$\lim_{P_i \to \frac{L}{\delta X}^-} T^{NoAS}\left(\mu^{[T]} \mid P_i\right) = +\infty.$$

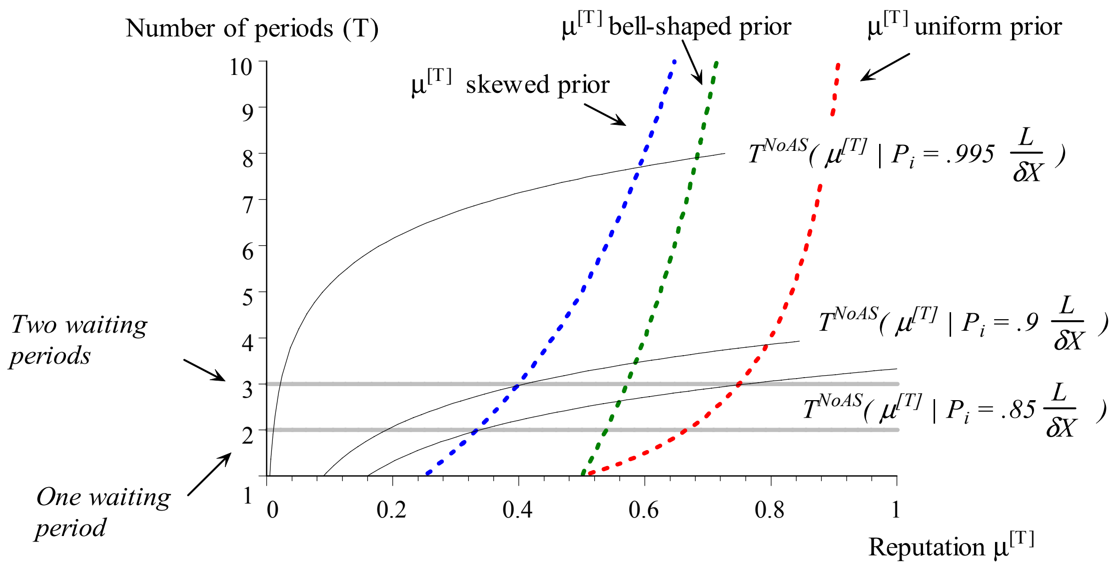

Figure 5: Effect of Prior on Adverse Selection

For any minimal waiting period chosen, there will remain some borrowers who just wait in order to sign up for insurance and immediately default.[35]

How much adverse selection remains? It depends on the financial institution's prior on the distribution of borrowers' risk. Figure 5 illustrates this for three particular priors: a uniform distribution (right-most); a symmetric bell-shaped distribution (beta(6,6) in the middle); and a distribution skewed towards a higher mass of risky types (beta(2,6) on the left) to represent a pessimistic financial institution. Given a choice of waiting periods T, take the lowest P_i such that the condition (9) deterring participation in the insurance program does not hold:

$$P(T) = \min \left\{ P_i \mid T \geq T^{NoAS}\left(\mu^{[T]} \mid P_i\right) \right\}$$

Then, for any chosen T, all borrowers in $\left[P(T), \frac{L}{\delta X}\right]$ will mimic the behavior of "good borrowers" in order to use the insurance to default. The faster the reputation increases with successful repayment, the faster the premium falls, and the more borrowers are willing to undertake the $T-1$ periods of repayment to qualify for two "free" loans.

In the examples in Figure 5, we see that two waiting periods is enough to limit adverse selection to borrowers in $\left[.9\frac{L}{\delta X}, \frac{L}{\delta X}\right]$ in case of a prior skewed towards a large mass of risky

[35] The effect of the waiting time on the participation of "desirable borrowers" is addressed in the main text. The waiting time does not discourage them since their benefit is higher than simply two periods of strategic default.

types, whereas adverse selection increases to $\left[.85\frac{L}{\delta X}, \frac{L}{\delta X}\right]$ if the institution has a uniform prior due to the lower insurance premium required by the financial institution (and thus higher participation by risky types).

Nonetheless, the waiting period – even if it does not eliminate all the adverse selection – can still have the positive effect of inducing borrowers to repay a few loans before defaulting, potentially improving repayment rates. Explicitly, the expected cost for financial institution of giving borrower P_i a loan contract which she intends to use to repay $T-1$ loans (if she can) before defaulting on two loans in a row using the insurance is given by:

$$\sum_{t=1}^{T-1}\left((\delta P_i)^{t-1}(1-P_i)\,L\right)+(\delta P_i)^{T-1}\left(-\left(1-\mu^{[T]}\right)L+L+\delta L\right)$$

i.e. in each period, the expected cost of default to the financial institution is $(1-P_i)\,L$. With probability P_i^{T-1}, the borrower does not default before period T and pays the insurance premium before defaulting on the two subsequent payments and losing access to future loans. This cost has to be compared to the cost L if a borrower simply defaults in the first period (which would happen if no insurance contract were offered):

$$\sum_{t=1}^{T-1}\left((\delta P_i)^{t-1}(1-P_i)\,L\right)+(\delta P_i)^{T-1}\left(-\left(1-\mu^{[T]}\right)L+L+\delta L\right)\leq L. \tag{12}$$

If the waiting period is long enough, the expected cost of adverse selection under the insurance contract is lower than under the no-insurance contract, i.e. (12) holds iff

$$T\geq 1+\frac{\ln\left(\dfrac{\left(\delta+\mu^{[T]}\right)(1-\delta P_i)-(1-P_i)}{(1-\delta)\,P_i}\right)}{-\ln\delta P_i}\equiv T^{\min C}\left(\mu^{[T]}\mid P_i\right) \tag{13}$$

Note that the waiting period chosen to deter adverse selection is long enough to lead to lower cost of adverse selection in the insurance case than in the no-insurance case as long as all borrowers below $P_i=\frac{L}{X}$ are selected out:

$$T^{NoAS}\left(\mu^{[T]}\mid P_i\right)\geq T^{\min C}\left(\mu^{[T]}\mid P_i\right)\Longleftrightarrow P_i\geq\frac{L}{X}$$

since $P_i=\frac{L}{X}$ is the unique value that equates (13) and (9) – i.e. the curves only cross once – :

$$1+\frac{\ln\left(\frac{\left(\delta+\mu^{[T]}\right)(1-\delta P_i)-(1-P_i)}{(1-\delta)P_i}\right)}{-\ln\delta P_i}=1+\frac{\ln\frac{P_i(L-\delta P_iX)}{(P_i(1+\delta)-1)(L-\delta P_iX)+(1-\delta P_i)\mu^{[T]}L}}{\ln\delta P_i}\Longleftrightarrow P_i=\frac{L}{X}$$

and beyond the crossing point, the condition to reduce adverse selection (9) is stronger than the condition to reduce cost (13):

$$\lim_{P_i = \frac{L}{\delta X}} T^{\min C}\left(\mu^{[T]} \mid P_i\right) < \infty \quad \text{and} \quad \lim_{P_i = \frac{L}{\delta X}} T^{NoAS}\left(\mu^{[T]} \mid P_i\right) = \infty.$$

This means that, as long as the waiting period is sufficient to screen out all borrowers with $P_i \leq \frac{L}{X}$, then the institution is better off providing insurance rather than not, even if there remains some adverse selection. The minimum waiting period the financial institution thus has to maintain is the one that screens out all borrowers with $P_i \leq \frac{L}{X}$:

$$T \geq T^{NoAS}\left(\mu^{[T]} \mid P_i = \frac{L}{X}\right)$$

Table 1 reports the first period in which insurance can be given such that all $P_i \leq \frac{L}{X}$ are excluded (so that the adverse selection costs remain the same as if no insurance were given). The values for $T\left(\frac{L}{X}\right)$ are computed for various values of δ and the three priors used in the examples above. The less agents discount, the longer the waiting period has to be because they value the two "free loans" more. More surprisingly, the more pessimistic the financial institution about the quality of borrowers, the sooner it can start offering insurance. This is because they charge a high premium (due to slow updating of borrower reputations), thus discouraging more borrowers. We should note that these waiting periods are decreasing in $\frac{X}{L}$: there is less of an adverse selection problem, since borrowers value the future more. Since the cost of insurance remains the same, less borrowers have to be discouraged to maintain the cost at the same level as without insurance.

In summary, we have shown that the institution can never completely eliminate adverse selection through waiting periods, as some risky borrowers will mimic the behavior of safe borrowers to qualify for insurance in order to strategically default twice. However, the financial institution can control how much adverse selection it is willing to endure through the choice of the waiting period. Furthermore, despite the adverse selection into the insurance contract, the cost of this adverse selection is smaller than the cost of the original adverse selection in the loan contracts without insurance. Repayment rates are improved since borrowers repay a certain amount of loans before defaulting (instead of defaulting on 100% of their loans).

	Prior Distribution			Remaining AS
δ	beta(2, 6) (skewed)	beta(6, 6) (bell-shaped)	Uniform	$\left[\frac{L}{X}, \frac{L}{\delta X}\right]$
0.99	$T = 7$ $\left(\mu^{[T]} = \frac{4}{7}\right)$	$T = 7$ $\left(\mu^{[T]} = \frac{2}{3}\right)$	$T = 8$ $\left(\mu^{[T]} = \frac{8}{9}\right)$	$\left[\frac{1}{2}, .505\right]$
0.9	$T = 3$ $\left(\mu^{[T]} = \frac{2}{5}\right)$	$T = 4$ $\left(\mu^{[T]} = \frac{3}{5}\right)$	$T = 4$ $\left(\mu^{[T]} = \frac{4}{5}\right)$	$\left[\frac{1}{2}, .556\right]$
0.75	$T = 1$ $\left(\mu^{[T]} = \frac{1}{4}\right)$	$T = 2$ $\left(\mu^{[T]} = \frac{7}{13}\right)$	$T = 3$ $\left(\mu^{[T]} = \frac{3}{4}\right)$	$\left[\frac{1}{2}, .667\right]$
0.5	$T = 1$ $\left(\mu^{[T]} = \frac{1}{4}\right)$	$T = 1$ $\left(\mu^{[T]} = \frac{1}{2}\right)$	$T = 1$ $\left(\mu^{[T]} = \frac{1}{2}\right)$	$\left[\frac{1}{2}, 1\right]$

Table 1: First period of Insurance for same Adverse Selection costs as no-insurance case $(X = 2L)$

D Properties of the Insurance Premium

D.1 Upper bound on Premium

In this section, we derive the upper bound on the premium that borrower i is willing to repay at the beginning of period $T(i) - N$.

Take period $T(i) - N$. The expected return of having an insurance contract from $T(i) - N$ onwards is given by:

$$\begin{aligned} -\psi_i^{[T(i)-N]} + P_i(X - L) + \delta\left(-E\left(\psi_i^{[T(i)-N+1]}\right) + P_i(X - L)\right) + \ldots \\ + \quad \delta^{N-1}\left(-E\left(\psi_i^{[T(i)-1]}\right) + P_i(X - L)\right) + \delta^N \frac{P_i X - L}{1 - \delta} \end{aligned}$$

where the expectations are taken at the beginning of period $T(i) - N$. Rewriting[36], this is equivalent to:

$$-\psi_i^{[T(i)-N]} + P_i(X - L) + \left(-\sum_{s=1}^{N-1} \delta^s \left(E\left(\psi_i^{[T(i)-N+s]}\right) - (1 - P_i) L\right) + \delta \frac{P_i X - L}{1 - \delta}\right). \quad (14)$$

Compare this expected return of signing up for insurance in period $T(i) - N$ to the expected return if borrower i waits one extra period before signing up for the insurance

[36] Using $P_i(X - L) = P_i X - L + (1 - P_i) L$.

contract (which she can do only if her project succeeds):

$$P_i\left(X-L\right)+P_i\left(-\sum_{s=1}^{N-1}\delta^s\left(E\left(\psi_i^{[T(i)-N+s]}\mid S\text{ in }T\left(i\right)-N\right)-\left(1-P_i\right)L\right)+\delta\frac{P_iX-L}{1-\delta}\right). \tag{15}$$

where $E\left(\psi_i^{[T(i)-N+s]}\mid S\text{ in }T\left(i\right)-N\right)$ denotes the expected value (taken at the beginning of time $T\left(i\right)-N$) of the premium in $T\left(i\right)-N+s$ conditional on the fact that borrower i's project's success in period $T\left(i\right)-N$.[37]

To decide whether to sign up for insurance at the beginning of period $T-N$, borrower i compares the expected returns (14) and (15). Signing up for insurance in period $T\left(i\right)-N$ yields higher expected returns than waiting one more period if the premium does not exceed the following bound:

$$\begin{aligned}\psi_i^{[T(i)-N]} &\leq \delta\left(1-P_i\right)\frac{P_iX-L}{1-\delta}\\ &+\sum_{s=1}^{N-1}\delta^s\left(P_iE\left(\psi_i^{[T(i)-N+s]}\mid S\text{ in }T\left(i\right)-N\right)-E\left(\psi_i^{[T(i)-N+s]}\right)\right).\end{aligned}$$

Note that this is equivalent to:

$$\psi_i^{[T(i)-N]}\leq\left(1-P_i\right)\delta\frac{P_iX-L}{1-\delta}-\left(1-P_i\right)\sum_{s=1}^{N-1}\delta^sE\left(\psi_i^{[T(i)-N+s]}\mid F\text{ in }T\left(i\right)-N\right)$$

since

$$\begin{aligned}E\left(\psi_i^{[T(i)-N+s]}\right) &= P_iE\left(\psi_i^{[T(i)-N+s]}\mid S\text{ in }T\left(i\right)-N\right)\\ &+\left(1-P_i\right)E\left(\psi_i^{[T(i)-N+s]}\mid F\text{ in }T\left(i\right)-N\right).\end{aligned}$$

Define the upper bound to the premium that i is will to pay for a new insurance contract in period n as:

$$\psi_i^{[n]\max}\equiv\left(1-P_i\right)\delta\frac{P_iX-L}{1-\delta}-\left(1-P_i\right)\sum_{s=1}^{T(i)-n-1}\delta^sE^{[n]}\left(\psi_i^{[n+s]}\mid F\text{ in }n\right)$$

where $E^{[n]}$ denotes the expectation taken at the beginning of period n. This is exactly equation (8) in the text.

[37] If the project is unsucessful in $T\left(i\right)-N$, borrower i defaults and loses access to future loans.

D.2 Proof that maximum premium $\psi_i^{[n]\max}$ is increasing in n

We want to show that the maximum premium borrower i is willing to pay in period n, namely (equation (8) in the text)

$$\psi_i^{[n]\max} \equiv (1-P_i)\,\delta\frac{P_iX-L}{1-\delta} - (1-P_i)\sum_{s=1}^{T(i)-n-1} \delta^s E^{[n]}\left(\psi_i^{[n+s]} \mid F \text{ in } n\right)$$

is increasing in n.

For a borrower with a given history up to time n, compare this maximum premium in two successive periods: n and $n+1$. The difference is given by:

$$\begin{aligned} &\psi_i^{[n]\max} - \psi_i^{[n+1]\max} \\ &= -(1-P_i)\,E^{[n]}\left(\psi_i^{[n+1]} \mid F \text{ in } n\right) \\ &+ (1-P_i)\textstyle\sum_{s=2}^{n-1}\delta^s \left\{E^{[n]}\left(\psi_i^{[n+s]} \mid F \text{ in } n\right) - E^{[n+1]}\left(\psi_i^{[n+1+s]} \mid F \text{ in } n+1\right)\right\}. \end{aligned} \tag{16}$$

The first term is negative. To compare the terms inside the summation, we note that borrower i's project has to be successful in n to receive a loan in period $n+1$ since she has no insurance in period n. We can thus rewrite:

$$\begin{aligned} E^{[n+1]}\left(\psi_i^{[n+1+s]} \mid F \text{ in } n+1\right) &= E^{[n]}\left(\psi_i^{[n+1+s]} \mid S \text{ in } n; F \text{ in } n+1\right) \\ &= P_i \cdot E^{[n]}\left(\psi_i^{[n+1+s]} \mid S \text{ in } n; F \text{ in } n+1; S \text{ in } n+2\right) \\ &\quad + (1-P_i)\cdot E^{[n]}\left(\psi_i^{[n+1+s]} \mid S \text{ in } n; F \text{ in } n+1; F \text{ in } n+2\right). \end{aligned}$$

Similarly, we can rewrite

$$\begin{aligned} E^{[n]}\left(\psi_i^{[n+s]} \mid F \text{ in } n\right) = \; & P_i \cdot E^{[n]}\left(\psi_i^{[n+s]} \mid F \text{ in } n; S \text{ in } n+1\right) \\ & + (1-P_i)\cdot E^{[n]}\left(\psi_i^{[n+s]} \mid F \text{ in } n; F \text{ in } n+1\right). \end{aligned}$$

By the fact that premia go up with failures (claims) and down with successful repayments, and that project outcomes are *iid* over time,[38] we have that

$$E^{[n]}\left(\psi_i^{[n+1+s]} \mid S \text{ in } n; F \text{ in } n+1; S \text{ in } n+2\right) < E^{[n]}\left(\psi_i^{[n+s]} \mid F \text{ in } n; S \text{ in } n+1\right)$$

and

$$E^{[n]}\left(\psi_i^{[n+1+s]} \mid S \text{ in } n; F \text{ in } n+1; F \text{ in } n+2\right) < E^{[n]}\left(\psi_i^{[n+s]} \mid F \text{ in } n; F \text{ in } n+1\right).$$

[38] i.e., it is not the order of success and failures that matter but the total number of each.

This implies that

$$E^{[n+1]}\left(\psi_i^{[n+1+s]} \mid F \text{ in } n+1\right) < E^{[n]}\left(\psi_i^{[n+s]} \mid F \text{ in } n\right) \quad \forall s$$

and, thus, that the difference in (16) is negative:

$$\psi_i^{[n]\max} - \psi_i^{[n+1]\max} < 0.$$

i.e. $\psi_i^{[n]\max}$ is increasing in n.

E Proof of Proposition 4

E.1 Bayesian updating of reputations

When a borrower undertakes her first loan, the financial institution has no information on her type. The new borrower's reputation is therefore set at the mean of the institution's prior on the distribution of borrower types:

$$\mu_i^{[1]} = \mu^{[1]} = \int_0^1 g(p)\, p dp$$

where $g(p)$ denotes the institution's prior. However, as the financial institution gathers information on the borrower's repayment behavior, it can update its assessment on her type. For example, before the second loan, a borrower's reputation is updated by Bayes' rule according to whether she repaid or not:

$$\mu_i^{[2]} = \frac{\int_0^1 p^{1-c}(1-p)^c g(p)\, p dp}{\int_0^1 p^{1-c}(1-p)^c g(p)\, dp}$$

where $c = 0$ if i repaid her loan and $c = 1$ if i claimed insurance in period 1.

Since the projects are assumed to be independently and identically distributed for each borrower over time, borrower i's reputation in time t depends simply on the number of loans $(t-1)$ and the number of insurance claims $c_i^{[t]}$ that i has filed up to period t :

$$\mu_i^{[t]} \equiv \mu\left(t, c_i^{[t]}\right) = \frac{\int_0^1 \binom{t-1}{c_i^{[t]}} p^{(t-1)-c_i^{[t]}} (1-p)^{c_i^{[t]}} g(p)\, p dp}{\int_0^1 \binom{t-1}{c_i^{[t]}} p^{(t-1)-c_i^{[t]}} (1-p)^{c_i^{[t]}} g(p)\, dp}$$

The prior distribution $g(p)$ determines how much weight the institution puts on the new information for each type.

E.2 Eliminating false claims from safe borrowers

In order to gain intuition on the results, we restrict our attention to beta distributions as priors, since they are very flexible distributions that can take various shapes and that they have the advantage of being easy to use (see Rice, 89):

$$g(p) = \frac{\Gamma(a)\Gamma(b)}{\Gamma(a+b)} p^{a-1} (1-p)^{b-1}$$

Borrower i's reputation at the beginning of period t is then given by the simple formula:

$$\mu_i^{[t]} = \frac{(t-1) - c_i^{[t]} + a}{(t-1) + (a+b)}$$

Note that the uniform distribution is simply a beta with $a = b = 1$, so that the initial reputation at $t = 1$ would simply be $\mu_i^{[1]} = 1/2$.

The marginal contribution of an extra insurance claim to borrower i's reputation is given by

$$\mu(t, c+1) - \mu(t, c) = \frac{\int_0^1 (1-p) g^{[t-1]}(p) p dp}{\int_0^1 (1-p) g^{[t-1]}(p) dp} - \frac{\int_0^1 p g^{[t-1]}(p) p dp}{\int_0^1 p g^{[t-1]}(p) dp}$$

where $g^{[t-1]}(p)$ is the distribution of borrower reputations at the beginning of time $t-1$, given c claims up to the beginning of period $t-1$. Taking the prior distribution to be a beta, this difference works out to:

$$\begin{aligned}\mu(t, c+1) - \mu(t, c) &= \frac{(t-1) - (c+1) + a}{(t-1) + (a+b)} - \frac{(t-1) - c + a}{(t-1) + (a+b)} \\ &= -\frac{1}{(t-1) + (a+b)}\end{aligned}$$

which is negative and of magnitude decreasing in t.[39]

False claims lead to a loss in income due to loss in reputation

This loss in reputation translates to a loss of income (through higher premium) in every period equivalent to:

$$(1 - \mu(t, c+1)) \delta L - (1 - \mu(t, c)) \delta L = \delta \frac{L}{(t-1) + a + b}$$

[39] This is where the use of a beta distribution is convenient: the loss in reputation in each period is independent of the number of claims made up to that point.

or a loss of expected income from t onwards (ignoring the increase in the probability of falling below the cutoff) equal to:

$$\sum_{k=1}^{\infty}\left(\frac{\delta^{k}L}{(t+k-1)+a+b}\right). \tag{17}$$

As t becomes large, this cost goes to zero for any beta prior.[40]

False claims lead to a loss in income due to a higher probability of losing access to insurance

In addition to the loss on income due to loss in reputation, there is a loss associated with an increased probability of falling below the cutoff due to repeated failures. Take a borrower with c claims up to time t :

$$\mu\left(t,c\right)=\frac{(t-1)-c+a}{(t-1)+a+b}$$

To reach the limit below which insurance claims are denied – denote it μ_{*} – it takes a certain amount of further claims. For example, denote by $s_{t}^{c}\left(0\right)$ the number of claims in a row to go from a reputation of $\mu\left(t,c\right)$ to a reputation just below μ_{*}, where $s_{t}^{c}\left(0\right)$ is the first integer such that:

$$\frac{(t-1)-c+a}{(t-1)+s_{t}^{c}\left(0\right)+a+b}<\mu_{*},$$

Similarly, it takes $s_{t}^{c}\left(1\right)$ loans with $s_{t}^{c}\left(1\right)-1$ claims (and 1 repayment) to go from a reputation of $\mu\left(t,c\right)$ to a reputation just below μ_{*}, where $s_{t}^{c}\left(1\right)$ is the first integer such that:

$$\frac{(t-1)+1-c+a}{(t-1)+s_{t}^{c}\left(1\right)+a+b}<\mu_{*}.$$

More generally, it takes $s_{t}^{c}\left(z\right)$ loans with $s_{t}^{c}\left(z\right)-z$ claims (and z repayments) to go from $\mu\left(t,c\right)$ to just below μ_{*}, where $s_{t}^{c}\left(z\right)$ is the first integer such that:

$$\frac{(t-1)+z-c+a}{(t-1)+s_{t}^{c}\left(z\right)+a+b}<\mu_{*} \tag{18}$$

and is given by

$$s_{t}^{c}\left(z\right)=\operatorname{int}\left\{\left(\frac{1}{\mu_{*}}-1\right)t+\frac{z-c}{\mu_{*}}-\frac{\left(1-\mu_{*}\right)\left(1-a\right)+b\mu_{*}}{\mu_{*}}\right\}+1$$

Note that $s_{t}^{c}\left(z\right)$ is increasing in t and $\lim_{t\longrightarrow\infty}s_{t}^{c}\left(z\right)=\infty$ since $\mu_{*}<1$.

[40] By virtue of Bayesian updating, it is actually true for any prior. We restrict our attention to beta priors because of what follows.

If a borrower makes no false claims, the probability for a borrower with reputation $\mu(t,c)$ of hitting the limit μ_* is thus given by summing the number of ways a borrower can have $s_t^c(z)-z$ failures times the probability of having $s_t^c(z)-z$ failures for all values of z :

$$\sum_{z=0}^{s_t^c(z)} \tbinom{s_t^c(z)}{z} p^z (1-p)^{s_t^c(z)-z} \tag{19}$$

Note that, from (18), a borrower with an additional insurance claim at time t (i.e. $c+1$ claims) faces fewer rounds before hitting the limit:

$$\begin{aligned} s_t^{c+1}(z) &= \operatorname{int}\left\{\left(\frac{1}{\mu_*}-1\right)t+\frac{z-(c+1)}{\mu_*}-\frac{(1-\mu_*)(1-a)+b\mu_*}{\mu_*}\right\}+1 \\ &= s_t^c(z-1) \end{aligned}$$

The probability of hitting the limit μ_* with $(c+1)$ claims is then given by:

$$\sum_{z=0}^{s_t^c(z-1)} \binom{s_t^c(z-1)}{z} p^z (1-p)^{s_t^c(z-1)-z} \tag{20}$$

We note that the difference between (20) and (19) is decreasing in t and converges to zero as $t \longrightarrow \infty$. This is due to the fact that the difference can be written as

$$\text{eq(20)} - \text{eq(19)} = \sum_{z=0}^{s_t^c(z)} \left[\binom{s_t^c(z)}{z} - \binom{s_t^c(z-1)}{z} p^\xi\right] p^z (1-p)^{s_t^c(z-1)-z} \tag{21}$$

where ξ denotes the difference $s_t^c(z)-s_t^c(z-1)$;[41] that each term in the sum is bounded above by:

$$s_t^c(z)^z (1-p)^{s_t^c(z)-z} > \left[\binom{s_t^c(z)}{z} - \binom{s_t^c(z-1)}{z} p^\xi\right] p^z (1-p)^{s_t^c(z-1)-z} \tag{22}$$

(since the term in brackets is smaller than $\tbinom{s_t^c(z)}{z}$, which itself is smaller than $s_t^c(z)^z$, and that $p \leq 1$); that the left-hand side of (22) goes to zero as t goes to infinity by the fact that

$$\lim_{n \longrightarrow \infty} n^z p^z (1-p)^{n-z} = 0 \quad \text{for all } z \geq 0$$

(because $p \leq 1$); and that the limit of $n^z p^z (1-p)^{n-z}$ as z approaches n is zero (the sum in (21) hence does not diverge).

The loss associated with the increased probability of falling below the cutoff due to an additional false insurance claim thus goes to zero as the number of loans increases.

[41] Note that $\tbinom{s_t^c(z-1)}{z} = 0$ for $z > s_t^c(z-1)$.

Net gains from false claims are positive for t large enough

The gains from deviating, however, remain significant and comprise of not repaying the current loan L. As we saw above, the costs of false claims are twofold: (1) false claims decrease future income due to a loss of reputation; and (2) false claims increase the probability of falling below the cutoff (21) in the future. Since both costs tend to zero as the number of periods increase, and since the cost of deviation remains constant, we have that all borrowers will thus eventually benefit for filing false claims. It is therefore necessary for the insurance contract to impose costs beyond simple loss of reputation after insurance claims in order to deter false claims, as stated in Proposition 4.

F Proof of Proposition 5

To prove the proposition, we have to show (1) that there exists a cutoff to deter adverse selection; (2) that there exists a punishment sufficient to deter false claims (moral hazard); (3) that the insurance premium is sufficient to cover the financial institution's insurance costs; and (4) that the contract satisfies the borrowers' participation constraint.

Cutoff to deter adverse selection

In the proof of Proposition 1, we showed that the financial institution can choose a number of waiting periods to make the adverse selection problem as small as it wants.

Sufficient punishment to deter false claims (moral hazard)

In the proof of Proposition 4, we showed that extra sanctions beyond simple loss of reputation were necessary to deter false insurance claims.

The gross benefits from filing a false insurance claim are equal to the cost of not repaying the loan L. To discourage moral hazard behavior, the sanction for a claim simply has to be equal to the benefit of the moral hazard.

The simple punishment we propose in this paper is the following. When a borrower files a claim in period t, the institution "demotes" the period-t borrower to a period-$\left(t - N_i^{[t]}\right)$ borrower, where $N_i^{[t]}$ is the minimal integer such that:

$$\sum_{s=1}^{N} \delta^s \left(\mu_i^{[t]} - \mu_i^{[t-N+s]}\right) L \geq L. \tag{23}$$

The left-hand side of (23) is the premium costs above the current premium cost that borrower i paid in the $N_i^{[t]}$ previous periods. The financial institution chooses $N_i^{[t]}$ such that this extra cost is exactly equal to the benefit of deviation for borrower i in period t in order to avert any false claims.

Does this contract maintain the participation constraint in case of real claims? If borrower i already had an insurance contract in $t - N_i^{[t]}$, her participation constraint is clearly satisfied, since it is just a repetition of what she did in the past, which took into account this risk of failure. If $t - N_i^{[t]}$ is greater that a borrower's insurance experience (i.e. borrower i did not have an insurance contract in $t - N_i^{[t]}$), then the financial institution considers the borrower in default.

Participation constraint for financial institution

As shown in the proof of how to limit adverse selection above (appendix F), the insurance scheme increase repayment rates for borrowers who strategically default. This softens the institutions' participation constraint.

Furthermore, borrowers only participate once the premium charged is "not too high" compared to the actual cost of insuring the borrowers. On average, the institution thus charges borrowers higher premia than the actual cost of insuring them (although the institution cannot change this because of adverse selection issues).

If the institution offered credit without insurance, offering credit with insurance satisfies its participation constraint.

Participation constraint for borrowers

Participation in the insurance contract of the "good guys," i.e. borrowers with $P_i > \frac{L}{\delta X}$, follows from the argument given in Section 4.1 (p. 17). They are willing to repay their loans even without insurance. This means that the waiting periods do not deter them from participation. They start participating once the premium has gone down sufficiently.

Table 1. Descriptive Statistics

Variables	Mean	Std. Dev.*	Median*	Min*	5%*	95%*	Max*	Number observ.
Personal/Business characteristics								
Average weekly sales in good weeks ($US)	531	770	381	14	112	1203	13333	782
Bad week sales, as a fraction of good week	0.58	0.17	0.58	0.03	0.29	0.84	1.00	782
Buying merchandise daily	0.19	---	---	---	---	---	---	782
Buying 2-3 times per week	0.29	---	---	---	---	---	---	782
Buying once a week	0.35	---	---	---	---	---	---	782
Only one business	0.79	---	---	---	---	---	---	772
Sole income provider to household	0.40	---	---	---	---	---	---	782
Loan characteristics								
Loan size (in US$)	740	555	650	56	167	1700	5000	782
Loan size/average daily purchases	17	20	12	1	2	47	93	647
Weekly payments	0.30	---	---	---	---	---	---	782
Fortnightly payments	0.32	---	---	---	---	---	---	782
Monthly payments	0.38	---	---	---	---	---	---	782
Payment size (in US$)	124	97	93	5	29	276	718	782
Payment/average daily purchase	2.98	3.40	1.92	0.02	0.29	8.73	27.69	647
% keeping loans to make first payments	0.19	---	---	---	---	---	---	780
Number of payments kept	1.88	1.17	1.75	0.10	1.00	5.00	5.00	146
Group characteristics								
Group size	3.7	0.94	3	3	3	6	8	210
groups of 3	0.50 †							105
groups of 4	0.34 †							72
groups of 5	0.12 †							26
groups of 6	0.01 †							3
groups of 7	0.00 †							1
groups of 8	0.01 †							3

* Standard deviation, minimum, maximum, median, and 5% and 95% points are not reported for dummy variables.
† As a percentage of total number of groups.

Table 2. Insurance Occurances in Credit Groups

Insurance need in past year.	(Someone in group has had trouble making own payment in past year)			
			%	
	none	79	0.38	
	1-4 times	85	0.40	
	more than 4 times	46	0.22	
		210		
Reason insurance was needed.		N	%	
	low sales	155	0.63	
	bad planning	30	0.12	
	robbery	7	0.03	
	family illness	49	0.20	
	other	7	0.03	
		248		
Who provides insurance?		N	%	
	a member of the group	128	0.52	
	the whole group	42	0.17	
	someone from outside	49	0.20	
	self insurance	8	0.03	(savings, money-lender)
	resulted in late payment	20	0.08	(insurance failed)
		247		
How much?		**Amount (in $)**	**As fraction of payment***	
	mean	28	0.24	
	median	17	0.17	
	5%	5	0.04	
	95%	88	0.67	
	min	2	0.01	
	max	167	1.25	

* As we have only current payment information, and not the payment information at the time insurance was given, these are only approximations.

Table 3. Risk heterogeneity in groups

Number of groups

Lowest risk quantile in group	Highest risk quintile in group: 1	2	3	4	5	N
1	*2*	18	21	26	33	**100**
2		*5*	11	13	17	**46**
3			*2*	14	22	**38**
4				*1*	17	**18**
5					8	**8**
						210 groups

(The small italics indicate cells with less than 5 observations)

Table 4. Net insurance provision in groups

Net insurance provision

(mean # times provided - # times received)

Lowest risk quantile in group	Highest risk quintile in group: 1	2	3	4	5
1	*2.00* *(0.00)*	**0.91** (0.46)	**0.67** (0.33)	**1.33** (0.46)	**0.47** (0.25)
2		*0.75* *(0.43)*	**1.00** (0.43)	**1.00** (0.46)	0.00 (0.40)
3			*-0.50* *(0.50)*	**-1.33** (0.31)	**1.13** (0.14)
4				*0.00* *(0.00)*	**2.00** (0.97)
5					**-0.50** (0.25)

(The small italics indicate cells with less than 5 observations)
(Bold indicates significance at 10% level)
(Standard errors of mean in parenthesis)