Savings-and-Credit Contracts

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Abstract

In this paper, we present a Savings-and-Credit Contract (SCC) design that mandates a savings period with a default penalty before providing credit. We demonstrate that SCCs mitigate adverse selection and can outperform traditional loan contracts amidst information frictions, thereby expanding access to credit. Empirical evidence from a financial product incorporating an SCC design supports our theory. While appearing riskier on observables, we observe lower realized default rates for product participants than for bank borrowers. Further consistent with the theory, a reform that reduces the default penalty during the savings period induces worse selection and higher realized default rates.

JEL Codes: D47, G21, G23, G51, J61.

Keywords: access to credit, contract design, information asymmetry, signaling.

1 Introduction

When financial markets fail to provide efficient intermediation, society bears deadweight loss through resource misallocation and foregone growth opportunities (Gurley and Shaw, 1955). In credit markets, information asymmetry is one of the primary causes of distortions. The traditional approach to alleviate information frictions involves collecting information about borrowers. However, this approach faces limitations in environments with sparse information. An alternative solution is to design contracts that enable borrowers to reveal private information by signaling their quality, for instance, by posting physical collateral.

In this paper, we explore a contract design – Savings-and-Credit Contract (SCC) – which alleviates information asymmetry through signaling via costly savings. Specifically, the contract mandates a savings period before providing credit and imposes a pecuniary penalty for defaulting during the savings period. That is, unlike in traditional spot loan contracts in which borrowers make a down payment and obtain credit immediately, in the SCC design, credit is awarded only after borrowers successfully make regular down payments to a lender over a contractually specified savings period.

In the first part of the paper, we develop a model demonstrating how the SCC design can expand access to credit and outperform traditional spot loan contracts in the presence of information frictions and liquidity constraints. In the second part of the paper, we provide empirical support for our model by examining a financial product in Brazil – Consorcio – that applies an SCC design, and a reform altering the cost of default during the savings period. We find broad empirical support for the model's predictions.

In the model, borrowers commit to making two down payments before receiving credit. If borrowers make the first down payment, but fail to make the second down payment, they are repaid the initial down payment minus a penalty. If borrowers make both down payments, they receive credit to buy the asset, and, if the credit is repaid, the borrowers get to enjoy the value of the asset permanently. Otherwise, the asset is seized by the lender. There are two types of borrowers whose types are not verifiable. Good (low risk) borrowers are less likely to experience income shocks during both the savings and credit period compared with bad (riskier) borrowers. Thus, good types are more likely to be able to make both down payments and to repay credit. This persistence in types is necessary for screening to be informative.

With a standard loan contract, pricing is based on the expected credit risk of all borrowers, which may lead to adverse selection and lower credit supply under information asymmetry (Akerlof, 1970). We show that the SCC design allows the lender to better separate between good and bad borrowers. While lenders can also screen borrowers using variation in down payments in standard spot loans (e.g., Milde and Riley (1988), Adams, Einav, and Levin (2009), and Einav, Jenkins, and Levin (2012)), in the presence of liquidity constraints, the SCC design is a more efficient separating device. Intuitively, for bad borrowers, committing to the savings period adds additional exposure to default risk, which is costly due to the associated penalty. Put differently, with a standard loan contract, agents save on their own and can walk away if they are hit with a bad income shock before making the down payment. With a mandatory savings period they have to commit some funds earlier, part of which they forego if the income shock hits before the second down payment. While this applies to good and bad types, the expected cost of committing to the savings period is lower for the good type, since they are less likely to default.

The property that allows for screening and separation with both types of contracts is that the single-crossing property holds. That is, the marginal rate of substitution between savings and loan payments (for SCCs) or between down payments and loan payments (for spot loans) is increasing in borrower quality. However, the increase in the marginal rate of substitution is stronger for signaling with costly savings than with a single down payment. This makes SCCs a more effective way to screen borrowers than spot loans.[1]

We characterize the Pareto dominant competitive separating equilibrium when only spot

[1] Conditional on selection, the borrower pool further improves before credit is provided since low-quality borrowers are more likely to default during the savings period in an SCC.

loans are available and when SCCs are offered as well. Offering SCCs increases credit supply compared with a credit market with only spot loan contracts, in particular when borrowers face higher real interest rates or have a higher discount rate, and when there is more unobservable information as measured by the spread between good and bad types. Finally, credit supply increases more with SCC contracts when the default penalty during the savings period is higher, since it facilitates signaling for the good type by making it costlier for the bad type to mimic the behavior of the good type by committing to the savings period.

We provide empirical support for the predictions of the model using data on consorcio participants and bank borrowers in Brazil that seek financing to buy a car. Consorcios provide credit to finance durable goods and apply an SCC design. They are used by almost 10m participants in a given year. Every month, participants in a consorcio group make identical contributions, which are then allocated to a subset of participants as credit designated for purchase of an asset. All participants continue their contributions until everybody has been awarded credit. If an individual defaults before obtaining credit (i.e., during the savings period), their savings are returned after discounting a significant penalty. If an individual defaults after obtaining credit, the asset is seized by the group's administrator. When individuals sign up for a group there is no active screening. Anybody with a social security number can sign up. Enforcement operates through physical rather than social collateral. Participants share no social ties and do not live in geographic proximity.

We start our empirical analysis by comparing observable characteristics of bank borrowers and consorcio participants. Our model suggests that SCCs achieve positive selection based on unobservables. Thus, conditional on controlling for observable characteristics, we should observe lower realized default rates for consorcios than for bank loans. First, we show that on observables consorcio participants appear riskier than bank borrowers. Specifically, consorcio participants are 15 percentage points less likely to be formally employed, 1.7 percentage points more likely to currently be in default on a bank loan, 1.3 percentage points more likely to have defaulted on a bank loan in the last 5 years, and their simulated credit score is 12.4 percent worse. However, conditional on controlling for contract- and borrower-level observable characteristics, we observe an about 5 percentage point lower realized default rate on credit allocated to consorcio participants compared with standard bank loans. Together, this suggests that consorcios extract relatively safer borrowers conditional on observables. This is consistent with the positive selection and screening effects of mandating a costly savings period predicted by the model.

Since consorcios differ from bank loans in other ways, we sharpen the interpretation of the analysis by exploiting a regulatory reform in 2009 that changed the default cost associated with the penalty. Prior to the reform, participants who default during the savings period were returned their savings minus a penalty at the ultimate dissolution of the group. After the reform, participants who default during the savings period are returned their savings minus a penalty when their number is drawn in a lottery. Thus, after the reform, savings are returned after a (about 50 percent) shorter waiting period compared with before the reform. In our model, lowering the expected penalty during the savings period weakens SCCs' ability to separate borrowers and leads to more adverse selection.

Comparing bank and consorcio borrowers around the reform, we find that observable characteristics of consorcio participants relatively worsen compared with bank borrowers. In addition, realized default rates significantly increase for consorcio participants relative to bank borrowers after the reform. This suggests that the penalty plays an important role in improving selection into the SCC contract, as suggested by the model. It is important to highlight that higher realized default rates *after* providing credit to consorcio participants also rule out moral hazard as the explanation for the effects around the reform. Even if borrowers are more likely to default during the savings period after the reform because default is less costly, we should not see higher default rates *after* credit is allocated, since there is no variation in moral hazard incentives after receiving credit.

The insights from this paper contribute to several strands of literature. The key insight of Spence (1973) is that when agents have different marginal costs of signaling, they can be induced to take actions that reveal their type in equilibrium. However, when Adams, Einav, and Levin (2009) empirically study subprime auto lending in the U.S., they find little variation in down payments, even though subprime borrowers should exhibit large heterogeneity in unobservables. One possible explanation for the lack of screening and signaling with spot loans documented in Adams, Einav, and Levin (2009) could be that spot loans are a weak mechanism to separate borrowers. To achieve a significant reduction in the interest rate, the borrower has to make a very large down payment, which may not be feasible due to liquidity constraints or too costly even for good-quality borrowers. In contrast, an SCC design may improve screening and signaling by generating a higher wedge in the marginal rates of substitution between the signaling device and loan payments for good and bad borrowers.

Many studies on household finance focus on private information about the cost of default, such as credit score effects and social stigma (e.g., Brueckner (2000), Gupta and Hansman (2022)), or on asymmetric information about collateral values (Stroebel, 2016). In addition, the literature explores how lenders can utilize collateral pledging to screen borrowers' private information (Bester (1985), Stiglitz and Weiss (1981), Besanko and Thakor (1987), Chan and Thakor (1987)), by offering a menu of loans with higher or lower collateral pledging linked to lower or higher interest rates. Focusing on private information about the distribution of borrowers' future income, our paper extends the use of down payments or loan size as the relevant sorting device for household financing studied in Milde and Riley (1988), Adams, Einav, and Levin (2009), and Einav, Jenkins, and Levin (2012).

In principle, the idea of linking regular savings to assessing credit risk, as in the SCC design, is implicitly present in other areas of financial intermediation.[2] For example, the widely available Credit Builder Loans (CBLs) in the U.S. require individuals to commit to regular monthly deposit payments that are reported to credit bureaus as installment loans. Consistent with our model, Burke et al. (2022) find that CBLs exhibit positive selection. While CBLs do not directly offer credit as in a SCC, successfully completing a CBL improves an individual's access to future credit by improving their credit score. This suggests that the

[2]While we do not explore the role of SCC design as a commitment device to saving, in principle, it may help individuals who struggle to commit to saving in the absence of strong incentives (Laibson, 1997; Karlan, Ratan, and Zinman, 2014; Ericson and Laibson, 2019).

ability to make regular monthly payments provides important information about individuals' creditworthiness,[3] as reflected in the high weight on regular on-time payments in credit scoring algorithms. The benefit of the SCC design is that it can directly link access to credit with a savings period and a monetary penalty rather than the indirect channel through a credit registry, which is important in settings without sophisticated credit scoring systems and limited information sharing. Some aspects of SCC design can also be observed in other applications. For example, more favorable rates in mortgages can be linked to a mandatory savings period, such as in building-and-savings contracts (Bausparvertrag) in Germany that link a long savings period with some cost of default (3-6 months waiting period to receive savings or cancellation penalty) to credit for investment in housing (Scholten, 2000).

Our paper also relates to the literature examining rotating savings and credit associations (RoSCAs), which resemble many features of an SCC.[4] Different from consorcios, RoSCAs rely on social rather than physical capital for enforcement (Besley, Coate, and Loury, 1993). As a result, the literature on RoSCAs primarily focuses on the role of social capital in improving screening and enforcement (e.g., Banerjee, Besley, and Guinnane, 1994; Besley and Coate, 1995; Ghatak and Guinnane, 1999; Morduch, 1999; Anderson, Baland, and Moene, 2009), including cases in which RoSCAs are organized through third-party intermediation (Klonner and Rai, 2007; El-Gamal et al., 2014). In contrast, we highlight the positive selection effect of having a default penalty before obtaining credit in a combined savings-and-credit contract. In fact, defaulting before winning the "pot" in RoSCAs, which is akin to defaulting during the savings period in an SCC, also involves substantial costs. Typically, a defaulted individual cannot win the pot in future allocations, and foregoes all prior payments. The insights from our analysis suggest that the expected cost of default during the savings period could help explain why RoSCAs attract low-risk individuals (Levenson and Besley, 1996) and can charge lower interest rates (Kapoor et al., 2011), similar to what we document for consorcios.

[3]Similarly, cash flow information can be used by lenders to assess borrowers' creditworthiness (Cao, Garcia-Appendini, and Huylebroek, 2024).

[4]Similar products exist under different names in a wide range of countries with some variation in their design (e.g., Tanda in Mexico, Stokvel in South Africa, Ajo in Nigeria, Gamiya in Egypt). Zambrano et al. (2023) provide an excellent recent review.

An important limitation for RoSCAs is their narrower scope, since they rely on social capital in tight-knit local communities. By relying on physical collateral, consorcios allow for vastly greater scale. The downside is that enforcement in consorcios requires physical collateral and its efficient seizure and liquidation, which makes it unsuitable in contexts where financing is required for non-durable assets and consumption goods or where seizing collateral is difficult.

Recent developments in fintech have significantly increased lenders' ability to access new types of information to reduce information frictions and expand access to credit (Berg et al., 2019; Berg, Fuster, and Puri, 2022; Fuster et al., 2022). In addition, services such as pay-as-you-go (PAYgo) have become a popular technology in low-income countries that allows the lender to suspend the flow benefits of collateral remotely in case of missed payments (Gertler, Green, and Wolfram, 2024). This can improve enforcement of contracts and facilitate the spread of innovation in contract design that relies on physical collateral to enforce contracts. Thus, technological innovation and innovation in contract design, such as SCCs, are not mutually exclusive approaches to resolve frictions in credit markets, but can be complimentary to expand access to credit and increase borrower welfare. Innovation in contract design provides additional advantages. Unlike backward-looking measures, such as credit scores, which are based on historical data, borrowers' private information is forward-looking and may account for structural changes ignored by predictive models. Incorporating this information can also help avoid perpetuating inequalities by allowing borrowers with low or no credit scores to gain access to credit at fair prices based on their positive, forward-looking private information.

As we show in the model, signaling through SCCs is most valuable when borrowers face higher real interest rates, when they have a higher discount rate or when there is more unobservable information. This is likely to apply to financial markets in mid-income and developing countries or to low-income households without formal income or credit history more generally. An active debate in the literature seeks to understand how to improve credit allocation in such environments, and to expand access to finance while also maximizing returns to credit (Karlan and Zinman, 2011; Attanasio et al., 2015; Augsburg et al., 2015;

Banerjee et al., 2015; Crepon et al., 2015; Tarozzi, Desai, and Johnson, 2015; Banerjee et al., 2021; Meager, 2019, 2022; Gertler, Green, and Wolfram, 2024; Bari et al., 2024). While we focus on the signaling and screening features of SCCs in this paper, Doornik et al. (2024) provide evidence that recipients of credit in consorcios also generate high returns on the credit they receive, which suggests that SCC design can succeed at allocating credit to individuals with profitable investment opportunities.

2 Model

This section develops a parsimonious model to describe Savings-and-Credit contracts (SCC), demonstrating how they can outperform standard loan contracts under asymmetric information, creating advantageous selection in terms of borrowers' default risk.

Set-up The model has three periods $t = 0$, $t = 1$, and $t = 2$. Agents (borrowers) intend to invest in an asset and require credit financing.

We assume that agents may obtain financing to purchase the asset from a competitive credit market with risk-neutral lenders. For simplicity, we set the opportunity cost of lenders to zero, which implies that their discount rate is one. Agents are also risk-neutral but impatient, with a discount factor $\delta < 1$. They maximize their expected utility $E\left[\sum_{t=0}^{2} \delta^t c_t\right]$, where c_t represents consumption in period t. Because agents have a lower discount rate than lenders, value is created by borrowing as much as possible, and saving is costly.

We allow for two types of contracts: Agents can finance the asset purchase with an SCC or spot secured loan. The timeline with the SCC design is shown in Figure 1. Unlike traditional spot loans, where borrowers make a down payment to get credit immediately, the SCC design requires borrowers to pre-plan for future credit, including a preliminary saving period. At time 0, the borrower contracts with a lender for a future loan provided at time $t = 1$ and agrees to make down payments at times $t = 0$ and $t = 1$. If the borrower is not hit with a liquidity shock and makes both down payments, the loan is provided, and the asset is purchased. At time $t = 2$, the borrower repays the loan. If the first down payment is made but the borrower is hit with a liquidity shock and cannot make the second down payment, they default and the initial down payment is refunded minus a penalty.

Agents are endowed with wealth $w > 0$ in period $t = 0$, and receive an income stream y_t in periods $t = 1$ and 2. The value of the asset to the agent is v (at time $t = 2$), and the cost of the asset is I (at time $t = 1$), where $v > I$. To incentivize the borrower to repay the loan during period $t = 2$, lenders can seize the collateralized asset if they do not receive the loan payment. The value of the collateral to the lender is worth $\vartheta < I$, a fraction of the asset's cost.

Debt defaults in our model are triggered by liquidity shocks that make debt payments unaffordable to debtors (Aydin, 2024). We assume that agents have private information regarding the likelihood of liquidity shocks not fully captured by credit scores or observable metrics. A key model assumption is that agents' private information regarding liquidity shocks during the saving period positively correlates with liquidity shocks during the credit period.

Formally, we assume that agents can be of two "types" –the simpler case that allows us to obtain the main insights from the adverse selection model. Agents privately learn their type $\theta \in \Theta := \{\theta_l, \theta_h\}$, where $\theta_h > \theta_l$, at the beginning of period $t = 0$. We denote by θ_h the high-type (or good, safe type) agent and by θ_l the low-type (or bad, risky type) agent. The liquidity shock process has the following distribution: an agent of type $\theta \in \Theta$ suffers a liquidity shock during the saving period $t = 1$ with probability $1 - \theta$ and defaults, and conditional on not suffering a liquidity shock during the saving period, suffers a liquidity shock during the credit period $t = 2$ with probability $1 - \theta$. Therefore, a low (high) probability of experiencing a liquidity shock during the saving period corresponds to a low (high) probability of experiencing such a shock during the credit period.

Savings-and-Credit Contracts (SCC): Under an SCC contract, the borrower agrees to make a stream of payments (s, d, p) to the lender. Specifically, the borrower makes an additional initial deposit s in period $t = 0$, the savings period, and agrees to make a further down payment d in period $t = 1$ to receive a secured loan I. If the borrower fails to make the second down payment, they forfeit a fraction $\tau \leq 1$ of the deposit s and does not receive the loan. The secured loan, as specified above, is such that the agent keeps the asset conditional on making the payment p in period $t = 2$, or if the payment is not made, the lender seizes the asset. We denote such an SCC by $x = (s, d, p|\tau)$, and let $\mathcal{C}$ be the set of all such contracts.

Spot Secured Loans: Under the standard loan contract, the borrower makes down payment d at time $t = 1$, and the lender provides $I - d$ to purchase the asset. Agents promise to pay p in the next period, in which case they enjoy the value of the asset v, or if the payment is not made, the lender seizes the asset, in which case the borrower gets 0 and the lenders get the collateral worth ϑ. We denote a loan contract as $x = (d, p)$ and let $\mathcal{L}$ be the set of all such loan contracts.

Value Functions The time-0 expected utility of contract $x = (s, d, p|\tau)$ to a type θ agent is $U_\theta(x)$ given by,

$$U_\theta (s, d, p|\tau) := \theta\delta (\theta\delta (v - p) - d) + (1 - \theta) \delta (1 - \tau) s - s. \tag{1}$$

The expected utility takes into account that the agent will only get the loan and make the down payment d if she remains employed in period $t = 1$ and that she forfeits a fraction τ of the deposit s in case she becomes unemployed. At $t = 0$, the agent pays s, and the $t = 1$ cash flows, discounted by δ, are either $-d$ if the agent is able to make the down payment, which occurs with probability θ, or is $(1 - \tau) s$, since the agent forfeits τs if she receives a bad shock with probability $1 - \theta$. In period $t = 2$, the agent enjoys the value v of the asset and makes a payment of p with probability θ^2 and discounted by δ^2.

The lenders' expected profit associated with offering contract $x = (s, d, p|\tau)$ to a type θ

agent is $\Pi_\theta(x)$ given by,

$$\Pi_\theta(s,d,p|\tau) := \theta(\theta p + (1-\theta)\vartheta - (I-d)) - (1-\theta)(1-\tau)s + s. \tag{2}$$

At $t=0$, the lender receives the deposit s, and the $t=1$ cash flows are $-(I-d)$ if the agent receives a positive shock because the lender finances the asset costing I after receiving the down payment d or is $-(1-\tau)s$ if the agent receives a bad shock and the lender returns a fraction $(1-\tau)$ of the savings s to the agent. Conditional on providing the loan, the $t=2$ cash flows are either p if the agent receives a positive shock or ϑ after seizing the collateral.

Note that the set of spot loan contracts is a subset of the SCC contracts by making the early down payment equal to zero, thus $\mathcal{L} \subset \mathcal{C}$. Therefore, expected utility and profits associated with a loan $x=(d,p)$ to a type θ agent can be simply denoted as

$$U_\theta(d,p) \equiv U_\theta(0,d,p|\tau) \text{ and } \Pi_\theta(d,p) \equiv \Pi_\theta(0,d,p|\tau). \tag{3}$$

To focus on interesting cases, we impose simplifying assumptions on the model parameters.[5] We abstract from moral hazard by adding a cap $\bar{p}$ on the maximum loan payment p which ensures that borrowers' incentive constraint is satisfied (see discussion in the Appendix based on Tirole (2010)). Thus, we only allow loans $x=(d,p)$ and contracts $x=(s,d,p|\tau)$ satisfying:

$$p \le \bar{p} \tag{A1}$$

Furthermore, agents need to borrow to purchase the asset because the cost of the asset is higher than their income, $I > w + y_1$, and that they earn high enough income in period $t=2$ to repay the loan, thus $y_2 > \bar{p}$:

$$w + y_1 < I \text{ and } y_2 > \bar{p} \tag{A2}$$

[5]We also abstract from some consorcio-specific features, such as that consorcios as self-financing and the timing of credit is random (see Section 3). In our model credit is provided by a lender and the timing of issuing credit is pre-determined. While these features could be incorporated in the model, they would add complexity without generating additional insights.

Formally, the set of feasible SCC contracts belongs to the set

$$\mathcal{C} = \{(s, d, p|\tau) : 0 \leq s \leq w,\ d \geq 0,\ p \leq \bar{p},\ \text{and } 0 \leq \tau \leq 1\},$$

and the set of feasible loans is $\mathcal{L} = \{(d, p) : d \geq 0 \text{ and } p \leq \bar{p}\}$.

Finally, we assume that agents are liquidity-constrained such that their wealth w at $t = 0$ is such that they cannot afford the minimum down payment d in period $t = 0$. Moreover, their income y_1 is high enough that they can afford the down payment, and borrowing can take place in period $t = 1$:

$$w < \bar{w} \text{ and } y_1 > \bar{y} \tag{A3}$$

where the bounds $\bar{w}$ and $\bar{y}$ are specified below.

2.1 Full Information Case: Benchmark

We first analyze the benchmark case where the agent's type θ is common knowledge, and there is no adverse selection. We show that the optimal contract in the full information case is a spot loan contract. Intuitively, agents have a lower discount rate δ than lenders and, therefore, want to borrow as much as possible, and saving is inefficient. Thus, the SCC design, which mandates early down payments, is not optimal under full information whenever borrowers can afford the down payment without saving.

The optimal contract maximizes the agent's utility subject to the lender breaking even:

$$\begin{aligned} \bar{U}_\theta = \underset{x=(s,d,p,\tau)\in\mathcal{C}}{\text{maximize}}\ & U_\theta(x) \\ \text{subject to }\ & \Pi_\theta(x) \geq 0 \end{aligned}$$

We show in the Appendix that the unique solution of the full information problem above is a spot loan, where the agents do not save $s = 0$ and make the minimum possible down payment $\underline{d}_\theta := I - (\theta\bar{p} + (1-\theta)\vartheta)$, and the maximum possible future loan payment $p = \bar{p}$. Note that without asymmetric information, the high-type down payment is smaller than the low-type down payment, i.e., $\underline{d}_{\theta_h} < \underline{d}_{\theta_l}$.

The asset financing with the loan $x = (\underline{d}_\theta, \bar{p})$ generates zero profit to lenders, and utility $\bar{U}_\theta = U_\theta(\underline{d}_\theta, \bar{p})$ to borrowers satisfying $\bar{U}_{\theta_h} > \bar{U}_{\theta_l}$. To simplify the analysis and focus on interesting cases, we assume that the low-type's participation constraint for spot loans is always satisfied:

$$\bar{U}_{\theta_l} = U_{\theta_l}\left(\underline{d}_{\theta_l}, \bar{p}\right) > 0 \tag{A4}$$

Therefore, without adverse selection, both borrowers optimally finance the asset purchase in period $t = 1$ with a spot loan $x = (\underline{d}_\theta, \bar{p})$.

2.2 Equilibrium Concept under Asymmetric Information

We apply the revelation principle to analyze the optimal contracting problem under asymmetric information. The key insight of the revelation principle is that it is sufficient to consider a single contract for each type, ensuring that each type has an incentive to select the contract designated for them.

Consider the following definition of equilibrium under asymmetric information.

Definition 1 *Given a feasible contract set $\mathcal{X}$ and the private types $\Theta = \{\theta_l, \theta_h\}$ then:*
(Separating competitive equilibrium) A competitive separating equilibrium $x = (x_\theta)_{\theta\in\Theta}$ is a choice $x_\theta \in \mathcal{X}$ for all $\theta \in \Theta$ such that $x_{\theta_h} \neq x_{\theta_l}$ and:
(i) $U_\theta(x_\theta) \geq U_\theta(x_{\theta'})$ for all $\theta, \theta' \in \Theta$ (the incentive compatibility condition- IC) and;
(ii) $\Pi_\theta(x_\theta) \geq 0$ for all $\theta \in \Theta$ (the individual rationality condition- IR).
(Pareto ranking) A separating equilibrium $x = (x_\theta)_{\theta\in\Theta}$ Pareto dominates another separating equilibrium $x' = (x'_\theta)_{\theta\in\Theta}$ if $U_\theta(x_\theta) \geq U_\theta(x'_\theta)$, for all $\theta \in \Theta$, with strict inequality holding for at least one type. A separating equilibrium is Pareto dominant if it Pareto dominates all other separating equilibrium.

The equilibrium entails credit policies that are informationally consistent (or separating) given the set of feasible credit policies or contracts. The competitive separating equilibrium solution entails offering a set of contracts so that each type self-selects into a contract designed for them, and the lender breaks even. The Pareto-dominant separating equilibrium is the one that dominates all the other separating equilibrium.

2.3 Equilibrium with Spot Loan Contracts

We first study the equilibrium with asymmetric information when only spot loan contracts are feasible, that is $\mathcal{X} = \mathcal{L}$.

Asymmetric information creates a distortion because the unverifiability of types implies that high-type borrowers can no longer be offered a loan with a lower down payment than low-type borrowers, as would be possible in a full information scenario. If this were not the case, low-type borrowers would mimic high-type borrowers, leading to losses for lenders. We characterize the Pareto-dominant separating equilibrium below.

Proposition 1 *(Standard credit market separating equilibrium) Consider a credit market in which only spot-secured loans are allowed, $\mathcal{X} = \mathcal{L}$, and Assumptions A1-A4 hold. Then the Pareto dominating competitive separating equilibrium is the equilibrium where the low-type chooses loan $x = (d_l^*, p_l^*)$, where $p_l^* = \bar{p}$ and $d_l^* = I - (\theta_l \bar{p} + (1 - \theta_l)\vartheta)$, and the high-type chooses loan $x = (d_h^*, p_h^*)$, where*

$$d_h^* = d_l^* + \frac{\theta_l \delta (p_l^* - \vartheta)(\theta_h - \theta_l)}{\theta_h - \delta\theta_l} \text{ and } p_h^* = p_l^* - \frac{(p_l^* - \vartheta)(\theta_h - \theta_l)}{\theta_h - \delta\theta_l}. \tag{4}$$

In equilibrium, the higher type borrowers make a higher down payment (or lower LTV) and receive lower interest rates than lower types.

In this standard equilibrium, the low-type obtains her full information value, and the high-type makes higher down payments (lower LTV), and, in exchange, a lower interest rate than the low-type. There are many separating equilibria, but the Pareto dominant one is given uniquely by the expressions above.

The marginal rate of substitution (MRS) is the rate at which a borrower is willing to increase the down payment in exchange for decreasing loan payments while maintaining the same level of utility. The marginal rate of substitution is formally

$$MRS_{d,p}^{\theta} = -\frac{\partial U_{\theta}(x)}{\partial d} / \frac{\partial U_{\theta}(x)}{\partial p} = -\frac{1}{\theta\delta},$$

which is the slope of the indifference utility curve of type θ in the loan payment/down payment space. When the single-crossing-property holds, the marginal rate of substitution is increasing in the type θ. Indeed, the derivative with respect to type of the $MRS_{d,p}^{\theta}$ is increasing, so higher types have flatter indifference curves.[6]

A separating equilibrium exists because the single-crossing property holds. The indifference utility curves of the high- and low-type crosses only once, and whenever they intersect, the slope of the indifference line of the low-risk type is steeper than the slope of the high-risk type.

2.4 Equilibrium with Savings-and-Credit Contracts

We now characterize the unique Pareto dominating separating equilibrium when lenders can offer long-term contracts with costly savings features, and the set of feasible contracts is expanded to $\mathcal{X} = \mathcal{C} \supset \mathcal{L}$.

We show below that the Pareto-dominant separating equilibrium is obtained from solving the following maximization problem:

$$\begin{aligned} \underset{x=(s,d,p,\tau)\in\mathcal{C}}{\text{maximize}} \quad & U_{\theta_h}(x) \\ \text{subject to} \quad & U_{\theta_l}(x) \leq \bar{U}_{\theta_l} \text{ (IC)} \\ & \Pi_{\theta_h}(x) \geq 0 \text{ (IR)} \end{aligned}$$

The single-crossing-property also holds in the contracting space $x = (s, d, p|\tau)$. The marginal

[6] The derivative with respect to type of the $MRS_{d,p}^{\theta}$ is increasing: $\frac{\partial MRS_{d,p}^{\theta}}{\partial \theta} = \frac{1}{\theta^2\delta} > 0$.

rate of substitution between deposits s and down payments d or loan payments p, defined as

$$MRS_{s,d}^{\theta} = -\frac{\partial U_{\theta}(x)}{\partial s} / \frac{\partial U_{\theta}(x)}{\partial d} \text{ and } MRS_{s,p}^{\theta} = -\frac{\partial U_{\theta}(x)}{\partial s} / \frac{\partial U_{\theta}(x)}{\partial p},$$

are both increasing in the type θ. This property ensures that a separating equilibrium exists with SCC contracts, as shown below (see the proof of Proposition 2).

The optimal solution is such that the high-type agent saves as much as possible in period $t = 0$ and chooses a contract with maximum penalty. Both the lender's profit and the low-type utility are binding in the optimal solution, and the low-type chooses the same spot loan contract as in the full information case, which yields utility $\bar{U}_{\theta_l}$.

Proposition 2 *(Separating equilibrium with Savings-and-Credit contracts) Consider a credit market where costly savings contracts are allowed, $\mathcal{X} = \mathcal{C}$, and Assumptions A1-A4 hold. Then there exists a Pareto dominating competitive separating equilibrium where the low-type θ_l chooses the spot loan $x = (d_l^*, p_l^*)$, and the high-type chooses the costly saving contract $x = (w, d_h^{**}, d_h^{**}|1)$ with maximum penalty $\tau = 1$ and save all his wealth, $s = w$, and down payments and payments are:*

$$d_h^{**} = d_h^* - \left(\frac{\theta_h + \delta\theta_l}{\delta\theta_l\theta_h}\right) w \text{ and } p_h^{**} = p_h^* + \left(\frac{1}{\delta\theta_l\theta_h}\right) w, \tag{5}$$

where d_h^* and p_h^*, given by (4), are the high-type choices with spot loans.

The high-type obtains a loan with higher LTV with SCC contracting than with standard loans (and the low-type is unchanged). The equilibrium loan payment p_h^{**} is greater than p_h^*, which implies higher loan amounts $\theta_h p_h^{**} > \theta_h p_h^*$. The equilibrium down payments are in aggregate $w + d_h^{**}$, which is less than d_h^*, and the aggregate down payment is decreasing with savings $s = w$, while the loan payment p_h^{**} is increasing.

The new informative signal, the early down payment, is the key feature that makes costly savings contracts more effective than spot loans to screen out agents. This new signal provides lenders a new instrument to screen borrowers less costly, leading to more access to credit. Intuitively, a savings period exposes the agent to an additional period in which (costly) default can occur, which is more costly for the low-type agent in expectation. Importantly, this signal is relevant to lenders because it informs them of defaults during the credit period due to the positive correlation between liquidity shocks in the saving and credit period.

In standard loan arrangements, borrowers independently save for the down payment, especially when they are liquidity constrained, and can withdraw if they encounter an adverse income shock before making the down payment, thereby disregarding important information about borrower risk. Conversely, with a mandatory savings period, borrowers must commit funds earlier and forfeit a portion if an income shock occurs before securing the loan. While this requirement applies to all borrowers, good type borrowers incur lower marginal costs due to their reduced likelihood of defaulting during both the saving and credit periods.

Overall there is also an improvement in welfare when costly savings contracts are allowed.[7]

Corollary 1 *The high-type welfare with costly savings,* $U_{\theta_h}\left(w, d_h^{**}, p_h^{**}|1\right)$, *is higher than the high-type welfare in a standard credit market with spot loans,* $U_{\theta_h}\left(d_h^{*}, p_h^{*}\right)$. *The welfare gain for the high-type* $\Delta U_h = U_{\theta_h}\left(w, d_h^{**}, p_h^{**}|1\right) - U_{\theta_h}\left(d_h^{*}, p_h^{*}\right)$ *is*

$$\Delta U_h = w\frac{1}{\theta_l}\left(1-\delta\right)\left(\theta_h - \theta_l\right) > 0.$$

The high-type welfare increases with the introduction of the new contracts. The welfare gain is increasing in the spread, $\theta_h - \theta_l$, the level of agents' impatience, $1-\delta$, and the amount they can save w. These conditions are more likely to occur in underdeveloped financial markets in developing countries where low-income households only have informal

[7] Our welfare analysis relies on the assumptions that borrowers are risk-neutral and rational with time-consistent preferences. With risk aversion, borrowers are inclined to choose lower penalties, while time-inconsistent present-bias preferences may lead them to favor higher withdrawal penalties to encourage saving. Exploring how these changes in assumptions affect borrowers' welfare in a setting with adverse selection is a valuable direction for future research.

income and no credit history.

Regulatory Constraints In some settings there may be legal or regulatory constraints on the maximum penalty allowed. Let the set of allowed contracts be

$$\mathcal{X} = \mathcal{C}_{\hat{\tau}} = \{(s, d, p|\tau) \in \mathcal{C} : \tau \leq \hat{\tau}\}.$$

We show below that when penalty constraints are imposed, the optimal separating contract uses the maximum allowed penalty. However, the welfare gains of using costly savings contracts are reduced with penalty restrictions since it is less costly for the low type to imitate the actions of the high type. Recall that due to the lower discount factor of agents relative to the lending, saving has a negative effect on welfare. Thus, there is always a trade-off between gains from savings due to their signaling property and inefficiencies from saving because of agents' impatience.

Proposition 3 *(Constrained costly savings equilibrium) Consider a credit market with costly savings contracts constrained by the maximum penalty $\hat{\tau}$, i.e., $\mathcal{X} = \mathcal{C}_{\hat{\tau}}$. The Pareto dominating competitive separating equilibrium is as follows: the high-type chooses the costly saving contract $x = (w, \hat{d}_h, \hat{p}_h|\hat{\tau})$, with maximum penalty $\hat{\tau}$ and savings $s = w$, and down payments and loan payments given by (6); and the low-type chooses the spot loan $x = (d_l^*, p_l^*)$, whenever $\hat{\tau} \geq 1 - \frac{(\theta_h - \delta\theta_l)}{\delta\theta_h}$.*
The utility gain for the high-type $\Delta\hat{U} = U_{\theta_h}\left(w, \hat{d}_h, \hat{p}_h|\hat{\tau}\right) - U_{\theta_h}(d_h^*, p_h^*)$ is smaller than in the unconstrained case:

$$\Delta\hat{U}_h = \Delta U_h \left(1 - \frac{\delta\theta_h}{(\theta_h - \delta\theta_l)}(1 - \hat{\tau})\right) < \Delta U_h,$$

where ΔU_h is the welfare gain in the unconstrained case.

The equilibrium down payments and payments with lower penalties are given by

$$\begin{aligned} \hat{d}_h &= d_h^{**} + w\left(1-\hat{\tau}\right)\left(\frac{\theta_h - \delta\theta_l + (\delta-1)\theta_l\theta_h}{\theta_l\theta_h\left(\theta_h - \delta\theta_l\right)}\right) \text{ and} \\ \hat{p}_h &= p_h^{**} - w\left(1-\hat{\tau}\right)\left(\frac{\left(\theta_h - \theta_l\right)}{\theta_l\theta_h\left(\theta_h - \delta\theta_l\right)}\right). \end{aligned} \tag{6}$$

Note that when the penalty $\hat{\tau}$ decreases, then the down payment $\hat{d}_h$ increases, and the loan payment $\hat{p}_h$ decreases. With a lower penalty, it is less costly for the low-type to save to imitate the high-type. To reduce the incentives to mimic, the down payment has to be increased, and the loan payment decreased, which worsens the high-type welfare.

Decreasing the penalty improves the utility of low-types by more than high-types, and thus saving-and-credit contracts become a less efficient way to separate high and low-types because

$$-\frac{\partial U_{\theta_l}\left(s,d,p|\tau\right)}{\partial\tau} = \delta s\left(1-\theta_l\right) > \delta s\left(1-\theta_h\right) = -\frac{\partial U_{\theta_h}\left(s,d,p|\tau\right)}{\partial\tau}.$$

Consequently, an exogenous constraint on the penalty worsens the pool of borrowers choosing SCCs.

3 Empirical Evidence

To provide empirical support for the model's predictions we explore a credit contract in Brazil – Consorcio – that exhibits features of an SCC.

3.1 Consumer Lending and Consorcios in Brazil

First, we provide a brief overview of consumer lending in Brazil and a more detailed description of consorcio contracts.

Consumer Lending in Brazil In 2019, 17 percent of the working age population (17-64) in Brazil had no checking account with a bank and 55 percent had no active credit report with a loan balance greater than 200 BRL (40 USD). The mean interest rate for car loans was around 24 percent. For marginal borrowers, the rate is substantially higher.

While there is no centralized credit scoring system such as FICO score in the U.S., banks have access to information about individuals' current and past credit information from the Central Bank, which they can use for internal credit scoring models. Due to features of the Brazilian economy and labor market, information about borrowers is often incomplete. A large fraction of Brazilian businesses operate in the informal sector and 28.5 percent of workers are employed informally (Doornik, Schoenherr, and Skrastins, 2023). This prevents individuals from providing hard information on their employment and income. As a result, information asymmetry is a major obstacle in consumer lending markets in Brazil.

Consorcios Consorcios are a financial product in which participants pool funds to save towards the purchase of durable goods. Groups are typically administered by the finance division of a manufacturer, who provides the good towards which individuals save, a bank, or a specialty finance company. The administrator is in charge of marketing the consorcio, selecting applicants, managing payments, organizing the allocation of credit, and enforcing contracts. The administrator is compensated for these services through an administrative fee levied on all participants. Active screening of applicants is virtually non-existent. In practice, anyone with a social security number in Brazil can sign up for a consorcio group.

Prospective participants are provided with several pieces of information when considering to sign up for a group. They know the identity of the administrator, the price of the good, the number of months for which the group is set to operate, and a target number of participants. Once the group is formed, all participants contribute identical pre-determined payments at regular intervals, typically monthly. The payments are adjusted for inflation and changes in the price of the underlying good. In addition, monthly payments cover the administrative fee and establish a guarantee fund that covers losses resulting from defaults of individual participants. In most groups a fraction of the payments is used to insure the good against damage to preserve its value as collateral. All participants are required to continue their monthly contributions even after receiving credit from the group. Eventually, every participant that does not default during the savings period receives credit. Due to the organization of the group through a central and independent administrator and enforcement through physical collateral, personal relations between consorcio participants are uncommon and participants of the same group are not known to each other.

Credit Allocation All participants in a consorcio group start out as savers making equal monthly contributions to the group. Every month some participants receive credit from the group which they are required to repay through their monthly contributions. The decision which members receive credit in a given month is based on two mechanisms: lotteries and auctions. The relative number of allocations by lottery and auctions varies by group. By law, each period at least one good has to be allocated through a lottery.

Lotteries are based on the outcome of the national lottery (Loteria Federal), which is broadcast on TV. Each participant receives a ticket number at the start of the group. Based on an algorithm, which is known to all participants, the national lottery number is translated into a ticket number and the participant holding the respective ticket number is declared the winner of the lottery. Algorithms are designed such that at the beginning of the group each participant has the same unconditional probability of winning the lottery at any point in time over the duration of the group.

In credit auctions, participants bid a fraction of the total value of the good. Rather than constituting an additional payment, bids are equivalent to a higher down payment, and future contributions are adjusted accordingly. For example, if the value of a good is $5,000 with monthly contributions of $100 and a participant bids 40 percent, they would pay $2,000 immediately and would cease monthly payments 20 months early. In some groups, auctions are designed differently. For example, some auctions are capped such that bids may not exceed a fraction x of the total payments, and if several participants bid the same value, the algorithm related to the lottery determines the auction winner among the participants that bid the capped value.

Default After an individual obtains credit, the good is purchased. The good serves as physical collateral and can be seized if payments are late.[8] Participants are not allowed to sell the good to somebody else without the administrator's approval, to ensure that the good is not transferred to somebody that is a high credit risk to the group.

If a participant defaults before receiving credit, her past payments are retained by the group until they win a lottery. When a previously defaulted participant is declared the winner of a lottery, her funds are released and paid to her instead of obtaining credit to purchase the good. However, the defaulted participant receives only a fraction of her previous payments since default carries a contractually specified penalty of on average about 25 percent of the payments. Before February 2009, participants who default before receiving credit had to wait until the end of the group to have their payments minus the penalty returned.

Due to this contractual design, defaults of participants before receiving credit do not affect the required payments of other participants. However, defaults after receiving credit impose costs to the group if the liquidation value of the good is not sufficient to recover the full amount of credit that is owed to the group. This is more likely if the outstanding credit is higher, which applies to participants that default soon after receiving credit and for participants that obtained credit early in the group. The resulting losses are first covered by the guarantee fund, which is designed to be sufficiently generous to prevent a collapse of the group. If losses exceed the capacity of the guarantee fund, participants absorb the losses through higher contributions. In practice, losses from defaults virtually never exceed the capacity of the guarantee fund. At the termination date of the group, any remaining funds in the reserve fund are split equally and repaid to the participants.

[8]A supporting feature sustaining consorcio groups in Brazil is the ease and speed of recovery of physical collateral in Brazil that enables administrators to recover those quickly upon default.

Aggregate Statistics Consorcios are common in Brazil. In 2015, consorcios had 9,908,527 participants, about a third of them in groups that finance cars, which we analyze in this paper. The 3,681,235 participants in those groups are equivalent to 2.4 percent of the working age population or 7.4 percent of formally employed individuals in Brazil. 370,095 individuals, or 0.24 percent of the working age population obtained a car through a consorcio group in 2015 alone. These sales amount to about a quarter of all car sales on credit in Brazil in 2015.

The average car value across all groups is BRL 29,414 (about USD 10,000). Average monthly payments amount to about 1.8 percent of the value of the car and also cover administrative fees (11 percent of the monthly payment), and a guarantee fund (0.03 percent of the monthly payment). The average duration of a consorcio group is 68.2 months and the mean number of participants is 340 (median is 245), where the average group comprises participants from 125 different municipalities in 17 different states (out of 27). On average, less than two participants in a group are from the same municipality. The share of cars allocated through lotteries is 40 percent with the rest allocated through auctions.

24.17 percent of participants default during the savings period. An additional 6.6 percent of participants default after receiving credit, in which case the car is seized by the administrator and liquidated. If the liquidation value of the car is higher than the outstanding payments, the defaulted participant keeps the difference.

3.2 Data

The data for this paper comes from three main sources. Data on consorcios is from the Sistema de Administracao de Grupos/Cotas de Consorcio (SAG) database, which is maintained by the Banco Central do Brasil (BCB). Information on bank loans is derived from SCR (Sistema de Informações de Crédito do Banco Central), a restricted-access credit registry managed by the Central Bank of Brazil (BCB). Finally, information on labor markets outcomes is available through RAIS (Relação Anual de Informações Sociais), an employer-employee matched database that includes employment information and wages for all formally employed workers in Brazil.

The database on consorcios provides information on the administrator, all participants, the good that is being allocated, and the dates when credit is awarded to participants. The bank loan credit registry (SCR) provides information on loan characteristics (e.g., outstanding value, interest rate, issue date, maturity), issuing bank, location of the loan among other things. Our primary focus is on loans issued and consorcio groups started between 2008-02 and 2010-02, centered two years around the reform that changed the cost of defaulting in the savings period for consorcios (see Section 3.3).

The consorcio and bank credit registry databases provide the social security number of all individuals. This allows us to match them to the RAIS database. The RAIS database records information on all formally employed workers in a given year and is maintained by the Ministry of Labor and Employment of Brazil. All formally-registered firms in Brazil are legally required to report annual information on each worker that the firm employs. RAIS includes detailed information on the employer (tax number, sector of activity, establishment size, geographical location), the employee (social security number, age, gender, education), and the employment relationship (wage, tenure, type of employment, hiring date, layoff date, reason for layoff, etc.). By the end of 2015, the database covers about 50 million formal employees.

3.3 Empirical Analysis

In this section, we describe the analysis to provide empirical support for the predictions of the model.

Borrower Characterisitics Our model would predict that consorcios achieve a positive selection of borrowers on unobservables. This implies that while consorcio participants may look worse in terms of observable, we should see better performance of credit contracts allocated to consorcio participants than for bank loans *conditional* on controlling for observable characteristics.[9]

To assess whether the data support this prediction, we start by comparing observable characteristics for consorcio participants as well as bank borrowers that take out a car loan. Descriptive statistics on borrowers are reported in Panel A of Table 1. Overall, consorcio participants mostly exhibit characteristics commonly associated with riskier borrowers relative to bank borrowers. Specifically, consorcio participants are 17 percentage points less likely to be formally employed than bank borrowers, are 2.8 percentage points more likely to be currently be in default on an existing bank loan, and 2.4 percentage points more likely to have defaulted on a bank loan in the past five years.

Panel B compares contract characteristics of consorcio participants and bank borrowers. Consorcio participants tend to finance somewhat more expensive cars than bank loans (BRL 29,414 vs. BRL 23,144, respectively), whereas the average credit amount extended to borrowers is smaller for consorcio participants (BRL 12,535 vs. BRL 17,658). Consequently, consorcios exhibit a significantly lower LTV of about 0.4 compared with 0.8 for banks. The average maturity is shorter for consorcios with 38 months and compared with 43 months for bank loans. The implied interest rate of 16% in consorcios is lower than the average interest rate for bank loans, where the average rate is 24%. About 24% of all consorcio participants default during the savings period. The high default rate during the savings period is due to the fact that in the data there are individuals that are excluded from the regular loan market and therefore consorcios are the only option for them to access credit. This is not a feature of our model where all agents can choose between both contracts and only high types choose the consorcio. Despite these potentially lower type borrowers participating in consorcios as well, the realized default rate conditional on obtaining credit is lower for consorcios with 6.6% relative to 9.0% for bank borrowers.[10]

[9] In our model, both types of contracts (SCC and loans) are in principle available to all borrowers. In the data, there may well be individuals that do not have access to bank loans as a result of their observable risk type, whereas consorcios by design do not preclude any individual from participating.

[10] The lower default rate conditional on obtaining credit highlights the additional dynamic screening feature of mandating a (long) savings period to further improve the pool of borrowers conditional on selection into the SCC.

To control for contract characteristics, we complement the descriptive evidence in Table 1 by estimating

$$y_i = \alpha_{mt} + \delta \cdot Consorcio_i + \epsilon_{it}, \tag{7}$$

where y_i is the characteristic of the respective borrower for each contract i issued at time t. The dummy variable $Consorcio_i$ takes the value of one for contracts that are issued by a consorcio and zero for bank loans. We compare borrowers of bank and consorcio contracts signed within the same municipality and the same month by adding municipality-time fixed effects (α_{mt}).

The results are reported in Table 2. In column I, we find that consorcio participants are 17 percentage points less likely to be formally employed. To ensure that these differences are explained by the fact that different borrowers take out contracts with different characteristics, we refine the test to compare consorcio and bank borrowers taking out similar loans. The magnitude of the difference in formal employment rates is similar after controlling for contract characteristics, such as total credit amount, maturity, LTV deciles, and comparing loans for cars of similar value in columns II to IV. Controlling for the same contract characteristics, we find that consorcio participants are 1.9 percentage points more likely to be currently in default on a bank loan and 1.3 percentage points more likely to have defaulted on a bank loan in the past five years in columns V and VI, respectively. In addition, we find that controlling for differences in contract characteristics, consorcio participants have an about 12.4 percent worse credit score.

Altogether, the evidence in Tables 1 and 2 suggests that consorcio participants look riskier based on observable characteristics compared with bank borrowers even after controlling for contract characteristics.

Realized Default Rates The model's first empirical prediction is that the design of SCCs elicits positive selection into the contract, since low-quality borrowers are deterred by the higher expected default cost they are subjected to during the savings period. In addition, dynamic screening during the savings period further improves the pool of borrowers, as low-quality borrowers are more likely to be hit by adverse shocks during the savings period and thereby excluded them from accessing credit. As a result, we should observe in the data that, *conditional on observable characteristics*, SCCs generate lower realized default rates relative to standard bank loans.

To the analysis, in Figure 2, we estimate the predicted probability of default based on labor market and credit market information. Since there is no standardized formal credit score system in Brazil, like FICO in the US, we estimate our own risk model that predicts the probability of default over the next 12 months:

$$Default_{it,t+12} \quad = \quad \alpha + \beta \cdot X_{it} + \epsilon_{it}, \tag{8}$$

where $Default_{it,t+12}$ is a dummy variable that takes the value of 1 if individual i defaults on payments within the next twelve months, X_{it} is a vector of borrower characteristics: gender, age, employment characteristics (status, income, tenure), and credit market characteristics (repayment history over the past five years, whether an individual is banked). Specifically, to predict default risk in month t, we estimate the model based on a random sample of 50,000 contracts from $t-12$ to $t-1$. This ensures that we use past information in predicting future performance to avoid a look-ahead bias. Finally, we split the predicted default risk measure into 100 equally spaced bins.

Consistent with the descriptive statistics, the distribution of expected default rates for consorcio participants (orange solid line) is shifted to the right, i.e., predicted default rates are higher, than for bank borrowers (blue solid line). In contrast, plots of realized default rates on credit for consorcio participants and bank borrowers show lower realized default rates for consorcio participants. Specifically, realized default rates of consorcio participants (green dashed line) are 2.4 percentage points lower than for bank borrowers (yellow dashed line). In particular, default rates for consorcio participants are lower for a given predicted default rate, except for the lowest predicted default rates. This is consistent with positive selection in consorcios conditional on observable characteristics. That is, for the same observable risk characteristics, consorcio participants are, in fact, safer borrowers. In addition, the flatter slope of realized default rates for consorcio participants relative to bank borrowers suggests that observable risk is less informative about realized default rates in consorcios, consistent with the SCC design in consorcios using additional information due to its signaling and dynamic screening properties that is not exploited in standard bank loans.

We examine differences in realized default rates more formally in Table 3. Controlling for month-municipality fixed effects, we find that consorcio participants are 1.5 percentage points less likely to default relative to bank loans in column I. The difference in default rates becomes consistently stronger once we control for more contract characteristics, such as car values, total credit, maturity, and LTV in columns II to IV, and after controlling for individuals' characteristics based on employment and credit risk in columns V to VII. In column VIII, we add the predicted default risk measure from our credit risk model as a control, which implies that we compare realized default rates for consorcio participants and bank borrowers that are predicted to be equally likely to default based on their observable characteristics. We find that realized default rates are 4.8 percentage points lower for consorcio participants relative to bank borrowers after controlling for observable risk characteristics.

Altogether, the evidence from predicted and realized default rates supports the model's prediction that SCC design improves borrower quality conditional on observable characteristics by inducing a positive selection effect and eliminating more low-quality borrower through dynamic screening.

Regulatory Change The second testable prediction of our model is that positive selection into SCCs is a positive function of the expected cost of default during the savings period. Since lower quality borrowers are more likely to experience adverse shocks during the savings period, higher expected costs of default deter lower quality borrowers from participating in the contract. To provide empirical support for this prediction of the model, we exploit a regulatory change in 2009 that altered the expected cost of default during the savings period for consorcios.

Prior to February 2009, when an individual defaults during the savings period, their savings minus a penalty are returned to them after all non-defaulted participants receive credit and the group is dissolved. This is costly for participants since they not only face a large penalty on their savings, but also have to wait for their savings to be returned, sometimes for years. This feature was very salient to participants, and there were lawsuits between consorcio participants and administrators in which plaintiffs (mostly unsuccessfully) questioned whether withholding their savings until maturity violated existing laws (Superior Tribunal de Justiça, 2009; Júnior, 2014).[11]

To eliminate legal uncertainty, on October 8, 2008, the federal government announced a reform that would require changes to the timing of savings being returned to defaulted consorcio participants.[12] The reform was widely discussed in the public domain.[13] As a result of the reform, groups that start after February 2009 may retain the savings of defaulted participants only until their ticket number is drawn in one of the lotteries held to determine the recipient of credit. In expectation, participants have to wait for their savings to be returned half as long after the reform compared to before the reform. This significantly reduced the expected costs of default during the savings period.

To assess whether the reduction in expected default costs during the savings period after the reform affected selection into consorcios, we first plot default rates for consorcio participants during the savings period around the reform in Figure 3. Consistent with lower cost of default cost leading to more adverse selection, we observe that defaults during the

[11] A back-of-the-envelope calculation shows that the regulatory change led to a 24% decrease in the effective penalty rate. Consider a typical consorcio with a 38-month duration and a 25% withdrawal penalty. Assume a member discount rate of 2% per month, based on the average annual interest rate of 24% for car loans (see Table 1). Under the previous regulation, where the proceeds saved are returned at the end of the group, the effective penalty for a member dropping out after 12 months is calculated as $\tau = 1 - (0.75/(1.02)^{26}) = 55\%$ (i.e., after 26 months). After the regulatory change, the proceeds are returned when the member is randomly chosen (on average after 13 months), resulting in an effective penalty rate of $\tau = 1 - (0.75/(1.02)^{13}) = 42\%$. This represents a 24% decrease in the penalty.

[12] The specific law is 11,795/2008, available at https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2008/lei/l11795.htm.

[13] For instance, Júnior (2014), Menezes (2009), Costa (2009), and dos Santos and Rebelatto (2009).

savings period sharply increase after the reform. While this evidence is consistent with worse selection after the reform, it is also conceivable that lower default costs lead to moral hazard during the savings period. Put differently, higher default rates after the reform may simply reflect lower expected costs of default during the savings period.

To sharpen the interpretation of the results, we extend the analysis of the regulatory change to include changes in observable borrower characteristics and realized default rates around the reform. In addition, we use bank borrowers as a control groups to account for general changes in borrower characteristics and realized default rates in the time-series around the reform. Specifically, we estimate

$$y_i = \alpha_{cm} + \alpha_{mt} + \delta \cdot Consorcio_i \cdot Post_t + \epsilon_i, \tag{9}$$

where y_i is outcome of interest for contract i that is either issued by a bank or a consorcio. $Consorcio_i$ is a dummy variable that takes the value one for consorcio contracts and zero for bank loans. $Post_t$ equals one for the post-reform period from February 2009 to February 2010 and zero for the pre-reform period from February 2008 to January 2009. The municipality by consorcio (α_{cm}) fixed effects absorb time invariant differences among consorcio and bank participants within a municipality, and municipality by time (α_{mt}) fixed effects ensure we compare outcomes for consorcio participants and bank borrowers for contracts issued in the same municipality and the same month. The coefficient of interest is δ, which measures the effect of reducing the cost of default during the savings period in consorcios.

The results are reported in Table 4. First, we find that observable characteristics of consorcio participants deteriorate relatively to bank borrowers after the reform. Specifically, consorcio participants experience a relative drop in formal employment by 3.7 percentage points relative to bank borrowers (columns I), a 0.4 percentage point higher increase in the likelihood of being in default on a current bank loan (column II), a 0.4 percentage point increase of having been in default on a bank loan during the past five years (column III), and a 10.3 percent relative increase in their credit risk measure (column IV).

On examining changes in realized default rates around the reform in column V, we find that consorcio participants experience a 2.5 percentage point higher increase in default rates after the reform relative to bank borrowers. In Figure 4, we plot quarter-by-quarter estimates of differences in realized default rates for consorcio participants and bank borrowers around the reform. While we observe parallel trends in default rates for contracts signed up to the reform, we observe a significant relative jump in realized default rates for consorcio contracts signed after the reform. This suggests that the increase in realized default rates is driven by the regulatory change rather than being a result of time-series trends in default rates for consorcio participants relative to bank borrowers.

Together, the evidence from the regulatory changes suggests that reducing the expected costs of default during the savings period leads to more adverse selection into SCCs, consistent with the predictions of the model. Higher realized default rates also suggest that the effects around the reform is not driven by changes in moral hazard during the savings period. If agents are more likely to default during the savings period after the reform because default is less costly, we should not expect to see higher default rates *after* credit is allocated, since there is no variation in default cost and moral hazard after receiving credit around the reform.

4 Conclusion

In this paper, we explore a contract design – Savings-and-Credit Contract (SCC) – that reduces information asymmetry in lending by providing the opportunity for high-quality borrowers to signal their type. The main feature generating a separating equilibrium is a mandatory savings period with a high penalty for default before providing credit. We show that an SCC design can expand access to credit and dominate classic loan contracts in the presence of information frictions. We also show that an SCC is a more efficient separating device than a single down payment in standard spot loans, since for bad borrowers committing to the savings period adds additional exposure to costly default risk.

We provide empirical support for the predictions of the model using data on consorcio participants and bank borrowers in Brazil. Comparing bank borrowers' and consorcio participants' observable characteristics in the cross section, we show that consorcio participants appear riskier than bank borrowers along a broad range of characteristics. Notwithstanding, default rates for consorcio participants are about 5 percentage points lower than for bank loans. Together, this suggests that consorcios manage to identify safer borrowers among the pool of observably riskier borrowers. To isolate the role of the penalty during the savings period, we exploit a regulatory reform that changes the expected default cost associated with the default penalty. We find that the relative quality of consorcio borrowers declines when the default penalty is lower both in terms of observable characteristics and realized default rates.

Signaling through SCCs is most valuable when borrowers face a higher real interest rates or when there is more unobservable information, which often applies to financial markets in mid-income and developing countries with sparse information environments. Thus, innovation in contract design may help to allocate credit to individuals with profitable investment opportunities more effectively. Consistent with the view, features of SCC design exist in a wide range of mid-income and developing countries, such as Brazil, Cambodia, China, Colombia, India, Mexico, Nigeria, South Africa, or Turkey. This suggests that SCCs are an effective tool to improve financial intermediation and expand credit to a broader set of otherwise underserved households.

While the literature on RoSCAs primarily emphasizes the role of social capital, we focus on the positive selection effect of a default penalty within a combined savings-and-credit contract. Our analysis suggests that the expected cost of default during the savings period contributes to positive selection into RoSCAs, helping to explain why they attract low-risk individuals (Levenson and Besley, 1996) and can offer lower interest rates (Kapoor et al., 2011), similar to our findings for Consorcios.

While we do not explore the role of SCC design as a commitment device to saving, in principle, the SCC design may generate savings incentives for individuals who struggle to commit to saving in the absence of strong incentives (Laibson, 1997; Karlan, Ratan, and Zinman, 2014; Ericson and Laibson, 2019). While in theory there should be strong demand for contracts that help solving commitment problems, little take-up has been documented in practice (Laibson, 2015) and evidence on whether such contracts can improve welfare is mixed (Allcott et al., 2021; Carrera et al., 2021). A design that provides better incentives to overcome present-bias problems, for instance, via long-term contracting (Gottlieb and Zhang, 2021), may improve take-up and welfare effects. Whether SCC design is successful at solving commitment problems and can enhance welfare for present-biased individuals is an interesting question for future research.

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Figure 1: **Model Timeline**

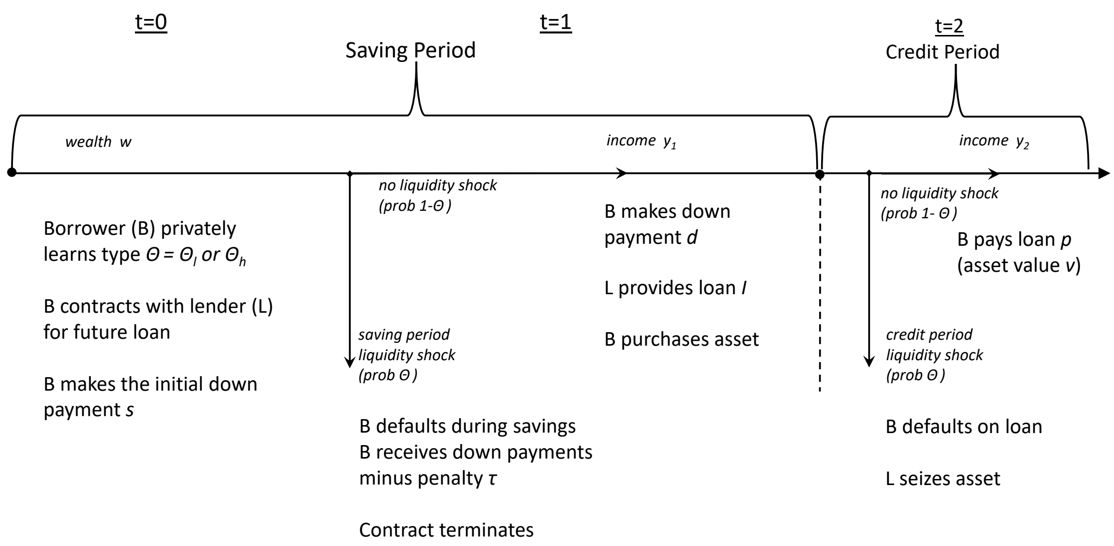
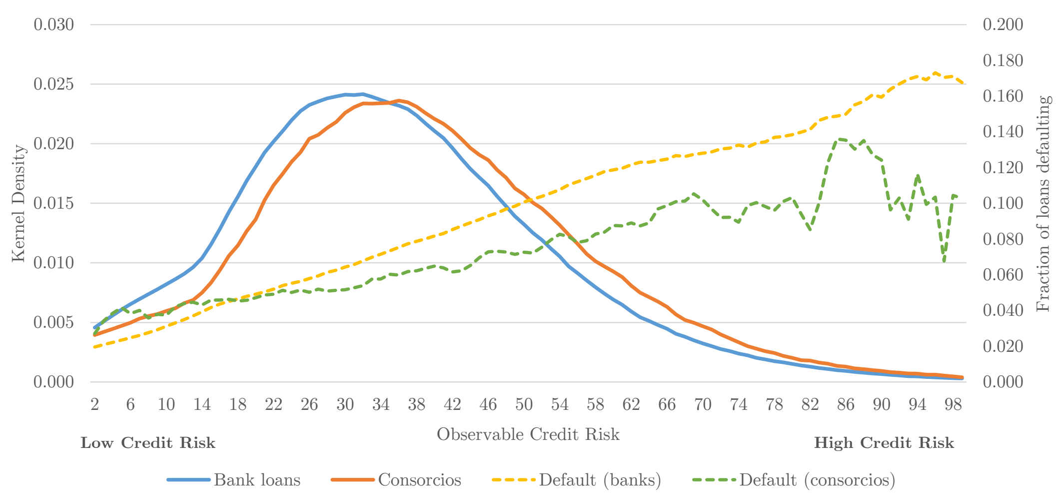
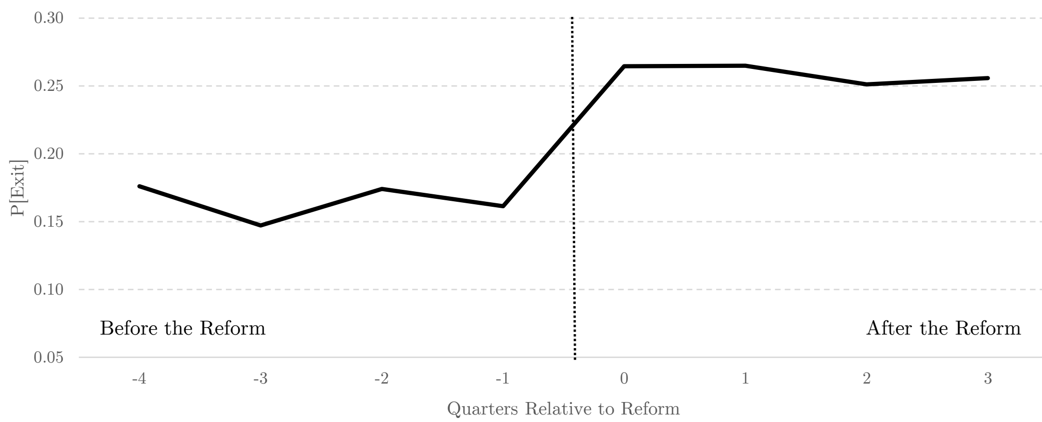


Figure 2: **Predicted and Realized Default Rates**



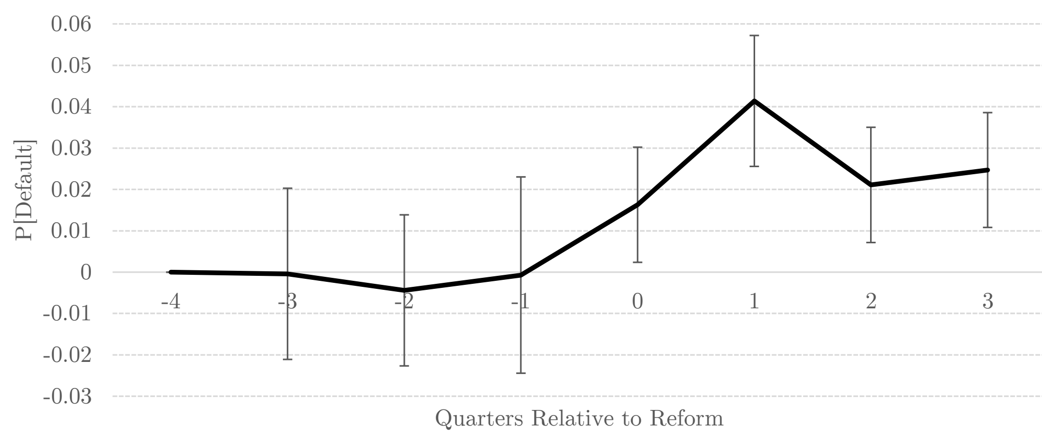
This figure depicts the kernel density plots of predicted default rate (left axis) and realized default rates (right axis) separately for bank loans (blue) and consorcio borrowers (orange) for each of the 100 equally-spaced default rate bins (x-axis). Default is predicted following the default model in equation (8). The dashed lines depict realized default rates for bank loans (yellow) and consorcio borrowers (green).

Figure 3: **Default Rates During Savings Period Around the Reform**



The figure depicts the fraction of people who default during the savings period in consorcios in a given quarter from February 2008 to February 2010. The x-axis shows the distance to the reform in quarters, where 0 is the quarter when the reform first applies (February to April 2009).

Figure 4: **Realized Default Rates Around the Reform**



This figure depicts the differences in realized default rates for consorcio borrowers relative to bank loans estimated in equation (9) with 95 percent confidence bounds and normalized to zero in the quarter before the reform. The x-axis depicts the distance to the reform in quarters, where 0 is the quarter when the reform first applies (February to April 2009).

Table 1: **Descriptive Statistics**

	Consorcios	Loans (Banks)	Difference
Panel A: Individual Characteristics			
Male	0.69	0.68	-0.01
Age	35.01	39.68	4.67
Formal employment share	0.42	0.59	0.17
Currently in default on a bank loan	0.067	0.039	-0.028
Default on a bank loan in past 5 years	0.049	0.025	-0.024
Panel B: Contractual Characteristics			
Value good (BRL)	29,414	23,144	-6,270
Loan (BRL)	12,535	17,658	5,123
LTV	0.395	0.791	0.396
Maturity	38	43	5
Interest rate (implied)	0.16	0.24	0.08
Exit rate	0.24		
Default rate	0.066	0.090	0.024

This table provides descriptive statistics on individuals and credit contracts. Panels A provides descriptive statistics on individuals separately for consorcio participants and bank borrowers as well as the differences between them. Panel B provides contract characteristics and outcomes separately for consorcios participants and bank borrowers as well as the differences between them.

Table 2: **Observable Characteristics**

	I	II	III	IV	V	VI	VII
Dep. Var.:	$Formally\ Employed_i$				$Default\ Currently_i$	$Default\ Past\ 5\ yrs_i$	$Credit\ Risk_i$
$Consorcio_i$	-0.171***	-0.194***	-0.143***	-0.148***	0.019***	0.013***	0.124***
	(0.009)	(0.009)	(0.008)	(0.008)	(0.001)	(0.001)	(0.008)
Month-Municipality FE	yes	yes	yes	yes	yes	yes	yes
Month-Colat val. dec. FE				yes	yes	yes	yes
Contract-level controls							
Total credit		yes	yes	yes	yes	yes	yes
Maturity		yes	yes	yes	yes	yes	yes
Month-LTV dec			yes	yes	yes	yes	yes
Clustered SE	muni	muni	muni	muni	muni	muni	muni
Observations	3,998,993	3,956,788	3,956,788	3,194,796	3,194,796	3,194,796	2,976,424
R^2	0.049	0.096	0.133	0.106	0.034	0.030	0.083

This table shows the results from estimating equation (7) where the dependent variable is a dummy variable that equals one if individual i is formally employed and zero otherwise in columns I through IV, a dummy variable that equals one if individual i is currently in default on bank credit in column V, a dummy variable that equals one if individual i defaulted on bank credit contract within the last five years in column VI, and the credit score estimated in equation (8) in column VII. $Consorcio_i$ is a dummy variable that equals one for consorcio contracts and zero for bank loans. *Total credit* and *Maturity* are the credit volume and maturity, respectively. Standard errors are reported in parentheses. The bottom of the table provides information on fixed effects and the clustering of standard errors. *** denotes statistical significance at the 1% level.

Table 3: **Realized Default Rates**

	I	II	III	IV	V	VI	VII	VIII
Dep. Var.:				$P[Default_i]$				
$Consorcio_i$	-0.015***	-0.032***	-0.059***	-0.053***	-0.058***	-0.055***	-0.054***	-0.048***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.002)	(0.004)	(0.004)	(0.002)
Month-Municipality FE	yes	yes	yes	yes	yes	yes	yes	yes
Month-Colat val. dec. FE				yes	yes	yes	yes	yes
Contract-level controls								
Total credit		yes	yes	yes	yes	yes	yes	yes
Maturity		yes	yes	yes	yes	yes	yes	yes
Month-LTV dec			yes	yes	yes	yes	yes	yes
Ex-ante controls					$Employed$	$DefCur$	$Def5yr$	$CrRisk$
Clustered SE	muni	muni	muni	muni	muni	muni	muni	muni
Observations	3,980,198	3,956,788	3,194,796	3,194,796	3,194,796	3,194,796	3,194,796	3,194,796
R^2	0.036	0.132	0.077	0.083	0.084	0.085	0.084	0.115

This table shows the results from estimating equation (7). $Consorcio_i$ is a dummy variable that equals one for consorcio contracts and zero for bank loans. *Total credit* and *Maturity* are the credit volume and maturity, respectively. *Employed* is a dummy variable that equals one if individual i is formally employed and zero otherwise, $DefCur$ is a dummy variable that equals one if individual i is currently in default on a bank credit contract, $Def5yr$ is a dummy variable that equals one if individual i defaulted on a bank credit contract in the last five years in, $CrRisk$ is the credit score estimated in equation (8). Standard errors are reported in parentheses. The bottom of the table provides information on fixed effects and the clustering of standard errors. *** denotes statistical significance at the 1% level.

Table 4: **Regulatory Constraints**

	I	II	III	IV	V
Dep. Var.:	$Formally$ $Employed_i$	$Default$ $Currently_i$	Default $Past\ 5\ yrs_i$	Credit $Risk_i$	$P[Default_i]$
$Consorcio_i * Post_t$	-0.037***	0.004**	0.004**	0.103***	0.025***
	(0.006)	(0.002)	(0.004)	(0.012)	(0.004)
Observations	4,018,126	4,018,126	4,018,126	3,778,051	3,999,403
R^2	0.056	0.031	0.029	0.061	0.041
Month-Municipality FE	yes	yes	yes	yes	yes
Consorcio-Muni FE	yes	yes	yes	yes	yes
Clustered SE	muni	muni	muni	muni	muni

This table shows the results from estimating equation (9) where the dependent variable is a dummy variable that equals one if individual i is formally employed and zero otherwise in columns I, a dummy variable that equals one if individual i is currently in default on bank credit in column II, a dummy variable that equals one if individual i defaulted on bank credit in the last five years in column III, the credit score estimated in equation (8) in column IV, and a dummy variable that equals one if the contract defaults and zero otherwise in column VI. $Consorcio_i$ is a dummy variable that equals one for consorcio contracts and zero for bank loans. $Post_t$ equals one for post-reform period after February 2009 and zero before. Standard errors are reported in parentheses. The bottom of the table provides information on fixed effects and the clustering of standard errors. *** and ** denote statistical significance at the 1% and 5% levels, respectively.

Appendix A. Proofs

Appendix A.1. Moral Hazard Problems

In addition to liquidity constraints ($p \leq y_2$), moral hazard problems can lead to further caps on the loan payments. For example, consider a basic moral hazard such as in Tirole (2010). Borrowers of any type θ can shirk on working which reduces the probability of being employed by Δ yielding a increase in private benefits worth B. Thus, borrower's expected payoff, while working is $\theta\delta\left(v-p\right)$ and while shirking is $\left(\theta-\Delta\right)\delta\left(v-p\right)+\delta B$. In order to provide incentive for the borrower to work,

$$\theta\left(v-p\right)>\left(\theta-\Delta\right)\left(v-p\right)+B\Rightarrow\Delta\left(v-p\right)>B\Rightarrow p<\bar{p}:=v-\frac{B}{\Delta}.$$

Therefore, the loan payment has to be capped at $\bar{p}=v-\frac{B}{\Delta}$.

Appendix A.2. Proof of the Full Information Case

The optimal contract maximizes the agents' utility subject to the lenders breaking even for any given τ:

$$\begin{aligned}\underset{s,d,p}{\text{maximize}}\ & U_\theta\left(s,d,p|\tau\right)\\ \text{subject to}\ & \Pi_\theta\left(s,d,p|\tau\right)\geq 0\\ & U_{\theta_l}\left(d,p\right)\leq\bar{U}_{\theta_l}\\ & s\geq 0, s\leq w, p\geq 0, p\leq\bar{p}\end{aligned}$$

Consider the Lagrangian

$$\mathcal{L}=U_\theta\left(s,d,p|\tau\right)+\lambda_1\Pi_\theta\left(s,d,p|\tau\right)-\lambda_2(p-\bar{p})+\lambda_2 s.$$

By Karush-Kuhn-Tucker (KKT) theorem there exists Lagrange multipliers $\lambda_1,\lambda_2,\lambda_3\geq 0$

for the three inequalities above so that the three FOCs hold:

$$\begin{aligned}
\frac{\partial U_\theta(s,d,p|\tau)}{\partial s}+\lambda_1\frac{\partial \Pi_\theta(s,d,p|\tau)}{\partial s}+\lambda_3\frac{\partial s}{\partial s} &= 0\\
\frac{\partial U_\theta(s,d,p|\tau)}{\partial d}+\lambda_1\frac{\partial \Pi_\theta(s,d,p|\tau)}{\partial d} &= 0\\
\frac{\partial U_\theta(s,d,p|\tau)}{\partial p}+\lambda_1\frac{\partial \Pi_\theta(s,d,p|\tau)}{\partial p}+\lambda_2\frac{\partial(-p)}{\partial p} &= 0
\end{aligned}$$

and the three complementary slackness conditions hold:

$$\begin{aligned}
\lambda_1\Pi_\theta(s,d,p|\tau) &= 0\\
\lambda_2(p-\bar{p}) &= 0\\
\lambda_3.s &= 0
\end{aligned}$$

The three FOCs simplify to

$$\begin{aligned}
\partial s &: (1-\theta)\delta(1-\tau)-1+\lambda_1(-(1-\theta)(1-\tau)+1)+\lambda_3=0\\
\partial d &: -(\theta\delta)+\theta\lambda_1=0\Rightarrow\lambda_1=\delta>0\\
\partial p &: -(\theta\delta)^2+\theta^2\lambda_1-\lambda_2=0\Rightarrow\lambda_2=\theta^2\delta(1-\delta)>0
\end{aligned}$$

From the first FOC,

$$\lambda_3=1-(1-\theta)\delta(1-\tau)-\delta(1-(1-\theta)(1-\tau))=1-\delta.$$

Thus $\lambda_1=\delta>0$, $\lambda_2=\theta^2\delta(1-\delta)>0$, and $\lambda_3=1-\delta>0$, and from the three complementary slackness conditions, $s=0$, $p=\bar{p}$, and $\Pi_\theta(s=0,d,\bar{p}|\tau)=0$, which implies $d=\underline{d}_\theta$, is the unique solution of the maximization problem for any τ.

Appendix A.3. Proof of Proposition 1

The Pareto-dominant separating equilibrium is obtained by maximizing the utility of the high-type subject to the lender breaking even and that the low-type does not prefer the high-type loan compared to his full information loan. Note that because the SCP holds, the incentive constraint for the high-type is non-binding $U_{\theta_h}(d_l^*, p_l^*) < U_{\theta_h}(d, p)$, so we exclude this inequality in the maximization problem below. In any Pareto dominating competitive separating equilibrium, the low-type chooses the same solution as in the full-information case and derives utility $\bar{U}_{\theta_l}$.

The optimal contract maximizes the high-type agents' utility subject to the break-even and the incentive compatibility constraints:

$$\begin{aligned} \underset{d,p}{\text{maximize}} \;& U_{\theta_h}(d,p) \\ \text{subject to } & \Pi_{\theta_h}(d,p) \geq 0 \text{ (IR)} \\ & U_{\theta_l}(d,p) \leq \bar{U}_{\theta_l} \text{ (IC)} \\ & d \geq 0, d \leq y_1, p \geq 0, p \leq \bar{p} \end{aligned}$$

Disregard the constraints on d and p momentarily, and consider the maximization just with constraints IC and IR. Both of these constraints must bind at the optimum. Indeed, by KKT theorem, there exists Lagrange multipliers $\lambda_1, \lambda_2 \geq 0$ for the two inequalities above so that the two FOCs,

$$\begin{aligned} \frac{\partial U_{\theta_h}(d,p)}{\partial d} + \lambda_1 \frac{\partial \Pi_{\theta_h}(d,p)}{\partial d} - \lambda_2 \frac{U_{\theta_l}(d,p)}{\partial d} &= 0 \\ \frac{\partial U_{\theta_h}(d,p)}{\partial p} + \lambda_1 \frac{\partial \Pi_{\theta_h}(d,p)}{\partial p} - \lambda_2 \frac{U_{\theta_l}(d,p)}{\partial p} &= 0, \end{aligned}$$

and the two complementary slackness conditions hold:

$$\begin{aligned} \lambda_1 . \Pi_{\theta_h}(d,p) &= 0 \\ \lambda_2 . \left(U_{\theta_l}(d,p) - \bar{U}_{\theta_l}\right) &= 0 \end{aligned}$$

The two FOCs simplify to

$$\begin{aligned} \partial d &: -(\theta_h \delta) + \theta_h \lambda_1 + \lambda_2 (\theta_l \delta) = 0 \\ \partial p &: -(\theta_h \delta)^2 + \theta_h^2 \lambda_1 + \lambda_2 (\theta_l \delta)^2 = 0 \end{aligned}$$

which has the unique solution

$$\begin{array}{c} \lambda_1 = \frac{\delta^2}{\theta_h - \delta\theta_l} (\theta_h - \theta_l) > 0 \\ \lambda_2 = \frac{\theta_h^2}{\theta_l(\theta_h - \delta\theta_l)} (1 - \delta) > 0 \end{array}$$

Thus, both inequalities bind at the optimum.

Therefore, the solution of the optimization is just obtained by solving the system of linear equations:

$$\Pi_{\theta_h} (d, p) = 0$$
$$U_{\theta_l} (d, p) = \bar{U}_{\theta_l} = U_{\theta_l} (d_l^*, p_l^*) .$$

which yields explicitly:

$$d_h^* = d_l^* + \frac{\theta_l \delta (p_l^* - \vartheta) (\theta_h - \theta_l)}{\theta_h - \delta\theta_l} \text{ and } p_h^* = p_l^* - \frac{(p_l^* - \vartheta) (\theta_h - \theta_l)}{\theta_h - \delta\theta_l},$$

Notice that the solution is such that $p_h^* < p_l^*$ and $d_h^* > d_l^*$.

Finally, the constraints on d and p that we initially ignored are satisfied because we assume that the high-type can afford the down payment in period $t = 1$, $y_1 \geq \bar{y} = d_h^*$, but borrowers cannot afford it in period $t = 0$, $w < \bar{w} = d_l^*$ (Assumption A4).

Appendix A.4. Proof of Proposition 2

The marginal rate of substitution between deposits s and down payments d or payments p are given by,

$$\begin{aligned} MRS_{s,d}^{\theta} &= -\frac{\partial U_\theta (x)}{\partial s} / \frac{\partial U_\theta (x)}{\partial d} = -\frac{1}{\theta\delta} (1 - \delta (1 - \theta) (1 - \tau)) \text{ and} \\ MRS_{s,p}^{\theta} &= -\frac{\partial U_\theta (x)}{\partial s} / \frac{\partial U_\theta (x)}{\partial p} = -\frac{1}{\theta^2\delta^2} (1 - \delta (1 - \theta) (1 - \tau)) . \end{aligned}$$

Taking the derivatives with respect to θ shows the SCP holds,

$$\begin{aligned}\frac{\partial MRS^{\theta}_{s,d}}{\partial\theta} &= \frac{1}{\theta^{2}\delta}\left(\tau\delta+1-\delta\right)>0 \text{ and}\\ \frac{\partial MRS^{\theta}_{s,p}}{\partial\theta} &= \frac{1}{\theta^{3}\delta^{2}}\left(2-\delta\left(2-\theta\right)\left(1-\tau\right)\right)>0.\end{aligned}$$

Because the SCP holds, the incentive constraint for the high-type is non-binding, so we exclude this inequality in the maximization problem. Therefore, the Pareto-dominant separating equilibrium is obtained by the maximization problem below, in which the utility of the high-type is maximized subject to the lender breaking even, and the low-type does not prefer the high-type loan.

We claim that $s=w$, $\tau=1$, $d=d_h^{**}$, and $p=p_h^{**}$ is the optimal solution of:

$$\begin{array}{ll}\underset{s,d,p,\tau}{\text{maximize}} & U_{\theta_h}\left(s,d,p|\tau\right)\\ \text{subject to} & \Pi_{\theta_h}\left(s,d,p|\tau\right)\geq 0\\ & U_{\theta_l}\left(s,d,p|\tau\right)\leq \bar{U}_{\theta_l}\\ & s\geq 0, s\leq w, \tau\geq 0, \tau\leq 1, d\geq 0, d\leq y_1, p\geq 0, p\leq \bar{p}\end{array}$$

Consider the Lagrangian $\mathcal{L}$ and disregard momentarily the constraints on d and $p:$

$$\mathcal{L}=U_{\theta_h}\left(s,d,p|\tau\right)+\lambda_1\Pi_{\theta_h}\left(s,d,p|\tau\right)-\lambda_2(U_{\theta_l}\left(s,d,p|\tau\right)-\bar{U}_{\theta_l})+\lambda_3 s-\lambda_4(s-w)+\lambda_5\tau-\lambda_6(\tau-1).$$

By KKT theorem there exist Lagrange multipliers $\lambda_i\geq 0$, $i=1,...6$, for the inequalities above so that the four FOCs hold:

$$\begin{aligned}\frac{\partial U_{\theta_h}\left(s,d,p|\tau\right)}{\partial s}+\lambda_1\frac{\partial \Pi_{\theta_h}\left(s,d,p|\tau\right)}{\partial s}-\lambda_2\frac{\partial U_{\theta_l}\left(s,d,p|\tau\right)}{\partial s}+\lambda_3-\lambda_4 &= 0\\ \frac{\partial U_{\theta_h}\left(s,d,p|\tau\right)}{\partial d}+\lambda_1\frac{\partial \Pi_{\theta_h}\left(s,d,p|\tau\right)}{\partial d}-\lambda_2\frac{\partial U_{\theta_l}\left(s,d,p|\tau\right)}{\partial d} &= 0\\ \frac{\partial U_{\theta_h}\left(s,d,p|\tau\right)}{\partial p}+\lambda_1\frac{\partial \Pi_{\theta_h}\left(s,d,p|\tau\right)}{\partial p}-\lambda_2\frac{\partial U_{\theta_l}\left(s,d,p|\tau\right)}{\partial p} &= 0\\ \frac{\partial U_{\theta_h}\left(s,d,p|\tau\right)}{\partial \tau}+\lambda_1\frac{\partial \Pi_{\theta_h}\left(s,d,p|\tau\right)}{\partial \tau}-\lambda_2\frac{\partial U_{\theta_l}\left(s,d,p|\tau\right)}{\partial \tau}+\lambda_5-\lambda_6 &= 0\end{aligned}$$

and the six complementary slackness conditions hold:

$$\begin{aligned}
\lambda_1.\Pi_\theta\left(s,d,p|\tau\right) &= 0\\
\lambda_2.\left(U_{\theta_l}\left(s,d,p|\tau\right)-U_{\theta_l}\right) &= 0\\
\lambda_3.s &= 0\\
\lambda_4.\left(s-w\right) &= 0\\
\lambda_5.\tau &= 0\\
\lambda_6.\left(1-\tau\right) &= 0
\end{aligned}$$

The FOCs simplify to

$$\begin{aligned}
\partial s &: \left(1-\theta_h\right)\delta\left(1-\tau\right)-1+\lambda_1\left(-\left(1-\theta_h\right)\left(1-\tau\right)+1\right)+\lambda_2\left(1-\left(1-\theta_l\right)\delta\left(1-\tau\right)\right)+\lambda_3-\lambda_4=0\\
\partial d &: -\left(\theta_h\delta\right)+\theta_h\lambda_1+\left(\theta_l\delta\right)\lambda_2=0\\
\partial p &: -\left(\theta_h\delta\right)^2+\theta_h^2\lambda_1+\left(\theta_l\delta\right)^2\lambda_2=0\\
\partial\tau &: -\left(1-\theta_h\right)\delta s+\lambda_1\left(1-\theta_h\right)s+\lambda_2\left(1-\theta_l\right)\delta s+\lambda_5-\lambda_6=0
\end{aligned}$$

Solving the equations yield

$$\lambda_1=\tfrac{\delta^2}{\theta_h-\delta\theta_l}\left(\theta_h-\theta_l\right)>0 \text{ and } \lambda_2=\tfrac{\theta_h^2}{\theta_l\left(\theta_h-\delta\theta_l\right)}\left(1-\delta\right)>0.$$

Replacing the values of λ_1 and λ_2 yields

$$\begin{aligned}
\lambda_4-\lambda_3 &= \frac{1}{\theta_l\left(\theta_h-\delta\theta_l\right)}\left(1-\delta\right)\left(\theta_h-\theta_l\right)\left(\theta_h-\delta\theta_h-\delta\theta_l+\tau\delta\theta_h\right)\\
\lambda_6-\lambda_5 &= s\frac{\delta\theta_h}{\theta_l\left(\theta_h-\delta\theta_l\right)}\left(1-\delta\right)\left(\theta_h-\theta_l\right).
\end{aligned}$$

Because it satisfies all the FOCs and all the complementary slackness conditions, we now show that optimal solution to the maximization problem is: $s=w$, $\tau=1$, $\lambda_5=0$ and $\lambda_6=w\frac{\delta\theta_h}{\theta_l(\theta_h-\delta\theta_l)}\left(1-\delta\right)\left(\theta_h-\theta_l\right)>0$, and $\lambda_3=0$, $\lambda_4=\frac{1}{\theta_l}\left(1-\delta\right)\left(\theta_h-\theta_l\right)>0$ and d,p

solution of the system of two equations:

$$\Pi_\theta (w, d, p|1) = 0 \text{ and } U_{\theta_l} (w, d, p|1) = U_{\theta_l}.$$

Indeed, note that with $\tau = 1$,

$$\lambda_4 - \lambda_3 = \frac{1}{\theta_l} (1 - \delta) (\theta_h - \theta_l) > 0 \Rightarrow \lambda_4 > 0,$$

and solving the system of equations above on d and p yields,

$$d_h^{**} = d_h^* - \left(\frac{\theta_h + \delta\theta_l}{\delta\theta_l\theta_h} \right) w \text{ and } p_h^{**} = p_h^* + \left(\frac{1}{\delta\theta_l\theta_h} \right) w$$

Let w and y_1 satisfy the liquidity constraint assumption, $w < \bar{w}$ and $y_1 > \bar{y}$, where:

$$\bar{w} = \min \left\{ d_l^*, \left(\frac{\delta\theta_l\theta_h}{\theta_h + \delta\theta_l} \right) d_h^*, \delta\theta_l\theta_h (\bar{p} - p_h^*), \right\} \text{ and } \bar{y} = \max \{d_h^{**}, d_l^*\} \qquad (10)$$

Finally, the constraints on d and p that we initially ignored are satisfied because the inequality $w < \bar{w}$ implies that $d = d_h^{**} > 0$ and $p = p_h^{**} < \bar{p}$. Also, because $y_1 > \bar{y}$ then both types have enough liquidity to afford the down payment in $t = 1$, which completes the proof.

Appendix A.5. Proof of Corollary 1

The high-type utility in equilibrium with SCC contracts and with standard spot loans are, respectively,

$$\begin{aligned} U_{\theta_h} (w, d_h^{**}, p_h^{**}|1) &= \theta_h\delta (\theta_h\delta (v - p_h^{**}) - d_h^{**}) - w, \\ U_{\theta_h} (0, d_h^*, p_h^*|1) &= \theta_h\delta (\theta_h\delta (v - p_h^*) - d_h^*), \end{aligned}$$

where

$$d_h^{**} = d_h^* - \left(\frac{\theta_h + \delta\theta_l}{\delta\theta_l\theta_h} \right) w \text{ and } p_h^{**} = p_h^* + \left(\frac{1}{\delta\theta_l\theta_h} \right) w.$$

Thus

$$U_{\theta_h}\left(w, d_h^{**}, p_h^{**}|1\right) = \theta_h\delta\left(\theta_h\delta\left(v - p_h^*\right) - d_h^*\right) + \frac{w}{\theta_l}\left(1-\delta\right)\left(\theta_h - \theta_l\right),$$

which implies that

$$\Delta U_h = U_{\theta_h}\left(w, d_h^{**}, p_h^{**}|1\right) - U_{\theta_h}\left(0, d_h^*, p_h^*|1\right) = \frac{w}{\theta_l}\left(1-\delta\right)\left(\theta_h - \theta_l\right).$$

Alternatively, the proof can also be obtained from the fact that the lagrangian multiplier λ_4 of constraint $s \leq w$ is

$$\lambda_4 = \frac{\partial U_{\theta_h}}{\partial w} = \frac{1}{\theta_l}\left(1-\delta\right)\left(\theta_h - \theta_l\right).$$

Appendix A.6. Proof of Proposition 3

The problem with penalty constraints is similar to the maximization problem in Proposition 2, where only the last constraint changes to $\tau \leq \bar{\tau}$. We have shown in the proof of Proposition 2 that the FOCs are:

$$\begin{aligned}
\partial s &: \left(1-\theta_h\right)\delta\left(1-\tau\right) - 1 + \lambda_1\left(-\left(1-\theta_h\right)\left(1-\tau\right)+1\right) + \lambda_2\left(1-\left(1-\theta_l\right)\delta\left(1-\tau\right)\right) + \lambda_3 - \lambda_4 = 0 \\
\partial d &: -\left(\theta_h\delta\right) + \theta_h\lambda_1 + \left(\theta_l\delta\right)\lambda_2 = 0 \\
\partial p &: -\left(\theta_h\delta\right)^2 + \theta_h^2\lambda_1 + \left(\theta_l\delta\right)^2\lambda_2 = 0 \\
\partial \tau &: -\left(1-\theta_h\right)\delta s + \lambda_1\left(1-\theta_h\right)s + \lambda_2\left(1-\theta_l\right)\delta s + \lambda_5 - \lambda_6 = 0,
\end{aligned}$$

and that the complementary slackness conditions are:

$$\begin{aligned}
\lambda_1.\Pi_\theta\left(s, d, p|\tau\right) &= 0 \\
\lambda_2.\left(U_{\theta_l}\left(s, d, p|\tau\right) - U_{\theta_l}\right) &= 0 \\
\lambda_3.s &= 0 \\
\lambda_4.\left(s - w\right) &= 0 \\
\lambda_6.\tau &= 0 \\
\lambda_6.\left(\tau - \bar{\tau}\right) &= 0.
\end{aligned}$$

Solving the system of equations yields:

$$\lambda_1 = \frac{\delta^2}{\theta_h - \delta\theta_l}\left(\theta_h - \theta_l\right) > 0 \text{ and } \lambda_2 = \frac{\theta_h^2}{\theta_l\left(\theta_h - \delta\theta_l\right)}\left(1-\delta\right) > 0,$$

and, replacing λ_1 and λ_2, yields:

$$\lambda := \qquad \lambda_4 - \lambda_3 = \frac{1}{\theta_l\left(\theta_h - \delta\theta_l\right)}\left(1-\delta\right)\left(\theta_h - \theta_l\right)\left(\theta_h - \delta\theta_h - \delta\theta_l + \tau\delta\theta_h\right)$$

$$\hat{\lambda} := \qquad \lambda_6 - \lambda_5 = s\frac{\delta\theta_h}{\theta_l\left(\theta_h - \delta\theta_l\right)}\left(1-\delta\right)\left(\theta_h - \theta_l\right) > 0$$

Let $\hat{\tau} = 1 - \frac{1}{\delta\theta_h}\left(\theta_h - \delta\theta_l\right),$ and let $\hat{d}_h$ and $\hat{p}_h$ be the unique solution of the equations $\Pi_\theta\left(w, \hat{d}_h, \hat{p}_h|\hat{\tau}\right) = 0$ and $U_{\theta_l}\left(w, \hat{d}_h, \hat{p}_h|\hat{\tau}\right) = \bar{U}_{\theta_l}$, which are given by equations (6).

Suppose that $\tau \geq \hat{\tau}$, in which case $\lambda \geq 0$. Further, assume that liquidity constraint $w < \bar{w}$ holds so that $\hat{d}_h > 0$ and $\hat{p}_h < \bar{p}$. In this case, $s = w, \tau = \bar{\tau}\ \lambda_3 = 0, \lambda_4 = \lambda > 0,\ \lambda_6 = \hat{\lambda} \geq 0, d = \hat{d}_h,$ and $p = \hat{p}_h$, is a solution to the optimization problem, because it satisfies all the FOCs and the complementary conditions.