Towards anonymous undercollateralized loans

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Abstract

Undercollateralized or unsecured loans are often considered impossible in fully decentralized and permissionless settings due to the lack of recourse for lenders if borrowers default. In this paper, I consider the problem of pricing anonymous undercollateralized loans while allowing for the possibility of default. The only consequence to borrowers for defaulting is that subsequently, they only have access to overcollateralized loans for a given amount of time. I show the conditions for which always-honest strategy dominates all subgames, i.e., always-honest is a Subgame Perfect Nash Equilibrium. Importantly, even under conservative parameter assumptions, it is possible to charge reasonably high interest rate that also incentivizes honest behavior from anonymous borrowers. In addition, because the proposed system does not require consensus on external data, it is not subject to the oracle problem present in many decentralized applications.

Introduction

Despite its phenomenal growth, decentralized finance (DeFi) lacks an important feature: providing liquidity. This is because DeFi only allows overcollateralized loans, in which the collateral value must exceed the loan value at all times. This type of loan is risky and expensive (Packin and Aretz, 2023). It is often believed that eliminating DeFi's anonymity necessitates the introduction of a trusted third party to oversee the borrowers' credit ratings. Early efforts in designing semi-anonymous credit cards date back at least to Low et al. (1996). However, these systems are only semi-anonymous because it still involves a trusted third party to vouch for the borrower.

In this paper, I consider a lending platform that imposes a restriction: a credit building phase that lasts for some τ periods. If the borrower defaults, he/she forgoes the whole credit history. To the extent that credit history is valuable, such a simple restriction imposes a cost of default on the borrowers. This cost may be enough to deter borrowers from defaulting. The problem I study is: given τ periods, what is the maximum interest rate r the lender can charge for undercollateralized loan that is still incentive-compatible? An interest rate is incentive-compatible if it is higher than the lender's minimum required rate and is the rate at which always-honest strategy dominates other strategies in expectation. The main result of the paper is an inequality that can be solved for interest rate r.

After establishing the main result, I use simulation to validate the basic model and to account for more practical scenarios such as accidental defaults and moral hazard. The simulation framework employed is cadCAD, which is widely used in practice. The theoretical results show robustness across a wide range of simulated scenarios.

Model

The basic setup is an infinitely repeated game consisting of a lending platform and a borrower. The lending platform has infinite money to lend and will lend if the interest rate charged exceeds some minimum required rate. In addition, the lending platform can offer both overcollateralized loans and undercollateralized loans. Overcollateralized loans are charged a rate c, and undercollateralized loans are charged a rate r. However, new borrowers can only borrow overcollateralized loans. A borrower is considered new if he/she has borrowed for fewer than τ periods. After τ periods, the borrower can borrow undercollateralized loans. The borrower can use loaned funds to generate an exogenous return u and receive a yield y on his/her crypto holdings. I also assume that the distribution of the collateral assets is known. The exact distribution can be arbitrary. The borrower demands an exogenous unit of capital P every period and applies a discount rate of i on all cash flows. The borrower can borrow undercollateralized loans as long as he/she did not default in the previous period. The borrower receives a payoff B for overcollateralized loan, a payoff H for undercollateralized loan if he/she did not default, and a payoff S for undercollateralized loan if he/she defaults.

If the borrower defaults, he/she simply forfeits the defaulted account and creates a new one. However, creating a new account means the borrower can only borrow overcollateralized loans for τ periods again. An illustration for the borrower's payoff paths with $\tau = 2$ is given in Figure 1.

Results

Proposition 2.

$$\mathbb{E}[H(r) - M(r)] > 0$$
$$\leftrightarrow \frac{F(D_{HB}e^{-(2\tau+1)i}(1-F)^{\tau+1})}{(e^i-1+F)(e^i-1)} + \frac{F((D_{HS}-D_{HB})e^{-i(\tau+1)}D_{HS}e^{-ir})(1-F)^{\tau+1}}{(e^i-1+F)(e^i-1)}$$
$$+ \frac{F(D_{HS}e^i + D_{HB} - D_{HS}e^{-ir}D_{HB})}{(e^i-1+F)(e^i-1)} > 0$$

where

$$D_{HS} = \mathbb{E}[H_B(r) - S_B(r) | l(1+\rho) < 1+r]$$
$$D_{HB} = \mathbb{E}[H_B(r) - B_B(r) | l(1+\rho) < 1+r]$$
$$H_B(r) = P(u - r + l\rho) + (k-l)Py(1+\rho)$$
$$S_B(r) = P(u + 1 - l) + (k-l)Py(1+\rho)$$

Proposition 2 gives the inequality that must be satisfied for an anonymous undercollateralized loan market to be incentive-compatible for the borrowers. That is, the *always-honest* strategy yields the highest expected payoff. The result shows that higher collateral assets incentivize honest behavior. This is intuitive because borrowers would not want to lose their collateral (by defaulting) if the assets are of high quality.

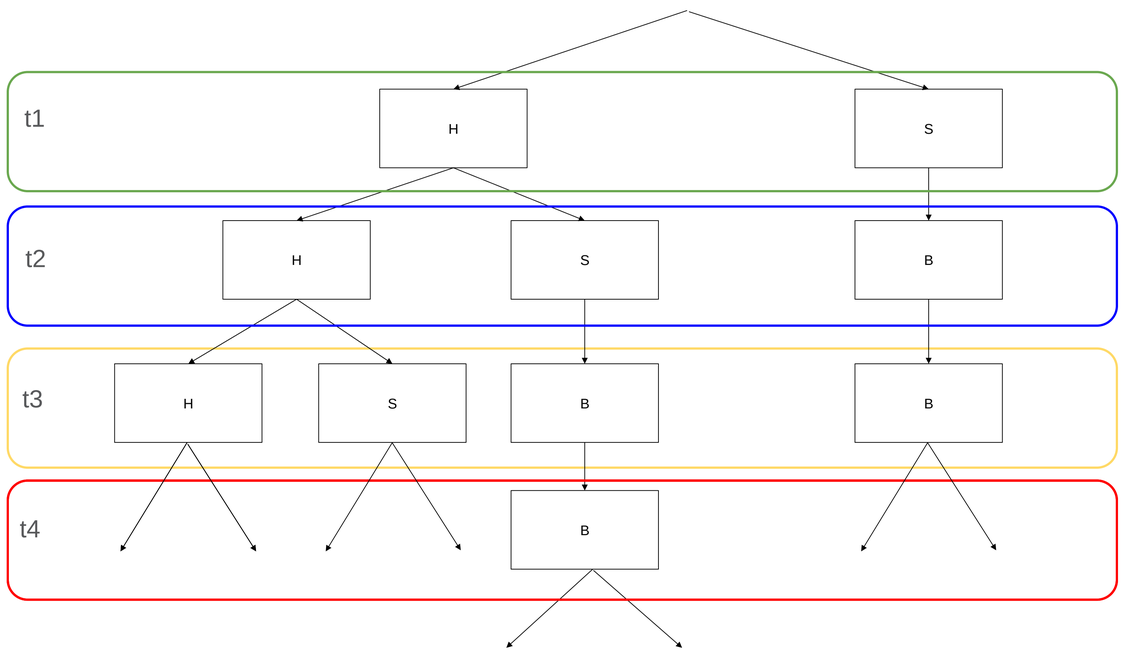

Figure 1. Visualization of possible payoff paths for a borrower given the credit building phase $\tau = 2$.

Discussion

The main result as proposed in *Proposition 2* suggests that with the right parameters, an anonymous undercollateralized loan market can be possible. Importantly, the result does not depend on the unobservable variable u – the borrower's expected return. While my design is not yet implemented in practice, empirical evidence supports this possibility. The first piece of evidence is the dark net markets. In these markets, buyers are similar to undercollateralized loan lenders because there is no buyer protection and recourse. Another piece of evidence is the P2P credit loan market on online forums such as *Reddit* (Correi et al., 2023). Such a market is very loosely designed without built-in incentives for pay back except for the users' online reputation and thus can only accommodate very small loans. My result can help extend such a market and combine it with blockchain systems to allow an anonymous undercollateralized loan market at scale. In extended models, I also consider accidental defaults and moral hazard. Under the assumption that borrowers maximize their risk-adjusted returns, the result is robust to moral hazard. Other considerations such as covenants and reputation systems can help improve the incentives for honesty.

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