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Third-party bailouts and tough lenders☆

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ABSTRACT

Contrary to the standard view, we argue that bailouts can sometimes alleviate moral hazard. In our model, a lender who interacts with a sequence of borrowers may wish to cultivate a reputation for toughness, by liquidating projects following default. However, when the opportunity cost of liquidation is high and the lender cannot publicly commit to randomization, such reputation may be unsustainable. In a subset of such cases, the possibility of a third-party bailout by the government or another investor is essential for the lender to build/maintain a reputation, by reducing the lender's short-term incentives to deviate from tough play.

1. Introduction

It is well-understood that bailouts tend to exacerbate moral hazard. The mechanism is straightforward: when the payoff associated with failure/default is increased, there are fewer incentives for effort exertion and/or higher incentives for risk-shifting. In this paper, we argue that sometimes bailouts can alleviate incentive problems rather than worsen them. We present a stylized model, in which a lender finances a project whose success probability depends on the effort exerted by the manager/borrower (Holmstrom and Tirole, 1997; Tirole, 2006). We show that the possibility of a bailout, while directly increasing the tendency for the manager to shirk, can sometimes encourage the lender to play "tough". A bailout that occurs with some probability allows the lender to play the prescribed equilibrium strategy (i.e., "tough") even though liquidation might actually not occur, which reduces the cost of the threat. When liquidation threats are critical for disciplining the borrower, the possibility of third-party bailouts can therefore become instrumental in making such threats credible, i.e., not overly costly for the lender. A caveat to our result is that if the probability of a bailout is too high, then the direct moral hazard effect (classic view) will tend to dominate as compared to our indirect reputation channel.

The main contribution of our work is to the literature on bailouts: Cordella and Yeyati (2003), Farhi and Tirole (2012), Chari and Kehoe (2016), Dell'Ariccia and Ratnovski (2019), and Philippon and Wang (2023), among others. To the best of our knowledge, we are the first to analyze the reputation channel of bailouts. Our work also links with theories about the role of liquidation threats in corporate finance. Bolton and Scharfstein (1990) show that not funding a later-stage project after a poor performance report is sometimes enough to overcome the perverse incentive to under-report interim cash flows. Dynamic agency models also employ firm size and liquidation as mechanisms that can curb moral hazard (e.g., DeMarzo and Fishman, 2007 and DeMarzo and Sannikov,

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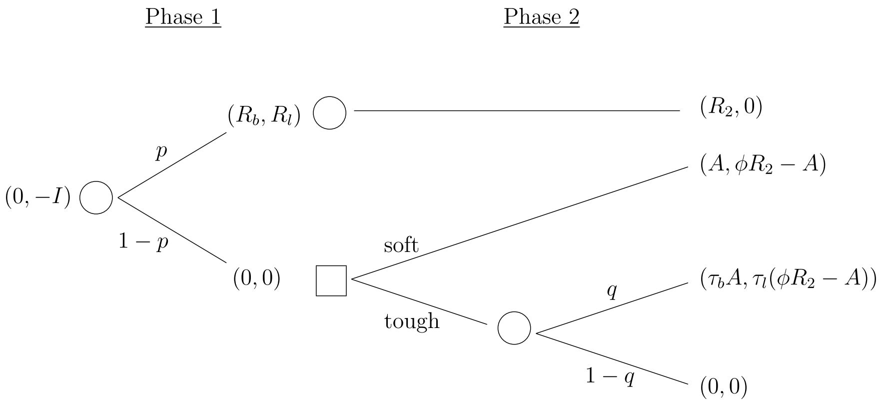

Fig. 1. The stage game. The figure refers to the case where the borrower played "work". Circle nodes denote moves by nature, the square node denotes a move by the lender. In phase 1 there is success if the borrower works with probability p ($p - \Delta$ otherwise). In phase 2, following success, the game ends; following failure, the lender chooses whether to play soft or tough. Upon playing tough there is a probability $q \in [0, 1)$ of a third-party bailout. The first entry inside parentheses refers to borrower payoffs, the second to lender payoffs.

2006). We contribute to this literature by asking what happens to liquidation threats when a third party intervenes in the financing and production dynamics. Finally, our paper makes a contribution to research on banks' reputation for toughness. Deviatov and Ickes (2005) find that lenders who acquire a reputation for being tough can earn higher profits than lenders with a reputation for being soft. In the context of mortgage loans, Riddiough and Wyatt (1994) show that lenders are sometimes willing to incur economic losses in the short term (e.g., foreclosing when a workout is cheaper) to improve expected future revenues. Our model contributes to this literature by showing that a third party can help banks maintain their reputation.

2. Model

The economy comprises a long-lived lender (or investor) who faces a sequence of identical short-lived borrowers. All agents are risk-neutral, and the lender discounts the future at a rate r per borrower round. Each round of lender–borrower interaction comprises a project with two phases, described in Fig. 1. The project requires an initial investment of I, which must be fully financed by the lender. The first phase is a success with probability p if the borrower *works* and $p - \Delta$ if the borrower *shirks*. Shirking generates a private benefit of B for the borrower. Upon phase-1 success, which yields a total payoff of R_1, the lender collects a payoff of $R_l \in [0, R_1]$ (the face value of debt) and the borrower collects the remainder, $R_b := R_1 - R_l$.[1]

The total surplus following success is denoted by R_2 and entirely captured by the borrower. Phase-1 failure is associated with *default* and a subsequent control shift to the lender who then decides whether to play *tough* or *soft*.[2] If the lender plays soft upon phase-1 failure, then the project is kept alive for phase 2 and yields a smaller continuation value than under success: ϕR_2 with $\phi \leq 1$. From this total surplus, the borrower receives a fixed payoff of A, which can be thought of as an agency rent associated with the second phase of the project. The lender receives the remaining payoff of $\phi R_2 - A \geq 0$. If the lender plays tough after phase-1 failure, then the project becomes at risk of being liquidated, leading to zero payoff for both players.[3]

Bailouts are modeled in reduced-form and carried out by an unspecified third party, which can be an investor or the government (but please see the appendix for a more endogenous version). Bailouts take place with probability q for the projects that failed during phase 1 and which the lender threatens to liquidate. In case a bailout materializes, then the project is still operated during phase 2 with the manager/borrower remaining involved (e.g., due to firm-specific human capital). The bailout payoffs of the borrower and the lender are modeled as a (positive) fraction of their respective levels when the lender plays soft. Specifically, the borrower receives $\tau_b A$ and the lender $\tau_l(\phi R_2 - A)$.

Assumption 1. The following aspects are true of bailouts: (i) bailouts exacerbate borrower ex ante moral hazard, since with a bailout the borrower receives a relatively higher payoff upon failure ($\tau_b \geq 1$), and therefore has fewer incentives to exert effort during phase 1; (ii) bailouts are not a panacea for the lender who can obtain a better payoff by playing soft ($\tau_l \leq 1$); (iii) bailouts do not improve the aggregate surplus generated by the project ($\tau_b A + \tau_l(\phi R_2 - A) \leq \phi R_2$).

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[1] For simplicity, we take the payoffs (R_b, R_l) as exogenous, implicitly reflecting the (un-modeled) relative bargaining power of the two players.

[2] For example, playing tough could mean denying funds for the next phase of the project or initiating bankruptcy proceedings, which is not explicitly modeled.

[3] We make two additional assumptions about the parameter configuration. First, the upfront investment required for the project is low enough that the lender's participation constraint is satisfied even when the borrower shirks and the project is liquidated after phase-1 default: $I \leq (p - \Delta)R_l$. Second, the face value of debt is higher than the maximal payoff the lender can receive after phase-1 default: $R_l \geq \phi R_2 - A$, and hence the lender is always better off after phase-1 success than after phase-1 failure.

Let us for a moment assume that the lender is able to announce her strategy at the outset and credibly convey it to the borrower. We denote the borrower's ex ante payoff by $\pi_b^i(m)$, where $i \in \{w, s\}$ represents the actions available to the borrower, namely work or shirk, and $m \in \{0, 1\}$ represents the equilibrium probability that the lender plays tough following phase-1 failure. More specifically,

$$\begin{aligned}\pi_b^w(m) &= p(R_b + R_2) + (1-p)(1-m)A + (1-p)mq\tau_b A\\ \pi_b^s(m) &= (p-\Delta)(R_b + R_2) + (1-p+\Delta)(1-m)A + (1-p+\Delta)mq\tau_b A + B.\end{aligned}$$

Working is incentive-compatible for the borrower if and only if

$$\pi_b^w(m) \geq \pi_b^s(m) \Leftrightarrow \frac{B}{\Delta} \leq R_b + R_2 - A[(1-m) + mq\tau_b].$$

When the probability of bailout (q) is low, it is easier to discipline the borrower under tough play ($m = 1$), provided that $q\tau_b < 1$. Bailouts worsen the moral hazard problem because the borrower gets a relatively higher payoff upon failure. The ex ante payoffs for the lender, denoted by $\pi_l^i(m)$ for $i \in \{w, s\}$, are in turn given below:

$$\begin{aligned}\pi_l^w(m) &= pR_l + (1-p)(1-m)(\phi R_2 - A) + (1-p)mq\tau_l(\phi R_2 - A) - I\\ \pi_l^s(m) &= (p-\Delta)R_l + (1-p+\Delta)(1-m)(\phi R_2 - A) + (1-p+\Delta)mq\tau_l(\phi R_2 - A) - I.\end{aligned}$$

Lemma 1 describes the conditions that characterize the cases of interest, that is, the lender has a latent incentive to play tough if she could credibly announce it ex ante.

Lemma 1. *The lender (ideally) plays tough ($m = 1$) if and only if the following two conditions are satisfied simultaneously:*

$$B \in \left[\Delta(R_b + R_2 - A), \Delta(R_b + R_2 - q\tau_b A)\right] \tag{1}$$

$$\phi R_2 - A \leq \frac{\Delta R_l}{[(1-p)(1-q\tau_l) + \Delta]}. \tag{2}$$

The upper bound of B given in condition (1) rules out the cases where incentive problems are so severe that even playing tough does not make the borrower work. At the same time, incentive problems cannot be so mild that moral hazard does not exist if the lender plays soft, which yields the lower bound for B in condition (1). We also require that the lender prefers to play tough and have the borrower work than play soft and let the borrower shirk. The LHS of condition (2) is the lender's payoff when she never liquidates (i.e., plays soft) which should be low enough that playing tough is not too costly. Finally, it is easy to check that the RHS of inequality (2) increases with q, meaning that with bailouts it is marginally more economic for the lender to play tough, as bailouts make punishment threats less costly on average.

In the dynamic setting, the infinitely-lived lender faces a sequence of short-lived identical managers/borrowers and all prospective borrowers perfectly observe whether the lender acted tough or soft in the past. This allows the lender to potentially build a reputation for toughness. Following standard arguments from the repeated-games literature (e.g., Mailath and Samuelson (2006)), we can then characterize a subgame perfect Nash equilibrium (SPNE) where the lender optimally chooses to act tough, even though this is costly in the short-run.[4]

Consider a lender who would ideally find it useful to develop a reputation for playing tough such that conditions (1) and (2) are met. Let $Z(q)$ denote the slack in the reputation sustainability condition and is given by

$$Z(q) = \underbrace{\frac{\pi_l^w(1) - \pi_l^s(0)}{r}}_{\text{Long-term loss when deviating}} - \underbrace{(1-q\tau_l)(\phi R_2 - A)}_{\text{Short-term gain when deviating}}. \tag{3}$$

The function $Z(q)$ captures how much the lender loses (in net) when deviating from playing tough to soft, with a long-term and short-term component. By deviating to soft play (and the borrowers always shirk), the lender loses a perpetuity worth $\pi_l^w(1)/r$ but gains a perpetuity worth $\pi_l^s(0)/r$. The short-term component is the difference between the foregone one-round payoff to playing tough ($q\tau_l(\phi R_2 - A)$) and the corresponding payoff to playing soft ($\phi R_2 - A$). As is standard in repeated-game settings, $Z(q) \geq 0$ is easier to satisfy if the discount rate r is lower (i.e., higher continuation value).

We now state the main result of the paper.

Proposition 1. *The lender does not have an incentive to deviate from tough play (i.e., $Z(q) \geq 0$) as long as the opportunity cost of liquidation is not too high:*

$$\phi R_2 - A \leq \frac{\Delta R_l}{[(1-p+r)(1-q\tau_l) + \Delta]}. \tag{4}$$

Furthermore, the effect of q on reputation sustainability is always positive at the margin:

$$\frac{\partial Z(q)}{\partial q} > 0. \tag{5}$$

[4] We focus on equilibria with grim-trigger strategies, i.e., where a one-time deviation to playing soft is associated with all prospective borrowers assigning a probability of 1 to the lender playing soft. In contrast, if the lender always acted tough, then prospective borrowers assign a probability of 1 that the lender will continue to play tough in the future. Please see a more detailed discussion about equilibrium selection in the appendix.

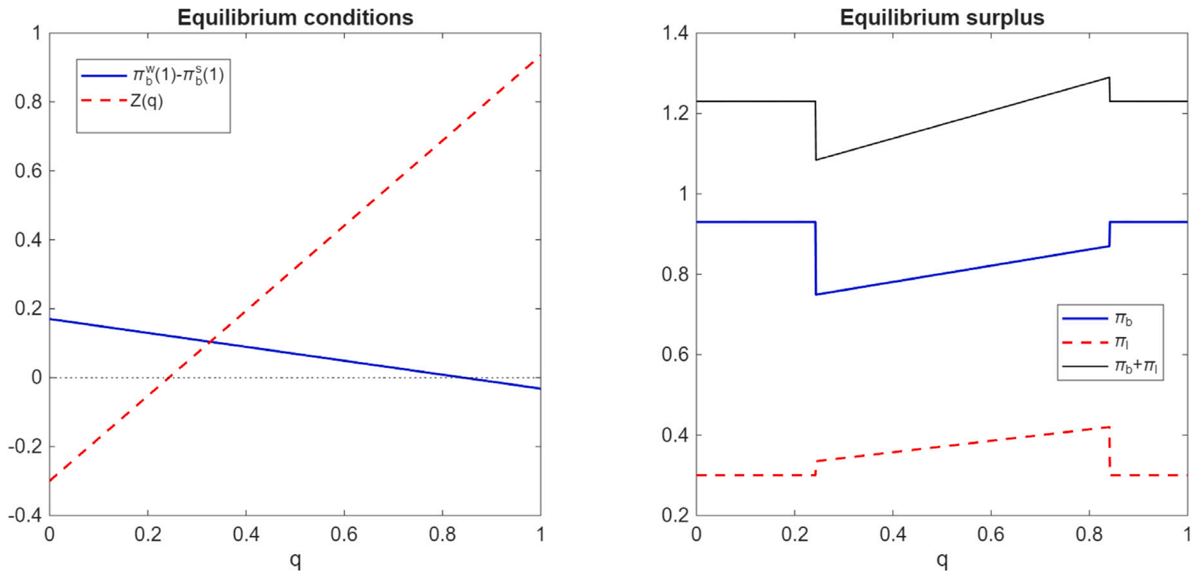

Fig. 2. Bailout probability (q) and equilibrium outcomes. The left panel shows how two of the conditions required for the equilibrium to be (work,tough) vary with q; the condition $\pi_b^w(1) - \pi_b^s(1) \geq 0$ (solid blue line) refers to working being incentive-compatible for the borrower; the condition $Z(q) \geq 0$ (dashed red line) refers to the sustainability of principal tough play, from a repeated-games perspective. The right panel plots the (one round) equilibrium ex ante payoff for borrower (π_b; solid blue line) and lender (π_l; dashed red line). Choice of parameters: $I = 0$, $R_1 = R_2 = 1$, $p = \Delta = 0.5$, $R_b = A = 0.4$, $\phi = 0.7$, $\tau_b = 1.01$, $\tau_l = 0.95$, $B = 0.53$, $r = 0.15$.

In our model, bailouts increase the returns to tough play by lowering the short-run cost (per round) of using liquidation threats as a way to discipline the borrower and by making it incentive-compatible for the lender to carry out said threats in a repeated-game sense. Bailouts worsen the incentives problem of the borrower directly (classic view), but also help solve it in an indirect fashion, by encouraging the lender to discipline the borrower.

A limitation of our analysis above is if the true bailout probability q, which in the real world is endogenous, correlates with other economic variables in a way that might reduce the importance of the indirect reputation channel. For example, suppose that q is partly determined by some direct cost of entry faced by the third party who is doing the rescue. Moreover, assume that this cost of entry is correlated with interest rates, which are key for our mechanism to operate (in particular, discount rates need to be low enough). Then if for whatever reason interest rates were negatively correlated with the aforementioned entry costs, our mechanism would potentially never be observed in equilibrium. This type of concern could be addressed in a more complex model, which is beyond the scope of our paper.

3. Discussion

In this section we use a numerical example to illustrate both the benefits and limitations of the reputation channel, within the context of our model. The example is shown in Fig. 2, which plots equilibrium outcomes for varying levels of bailout probability q. The example chosen guarantees a priori two important conditions for any q, conditions that are necessary for the reputation mechanism to be relevant, as discussed in the previous section: (i) if the lender plays soft, the borrower shirks, i.e., $\pi_b^w(0) - \pi_b^s(0) < 0$; and (ii) the lender prefers to play tough and have the borrower work than play soft and have the borrower shirk. This last condition, to be applicable to all q, requires that

$$\pi_l^w(1) - \pi_l^s(0)\Big|_{\forall q} \geq 0 \Leftrightarrow \Delta R_l - (1 - p + \Delta)(\phi R_2 - A) \geq 0.$$

The other two conditions for the reputation mechanism to be relevant are shown in the left panel of Fig. 2 and point to the key tension in our result. On one hand increasing q makes the reputation sustainability condition $Z(q) \geq 0$ more slack (dashed red line); on the other hand increasing q makes the borrower's incentive-compatibility condition $\pi_b^w(1) - \pi_b^s(1) \geq 0$ less slack (solid blue line). This trade-off implies that there is only an intermediate region for q where both conditions are satisfied: an initial increase from zero can make tough play sustainable and useful for the lender; once q becomes very high, playing tough is no longer useful, since the borrower shirks anyway.

The right panel of the figure shows what happens in terms of the agents' ex ante payoffs. Interestingly, when playing tough becomes initially feasible (high enough q), there is a decrease in overall welfare. The lender is obviously better off, since her threats become credible and can now be used to discipline the borrower. At medium levels of q and having to work hard (loss of private benefit B), the borrower, however, is worse off relative to soft play. As q increases the borrower's payoff also increases since he faces a higher likelihood of continuation, even though he does not capture B. Total welfare is maximized right at the boundary where threats no longer have bite; this is the configuration where there is on-equilibrium-path punishment but said punishment is at an efficient level. Even if we assume that bailouts do not create additional value ($\tau_b A + \tau_l(\phi R_2 - A) \leq \phi R_2$), the example shows that for moderate to high values of q, bailouts increase aggregate surplus (i.e., they improve welfare) relative to the no-bailout case ($q = 0$).

Two caveats are warranted at this stage. First, a more rigorous welfare analysis would require us to consider externalities, and not just the payoffs for borrower and lender; since externalities play an important role for some types of bailouts, namely government interventions. Second, the results above implicitly assume that the contract/mechanism specifying R_b and R_l does not vary with q. In some settings with nominal or other institutional/cultural rigidities this might be an appropriate assumption, in other settings probably not. We leave these analyses for future work.

4. Conclusion

We develop a simple model of bailouts with a novel feature: the reputation channel. We show how sometimes bailouts are instrumental in enabling a lender to credibly announce to punish borrowers after default, which in turn can be critical to overcome moral hazard. While not a panacea — since the classic moral hazard mechanism still operates — our indirect reputation channel implies that bailouts might be less costly in terms of ex ante incentives than previously thought. This is relevant for both private organizations and policymakers.

CRediT authorship contribution statement

Fernando Anjos: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Irem Demirci:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Miguel Oliveira:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Appendix

A.1. Endogenous bailout probability

In this section we present a simple way of endogenizing the bailout probability q. Assume now that the rescuer, which can be the government or a private third party, faces uncertain costs of entry — known before entry is decided — denoted by C, which are uniformly distributed: $C \sim U(0, \overline{C})$. As before, bailout payoffs for the borrower and the lender are constant fractions of their respective levels when the lender plays soft: the borrower receives $\tau_b A$ and the lender $\tau_l(\phi R_2 - A)$, where $\tau_b \geq 1$ and $\tau_l \leq 1$.

For a private third party to rescue the company, the cost of rescue should not exceed the benefit to the rescuer. To compute the benefit to the rescuer let us assume that the total surplus available to all three players is still ϕR_2, as in the case where the lender plays soft. Moreover, let us assume the third party potentially receives some additional project-exogenous payoff of $G \geq 0$, which could represent public externalities. In short, after cost C is sunk, the rescuer receives $(1 - \tau_l)\phi R_2 - (\tau_b - \tau_l)A + G$. The ex ante probability of bailout is then given by

$$q = \begin{cases} \min\left(1, \frac{(1-\tau_l)\phi R_2 - (\tau_b - \tau_l)A + G}{\overline{C}}\right), & \text{if } (1 - \tau_l)\phi R_2 - (\tau_b - \tau_l)A + G > 0 \\ 0, & \text{otherwise.} \end{cases} \tag{A.1}$$

The results we derived in the main part of the paper are economically equivalent if we consider comparative statics on C and/or G instead of q.

A.2. Equilibrium selection

The equilibrium we focused on in the main part of the paper is an SPNE with grim-trigger strategies. This is a widely used equilibrium concept in repeated games, in part because it maximizes the punishment for deviations from long-run efficient play. More precisely, in our setting this equilibrium is characterized as follows: (i) the lender (LR player) plays "tough" after every history; (ii) each borrower (SR player) plays "work" after every history in which the LR player played "tough" in the previous round, and "shirk" after every history in which the LR player played "soft" (off-equilibrium-path action); (iii) each SR player assigns probability 1 to the LR player playing "tough" whenever she played "tough" in the previous round, and probability 0 otherwise (off-equilibrium-path belief).

While this SPNE exists, it is well known that repeated games admit a multiplicity of equilibria, including the stage-game Nash equilibrium (in our case "soft", "shirk"). Some equilibria are more plausible than others, and we argue that the grim-trigger equilibrium is particularly appropriate in our setting.

First, note that the LR player will not mix, except in knife-edge cases. Within each lender–borrower round there is a decision node at which only the lender moves and must choose between "soft" and "tough". For generic parameter values, the lender's continuation payoff is strictly higher under one of these actions, ruling out mixing. Therefore, any relevant SPNE involves the LR player choosing either "tough" or "soft" following different histories, rather than randomizing.

Second, it is reasonable to assume that SR players have limited memory and, in particular, focus on what happened in the most recent round.[5] Restricting attention to such equilibria, one might conjecture an alternative SPNE in which: (i) SR players believe that if the LR player chose "tough" in the previous round, then she will choose "soft" in the current round, and vice versa; and (ii) the LR player alternates between "soft" and "tough" so as to confirm these beliefs. However, this candidate equilibrium cannot be sustained. Suppose the current SR player believes the LR player will play "tough" after interim failure; then that borrower is already disciplined by these beliefs. The LR player's incentive is therefore to influence the beliefs of the next-round borrower, which is achieved by playing "soft" rather than "tough". This creates a profitable deviation from the prescribed strategy, violating sequential rationality. Hence, such a conjectured alternating equilibrium cannot be an SPNE.

Third, consider the SPNE that coincides with the stage-game Nash equilibrium. When our mechanism is relevant, this equilibrium is strictly inferior for the LR player. As a result, the LR player has an incentive to "teach" SR players that she will play "tough". This reasoning follows the logic of Fudenberg and Levine (1989), which formally relies on the presence of commitment types. Although commitment types are absent in our model, the underlying intuition remains applicable.

A.3. Proofs

Proof of Lemma 1. The upper bound in condition (1) of the lemma follows from requiring that the borrower would prefer to work when the lender plays tough:

$$\begin{aligned}
&\pi_b^w(1) \geq \pi_b^s(1) \Leftrightarrow p(R_b + R_2) + (1-p)q\tau_b A \geq (p-\Delta)(R_b+R_2) + (1-p+\Delta)q\tau_b A + B \\
&\Leftrightarrow \Delta(R_b+R_2) \geq \Delta q\tau_b A + B \Leftrightarrow B \leq \Delta(R_b + R_2 - q\tau_b A).
\end{aligned}$$

For the lower bound, we require that the worker would prefer to shirk under soft play:

$$\begin{aligned}
&\pi_b^w(0) \leq \pi_b^s(0) \Leftrightarrow p(R_b + R_2) + (1-p)A \leq (p-\Delta)(R_b+R_2) + (1-p+\Delta)A + B \\
&\Leftrightarrow \Delta(R_b+R_2) \leq \Delta A + B \Leftrightarrow B \geq \Delta(R_b + R_2 - A).
\end{aligned}$$

Condition (2) given in the lemma follows from requiring the lender to play tough and have the borrower work rather than play soft and let the borrower shirk:

$$\begin{aligned}
&\pi_l^w(1) \geq \pi_l^s(0) \Leftrightarrow pR_l + (1-p)q\tau_l(\phi R_2 - A) - I \geq (p-\Delta)R_l + (1-p+\Delta)(\phi R_2 - A) - I \\
&\Leftrightarrow \Delta R_l \geq [(1-p+\Delta) - (1-p)q\tau_l](\phi R_2 - A) \Leftrightarrow \phi R_2 - A \leq \frac{\Delta R_l}{[(1-p)(1-q\tau_l)+\Delta]}.
\end{aligned}$$

Proof of Proposition 1. The difference between the one-period payoffs to playing tough and soft is given by

$$\begin{aligned}
\pi_l^w(1) - \pi_l^s(0) &= pR_l + (1-p)q\tau_l(\phi R_2 - A) - I - [(p-\Delta)R_l + (1-p+\Delta)(\phi R_2 - A) - I] \\
&= \Delta R_l + [(1-p)q\tau_l - (1-p+\Delta)](\phi R_2 - A) \\
&= \Delta R_l - [(1-p)(1-q\tau_l)+\Delta](\phi R_2 - A).
\end{aligned}$$

By substituting this into Eq. (3), we obtain

$$\begin{aligned}
Z(q) &= \frac{\pi_l^w(1) - \pi_l^s(0)}{r} - (1-q\tau_l)(\phi R_2 - A) \\
&= \frac{\Delta R_l - [(1-p)(1-q\tau_l)+\Delta](\phi R_2 - A)}{r} - (1-q\tau_l)(\phi R_2 - A). \qquad \text{(A.2)}
\end{aligned}$$

The inequality in (4) solves for the highest $\phi R_2 - A$ for which the lender still finds deviating to soft play costly:

$$\begin{aligned}
&Z(q) \geq 0 \Longleftrightarrow \frac{\Delta R_l - [(1-p)(1-q\tau_l)+\Delta](\phi R_2 - A)}{r} - (1-q\tau_l)(\phi R_2 - A) \geq 0 \\
&\Longleftrightarrow \Delta R_l \geq r(1-q\tau_l)(\phi R_2 - A) + [(1-p)(1-q\tau_l)+\Delta](\phi R_2 - A) \\
&\Longleftrightarrow \phi R_2 - A \leq \frac{\Delta R_l}{[(1-p+r)(1-q\tau_l)+\Delta]}.
\end{aligned}$$

Taking the derivative of Eq. (A.2) with respect to q yields

$$\frac{\partial Z(q)}{\partial q} = \frac{\tau_l(\phi R_2 - A)(1-p)}{r} + \tau_l(\phi R_2 - A) = \frac{(1-p+r)\tau_l}{r}(\phi R_2 - A) > 0,$$

provided that $\phi R_2 > A$, $1 - p \geq 0$, and $r > 0$.

[5] Recent work on repeated games is particularly interested in understanding how short memories can still sustain long-run efficient play; see for example Pei (2024). See also Rubinstein (1986) for more classic arguments for focusing on equilibria with low complexity.

Data availability

Data will be made available on request.

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