# Credit Ratings and Investments *

Anna Bayona Oana Peia Razvan Vlahu

July, 2024

**Abstract**

We study the impact of potentially inflated credit ratings in bond markets using experimental coordination games. Theoretical models that feature a feedback effect between capital markets and the real economy suggest that inflated ratings can have both positive and negative effects. Comparing markets with and without a credit rating agency, we find that ratings significantly influence investor behaviour and capital allocation to firms. Our results suggest that the positive effects are likely to dominate. The main mechanism through which these real effects materialize is a shift in investors' beliefs about the behaviour of others rather than the firm's underlying fundamentals.

**JEL**: D81; D82; D83; G24
**Keywords**: Credit ratings; Imperfect information; Investor beliefs; Firm financing

*Bayona: ESADE Business School, Universitat Ramon Llull, e-mail: anna.bayona@esade.edu; Peia: University College Dublin, School of Economics, e-mail: oana.peia@ucd.ie; Vlahu: De Nederlandsche Bank, Economic Policy and Research Division, e-mail: r.e.vlahu@dnb.nl. We thank Dion Bongaerts, Martin Brown, Andrea Colciago, Camille Cornand, Vessela Daskalova, John Duffy, Lorenz Emter, Rustamdjan Hakimov, Frank Heinemann, Stefan Hirth, Anita Kopanyi-Peuker, Rosemarie Nagel, Mikael Paaso, Luba Peterson, Margaret Samahita, Spyros Terovitis, Stefan Trautmann, Radu Vranceanu, and Sweder van Wijnbergen, as well as seminar and conference participants at University of Innsbruck, Nottingham Business School, University of Piraeus, DNB, ESADE, University College Dublin, the 12$^{th}$ Workshop on Theoretical and Experimental Macroeconomics (Berlin), the 12$^{th}$ International Conference of the French Association of Experimental Economics (Lyon), the 8$^{th}$ ERMAS conference (Cluj-Napoca), CREST/LESSAC Workshop in Experimental Economics (Dijon), the 6$^{th}$ Stavanger Behavioural Economics and Finance Workshop, ICMAIF (Crete), IBEFA (San Diego), EEA (Barcelona), the Strategic Interaction in Corporate Finance Workshop (Aarhus), and the Economic Sciences Association (Exeter) for valuable comments and suggestions. We also thank Ji Ho Choi, Pablo López-Aguilar, Sergio Salas, and Néstor Salcedo for excellent research assistance. The views expressed in this paper are those of the authors and do not necessarily represent those of DNB or the Eurosystem.

# 1 Introduction

The feedback effects between capital markets and the real economy are often understated. Credit ratings play a pivotal role in this intricate relationship, as they do not merely reflect firms' creditworthiness, but also affect it (Manso, 2013). They do so by shaping investors' decisions on where to allocate their capital, subsequently affecting firms' access to credit and the associated borrowing costs.

Yet, the 'issuer pays' business model used by the leading credit rating agencies (CRAs) has raised concerns about potential rating inflation (i.e., instances when a CRA may overestimate a firm's creditworthiness), which could result in adverse effects on the functioning of the feedback mechanism between financial markets and the real economy.[1] The potential consequences of inflated credit ratings can be significant. They promote capital misallocation, distortion of market prices, and a false sense of security for investors.[2] Investors may be lured into taking on more risk than they can handle, while issuers may be able to access cheaper funding than they deserve. Inflated credit ratings can also lead to moral hazard problems with adverse real economic effects, where issuers take on more risk than they otherwise would. At the same time, inflated ratings can also foster market liquidity and facilitate firms' access to credit markets, which can benefit economic growth, particularly when improved financing conditions enable efficient investments. Understanding the role that inflated ratings play in shaping investors' behaviour and decision-making is empirically challenging, as it is difficult to establish the causal impact of ratings on investors' or firms' decisions, particularly in environments where multiple equilibria may be present (Boot *et al.*,

[1] See, for example, Ashcraft and Schuermann (2008), Jiang *et al.* (2012), Alp (2013), Cornaggia and Cornaggia (2013), White (2013), and Fulghieri *et al.* (2014). Factors that can lead to credit inflation include conflicts of interest, such as the desire to maintain a good relationship with an issuer (Mählmann, 2011; He *et al.*, 2012; Strobl and Xia, 2012; Frenkel, 2015); (lax) regulation (Opp *et al.*, 2013; Bae *et al.*, 2015); the pressure to retain market share (Becker and Milbourn, 2011; Bolton *et al.*, 2012; Baghai and Becker, 2020); or ratings-shopping (Skreta, 2009; White, 2010; Bongaerts *et al.*, 2012).

[2] During the Global Financial Crisis, large losses on highly-rated securities and their downgrades indicated that these securities had inflated ratings (US Senate, 2007; Benmelech and Dlugosz, 2009a,b; Griffin and Tang, 2011, 2012; US Government, 2011; Griffin *et al.*, 2013). Major rating agencies, such as Moody's and Standard & Poor's, paid more than \$1 billion in legal settlements to resolve allegations arising from their role in providing inflated ratings to mortgage-related securities in the run-up to the financial crisis.

2006).[3] In this paper, we design a laboratory experiment that allows us to overcome some of these challenges by providing an ideal environment to study investors' reactions to inflated ratings.

We provide evidence on the informational role of (potentially) inflated credit ratings and their impact on investment decisions. We adapt Goldstein and Huang's (2020) bond financing model to derive predictions that guide our experimental design. A firm can invest in two types of risky projects: low-risk or high-risk. To undertake a project, the firm uses two sources of financing: internal funds from ongoing activities and external financing from the bond market. The low-risk project has a higher net present value than the high-risk project but requires a larger investment due to its scarcity and associated cost of screening. If the firm cannot secure enough funds to undertake the efficient, low-risk project, it can either invest in a high-risk project or default. Default occurs in the model whenever external funds are insufficient to cover the firm's losses from existing activities.

The firm raises external financing from investors who receive noisy private signals about the firm's internal funds (representing its fundamentals). Additionally, these investors may observe a publicly available credit rating. A forward-looking CRA perfectly observes the firm's fundamentals and assesses its creditworthiness by assigning either a good (potentially inflated) or a bad (perfectly revealing) rating.[4] The inflated rating pools high- and low-risk firms together, thus not accurately reflecting the true quality of high-risk firms. Nevertheless, it provides positive information about a firm by implying lower default risk, attracting more investors to buy bonds. This increased availability of external financing indirectly influences the firm's project choice. On the positive side, it enables firms that would have pursued high-risk projects to undertake low-risk projects due to adequate financing. On the negative side, firms that would have defaulted in the absence of the inflated rating might gamble for

[3]While several studies document a positive correlation between changes in ratings and firms' and investors' decisions, these studies often face an endogeneity problem, as it is difficult to causally show that investors react to the change in rating itself and not some underlying firm fundamental that is observed by both investors and the rating agency (Cornaggia *et al.*, 2018).

[4]A firm receives a good rating when its internal funds are above a specific (default) threshold. When deriving the threshold, the rating agency considers the effect of the rating on investors' and the firm's decisions.

resurrection by undertaking an inefficient high-risk project.[5]

We design a laboratory experiment that allows us to evaluate these two opposing effects while controlling for investors' information sets and firm fundamentals. In the experiment, participants act as investors tasked with deciding whether to purchase or not a firm's bond. They play a five-person coordination game where their payoffs from investing depend on whether the firm undertakes the low- or high-risk project or defaults. The firm's decision is mechanical and depends on the number of investors financing the firm and the firm's fundamentals.[6] Before participants make their investment decision, they receive a noisy private signal about the firm's fundamentals (i.e., internal funds). We then elicit participants' beliefs about the true value of fundamentals and how many investors buy the bonds. We consider two treatments in a between-subject design: (i) a Baseline treatment, where subjects only receive the private signal, and (ii) a CRA treatment, where subjects observe a (potentially inflated) public credit rating about the firm's ability to repay its creditors in addition to the private signal. In the CRA treatment participants are not explicitly informed that the rating may be inflated. Similar to the firm's decision, the rating is computerized and automatically determined according to the theoretical model's predictions. Based on the model's predictions, we derive several testable hypotheses regarding the positive and negative effects of inflated ratings for different levels of firm fundamentals.

We find that the firm's access to external finance differs significantly across the two treatments conditional on firm fundamentals and the observed rating. First, firms in the CRA treatment with relatively high (low) fundamentals receive substantially more (less) external financing than firms in the Baseline treatment with similar fundamentals. Second, there is more investment in the CRA treatment conditional on investors observing a good (potentially inflated) rating and less investment conditional on the observation of a bad rating. Finally, the increased availability of external financing in the CRA treatment leads to significantly more firm investment in the efficient, low-risk project and significantly fewer firms

[5]The model allows for positive and negative effects of inflated ratings that depend on the parametrization.

[6]This experimental design allows us to focus on participants' decision-making while shutting down the possibility for firm strategic behaviour.

investing in a high-risk project compared to the Baseline treatment. These results point to an overall positive effect of inflated ratings leading to a more efficient allocation of capital and enhanced market outcomes.

To understand the mechanism that drives this result, we study individual investment behaviour and analyze the effects of credit ratings on investors' actions and beliefs. Our results suggest that ratings act as strong coordination devices. Investors in the CRA treatment who observe a good (bad) rating are more (less) likely to buy the firm's bonds than investors in the Baseline treatment. We document that the main channel through which the real effects materialize in the presence of feedback effects between credit ratings and firms' actions is not through the updating of investors' beliefs about the firm's fundamentals, but rather through the updating of beliefs about other investors' behaviour. On the one hand, investors in the CRA treatment who observe a good (bad) rating are much more (less) likely to believe that the other investors will (will not) buy the firm's bonds. Moreover, a bad rating has a stronger impact on expectations about the behaviour of other investors than a good rating. On the other hand, beliefs about firm fundamentals are unaffected by ratings. These results emphasize the importance of credit ratings even if they have a limited impact on beliefs about firms' fundamentals. The reason is that observed good (bad) rating makes investors more optimistic (pessimistic) about the number of others that invest. Moreover, the presence of the rating acts as a strong focal point, enabling players to coordinate around both good and bad ratings. This explains why we observe an overall positive effect of inflated ratings: in the Baseline treatment, the absence of this focal point leads to excessive investment in defaulting firms.

Our paper relates to several strands of the literature. There is a rich theoretical literature on the real effects of financial markets (see Bond *et al.*, 2012; Goldstein, 2023, for reviews), with several works specifically focusing on the real effects of credit ratings (Boot *et al.*, 2006; Jeon and Lovo, 2013; Manso, 2013; Hirth, 2014; Goel and Thakor, 2015; Fulghieri *et al.*, 2014; Sangiorgi and Spatt, 2017; Donaldson and Piacentino, 2018; Daley *et al.*, 2020; Parlour and Rajan, 2020; Terovitis, 2020). Our empirical results are consistent with the theoretical predictions from Boot *et al.* (2006), who show that credit ratings can serve as coordination mechanisms.

Second, our paper relates to the empirical literature that attempts to identify the causal effects of ratings on investors' decisions. Several papers exploit various exogenous changes in firms' ratings that are unrelated to fundamentals (e.g., rating refinements or automatic rating downgrades due to sovereign risk) to overcome the endogeneity concern that the change in rating and the change in investors' behaviour can be driven by the same (unobserved) confounding factors (see, for example, Kliger and Sarig, 2000; Kisgen, 2009; Tang, 2009; Sufi, 2009; Bannier and Hirsch, 2010; Kisgen and Strahan, 2010; Ellul *et al.*, 2011; Almeida *et al.*, 2017; Cornaggia *et al.*, 2018).[7] However, this literature cannot assess the informational role of *inflated* ratings, as one cannot empirically observe which ratings are inflated. Using a laboratory experiment allows us to overcome this obstacle and study the informational channels through which rating inflation can affect investors' decisions and market outcomes. While lab experiments, by their nature, have limitations in generalizing findings to broader contexts, the same is true for any empirical study in a specific institutional setting. Various factors, including portfolio structure, household wealth, and financial sophistication, influence investment decisions in the bond market. However, our goal is not the prediction of quantitative effects. Instead, our focus is on gaining a deeper understanding of the fundamental mechanisms at play when public information impacts investment behaviour within an environment of strategic uncertainty. The evidence suggests that such qualitative behavioural mechanisms identified in lab experiments generalize to non-student populations (Huck and Muller, 2012; Noussair *et al.*, 2014) and even professionals (Frechette, 2015; Weitzel *et al.*, 2020). As Levy (1994) argues, experimental participants create their own frame of mind in which they make decisions for modest stakes in the same way they would make decisions outside the lab for significant stakes.

Third, our work adds to an expanding experimental finance literature (see Sunder, 2007;

[7] This literature finds that CRAs' actions affect market participants and have real effects on firms' access to capital and their investments.

Bossaerts *et al.*, 2009; Bloomfield and Anderson, 2010, for reviews). Within this literature, there are a few experimental studies on credit ratings. Keser *et al.* (2017) study the repeated interaction between an issuer and a CRA and find that issuers frequently request ratings, while the CRA reciprocates with rating inflation. Rabanal and Rud (2017) show how market structure affects credit ratings. In contrast to these papers, we study the effect of a credit rating on investors' decisions. Importantly, in our experiment, participants play the role of investors who decide whether to buy the firm's bond, while the decisions of the firm and the rating agency are based on their optimizing behaviour. Our paper is the first to empirically study the economic efficiency of inflated ratings when there is a feedback effect between the real economy and the financial sector. In this aspect, our work relates to Weber *et al.* (2018), who study the feedback effect between a bond's initial public offering price and the probability of issuer default.

Finally, we add to a rich experimental global games literature that studies participants' reactions to private and public information in contexts of strategic complementarities. Several papers, including Heinemann *et al.* (2004), Cabrales *et al.* (2007), and Cornand and Heinemann (2014b), find that participants tend to overreact to public information with public signals acting as focal points. Public signals bear important welfare implications that depend on the optimal level of social coordination (Cornand and Heinemann, 2014a). Gao (2008) emphasizes the benefits of transparency in an experimental design based on Allen *et al.* (2006), and shows that public information in the form of accounting disclosure leads to market efficiency by driving market prices close to fundamental values. Sanjay and Maier (2016) study the role of the precision of public information on coordination failures and find that granular disclosure increases participants' strategic uncertainty, which, in turn, increases the likelihood of coordination failure. We complement this literature by showing how a public credit rating affects the allocation of capital and market outcomes in the presence of feedback effects between public signals and the real economy.

Our paper is structured as follows. Section 2 presents a simple model of credit ratings and investments and formulates the empirical hypotheses. Section 3 describes the experimental design and procedures. Section 4 shows our results. Section 5 concludes.

# 2 Theoretical framework, predictions and hypotheses

We sketch a simplified theoretical framework that adapts the model of Goldstein and Huang (2020) to derive theoretical predictions and hypotheses that guide our experimental design. In particular, we streamline two dimensions of Goldstein and Huang (2020). First, we simplify the firm's liabilities and financing structure by focusing on the size of funding available to the firm and, to a lesser extent, on the financing cost. Second, we use a uniform distribution for fundamentals and signals instead of a common improper prior for fundamentals and a normal distribution. Our predictions show that the essence of the results of Goldstein and Huang (2020) carry over in this simplified setting that we consider.[8]

## 2.1 Framework

We consider an economy consisting of investors, a credit rating agency, and a firm that raises financing from the bond market. There are three dates $(0, 1, 2)$, no discounting and all agents are risk-neutral. The timing of the game is as follows. At $t = 0$, the CRA assigns a credit rating to the firm (the issuer). Investors observe a private signal about the firm's fundamentals and, potentially, a credit rating. Each investor then decides whether or not to buy the firm's bonds. At $t = 1$, the firm chooses whether to default or invest in a new risky project based on its available funds. If the firm invests, the cash flow is realized at $t = 2$, and bondholders are repaid in full whenever the firm is solvent (i.e., the payoff from projects exceeds the total amount owned).

*Projects*

The firm is endowed with an ongoing project and has two additional investment opportunities: a low-risk project (LR) and a high-risk project (HR). The ongoing project produces

[8]While our framework uses Goldstein and Huang (2020) to derive predictions, our main goal is to study the mechanisms driving investor behaviour in response to the observed information (rating) signal. These aspects are not the primary focus of their paper's theoretical framework.

$\theta$ at date 0, which is drawn from a uniform distribution over $[\underline{\theta}, \overline{\theta}]$, with $\underline{\theta} < 0 < \overline{\theta}$, and represents the firm's fundamentals (internal funds). The LR project generates the following distribution of cash flows at date 2: $V > 0$ with probability $p \in (0, 1)$ and 0 with probability $1 - p$. Analogously, the HR project produces $H > V$ with probability $q$, and 0 with probability $1 - q$, where $0 < q < p$. The firm can also default at $t = 1$ and its liquidation value is $L$. Following Goldstein and Huang (2020), we assume that the firm's expected cash flows are ranked as follows: $pV > L > qH$. The fact that LR and HR projects have higher, respectively lower, expected cash flows than the firm's liquidation value allows us to generate predictions about the positive and negative implications of ratings. In our model, we interpret a firm's decision to take excessive risks by investing in an HR project instead of defaulting as a negative effect. Likewise, we interpret a firm's decision to invest in an LR project instead of defaulting or undertaking an HR project as a positive effect. The firm's investment choice is unobservable and unverifiable.

The firm needs a certain amount of funding to undertake a new project. We assume that the LR-type of projects are in short supply and can be uncovered through costly screening efforts. The LR project requires a higher initial investment (including screening costs), $I$, with $I \geq \overline{\theta}$, whereas the HR project can be undertaken with a smaller investment, $i < I$.[9] For simplicity, we set $i = 0$. We also assume that the LR project has a higher net present value: $pV - I > qH$.

*Funding*

The firm has two sources of financing: its own internal funds from the ongoing project, $\theta$, representing the firm's fundamentals, and external funds from capital markets. The firm may need to raise external funds not only to undertake a new project but also to cover any losses from the ongoing project.[10] If the firm's available funds at $t = 1$ are less than 0, it defaults, and creditors who financed the firm (if any) lose their investment. The firm's payoff

[9] This specification is consistent, for example, with the idea of higher entry costs required for access to LR projects, where entry costs may be thought of as a combination of transaction and informational costs.

[10] Note that since the ongoing project may generate losses, the problem of raising capital remains relevant even when the investment cost of the HR project $i$ equals zero.

in case of default is also zero, as any liquidation value $L$ is lost in the bankruptcy procedure.

External financing is obtained from investors in the bond market. The firm issues zero-coupon bonds with face value $F$, with $1 < F < I$, at price $B = 1$.[11] The bonds mature at $t = 2$. If the firm does not default at date 1 and the new project is successful, bondholders are fully repaid at date 2.[12] Conversely, when the risky investment returns 0, the firm is insolvent and its creditors receive nothing because of bankruptcy costs. We also assume that

$$pF > 1 > qF, \tag{1}$$

so that investors buy the bond when they know that the firm invests in the LR project, but not when the firm invests in the HR project or defaults at $t = 1$. Combining the two sources of funds, the total amount of financing available to the firm, $K(\theta)$, is:

$$K(\theta) = \theta + B \times W(\theta), \tag{2}$$

where we denote by $W(\theta)$ the mass of investors that buy the firm's bond at price $B = 1$. The firm's expected payoff is as follows:

$$\begin{cases} p[V - I + K(\theta) - FW(\theta)] & \text{if} \quad \text{the firm invests in LR project} \\ q[H + K(\theta) - FW(\theta)] & \text{if} \quad \text{the firm invests in HR project.} \\ 0 & \text{if} \quad \text{the firm defaults at } t = 1 \end{cases} \tag{3}$$

Specifically, when available funds are large enough (i.e., $K(\theta) \geq I$) and the firm invests in the LR project, its net profit is, with probability $p$, the return on the LR project net of investment $V - I$, plus any internal funds available after paying external investors $K(\theta) - FW(\theta)$. With probability $1-p$ the LR project fails, the firm cannot repay the investors in full, and its profit

[11] Since we want to analyze the effect of the credit ratings on the amount of bonds raised and not on their price, we follow He and Xiong (2012) and Goldstein and Huang (2020) and assume that the face value and price of the bond are exogenously given.

[12] This implies that the payoffs of both projects, when successful, are sufficient to repay all investors. A sufficient condition for this is: $H > V > F$, as, when everyone invests, the maximum repayment is $F$.

is zero.[13] Likewise, when the total funds are positive but not very high (i.e., $0 < K(\theta) < I$), the firm's expected profit from investing in the HR project is $q[H + K(\theta) - FW(\theta)]$, where $q$ is the probability of success of the HR project, $H$ is the return on the HR project, and $K(\theta) - FW(\theta)$ is the total amount of financing net of the amount owed to investors. With probability $1 - q$ the HR project fails, the firm cannot repay the investors in full, and its profit is zero. In Appendix A.1, we show that equation (3) implies that the firm's optimal investment strategy at date 1, conditional on the total available funding, is as follows:

$$\begin{cases} \text{Invest in LR project} & \text{if} \quad K(\theta) \geq I \\ \text{Invest in HR project} & \text{if} \quad 0 \leq K(\theta) < I. \\ \text{Default} & \text{if} \quad K(\theta) < 0 \end{cases} \tag{4}$$

Equation (4) indicates that the firm opts for default when its external financing falls short of covering the ongoing operation losses ($\theta + W(\theta) < 0$), while the firm selects the LR project when its total funds available cover the fixed investment ($K(\theta) \geq I$). The firm, in turn, chooses the high-risk project whenever it lacks sufficient funds to invest in the low-risk project ($0 \leq K(\theta) < I$).

*Investors and information structure*

There is a continuum of investors that are endowed with 1 unit of wealth. Investors do not observe the true value of $\theta$. However, before deciding whether to buy the bond, each investor $j$ receives a private signal about $\theta$: $x_j = \theta + \epsilon_j$, where the error terms $\epsilon_j$ are uniformly distributed over $[-\epsilon, \epsilon]$ and are independent across all investors. This information structure allows us to solve the game in the standard global games framework (Carlsson and Van Damme, 1993; Morris and Shin, 1998, 2004). All investors are identical and their actions are strategic complements (i.e., an investor's incentives to buy the bond increase with the number of other investors that also buy the bond).[14] Furthermore, investors may observe a

[13] With probability 1-p the LR project fails and there is no payoff for the firm since: $-I+K(\theta)-FW(\theta) < 0$. One can verify that this is equivalent to $(-I + \theta) + [W(\theta) - FW(\theta)] < 0$, which holds given that $I \geq \overline{\theta}$ and $F > 1$ by assumption.

[14] In the context of our framework, the core challenge predominantly pertains to the inherent market structure. Notably, the coordination issue can be effectively mitigated under specific conditions. First, the presence of a singular funding entity, such as a bank, would avert this issue. Second, a firm's ability

public credit rating provided by the CRA in addition to their private signals.

*The Credit Rating Agency*

The CRA observes perfectly the firm's true fundamentals and its optimal investment strategy. Therefore, the forward-looking CRA assigns a rating $R$ by taking into account its effects on the firm's optimal investment strategy and its subsequent probability of default. Following Boot *et al.* (2006) and Goldstein and Huang (2020), we restrict the space of ratings to $R=\{0, q, p\}$ with $p, q > 0$. A rating of zero is equivalent to default, while $q$ and $p$ correspond to the firm's investment in the HR and LR projects, respectively. In line with the "issuer-pays" business model, we assume that the CRA receives higher revenues when assigning better credit ratings. The CRA also faces reputational or legal costs when assigning ratings $R = p, q$, and the firm defaults. We assume that if a firm with rating $R > 0$ defaults at $t = 1$, the reputational costs for the CRA are very large, such that the CRA does not assign a rating to firms it foresees defaulting at $t = 1$. If a firm with rating $R > 0$ defaults at $t = 2$, the CRA incurs a cost, and this cost is greater for $R = p$ as compared to $R = q$.[15]

## 2.2 Theoretical predictions about investors and firms' behaviour

This section derives theoretical predictions of two versions of the model: one without the CRA (the benchmark) and the other with the CRA. We then compare investors' and the firm's behaviour under the two models, and derive predictions about whether potentially inflated credit ratings have positive or negative effects. The details and proofs are in Appendix A.

We first derive the equilibrium of the model without a CRA. We solve the model backwards as follows. First, given its total funding $K(\theta)$, the firm chooses its optimal strategy described in (4). As in models of global games, investors' strategies are monotonic in their private signals. As such, investors adopt a cutoff strategy, where they invest for signals above a

to credible pledge the return of funds in instances where insufficient capital is raised for a low-risk project, resembling the models observed in investment targets within peer-to-peer lending platforms or private equity funds, can also resolve this predicament.

[15]See Appendix A.2 for more details regarding the CRA's revenues and costs.

threshold signal, $\tilde{x}$, and do not buy the bond when $x_j < \tilde{x}$.[16] They use the Bayes rule to update their beliefs about the firm's fundamentals given their signals and maximize their expected payoffs given the firm's and other investors' optimal strategies.

**Theoretical prediction 1 (Benchmark without a CRA).** *In the benchmark model without a CRA, there is a unique equilibrium where the firm's investment strategy is*

$$\begin{cases} \textit{Invest in LR project} & \textit{if } \theta \geq \tilde{\theta}_2 \\ \textit{Invest in HR project} & \textit{if } \theta \in \left[\tilde{\theta}_1, \tilde{\theta}_2\right), \\ \textit{Default} & \textit{if } \theta < \tilde{\theta}_1 \end{cases}$$

*and investor $j$ buys the firm's bonds if and only if $x_j \geq \tilde{x}$, where $\tilde{x}$ is obtained from the indifference condition (of buying or not buying the bond) of the marginal investor who receives signal $\tilde{x}$.*

Intuitively, the cut-off value of $\theta$, below which default occurs $(\tilde{\theta_1})$ is the threshold value at which the firm is indifferent between defaulting and investing in the HR project, i.e., $K(\tilde{\theta_1}) = \tilde{\theta_1} + W\left(\tilde{\theta_1}\right) = 0$. Similarly, the cut-off value above which the firm undertakes the LR project $(\tilde{\theta_2})$ is obtained from the firm's indifference condition of choosing between the LR and HR projects $K(\tilde{\theta_2}) = \tilde{\theta_2} + W\left(\tilde{\theta_2}\right) = I$.

We then extend the benchmark model and allow for the presence of a credit rating agency. The CRA takes as given the firm's and investors' strategies, and maps the firm's fundamentals into a rating by maximizing its expected profits. We can show that when the ratio of revenues to cost is sufficiently high, the CRA's equilibrium strategy is to inflate the rating

[16] This equilibrium strategy rests on the existence of *lower* and *upper dominance* regions below and above which an investor has a dominant strategy to either not buy or buy the bond. The *lower dominance* region consists of values of fundamentals so low that even if all investors bought the bond, the firm would still not cover the losses from the ongoing project and would default. Hence, in the lower dominance region, an investor's dominant action is not to buy the bond. The *upper dominance* region corresponds to high fundamental values for which the firm can self-finance the LR project, even if nobody buys the bond. Therefore, an investor's dominant action is to buy the bond.

by assigning only two ratings: $R(\theta) = \{0, p\}$ as follows:[17]

$$R(\theta) = \begin{cases} p \text{ if } \theta \geq \theta_1^* \\ 0 \text{ if } \theta < \theta_1^*. \end{cases} \tag{5}$$

In equilibrium, the CRA chooses a threshold $\theta_1^*$ above which a $\theta$-firm receives a rating $R(\theta) = p$, while below the threshold the rating is $R(\theta) = 0$. In this model, *rating inflation* occurs when a $\theta-$firm receives a rating of $p$ (i.e., implying it will undertake the LR project at date 1), while the firm undertakes the HR project and has, in reality, a credit quality of $q$. While rating inflation can emerge as an equilibrium strategy of the CRA, such inflated ratings are still informative about firm fundamentals and affect the optimal decision of investors. This is because a potentially inflated rating implies that, if $R = p$, all investors know that $\theta > \theta_1^*$ and, as a result, that the firm's fundamentals are not extremely low to the extent that would trigger an immediate default at date 1. We describe the details in Lemma 1 in Appendix A.2. We describe the equilibrium of the model with a CRA in the following theoretical prediction.

**Theoretical prediction 2 (Model with a CRA).** *The model with a CRA has a unique equilibrium such that:*

*(1) If $R = 0$, no investor buys bonds and the firm defaults at date 1.*

*(2) If $R = p$, investors buy the bonds if and only if their private signals $x_j$ are larger than $x^*$, where $x^*$ is obtained from the indifference condition of the marginal investor that is indifferent from buying or not buying the bond.*

[17] As we want to investigate the relationship between potentially inflated ratings, investor behaviour and firm investment, we focus only on the case of inflating strategy, and do not explore further the cases when the CRA deflates the rating or accurately reveals the firm's credit quality.

*(3) The firm's investment strategy is*

$$\begin{cases} \textit{Invest in LR project} & \textit{if } \theta \geq \theta_2^* \\ \textit{Invest in HR project} & \textit{if } \theta \in [\theta_1^*, \theta_2^*) \\ \textit{Default} & \textit{if } \theta < \theta_1^* \end{cases}.$$

Intuitively, in the model with a CRA, the cut-off thresholds for $\theta$ and $x^*$ differ from those in the benchmark model. This is because investors receive a public signal, in addition to their private signals, which allows them to update their posterior beliefs about $\theta$. Specifically, observing a positive, though potentially inflated, rating $R = p$ truncates their posterior beliefs about $\theta$ from below $\theta_1^*$. As a result, investors are assured that the firm's fundamentals are not extremely bad.

We now contrast the investment thresholds in the benchmark model and the model featuring a CRA. We can show that when the noise in the private signals is small enough, the firm investment thresholds satisfy: $\theta_1^* < \tilde{\theta}_1$ and, $\theta_2^* < \tilde{\theta}_2$, and the sign of $\theta_2^* - \tilde{\theta}_1$ is ambiguous. The intuition is that when the CRA communicates inflated ratings, more investors buy the firm's bonds. As a result of their investment decisions, the firm has more funds available, which allows access to the LR project or helps avoid default at date 1. The lower thresholds in the model with a CRA capture these effects.

We identify the real effects of the CRA's ratings by analyzing the firm's investment decision (which determines investors' expected payoff). We define a positive effect as a situation where a $\theta$-firm invests in the LR project whereas it would have invested in the HR project without the credit rating. Credit ratings can also have negative effects when a firm that would have defaulted without the rating gambles for resurrection in the presence of potentially inflated ratings and invests in the HR project. We can now summarize the CRA's real effects as follows:

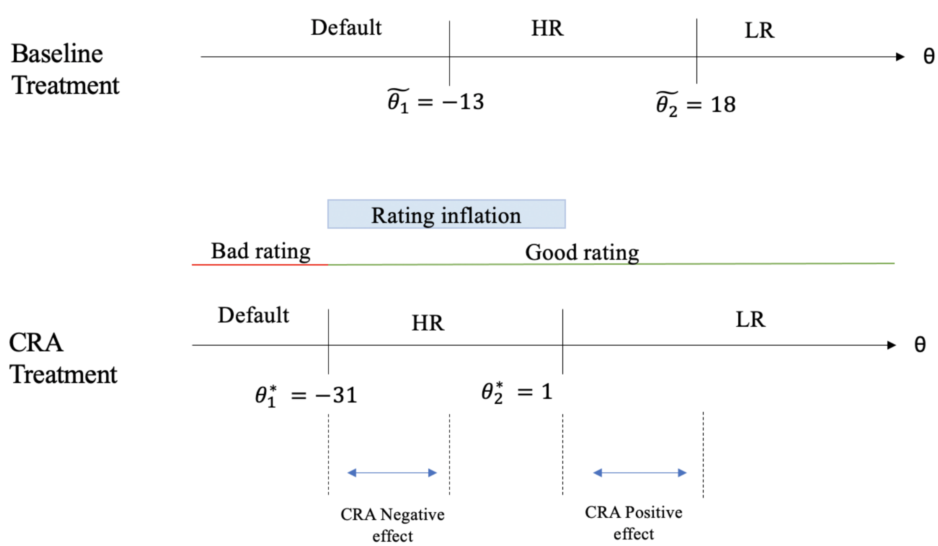
**Theoretical prediction 3 (Inflated ratings effects)**

*(1) When $\theta_2^* > \tilde{\theta}_1$, inflated ratings have a negative effect when $\theta_1^* \leq \theta < \tilde{\theta}_1$ because a firm invests in the HR project instead of defaulting. When $\theta_2^* \leq \theta < \tilde{\theta}_2$, the CRA rating has a positive effect because the firm switches from investing in the HR project to the more efficient LR project.*

*(2) When $\theta_2^* \leq \tilde{\theta}_1$, inflated ratings have a positive effect when $\theta_2^* \leq \theta < \tilde{\theta}_2$ and a negative effect when $\theta_1^* \leq \theta < \theta_2^*$.*

Notice that the CRA's real effects depend on the model's parameters. In what follows, we present the calibration of the model that we use for our experimental design and illustrate the real effects of inflated credit ratings for a specific parametrization.

Figure 1: Equilibrium illustration of firm and CRA actions.




## 2.3 Hypotheses

We adapt the theoretical model for a laboratory experiment and calibrate it in order to solve numerically for the equilibrium thresholds described in Section 2.2. To do so, we first compute the thresholds considering a finite number of investors. Following Heinemann et al. (2004; 2009), we employ the binomial distribution to calculate the mass of investors who buy the bond (see also, Peia and Vranceanu, 2019; Bayona and Peia, 2022). Specifically, we assume that the measure of investors $W(\theta)$ from (2) is the probability that 0,1,2,...,$n$ out of $n$ participants invest, where each participant invests for a signal above the threshold $x^*$, i.e., with probability $m(\theta) = \Pr(x_j \geq x^*|\theta)$. In other words, $W(\theta) \sim B(n, m(\theta))$. This implies that the expected number of investors buying the bond is $E[W] = n \times m(\theta)$. We calibrate the model using the parameters presented in Table 1.

Table 1: Experimental parametrization

| | |
|---|---|
| Initial endowment | 100 |
| Range of fundamentals ($IF$) | $[-400, 200]$ |
| Price of bond ($B$) | 100 |
| Face value of bond ($F$) | 200 |
| Probability of success of LR project ($p$) | 0.9 |
| Probability of success of HR project ($q$) | 0.2 |
| Amount of financing to undertake LR ($I$) | 300 |
| Amount of financing to undertake HR ($i$) | 0 |
| Signal noise ($\epsilon$) | 30 |

We use this calibration to compute the theoretical thresholds from Theoretical predictions 1 and 2. Figure 1 illustrates these thresholds and highlights the areas of firm fundamentals where the presence of a potentially inflated credit rating can lead to positive and negative effects.[18]

From our theoretical predictions, we develop several testable hypotheses that relate to the effects of an inflated credit rating on investors' actions and the firm's project choices.

Our first hypothesis concerns investor behaviour.

**H1** (*Investing behaviour*). *(i) Higher signals about fundamentals increase the probability of investing. (ii) For intermediate values of fundamentals, a good (but potentially inflated) rating increases investors' propensity to buy the bond compared to when there is no CRA.*

[18]Investors' equilibrium threshold signals above which buying the firm's bonds is the dominant strategy are as follows: $\tilde{x} = 14$ in the Baseline treatment and $x^* = -5$ in the CRA treatment.

Second, we conjecture that, when there is a CRA that inflates ratings, the higher level of external funds available to firms leads some of those with relatively low fundamentals to gamble for resurrection and invest in the high-risk project. As such, our second hypothesis is:

**H2** (*Negative effect of inflated ratings*). *For similar levels of relatively low fundamentals, firms with a good (but potentially inflated) rating receive more external funds, leading to more investment in high-risk projects instead of defaulting, compared to when there is no CRA.*

Hypothesis 2 follows from Theoretical prediction 3 and our specific parametrization. With our calibration, the threshold level of the firm's internal funds above which investing in the high-risk project is the firm's optimal strategy is lower in the equilibrium with a CRA than in the equilibrium without a CRA (i.e., $\theta_1^* < \tilde{\theta}_1$). We thus predict that for an intermediate range of relatively low firm fundamentals, there is more investment in the high-risk project when an inflated rating is available. Subsequently, early firm default is less likely in the presence of a public credit rating. This prediction follows from our comparison of investment thresholds between the benchmark model and the model with a CRA, where we have shown that a lower probability of firm default at date 1 is associated with the provision of ratings. Thus, unless a firm's fundamentals are very poor, we expect that a firm enjoys an increased supply of funds from investors when the rating is available. Better access to finance, in turn, increases the probability that external funds will cover potential losses from ongoing activities reducing the likelihood of early default.

At the same time, the increased availability of external funding in the presence of potentially inflated ratings allows some firms with relatively high fundamentals to undertake low-risk projects. Our third hypothesis predicts that:

**H3** (*Positive effect of inflated ratings*). *For similar levels of intermediate fundamentals, firms with a good (but potentially inflated) rating receive more external funds, leading to more investment in low-risk projects, instead of high-risk ones, compared to when there is no*

*CRA.*

This hypothesis also derives from our Theoretical prediction 3. Note that the threshold level of firm fundamentals above which investing in the low-risk project is the firm's optimal strategy is lower in the equilibrium with a CRA than when the CRA is absent (i.e., $\theta_2^* < \tilde{\theta_2}$). We predict that for an intermediate range of relatively high firm fundamentals, there is more investment in the low-risk project when an inflated rating is available.

## 3 Experimental design and procedures

We design a laboratory experiment to understand the informational role of potentially inflated credit ratings and their impact on investment decisions. The experiment has two parts. In Part I, participants play the role of investors who decide whether to buy the bond issued by a firm or not. The computer plays the role of the firm and takes the optimal investment decisions as outlined in (4). Participants play the coordination game for 15 independent rounds in groups of five with random matching between rounds. Subjects are endowed with 100 experimental currency points (EC) in each round. They have to choose one of the following two decisions: (a) *Do not invest* and keep the initial 100 EC or (b) *Invest* and finance the firm with 100 EC.

If a participant chooses to invest, their payoff from investing depends on the firm's action. If the firm invests in the LR project, participants obtain 200 EC with 90% probability and 0 with 10% probability. When the firm invests in the HR project, participants get 200 EC with 20% probability and 0 with 80% probability. Finally, participants obtain 0 EC with certainty if the firm defaults.

The firm's action depends on how much financing is available. There are two types of funds: internal (IF), representing the firm's fundamentals, $\theta$, and external (EF). In each round, the firm's IF are randomly selected from the uniform distribution $U \sim [-400, 200]$. This number is the same for all the investors in a group. The EF depend on how many investors from a group choose to invest. Similar to (4), the firm's decision is as follows: if $300 \leq IF + EF$, the firm has enough funds to take the LR project; otherwise, the firm chooses the HR project when $0 \leq IF + EF < 300$ or defaults when $IF + EF < 0$.

We consider two treatments in a between-subject design, which differ in the information provided to participants: the *Baseline treatment* and the *CRA treatment*. Participants receive a private signal about the firm's IF in both treatments. The signal is drawn independently from the uniform distribution $U[IF-30, IF+30]$. In the Baseline treatment, participants do not receive further information beyond their noisy private signal. In contrast to the Baseline treatment, in the CRA treatment participants also observe a public credit rating about the firm's ability to repay its creditors.

Specifically, we inform participants in the CRA treatment that there is a credit rating agency that assigns a public credit rating to the firm before participants' decisions and the firm's action. In the instructions, we explain that a credit rating is a grade that indicates the firm's ability to repay its investors. The rating can be either $A$ or $B$ (corresponding to the potentially inflated rating, $p$, and the default rating, 0, from Section 2, respectively). We inform participants that, in each round, the rating agency uses a theoretical scoring model to predict the ability of the firm to repay its investors. We explain how the CRA's model considers the firm's IF (which it knows perfectly), and how the rating might affect a hypothetical investor's decision and, thus, the total amount of funds available to the firm and its corresponding action. Participants receive the following information regarding the process of assigning the ratings:

> *Rating of A* when the firm's IF are greater than or equal to $-31$. The CRA estimates that the A-rated firm will invest in the LR project and investors have a 90% probability of being repaid.
>
> *Rating of B* when the firm's IF are smaller than $-31$. The CRA estimates that the B-rated firm will default and investors have a 0% probability of being repaid.[19]

[19] Note that $-31$ corresponds to the theoretical threshold $\theta_1^*$ from Theoretical prediction 2 under our parametrization from Table 1.

Participants are not explicitly informed that the rating may be inflated.

In each round, before taking their decisions, we elicited participants' beliefs about the true level of the firm's internal funds and the behaviour of other subjects in their group.[20] First, we asked participants to provide a point estimate for the firm's IF. Then, all participants had to state how many other subjects from their group were expected to invest.[21] Once beliefs were elicited, participants had access to a simulator and could make their decision.

Participants received written instructions at the beginning of the session. In the instructions, we provide examples of the firm's actions and investors' expected payoffs conditional on hypothetical estimated values of the IF and a hypothetical number of participants who choose to invest.[22] Before Part I of the experiment started, each participant had to pass a test with control questions to ensure that they understood the payoff structure and the decision process.[23] After all participants have made their decisions, they learn at the end of each round about the true level of the firm's IF, how many other participants choose Invest, the firm's action, and their potential payoffs in EC.

In Part II of the experiment, we asked participants to conduct two individual incentivized tasks to assess their risk and loss aversion, which have been shown to matter in coordination games similar to ours (Brown *et al.*, 2017; Kiss *et al.*, 2018). In the first task, we elicited risk aversion as in Eckel and Grossman (2008) and Dave *et al.* (2010). In the second task, participants answered a loss aversion questionnaire based on Gächter *et al.* (2022). Participants earned EC points depending on the outcome of the risky lotteries they chose in each task (see Appendix C for details). After Part II of the experiment, we asked several questions regarding their behaviour throughout the experiment (using Likert scales) and elicited selected socioeconomic characteristics through an on-screen questionnaire. In terms of earnings, the computer randomly selected one of the 15 rounds from Part I to determine

[20] Beliefs have been shown to affect outcomes in coordination games similar to ours (Szkup and Trevino, 2020; Baeriswyl and Cornand, 2021).

[21] Appendix C shows the screenshots from the first part of the experiment. Beliefs were not incentivized.

[22] Appendix B presents the instructions for the CRA treatment.

[23] Figure 11 (from Appendix D) presents the practice questions. These questions were not paid.

the participants' payoffs for this part of the experiment. We informed participants about their earnings for Part I and Part II of the experiment at the end of the session. For both parts of the experiment, 15 EC translated into 1 Euro for payment.

We conducted 12 experimental sessions, with either 15 or 20 participants in each session. In total 230 students (115 in each treatment) participated in our experiment at ESADE's Decision Lab and Universitat Pompeu Fabra BESLab, both in Barcelona (Spain).[24] On average, participants earned 18.05 Euros, and the experiment lasted approximately 75 minutes.

# 4 Results

We present the results by first describing aggregate investment behaviour and firm outcomes at the group level, followed by an analysis of the predictors of individual investment behaviour. We then investigate the channels that explain differences in investment behaviour across treatments.

## 4.1 Group level analysis

We start by analyzing how investment behaviour changes across the two treatments for different values of the firm's internal funds (i.e., fundamentals). Specifically, we compare the provision of external funding for firms with similar values of IF that correspond to the good (A) or bad (B) rating, but for which the rating is only observed in the CRA treatment. Table 2 provides summary statistics of the aggregate investment behaviour per treatment depending on whether fundamentals are sufficiently high (low) to receive a good (bad) rating. For both treatments, we report the average number of investors for firms with fundamentals below and above the threshold separating the two ratings in the CRA treatment.[25] These averages are based on group outcomes in our sample of 690 unique group-period observations

[24] The experiment was programmed and run using z-Ttree software (Fischbacher, 2007). Table 16 (from Appendix D) summarizes the sessions.

[25] The threshold above which a good (A) rating is assigned equals -31. Participants are informed about the value of this threshold in the CRA treatment instructions.

Table 2: Average number of participants that invest in each treatment

| Treatment | Baseline | | CRA | | Tests (p-values) | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (1) vs. (3) | | (2) vs. (4) | |
| Hypothetical/ Observed rating | Rating A | Rating B | Rating A | Rating B | Test 1 | Test 2 | Test 1 | Test 2 |
| Invest | 4.03 | 0.83 | 4.331 | 0.396 | 0.02 | 0.248 | 0.00 | 0.021 |
| | (1.3) | (1.02) | (0.93) | (0.67) | | | | |
| Observations | 146 | 199 | 163 | 182 | 381 | 12 | 309 | 12 |

*Notes:* Columns (1)-(4) present the mean (standard deviation) of the number of subjects (per group) investing conditional on the treatment and observed (in the CRA treatment)/hypothetical (in the Baseline treatment) rating. Test 1 is a t-test of equality of means performed at the group level. Test 2 is a non-parametric K-sample test on the equality of medians performed at the session level.

(46 random groups ×15 periods).

We observe a higher average number of investors in the CRA treatment compared to the Baseline for values of the fundamentals corresponding to the good rating (A) (column 1 vs. column 3) and a lower average number of investors for the bad rating (B) (column 2 vs. column 4). Throughout the analysis, we assess the statistical significance of the differences across treatments through t-tests at the group level (690 group-period observations) and non-parametric tests at the session level (6 observations per treatment).[26] These tests, presented in the last four columns of Table 2, show that the observed differences are statistically significant, albeit less conclusive for the good rating, where the non-parametric test is not significant at conventional levels.[27]

**Result 1** Firms in the CRA treatment with a good (bad) rating receive significantly more (less) external funding than firms in the Baseline treatment with similar fundamentals.

To understand the relationship between firm fundamentals and group investment behaviour, we run a series of regression analyses on the group (firm)-level. Specifically, in Table 3, we investigate whether the size of the external funding (i.e., the number of investors buying the firm's bonds) varies across the two treatments for different quartiles of fundamentals. We run a series of Poisson models where the dependent variable is the number of investors

[26]We obtain similar statistical results (unreported, available on request) using the non-parametric Mann-Whitney U test.

[27]Figure 6 (from Appendix B) illustrates the impact of a credit rating on aggregate investment behaviour.

buying the firm's bond. The main covariate is an indicator variable equal to one for the CRA treatment and zero for the Baseline treatment. In all regressions, we control for the size of the firm's internal funds (IF) and a period scalar. Column (1) shows that, as expected, external financing is increasing in the firm's internal funds. This result is robust across different subsamples of the data. However, the CRA treatment dummy in column (1) is not statistically significant, suggesting no significant difference between the treatments in average investment. Exploring further the aggregate investment behaviour across varying levels of fundamentals, we find in columns (2)-(7) significant differences between the two treatments across different quartiles of internal funds. In column (3), we find that, for relatively low fundamentals (i.e., $2^{nd}$ quartile), there is significantly less investment in the CRA than in the Baseline treatment (on average, 0.46 investors as compared to 0.97 in the Baseline Treatment). Conversely, results from column (4) suggest that there is significantly more investment in the CRA treatment (3.44 vs. 2.80 investors) for firms with relatively high fundamentals (i.e., $3^{rd}$ quartile).[28] Finally, columns (6)-(7) corroborate the findings from Table 2: there is a higher average number of investors in the CRA treatment for firms with fundamentals corresponding to the good rating (A) and a lower average for those with fundamentals corresponding to the bad rating (B). These results are generally consistent with Hypothesis H1, which we will test further in Section 4.2, where we examine individual investment behaviour. These findings, which suggest that ratings convey valuable information to market participants, are also consistent with results from studies using various natural experiments (Kliger and Sarig, 2000; Tang, 2009; Cornaggia *et al.*, 2018). We complement this literature by examining the informational channels through which rating inflation can affect investors' decisions and market outcomes.

The observed variations in external funding across treatments lead to significant differences in firms' actions across the two treatments, as illustrated in Figure 2. We observe a significantly

[28]We report in Table 10 (from Appendix B) the average number of investors across quartiles of fundamentals. Corroborating the results from Table 3, we observe significant differences in the $2^{nd}$ and $3^{rd}$ quartiles, corresponding to values of firm IF in the interval [-137, 20], which includes the rating threshold. There is no significant difference between the two treatments in the average number of investors for low and high values of the fundamentals corresponding to the $1^{st}$ and $4^{th}$ quartiles.

Table 3: Size of investment across different ranges of fundamentals

| Dependent variable: Size of investment | (1) All | (2) Quartile 1 | (3) Quartile 2 | (4) Quartile 3 | (5) Quartile 4 | (6) Bad rating (B) | (7) Good rating (A) |
|---|---|---|---|---|---|---|---|
| Internal funds (IF) | 0.006*** | 0.001 | 0.013*** | 0.014*** | 0.001** | 0.006*** | 0.002*** |
| | (0.000) | (0.003) | (0.002) | (0.002) | (0.000) | (0.001) | (0.000) |
| CRA treatment | 0.048 | -0.513 | -0.821*** | 0.210* | 0.020 | -0.707*** | 0.112** |
| | (0.063) | (0.382) | (0.267) | (0.109) | (0.021) | (0.219) | (0.053) |
| Period | 0.001 | -0.085*** | -0.060* | 0.006 | 0.005** | -0.052*** | 0.010*** |
| | (0.006) | (0.029) | (0.032) | (0.008) | (0.003) | (0.015) | (0.003) |
| Observations | 690 | 174 | 172 | 172 | 172 | 381 | 309 |

*Notes:* The table presents estimates from Poisson regressions where the dependent variable is the number of investors in a group buying the firm's bond. *Internal funds (IF)* captures the firm fundamentals. *CRA treatment* is an indicator variable equal to 1 if the treatment is CRA. *Period* indicates the round of the investment game. Constant terms are included, but not reported. Standard errors clustered at the session level are reported in parentheses. ***, ** , and * indicate significance at the 1%, 5%, and 10% levels, respectively.

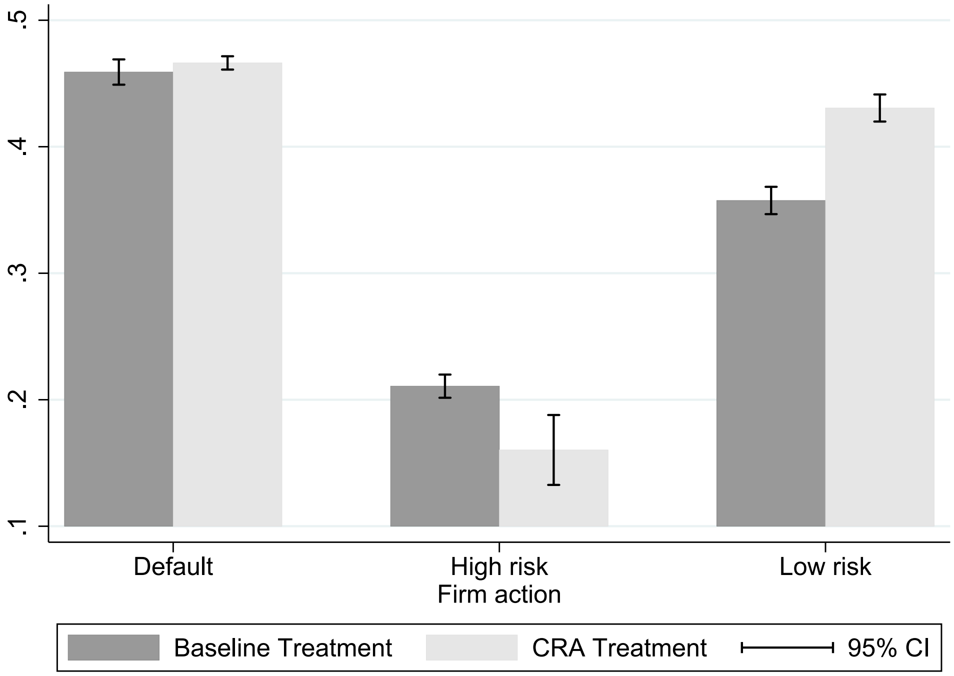
higher proportion of firms undertaking the low-risk project in the CRA treatment than in the Baseline treatment (43% vs. 36%).[29] At the same time, the proportion of high-risk projects is lower in the CRA treatment (16% vs. 21%). However, there is no significant difference in the number of early defaults between the two treatments (43% vs. 46%).

**Result 2:** As a result of investors' financing decisions, there is a significantly higher proportion of firms investing in low-risk projects and a lower proportion investing in high-risk projects in the CRA treatment compared to the Baseline treatment. There is no significant difference in default rates across the two treatments.

These results are confirmed in Table 4 in a series of probit regressions that investigate differences in firms' actions conditional on the presence of a credit rating. The dependent variables are indicator variables for the different firm actions: early default in column (1), high-risk project in columns (2)-(3), and low-risk project in column (4). The main covariates are two indicator variables that allow us to compare firms with fundamentals above or below the rating threshold in the two treatments. Specifically, the variable *Bad rating (B)* takes value one for firms in the CRA treatment with IF below -31 and zero when the firm is observed in the Baseline treatment and the firm's IF are below -31. Likewise, the variable *Good rating (A)* is an indicator variable equal to one for a firm from the CRA treatment with fundamen-

[29] Table 11 (from Appendix B) shows the proportion of firms undertaking the high- (low-) risk projects or defaulting early in the two treatments, together with tests assessing the statistical significance of the differences across treatments.

Figure 2: Firms' actions across treatments




*Notes*: The figure shows the proportion of firms across the two treatments conditional on their actions. The sample size is 690 firm outcomes (groups of investors). Whiskers mark the 95% confidence interval.

tals above -31 and zero for a firm from the Baseline treatment with fundamentals above -31. As such, the specifications in columns (1)-(4) allow us to compare the informational role of ratings by looking at firms with fundamentals either below or above the rating threshold, but for which the public rating is observed only in the CRA treatment. Results from column (1) show that firms receiving a bad rating in the CRA treatment are more likely to default than firms in the Baseline treatment with similar fundamentals. In column (2), we observe that a bad rating is associated with less firm investment in the HR project in the CRA treatment. Importantly, receiving a good rating is not associated with a significantly higher probability of undertaking the HR project in the CRA treatment compared to the Baseline treatment (column (3)). Results from columns (1)-(3) suggest that firms in the CRA treatment are less likely to gamble for resurrection by investing in the HR project. These results reject Hypothesis H2 on the negative effects of potentially inflated ratings. Finally, column (4) shows that receiving a good rating leads to a significantly higher probability of investing in the LR project for firms in the CRA treatment. This finding supports our Hypothesis H3 on the positive effects of potentially inflated ratings.[30]

Together, these results point to a significant informational role of potentially inflated credit ratings. Our findings suggest that the presence of the potentially (biased) public signal can impact investors' behaviour and firms' actions. While theoretically, we show that inflated ratings can have negative and positive effects, the empirical results reveal an asymmetric impact. Given the ranking of projects' efficiency assumed in Section 2 (i.e., $pV > qH$, corresponding to the higher efficiency of the LR project) and the significantly higher (lower) proportion of firms undertaking the LR (HR) project in the CRA treatment (see Table 11 from Appendix B), our results point to an overall positive effect of potentially inflated ratings on economic efficiency. A potential explanation for the discrepancy between our experimental results and the model's predictions is that the presence of the rating serves as a strong focal point, enabling players to coordinate around both good and bad ratings (as seen in Boot *et al.* (2006)). This accounts for the observed overall positive effect of inflated ratings: in the Baseline treatment, the absence of this focal point results in excessive investment in defaulting firms.

**Result 3** As a result of aggregate investors' decisions, firms in the CRA treatment with a good rating invest more in low-risk projects than firms in the Baseline treatment with similar fundamentals. Conversely, firms with a bad rating invest less in high-risk projects in the CRA treatment than in the Baseline treatment.

We next examine individual decisions and potential channels that could explain differences in investment behaviour across treatments.

[30]In Table 12 (from Appendix B) we show that these results are mainly driven by differences in firms' actions across the intermediate values of the firms' fundamentals. Specifically, we observe a significantly lower (higher) proportion of firms undertaking the high (low) risk project in the $3^{rd}$ quartile of IF in the CRA treatment as compared to the Baseline treatment. For low (high) fundamentals values (i.e., in the $1^{st}$ and $4^{th}$ quartiles, respectively), there is no significant difference in the proportion of firms defaulting (or taking the risky projects) between the treatments.

Table 4: Ratings and firms' actions

| | (1) Default | (2) High risk | (3) High risk | (4) Low risk |
|---|---|---|---|---|
| Internal funds (IF) | -0.023*** | 0.021*** | -0.037*** | 0.044*** |
| | (0.003) | (0.002) | (0.005) | (0.006) |
| Bad rating (B) | 0.974*** | -0.800*** | | |
| | (0.343) | (0.248) | | |
| Good rating (A) | | | -0.773* | 1.009** |
| | | | (0.396) | (0.463) |
| Observations | 381 | 381 | 309 | 309 |

*Notes:* The table reports estimates from probit regressions where the dependent variable is an indicator variable equal to 1 if the firm defaults early (column (1)), invests in the HR project (columns (2)-(3)), or invests in the LR project (column (4)). *Internal funds (IF)* captures the firm fundamentals. *Good rating (A) ((Bad rating (B))* is an indicator variable equal to 1 if the treatment is CRA and the firm's IF are above (below) -31 and 0 if the treatment is the Baseline and the firm's IF are above (below) -31. Constant terms are included, but not reported. Standard errors clustered at the session level are reported in parentheses. ***, ** , and * indicate significance at the 1%, 5%, and 10% levels, respectively.

## 4.2 Individual investment behaviour

We start by examining whether individual behaviour aligns with the global games equilibrium selection criteria (i.e., subjects' investment decisions are an increasing function of the hint about the firm's internal funds).

Table 5 presents a multivariate analysis of the individual probability of investing for different samples corresponding to varying levels of fundamentals. We observe that in all samples

Table 5: Probability of investing across different ranges of fundamentals

| | (1) All | (2) Quartile 1 | (3) Quartile 2 | (4) Quartile 3 | (5) Quartile 4 | (6) Bad rating (B) | (7) Good rating (A) |
|---|---|---|---|---|---|---|---|
| Hint about IF | 0.010*** | 0.002 | 0.012*** | 0.030*** | 0.007*** | 0.006*** | 0.014*** |
| | (0.001) | (0.002) | (0.002) | (0.003) | (0.002) | (0.001) | (0.002) |
| CRA treatment | -0.027 | -0.366 | -0.748*** | 0.395** | 0.190 | -0.598*** | 0.562*** |
| | (0.111) | (0.383) | (0.226) | (0.190) | (0.271) | (0.183) | (0.179) |
| Period | -0.006 | -0.098*** | -0.058*** | 0.029** | 0.060** | -0.046*** | 0.055*** |
| | (0.008) | (0.032) | (0.022) | (0.015) | (0.026) | (0.013) | (0.015) |
| Observations | 3,450 | 870 | 860 | 860 | 860 | 1,905 | 1,545 |

*Notes:* The table presents estimates from probit regressions for different samples where the dependent variable is an indicator equal to 1 if the investor buys the firm's bond. *Hint about IF* captures the private information about firm fundamentals. *CRA treatment* is an indicator variable equal to 1 if the treatment is CRA. *Period* indicates the round of the investment game. Constant terms are included, but not reported. Standard errors clustered at the session level are reported in parentheses. ***, ** , and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 6: Probability of investing across treatments

| | Baseline | | | | CRA | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Hint about IF | 0.009*** | 0.006*** | 0.004*** | 0.004*** | 0.011*** | 0.005*** | 0.004*** | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Belief about IF | | 0.585*** | | 0.031 | | 1.284*** | | 0.697*** |
| | | (0.164) | | (0.127) | | (0.192) | | (0.179) |
| Belief # investors | | | 1.880*** | 1.876*** | | | 1.725*** | 1.647*** |
| | | | (0.153) | (0.159) | | | (0.170) | (0.159) |
| Period | -0.011 | -0.005 | -0.006 | -0.006 | 0.002 | 0.018* | -0.004 | 0.006 |
| | (0.010) | (0.010) | (0.014) | (0.014) | (0.009) | (0.009) | (0.010) | (0.011) |
| Observations | 1,725 | 1,725 | 1,725 | 1,725 | 1,725 | 1,725 | 1,725 | 1,725 |

*Notes*: The table presents estimates from probit regressions where the dependent variable is an indicator equal to 1 if the investor buys the firm's bond. *Hint about IF* captures the private information about firm fundamentals. *Belief about IF* and *Belief # investors* capture the stated beliefs (as a number) about firm fundamentals and the other participants investing, respectively (both variables are standardized in the regressions). Standard errors clustered at the subject level are reported in parentheses. ***, ** , and * indicate significance at the 1%, 5%, and 10% levels, respectively.

there is a positive and statistically significant correlation between the propensity to invest and the private signal. This result is consistent with Hypothesis H1(i). The coefficient of the *CRA treatment* dummy in columns (1), (2), and (5) is not statistically significant, suggesting that there is no significant difference between the treatments in the average probability of investing (column (1)) nor for the lowest (column (2)) and highest (column (5)) levels of fundamentals. However, similarly with the results from Table 3, the results in columns (3)-(4) confirm that for relatively low (high) fundamentals (i.e., $2^{nd}$ and $3^{rd}$ quartiles, respectively) there is significantly lower (higher) probability of investing in the CRA than in the Baseline treatment.[31] Columns (6)-(7) consider the treatment effect in samples of firms with fundamentals corresponding to the bad (B) and good (A) ratings, respectively. We document a significant decrease in the probability of investing in the CRA treatment when a bad rating is disclosed and the opposite effect for a good rating.

We show next that participants' actions are consistent with their elicited beliefs. Table 6 shows how the probability of investing in each treatment relates to participants' stated beliefs about the true value of the fundamentals and the number of others investing. Recall that we elicit these beliefs before the decision to invest is taken in each period. Columns (2)

[31]The results in Table 5 are robust to splitting the sample by quartiles of the hints received as opposed to fundamentals.

and (6) consider the effect of beliefs about firm fundamentals on the investment decision. The coefficient of *Belief about IF* is positive and statistically significant, indicating that the probability of investing increases in the beliefs about fundamentals. Likewise, in columns (3) and (7), we find a similar relationship between the likelihood of investing and the beliefs about the number of others investing. We standardize *Belief about IF* and *Belief # investors* in these regressions such that the point estimates reported are directly comparable. In all specifications, we observe that the estimated coefficients for *Belief about IF* are smaller than those of *Belief # investors*, suggesting that the effect of the expected behaviour of other investors on the probability of investing is larger than the impact of the beliefs about fundamentals. Simultaneously including beliefs about firms and other investors in columns (4) and (8) confirms that the expected behaviour of others is a stronger predictor of investment.

**Result 4:** The expected behaviour of other investors is a strong predictor of a participant's investment decision, whereas the belief about the firm's fundamentals matters less.

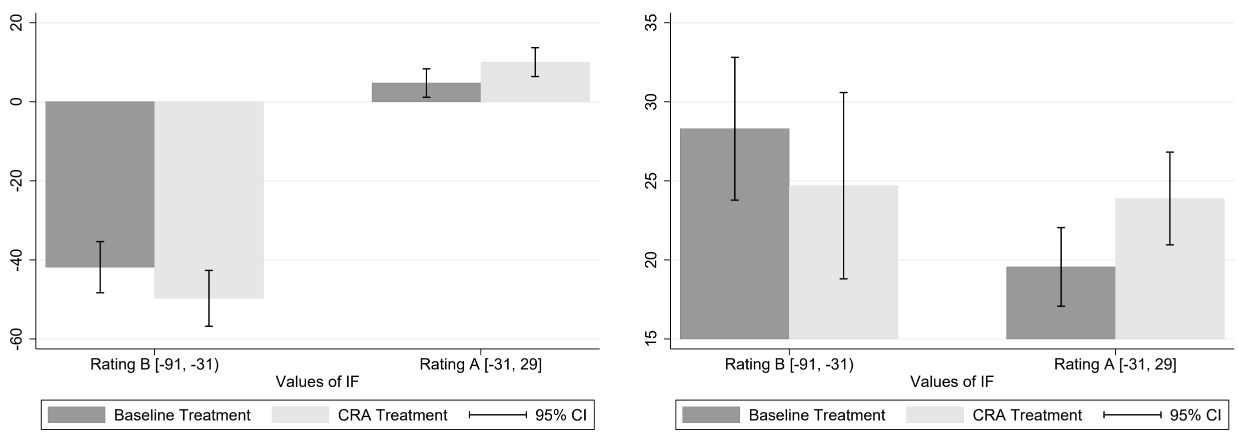
### 4.2.1 Channels

We investigate two channels that can potentially explain the differences in behaviour across the two treatments. The first channel relates to the impact of ratings on the beliefs about the firm's fundamentals. In the theoretical model presented in Section 2, inflated ratings have real effects because they provide useful information to investors: a good rating implies that the firm does not have extremely low fundamentals, and, as a result, will not default early. As such, we conjecture that potentially inflated ratings increase the propensity of investing by conveying positive information about the firm. Specifically, due to the partial verifiability constraint imposed on the CRA, observing a good rating (i.e., rating A) truncates investors' posterior beliefs about the firms' fundamentals from below -31. This, in turn, could make them more optimistic about the firm prospects and more likely to purchase the bond.

We start by investigating how the credit rating affects investors' posterior beliefs about firm fundamentals. In particular, for regions of IF that are close to the rating threshold, observing the rating should allow subjects to form more accurate posterior beliefs about the firm's IF.[32] Figure 3 shows the average stated belief about IF and the forecast error (measured as the absolute value of the difference between stated beliefs and actual fundamentals) across treatments. We find that posterior beliefs about fundamentals are not significantly different across the two treatments (p-value=0.11; 0.5).[33] However, participants seem to be more optimistic in the CRA treatment about the value of IF for good ratings: they have a higher average belief about IF (panel (a)), but they also exhibit a higher forecast error (panel (b)). For the bad ratings, average beliefs are more pessimistic, and the forecast error is slightly lower than in the Baseline treatment.

Figure 3: Beliefs about the firm's fundamentals

(a) Average belief about IF (b) Forecast error




*Notes*: Panel (a) shows the average stated belief across participants about the value of the firm's fundamentals around the rating threshold (-31). Panel (b) shows the forecast error measured as the absolute value of the difference between stated beliefs and actual fundamentals. Whiskers mark the 95% confidence interval.

**Result 5:** Posterior beliefs about the firm's fundamentals are not statistically different across the treatments around the rating threshold. However, investors are more optimistic

[32]Specifically, for fundamentals that are $2\epsilon$ around the theoretical threshold, observing the rating will result in a truncated posterior distribution of IF. This is because for a given $\theta = \theta_1^*$ subjects observing the lowest $(\theta_1^* - \epsilon)$ or higher $(\theta_1^* + \epsilon)$ private signal will have a posterior distribution of $\theta$ over the maximum interval $[\theta_1^* - 2\epsilon, \theta_1^* + 2\epsilon]$.

[33]The p-values reported in parenthesis in this section refer to (1) a t-test on the entire sample of individual decisions and (2) a non-parametric K-sample test on the equality of medians performed at the session level.

(pessimistic) about a firm's fundamentals in the case of a good (bad) rating in the CRA treatment than in the Baseline treatment. Still, investors lack accuracy in their posterior beliefs about fundamentals in both treatments.

A second channel that may explain the differences in investors' behaviour across treatments relates to the impact of the rating on the beliefs about the behaviour of others. Figure 4 shows the average stated beliefs about the number of others investing around the rating threshold (panel (a)) and the forecast error (panel (b)) across the two treatments. We observe that the average stated beliefs about the number of others investing is significantly higher for values of the fundamentals that correspond to the good rating (p-value$< 0.001; 0.02$) in the CRA treatment compared to the Baseline treatment. The opposite occurs for values of the fundamentals corresponding to the bad rating. Participants hold significantly lower beliefs about the number of others investing (p-value$< 0.001; 0.02$) in the CRA treatment compared to the Baseline. However, the rating does not improve the accuracy of posterior beliefs about the behaviour of others.[34]

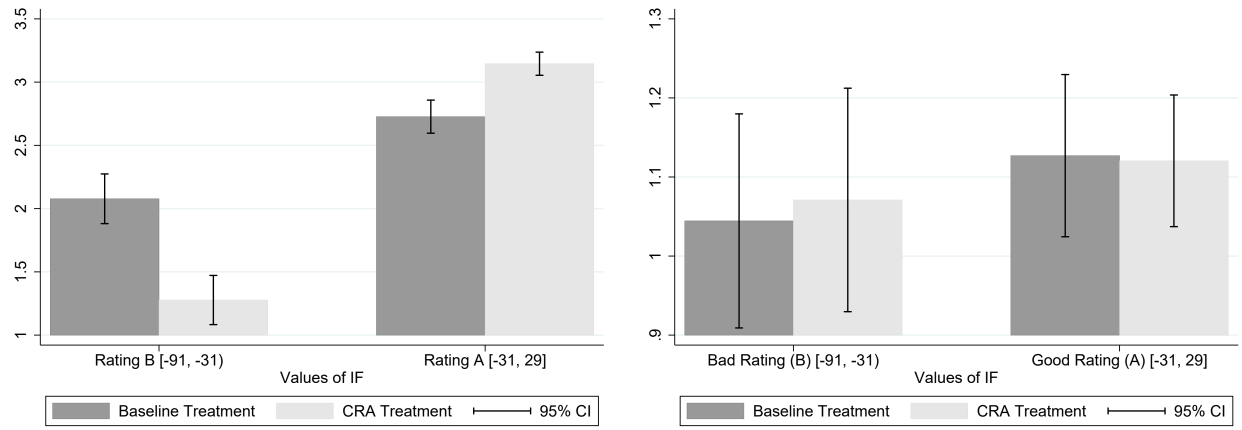
**Result 6:** Posterior beliefs about others' investment behaviour are statistically different across the treatments around the rating threshold. Investors are more optimistic (pessimistic) about the investing behaviour of others for a good (bad) rating in the CRA treatment than in the Baseline treatment. However, investors lack accuracy in their posterior beliefs about others' actions in both treatments.

We confirm these individual-level results through a series of regressions that allow us to cluster standard errors at the subject level to account for the correlation in investment decisions across periods. Columns (1)-(2) in Table 7 show results of probit models that investigate differences in the probability of investing conditional on the presence of a credit rating. The dependent variable is an indicator equal to 1 if a participant invests. In all specifications, the variable *Good rating (A)* takes value 1 for firms in the CRA treatment with IF above -31 and 0 when the firm is observed in the Baseline treatment and the firm's

[34] We report in Appendix B the posterior beliefs about firm fundamentals and the behaviour of others across quartiles of fundamentals. Figure 7 illustrates the differences across the two treatments.

Figure 4: Beliefs about the investment behaviour of others

(a) Average belief about the number of investors (b) Forecast error




*Notes*: Panel (a) shows the average stated belief across participants about the number of others investing around the rating threshold (-31). Panel (b) shows the forecast error measured as the absolute value of the difference between stated beliefs and the actual number of other participants investing. Whiskers mark the 95% confidence interval.

IF are above -31. Likewise, the variable *Bad rating (B)* is an indicator variable equal to 1 for a firm from the CRA treatment with fundamentals below -31 and 0 for a firm from the Baseline treatment with fundamentals below -31. As such, the specifications in columns (1)-(6) allow us to compare the informational role of ratings by looking at investors in firms with fundamentals either above or below the rating threshold but for which the public rating is observed only in the CRA treatment. Similar to our group-level findings reported in Table 4, we find that investors are more (less) likely to invest in firms receiving a good (bad) rating in the CRA treatment than in firms with similar fundamentals in the Baseline treatment.

In columns (3)-(6), we confirm the results reported in Figures 3 and 4 by showing how the presence of a rating in the CRA treatment affects the beliefs about fundamentals and the number of others investing. On the one hand, the results in columns (3) and (4) confirm that the rating does not affect the posterior beliefs about firm fundamentals in our treatments. On the other hand, the estimates from columns (5) and (6) reveal that the beliefs about the number of others investing are significantly higher (lower) in the CRA treatment compared to the Baseline treatment for values of the fundamentals corresponding to a good (bad)

Table 7: Ratings, investment behaviour and beliefs

| Dependent variable | $\mathbb{1}\{\text{Invest} = 1\}$ | | Belief fundamentals | | Belief number investors | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Hint about IF | 0.014*** | 0.006*** | 0.870*** | 0.927*** | 0.015*** | 0.010*** |
| | (0.002) | (0.001) | (0.015) | (0.011) | (0.001) | (0.001) |
| Good rating (A) | 0.562*** | | 5.059 | | 0.574*** | |
| | (0.166) | | (3.203) | | (0.140) | |
| Bad rating (B) | | -0.598*** | | 1.275 | | -0.961*** |
| | | (0.150) | | (7.047) | | (0.157) |
| Period | 0.055*** | -0.046*** | 0.173 | -2.628*** | 0.089*** | -0.064*** |
| | (0.015) | (0.017) | (0.150) | (0.423) | (0.010) | (0.018) |
| Observations | 1,545 | 1,905 | 1,545 | 1,905 | 1,545 | 1,905 |
| Number of subjects | 230 | 230 | 230 | 230 | 230 | 230 |

*Notes*: Columns (1)-(2) report estimates from probit regressions where the dependent variable is an indicator equal to 1 if a participant invests. Columns (3)-(4) present estimates from OLS regressions where the dependent variable is the stated belief about the value of the firm's internal funds (IF). Columns (5)-(6) report estimates from ordered logit regressions where the dependent variable is the stated belief about the number of participants that buy the bond. *Hint about IF* captures the private information about firm fundamentals. *Good (Bad) rating A (B)* is an indicator variable equal to 1 if the treatment is CRA and the firm's IF are above (below) -31 and 0 if the treatment is the Baseline and the firm's IF are above (below) -31. Standard errors clustered at the subject level are reported in parentheses. ***, ** , and * indicate significance at the 1%, 5%, and 10% levels, respectively.

rating. We observe that the coefficient for the *Good rating (A)* from column (5) is almost half the value (in absolute terms) of the estimate for the *Bad rating (B)* from column 6, suggesting that the effect on beliefs is larger for the bad rating.

**Result 7:** The effect of a bad rating on the beliefs about the behaviour of other investors is larger than that of a good rating.

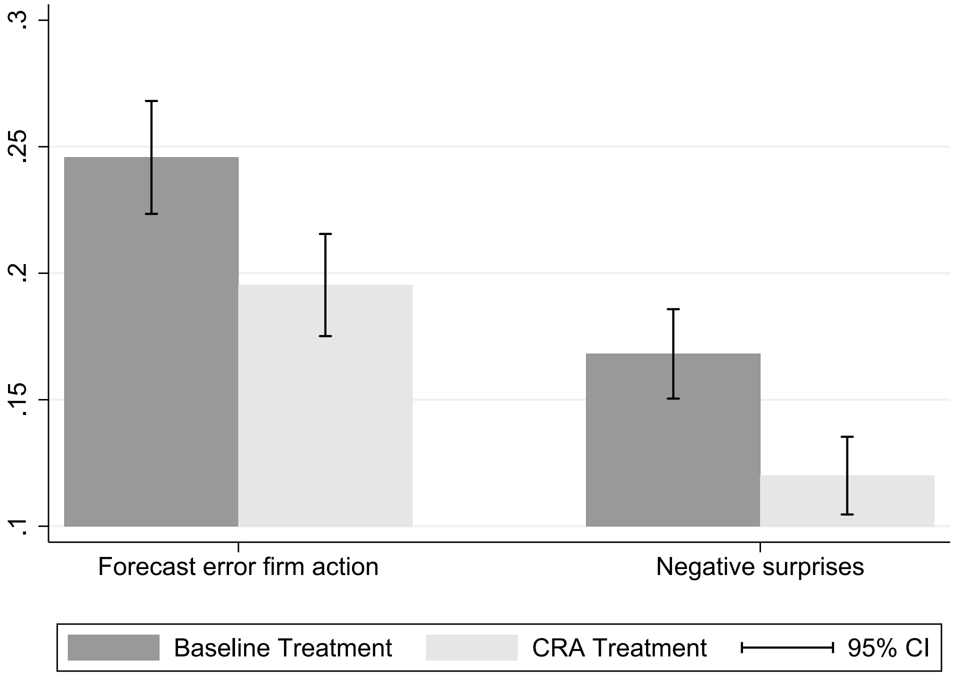
Results 4-7 speak to models that study public and private signals in games with strategic complementarities (Heinemann *et al.*, 2004; Cornand and Heinemann, 2014b; Baeriswyl and Cornand, 2016; Shurchkov, 2016; My *et al.*, 2021). We provide novel empirical evidence on the key mechanisms emphasized in these models. A key result in this literature is that public information has a larger impact on equilibrium outcomes because public signals are more informative about the behaviour of others. We confirm that the public credit ratings act as focal points for participants' coordination problem, even if they only have a modest impact on beliefs about firms' fundamentals. The reason is that observed ratings have a strong coordination effect on the beliefs of investors about their mutual investment behaviour. Notably, the enhanced coordination has positive welfare implications in a setting with feedback effects between the financial and real sectors. As shown in Section 4.1 (see Figure 2), potentially inflated ratings lead, on average, to a significantly higher (lower) proportion of firms undertaking the efficient, low-risk project (high-risk project). We can now provide the mechanism behind this result: for good (potentially inflated) ratings, investors hold significantly higher beliefs about the number of others investing. This leads to higher coordination on investing and, in a framework with feedback effects, to more efficient firm investment and better credit quality. Conversely, for bad ratings, investors coordinate on the decision not to invest, which results in less external funding and less firm investment in risky projects.

We further investigate whether participants' expected earnings from investing are also higher in the CRA treatment. To this end, we first compute for both treatments the total ex-ante expected gains of participants who invest. Specifically, the ex-ante gain from investing is 180 (200 with probability 90%) if the firm undertakes the LR project and 40 (200 with probability 20%) if the firm undertakes the HR project. We sum these anticipated gains across all investors that buy the bond and weigh this sum by the proportion of firms undertaking each type of project in each treatment. We then compare the total expected gains across the two treatments using non-parametric tests at the session level. We find that, on average, there is a significantly higher total expected return from investing in the CRA treatment than in the Baseline (p-value=0.021).

Next, we show that participants are better at forecasting the firm's action and are less likely to be negatively surprised by firm outcomes in the CRA treatment. Figure 5 (left panel) shows the average forecast error about firm action measured as the absolute value of the difference between the expected and realized firm actions. We compute the expected firm action based on a subject's stated beliefs about firm fundamentals and the behaviour of others.[35] We find that participants can better forecast the actual firm action in the CRA

[35] For example, if a participant who invests has a stated belief about the firm fundamentals of 50 and their belief about the numbers of others investing is 3, the expected firm action is LR (since $50+4\times100 > 300$).

Figure 5: Expectations and realized firm action




*Notes*: The left panel shows the average forecast error with regards to the firm action measured as the absolute value of the difference between the expected and realized firm actions. The expected firm action is computed based on the stated beliefs about firm fundamentals and the behaviour of others. Firm actions are codified as 1, 2, and 3 corresponding to Default, HR and LR, respectively. The right panel shows the percentage of negative surprises, where negative surprises are measured as instances when the firm outcome is worse than expected. Whiskers mark the 95% confidence interval.

than in the Baseline treatment (p-value = 0.001). This should also lead to fewer instances where a participant is negatively surprised by the firm outcome. We define a negative surprise as a situation where (i) the firm undertook the HR project or defaulted, while the participant expected the firm to undertake the LR project, or (ii) the actual firm action was to default, while the participant expected an HR/LR project to be undertaken. In the right panel of Figure 5, we show that the percentage of cases where firms' outcomes were worse than expected based on participants' stated beliefs is significantly lower in the CRA treatment (p-value$<$ 0.001).

**Result 8:** Investors are better at forecasting the firm's action and are less likely to be negatively surprised by firm outcomes in the CRA treatment.

## 4.3 Robustness tests and additional results

We provide several additional results and robustness tests for our main findings from the previous sections.

### Participants' characteristics

First, we show that our individual-level results are robust to controlling for risk and loss aversion metrics, as well as for participants' socioeconomic characteristics or experience in the game. Table 8 replicates the results from Table 7 including these additional covariates. Risk and loss aversion have been found to affect behaviour in coordination games (Brown *et al.*, 2017; Kiss *et al.*, 2018), and we, therefore, control for them in our experiment. We include indicator variables capturing risk and loss aversion, following the tests proposed in Dave *et al.* (2010) and Gächter *et al.* (2022), respectively.[36] We control for the following selected socioeconomic characteristics of subjects: gender, and whether the subject has more than one bank account or invests in capital markets. Finally, we control for past outcomes in the experiment by including a variable that captures the average number of negative surprises in previous rounds.

Our results from Table 7 are robust to including these additional explanatory variables. We find evidence that loss-averse individuals are less likely to invest (columns (1) and (2)) and hold more pessimistic beliefs about the behaviour of other investors (column (6)), while risk aversion has little explanatory power. At the same time, more negative past surprises appear positively correlated with the probability of investing (column (2)) and have a strong impact on investors' beliefs (columns (4) and (6)), but only when a bad rating is observed.

[36] The risk aversion indicator equals 1 if a subject chooses one of the first three gambles depicted in Figure 9 from Appendix C, corresponding to a risk-averse attitude in Dave *et al.*'s (2010) test. The loss aversion indicator equals one if a participant accepts at most two of the lotteries depicted in Figure 10 from Appendix C, corresponding to an implied degree of loss aversion greater than 1.5 in the loss aversion test proposed in Gächter *et al.* (2022).

Table 8: Investment behaviour - Robustness tests

| Dependent variable | $\mathbb{1}\{\text{Invest} = 1\}$ | | Belief fundamentals | | Belief number investors | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Hint about IF | 0.014*** | 0.006*** | 0.013*** | -0.003* | 0.014*** | 0.008*** |
| | (0.002) | (0.001) | (0.002) | (0.002) | (0.005) | (0.000) |
| Good rating (A) | 0.614*** | | 0.127 | | 0.517** | |
| | (0.167) | | (0.175) | | (0.246) | |
| Bad rating (B) | | -0.395*** | | -0.765 | | -0.540*** |
| | | (0.128) | | (0.569) | | (0.132) |
| Period | 0.057*** | -0.008 | 0.008 | 0.058 | 0.068*** | -0.028** |
| | (0.014) | (0.017) | (0.019) | (0.051) | (0.018) | (0.012) |
| Risk aversion | -0.276 | -0.072 | 0.024 | -0.543 | -0.400** | 0.070 |
| | (0.208) | (0.145) | (0.159) | (0.401) | (0.179) | (0.106) |
| Loss aversion | -0.270* | -0.365** | -0.051 | 0.504 | 0.096 | -0.398*** |
| | (0.138) | (0.150) | (0.137) | (0.442) | (0.201) | (0.100) |
| Negative past experiences | 0.447 | 2.799*** | 0.492 | -2.145*** | 0.489 | 2.985*** |
| | (0.334) | (0.239) | (0.466) | (0.721) | (0.424) | (0.442) |
| Capital market | 0.225 | -2.204*** | -0.854* | | -0.350 | -0.258 |
| | (0.797) | (0.639) | (0.499) | | (0.731) | (0.440) |
| Bank accounts | 0.390 | -0.318 | 0.551* | 0.456 | -0.284 | -0.498 |
| | (0.475) | (0.525) | (0.290) | (0.645) | (0.453) | (0.637) |
| Gender | -0.151 | 0.845 | 0.463* | 0.023 | -0.371 | 0.711 |
| | (0.432) | (0.565) | (0.250) | (0.844) | (0.415) | (0.600) |
| Observations | 1,545 | 1,905 | 1,545 | 1,882 | 1,545 | 1,905 |

*Notes:* Columns (1)-(2) report estimates from probit regressions where the dependent variable is an indicator equal to 1 if a participant invests. Columns (3)-(4) present estimates from OLS regressions where the dependent variable is the stated belief about the value of the firm's internal funds (IF). Columns (5)-(6) report estimates from ordered logit regressions where the dependent variable is the stated belief about the number of participants that buy the bond. *Hint about IF* captures the private information about firm fundamentals. *Good (Bad) rating A (B)* is an indicator variable equal to 1 if the treatment is CRA and the firm's IF are above (below) -31 and 0 if the treatment is the Baseline and the firm's IF are above (below) -31. *Risk/Loss aversion* are dummy variables equal to 1 if the participant was classified as risk/loss averse in the post-experiment questionnaire. *Negative past experiences* captures the average number of negative surprises from previous periods. *Capital market* is a dummy that equals 1 for subjects who report investing in capital markets. *Bank accounts* is a dummy that equals 1 for subjects with more than one bank account. *Gender* is a dummy that equals 1 for male participants. Standard errors clustered at the subject level are reported in parentheses. ***, ** , * indicate significance at the 1, 5, and 10% levels, respectively.

Socioeconomic characteristics such as gender and financial experience are not significantly correlated with the likelihood of investing or belief formation.[37]

[37] Table 13 (from Appendix B) shows the robustness of the results from Table 6 to the inclusion of additional controls.

Table 9: Post-experiment survey

| | N | Baseline Treatment | | CRA Treatment | |
|---|---|---|---|---|---|
| | | Mean | St. Dev. | Mean | St. Dev. |
| Making the choices in Part I of the experiment was easy | 115 | 3.696 | 0.929 | 3.678 | 0.969 |
| I was confident in taking the decisions in Part I of the experiment. | 115 | 3.922 | 0.919 | 3.93 | 0.934 |
| In Part I of the experiment, the most important element was estimating the level of the firm's internal funds | 115 | 3.165 | 1.051 | 3.104 | 1.18 |
| In Part I of the experiment, the most important element was estimating how many other investors invest. | 115 | 3.852 | 0.891 | 3.817 | 0.904 |

**Additional treatment: CRA Salient**

In the CRA treatment, participants can rationally deduce that, for some values of the fundamentals, the credit rating is inflated. However, we do not know whether they actually make this reasoning. Consequently, a potential concern arises: is the difference in subjects' behaviour between the CRA and the Baseline treatments due to the mere presence of the credit rating, or is it because the ratings are inflated? To disentangle these two potential explanations, we ran an additional treatment, called *CRA Salient*, where we explicitly stated that credit ratings might be inflated. The main difference between the CRA and CRA Salient treatments is the inclusion of the following sentence in the instructions:

*Notice that credit ratings can sometimes be inflated: this means that a Rating A can be assigned to some firms that do not have high levels of internal funds. Even if the rating agency expects these firms to invest in low-risk (LR) projects, they might still choose high-risk (HR) projects.*[38]

Similar to the main experiment, we conducted six additional sessions in which participants played this alternative CRA treatment with salient inflated ratings. These sessions involved 115 participants, with an average pay of 18.3 Euros.

[38] We have also added a sentence after the example explaining how credit ratings might be inflated.

We present in Appendix B the robustness of our main results by replacing the original CRA treatment with the alternative CRA Salient treatment. Specifically, Appendix Table 14 shows the average number of participants that invested in the Baseline treatment compared to the CRA Salient treatment. Similar to Result 1 above, in this CRA Salient treatment, we also find that firms with a good (bad) rating receive significantly more (less) external funding than firms in the Baseline treatment with similar fundamentals. Moreover, the results of the nonparametric tests are even stronger. Furthermore, in Appendix Figure 8, we show that Result 2 is also confirmed in the CRA Salient treatment: there is a significantly higher (lower) proportion of firms investing in the low- (high-) risk project in the CRA Salient treatment compared to the Baseline treatment.

Furthermore, the differences between the Baseline and CRA Salient treatments are larger in magnitude. Specifically, in Appendix Figure 8, we report the firms' actions across the three treatments: Baseline, CRA, and CRA Salient. We observe notable differences between the CRA Salient treatment and our main CRA treatment, which strengthens the results obtained so far. Specifically, defaults are significantly less likely in the CRA Salient treatment (p-value$<$ 0.001; 0.001) compared to the CRA treatment. The same applies to investment in high-risk projects, albeit with less precision (p-value=0.02; 0.63). For low-risk projects, the difference is not statistically significant. This suggests that making the rating inflation more salient impacts behaviour. We verify this in our individual-level regressions.

Appendix Table 15 replicates Table 7 but compares the CRA and CRA Salient treatments. We find no differences in the individual probability of investing for the same rating across the two CRA treatments. Similar to the main experiment, we do not find any difference in beliefs about fundamentals for firms with the same rating across the two CRA treatments. However, we do find that the belief about the number of others investing is significantly lower in the CRA Salient treatment for the bad rating. This is intuitive, as making the rating inflation more salient is expected to deter investment in high-risk firms and lead to better coordination on not investing, consistent with the results in Figure 8.

Overall, the findings of the CRA Salient treatment strengthen our main results and suggest that participants likely infer that the rating is inflated for high-risk firms in the CRA treatment. However, making the rating inflation more salient further improves coordination.

**Post-experimental questionnaire on the investment game**

Finally, we analyze the information collected during the experiment's second part, which included several questions aimed at understanding subjects' experience and attitudes in the investment game. Specifically, we inquired about the ease of making choices in the experiment, the level of confidence in making the investment decisions, and the importance of estimating the behaviour of others or the actual level of the firm's fundamentals. The questions were presented on a Likert scale from 1 to 5, with 1 representing "Strongly Disagree" and 5 representing "Strongly Agree", respectively. Table 9 presents the questions and summary statistics for participants' responses across the two treatments. There is minimal variation across the treatments and all responses average between 3 and 4. Notably, there are no statistically significant differences between the two treatments in the perceived ease of making choices or subjects' confidence. The results of the post-experiment survey corroborate with the findings previously discussed: on average, participants give more importance to estimating the behaviour of others as compared to the firm's fundamentals.

# 5 Concluding remarks

We conduct a laboratory experiment designed to examine the relationship between credit ratings, investor behaviour, and firm investment. Our study brings new empirical evidence on the potential mechanisms through which ratings can influence economic efficiency. While credit ratings can have significant economic consequences (as they not only reflect but also affect a debt issuer's credit quality), the impact of inflated credit ratings remains uncertain. On the one hand, inflated ratings may facilitate firms' excessive risk-taking, resulting in adverse economic outcomes. On the other hand, inflated credit ratings may also enhance economic efficiency by providing informative (though potentially biased) signals that can influence a firm's financing costs and investment choices, thus justifying the original rating. The net effect of inflated credit ratings remains an empirical question that has been difficult to address due to the challenge of identifying inflated ratings and dealing with endogeneity concerns arising from the potential influence of unobserved confounding factors on both ratings and investors' behaviour.

Our experimental design overcomes these challenges by controlling for firms' fundamentals and investors' information sets to isolate the informational role of potentially inflated credit ratings. Our main finding suggests that the positive effects of inflated credit ratings are more likely to dominate. Specifically, inflated credit ratings serve as a coordination mechanism that provides informative signals, shaping investors' beliefs about the investment behaviour of other investors while having a modest impact on their beliefs about firm's fundamentals. Receiving a good, potentially inflated, rating makes investors more optimistic about the behaviour of other investors, which enhances a firm's access to external funding and enables it to undertake value-enhancing projects. Conversely, a bad rating makes investors more pessimistic about others' behaviour, reducing their incentive to provide funding. As a result, firms with limited access to external financing are less likely to take excessive risks. Our findings suggest that the potential adverse real effects of inflated credit ratings are muted, indicating that inflated credit ratings may have positive effects beyond the laboratory in terms of efficient capital allocation and improved market outcomes.

Our findings imply that, from a policy standpoint, the interdependence between credit ratings and the actions of investors and firms is paramount. Inflated credit ratings can lead to greater economic efficiency if this feedback loop is present. In a market with credit rating agencies, even if ratings are potentially inflated, they provide valuable information that enhances the allocation of resources compared to markets without public ratings. Future research may explore whether accurate credit ratings (that reflect a firm's credit risk as closely as possible) impact economic efficiency more than inflated ratings.

## References


ALLEN, F., MORRIS, S. and SHIN, H. S. (2006). Beauty contests and iterated expectations in asset markets. *Review of Financial Studies*, **19** (3), 719–752.

ALMEIDA, H., CUNHA, I., FERREIRA, M. A. and RESTREPO, F. (2017). The real effects of credit ratings: The sovereign ceiling channel. *Journal of Finance*, **72** (1), 249–290.

ALP, A. (2013). Structural shifts in credit rating standards. *Journal of Finance*, **68** (6), 2435–2470.

ASHCRAFT, A. B. and SCHUERMANN, T. (2008). Understanding the securitization of subprime mortgage credit. *Foundations and Trends in Finance*, **2** (3), 191–309.

BAE, K. H., KANG, J.-K. and WANG, J. (2015). Does increased competition affect credit ratings? A reexamination of the effect of Fitch's market share on credit ratings in the corporate bond market. *Journal of Financial and Quantitative Analysis*, **50**, 1011–1035.

BAERISWYL, R. and CORNAND, C. (2016). The predominant role of signal precision in experimental beauty contests. *The BE Journal of Theoretical Economics*, **16** (1), 267–301.

— and — (2021). Double overreaction in beauty-contests with information acquisition: Theory and experiments. *Journal of Monetary Economics*, **118**, 432–445.

BAGHAI, R. P. and BECKER, B. (2020). Reputations and credit ratings: Evidence from commercial mortgage-backed securities. *Journal of Financial Economics*, **135**, 425–444.

BANNIER, C. E. and HIRSCH, C. W. (2010). The economic function of credit rating agencies – What does the watchlist tell us? *Journal of Banking & Finance*, **34** (12), 3037–3049.

BAR-ISAAC, H. and SHAPIRO, J. (2013). Ratings quality over the business cycle. *Journal of Financial Economics*, **108**, 62–78.

BAYONA, A. and PEIA, O. (2022). Financial contagion and the wealth effect: An experimental study. *Journal of Economic Behavior & Organization*, **200**, 1184–1202.

BECKER, B. and MILBOURN, T. (2011). How did increased competition affect credit ratings? *Journal of Financial Economics*, **101** (3), 493–514.

BENMELECH, E. and DLUGOSZ, J. (2009a). The alchemy of CDO credit ratings. *Journal of Monetary Economics*, **56**, 617–634.

— and — (2009b). The credit rating crisis. *NBER Working paper*, (15045).

Bloomfield, R. and Anderson, A. (2010). Experimental finance. *Behavioral Finance: Investors, Corporations, and Markets, John Wiley & Sons, Inc, Hoboken, NJ, USA*, pp. 113–130.

Bolton, P., Freixas, X. and Shapiro, J. (2012). The credit ratings game. *Journal of Finance*, **67** (1), 85–111.

Bond, P., Edmans, A. and Goldstein, I. (2012). The real effects of financial markets. *Annu. Rev. Financ. Econ.*, **4** (1), 339–360.

Bongaerts, D., Cremers, K. M. and Goetzmann, W. N. (2012). Tiebreaker: Certification and multiple credit ratings. *Journal of Finance*, **67** (1), 113–152.

Boot, A. W., Milbourn, T. T. and Schmeits, A. (2006). Credit ratings as coordination mechanisms. *Review of Financial Studies*, **19** (1), 81–118.

Bossaerts, P. *et al.* (2009). The experimental study of asset pricing theory. *Foundations and Trends® in Finance*, **3** (4), 289–361.

Brown, M., Trautmann, S. T. and Vlahu, R. (2017). Understanding bank-run contagion. *Management Science*, **63** (7), 2272–2282.

Cabrales, A., Nagel, R. and Armenter, R. (2007). Equilibrium selection through incomplete information in coordination games: An experimental study. *Experimental Economics*, **10** (3), 221–234.

Carlsson, H. and Van Damme, E. (1993). Global games and equilibrium selection. *Econometrica*, **61** (5), 989–1018.

Cornaggia, J. and Cornaggia, K. J. (2013). Estimating the Costs of Issuer-Paid Credit Ratings. *Review of Financial Studies*, **26** (9), 2229–2269.

—, — and Israelsen, R. D. (2018). Credit ratings and the cost of municipal financing. *Review of Financial Studies*, **31** (6), 2038–2079.

Cornand, C. and Heinemann, F. (2014a). Experiments on monetary policy and central banking. In *Experiments in macroeconomics*, Emerald Group Publishing Limited.

— and — (2014b). Measuring agents'reaction to private and public information in games with strategic complementarities. *Experimental Economics*, **17** (1), 61–77.

Daley, B., Green, B. and Vanasco, V. (2020). Securitization, ratings, and credit supply. *Journal of Finance*, **75** (2), 1037–1082.

Dave, C., Eckel, C. C., Johnson, C. A. and Rojas, C. (2010). Eliciting risk preferences: When is simple better? *Journal of Risk and Uncertainty*, **41** (3), 219–243.

Donaldson, J. and Piacentino, G. (2018). Contracting to compete for flows. *Journal of Economic Theory*, **173**, 289–319.

Eckel, C. C. and Grossman, P. J. (2008). Forecasting risk attitudes: An experimental study using actual and forecast gamble choices. *Journal of Economic Behavior & Organization*, **68** (1), 1–17.

Ellul, A., Jotikasthira, C. and Lundblad, C. (2011). Regulatory pressure and fire sales in the corporate bond market. *Journal of Financial Economics*, **101** (3), 596–620.

Fischbacher, U. (2007). z-tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics*, **10** (2), 171–178.

Frechette, G. (2015). Laboratory experiments: professionals versus students. *In: Fréchette, G.R., Schotter, A. (Eds.), Handbook of Experimental Economic Methodology. Oxford University Press*, pp. 360–390.

Frenkel, S. (2015). Repeated interaction and rating inflation: A model of double reputation. *American Economic Journal: Microeconomics*, **7** (1), 250–280.

Fulghieri, P., Strobl, G. and Xia, H. (2014). The economics of solicited and unsolicited credit ratings. *Review of Financial Studies*, **27** (2), 484–518.

Gächter, S., Johnson, E. J. and Herrmann, A. (2022). Individual-level loss aversion in riskless and risky choices. *Theory and Decision*, **92** (3), 599–624.

Gao, P. (2008). Keynesian beauty contest, accounting disclosure, and market efficiency. *Journal of Accounting Research*, **46** (4), 785–807.

Goel, A. M. and Thakor, A. V. (2015). Information reliability and welfare: A theory of coarse credit ratings. *Journal of Financial Economics*, **115** (3), 541–557.

Goldstein, I. (2023). Information in financial markets and its real effects. *Review of Finance*, **27** (1), 1–32.

— and Huang, C. (2020). Credit rating inflation and firms' investments. *Journal of Finance*, **75** (6), 2929–2972.

Griffin, J., Nickerson, J. and Tang, D. Y. (2013). Rating shopping or catering? An examination of the response to competitive pressure for cdo credit ratings. *Review of Financial Studies*, **26**, 2270–2310.

— and Tang, D. Y. (2011). Did credit rating agencies use biased assumptions? *American Economic Review*, **101**, 125–130.

— and — (2012). Did subjectivity play a role in CDO credit ratings? *Journal of Finance*, **67** (4), 1293–1328.

He, J., Qian, J. and Strahan, P. (2012). Are all ratings created equal? The impact of issuer size on the pricing of mortgage-backed securities. *Journal of Finance*, **67**, 2097–2137.

He, Z. and Xiong, W. (2012). Dynamic debt runs. *The Review of Financial Studies*, **25** (6), 1799–1843.

Heinemann, F., Nagel, R. and Ockenfels, P. (2004). The theory of global games on test: Experimental analysis of coordination games with public and private information. *Econometrica*, **72** (5), 1583–1599.

—, — and — (2009). Measuring strategic uncertainty in coordination games. *Review of Economic Studies*, **76** (1), 181–221.

Hirth, S. (2014). Credit rating dynamics and competition. *Journal of Banking & Finance*, **49**, 100–112.

Huck, S. and Muller, W. (2012). Allais for all: revisiting the paradox in a large representative sample. *Journal of Risk and Uncertainty*, **44**, 261–293.

Jeon, D.-S. and Lovo, S. (2013). Credit rating industry: A helicopter tour of stylized facts and recent theories. *International Journal of Industrial Organization*, **31**, 643–651.

Jiang, J., Stanford, M. and Xie, Y. (2012). Does it matter who pays for bond ratings? Historical evidence. *Journal of Financial Economics*, **105** (3), 607–621.

Keser, C., Özgümüs, A., Peterlé, E. and Schmidt, M. (2017). An experimental investigation of rating-market regulation. *Journal of Economic Behavior & Organization*, **144**, 78–86.

Kisgen, D. (2009). Do firms target credit ratings or leverage levels? *Journal of Financial and Quantitative Analysis*, **44** (6), 1323–1344.

— and Strahan, P. (2010). Do regulations based on credit ratings affect a firm's cost of capital? *Review of Financial Studies*, **23** (12), 4324–4347.

Kiss, H. J., Rodriguez-Lara, I. and Rosa-Garcia, A. (2018). Panic bank runs. *Economics Letters*, **162**, 146 – 149.

Kliger, D. and Sarig, O. (2000). The information value of bond ratings. *Journal of Finance*, **55** (6), 2879–2902.

Levy, H. (1994). Absolute and relative risk aversion: An experimental study. *Journal of Risk and Uncertainty*, **8**, 289–307.

Mählmann, T. (2011). Is there a relationship benefit in credit ratings? *Review of Finance*, **15** (3), 475–510.

Manso, G. (2013). Feedback effects of credit ratings. *Journal of Financial Economics*, **109**, 535–548.

Morris, S. and Shin, H. S. (1998). Unique equilibrium in a model of self-fulfilling currency attacks. *American Economic Review*, **88** (3), 587–597.

— and — (2004). Coordination risk and the price of debt. *European Economic Review*, **48** (1), 133–153.

My, K. B., Cornand, C. and Ferreira, R. D. S. (2021). Public information and the concern for coordination. *Journal of Behavioral and Experimental Economics*, **93**, 101710.

Noussair, C., Trautmann, S. and van de Kuilen, G. (2014). Higher order risk attitudes, demographics, and financial decisions. *Review of Economic Studies*, **81**, 325–355.

Opp, C. C., Opp, M. M. and Harris, M. (2013). Rating agencies in the face of regulation. *Journal of Financial Economics*, **108** (1), 46–61.

Parlour, C. A. and Rajan, U. (2020). Contracting on credit ratings: Adding value to public information. *Review of Financial Studies*, **33** (4), 1412–1444.

Peia, O. and Vranceanu, R. (2019). Experimental evidence on bank runs with uncertain deposit coverage. *Journal of Banking & Finance*, **106**, 214–226.

Rabanal, J. P. and Rud, O. A. (2017). Does competition affect truth telling? An experiment with rating agencies. *Review of Finance*, **22** (4), 1581–1604.

Sangiorgi, F. and Spatt, C. (2017). The economics of credit rating agencies. *Foundations and Trends in Finance*, **12** (1), 1–116.

Sanjay, B. and Maier, M. (2016). Public information precision and coordination failure: An experiment. *Journal of Accounting Research*, **54** (4), 941–986.

Shurchkov, O. (2016). Public announcements and coordination in dynamic global games: Experimental evidence. *Journal of Behavioral and Experimental Economics*, **61**, 20–30.

Skreta, . V. L., V. (2009). Ratings shopping and asset complexity: A theory of ratings inflation. *Journal of Monetary Economics*, **56** (5), 678–695.

Strobl, G. and Xia, H. (2012). The issuer-pays rating model and ratings inflation: Evidence from corporate credit ratings. *Available at SSRN 2002186*.

Sufi, A. (2009). The real effects of debt certification: Evidence from the introduction of bank loan ratings. *Review of Financial Studies*, **22** (4), 1659–1691.

Sunder, S. (2007). What have we learned from experimental finance? In *Developments on Experimental Economics*, Springer, pp. 91–100.

Szkup, M. and Trevino, I. (2020). Sentiments, strategic uncertainty, and information structures in coordination games. *Games and Economic Behavior*, **124**, 534–553.

Tang, T. T. (2009). Information asymmetry and firms' credit market access: Evidence from Moody's credit rating format refinement. *Journal of Financial Economics*, **93** (2), 325–351.

Terovitis, S. (2020). Information disclosure and the feedback effect in capital markets. *Journal of Financial Intermediation*, p. 100897.

US Government, U. (2011). Financial crisis inquiry commission. *Available online: http://fcic-static.law.stanford.edu/cdn_media/fcic-reports/fcic_final_report_conclusions.pdf.*

US Senate, U. (2007). The role and impact of credit rating agencies in the subprime credit markets. *Senate Hearing 110-931 September 26*.

Weber, M., Duffy, J. and Schram, A. (2018). An experimental study of bond market pricing. *Journal of Finance*, **73** (4), 1857–1892.

Weitzel, U., Huber, C., Huber, J., Kirchler, M., Lindler, F. and Rose, J. (2020). Bubbles and financial professionals. *Review of Financial Studies*, **33**, 2659–2696.

White, L. (2010). Markets: The credit rating agencies. *Journal of Economic Perspectives*, **24** (2), 211–226.

White, L. J. (2013). Credit rating agencies: An overview. *Annu. Rev. Financ. Econ.*, **5** (1), 93–122.

# Appendix

## A Theoretical predictions

In this section, we provide more technical details of the theoretical predictions exposed in the main text by writing them formally and deriving proofs based on the work of Goldstein and Huang (2020).

### A.1 Equilibrium without a CRA

We start by outlining the equilibrium in a benchmark model without a rating agency. The equilibrium concept is a monotone perfect Bayesian equilibrium. We solve the model backwards. First, we derive the firm's optimal investment strategy at date 1, conditional on $\theta$, by using the firm's expected profits in (3) and then deriving the firm's profit-maximizing strategy. The firm always has the incentive to choose the LR project over the HR project for $K(\theta) \geq I$ since $p[V - FW(\theta) + K(\theta) - I] > q[H - FW(\theta) + K(\theta)]$.[39] When the available funds are positive but not sufficient to allow investment in the LR project (i.e., $0 < K(\theta) < I$), choosing the HR project dominates the decision to default since $q[H - FW(\theta) + K(\theta)] > 0$.[40] Therefore, the firm's optimal investment strategy at date 1, conditional on the total available funding, $K(\theta) = \theta + W(\theta)$, is as follows:

$$\begin{cases} \text{Invest in LR project} & \text{if} \quad K(\theta) \geq I \\ \text{Invest in HR project} & \text{if} \quad 0 \leq K(\theta) < I. \\ \text{Default} & \text{if} \quad K(\theta) < 0. \end{cases} \tag{6}$$

Equation (6) implies that a firm would choose to default when the total funds available from bonds markets and the ongoing project are low enough. This happens when $\theta < \tilde{\theta}_1$, where

[39] One can verify that this is equivalent to $K(\theta) > FW(\theta) - ((p(V - I) - qH)/(p - q))$. For $K(\theta) \geq I$ it is sufficient to show that $I > FW(\theta) - (p(V - I) - qH)/(p - q))$, which holds given that $I > F$ and $pV - I > qH$ by assumption.

[40] The inequality holds since $H > F$.

$\widetilde{\theta}_1$ solves:

$$K(\tilde{\theta}_1) = \tilde{\theta}_1 + W\left(\tilde{\theta}_1\right) = 0. \tag{7}$$

As $K(\theta)$ is strictly increasing in $\theta$, for any $\theta < \widetilde{\theta}_1$ the firm's external funding is insufficient to cover the losses from the ongoing project. However, when $\theta > \widetilde{\theta}_1$, the firm has incentives to invest in a new project. The firm chooses the LR project over the HR project for $\theta \geq \widetilde{\theta}_2$, where $\widetilde{\theta}_2$ solves:

$$K(\tilde{\theta}_2) = \tilde{\theta}_2 + W\left(\tilde{\theta}_2\right) = I. \tag{8}$$

Next, we solve for investors' optimal investment actions. Given $\theta$, the realization of fundamentals, and the investors' threshold strategies, the measure of investors who buy the bond is:

$$W(\theta) = \Pr(x \geq \tilde{x}|\theta) = 1 - \Pr(x < \tilde{x}|\theta) = 1 - \frac{\tilde{x} - \theta + \epsilon}{2\epsilon} = \frac{\theta - \tilde{x} + \epsilon}{2\epsilon}, \tag{9}$$

following from the fact that signals are uniformly distributed over $[\theta - \epsilon, \theta + \epsilon]$.

Furthermore, an investor has a dominant strategy to invest when the expected payoff of doing so, conditional on the available information, is higher than the expected payoff of not investing. Any investor $j$ receiving a signal $x_j$ invests as long as her signal is higher than the threshold signal, $\tilde{x}$. As such, there must be a marginal investor who receives exactly the signal $\tilde{x}$ and is indifferent between buying or not the bond. The indifference condition is such that:

$$\text{Prob}\left[\theta \geq \widetilde{\theta}_2 \mid \tilde{x}\right] \times pF + \left\{\text{Prob}\left[\theta < \widetilde{\theta}_2 \mid \tilde{x}\right] - \text{Prob}\left[\theta < \widetilde{\theta}_1 \mid \tilde{x}\right]\right\} \times qF = 1, \tag{10}$$

where the first term of the left-hand side is the expected payoff on the LR project (the firm undertakes the LR project with the probability that $\theta$ is above $\widetilde{\theta}_2$ and investors receive $F$ with probability $p$), while the second term is the expected payoff on the HR project (the firm undertakes the HR project with the probability that $\theta$ is between $[\widetilde{\theta}_1, \widetilde{\theta}_2]$ and creditors receive $F$ with probability $q$).

**Proof of Theoretical prediction 1**

To find the unique equilibrium thresholds $\left(\tilde{\theta}_1, \tilde{\theta}_2, \tilde{x}\right)$ in the benchmark model without a CRA we need to show that there is a unique solution to equations (7), (8), and (10), which can be re-written as follows:

$$\begin{cases} \tilde{\theta}_1 + \frac{\tilde{\theta}_1 - \tilde{x} + \epsilon}{2\epsilon} = 0 \\ \tilde{\theta}_2 + \frac{\tilde{\theta}_2 - \tilde{x} + \epsilon}{2\epsilon} = I \\ \frac{\tilde{x} - \tilde{\theta}_1 + \epsilon}{2\epsilon} \times pF + \left(\frac{\tilde{\theta}_2 - \tilde{x} + \epsilon}{2\epsilon} - \frac{\tilde{\theta}_1 - \tilde{x} + \epsilon}{2\epsilon}\right) \times qF = 1, \end{cases}$$

where we have used the fact that the posterior belief over the firm fundamentals when observing a signal $\tilde{x}$ is uniformly distributed over $[\tilde{x} - \epsilon, \tilde{x} + \epsilon]$.

The linear system of equations with three unknowns (i.e., $\tilde{x}, \tilde{\theta}_1, \tilde{\theta}_2$) has an analytical solution of the form:

$$\begin{cases} \tilde{x} = \frac{2\epsilon+1}{pF} + \frac{(p-q)I}{p} - \epsilon - 1 \\ \tilde{\theta}_1 = \frac{\tilde{x} - \epsilon}{2\epsilon+1} \\ \tilde{\theta}_2 = \frac{\tilde{x} - \epsilon + 2\epsilon I}{2\epsilon+1} \end{cases}$$

As $2\epsilon I > 0$, we obtain that $\tilde{\theta}_2 > \tilde{\theta}_1$. *QED*

## A.2 Equilibrium with a CRA

We follow Goldstein and Huang (2020) and make several assumptions about the CRA's payoff function in order to derive conditions under which the CRA has an incentive to assign an inflated rating. Specifically, the payoff function of the CRA is as follows: it earns a revenue $S^R$ and faces a potential cost $C^R$ when assigning a rating $R = p, q$. In line with the "issuer-pays" business model, we assume that the CRA receives higher revenues when assigning better credit ratings: $S^p > S^q > 0$.[41] The cost $C^R$ corresponds to (exogenous) reputation or

[41] See Bar-Isaac and Shapiro (2013) and Sangiorgi and Spatt (2017) for a discussion of the relationship between reputational incentives and credit quality and the frictions associated with CRAs.

legal costs in the case of firm default. We assume that if a firm with rating $R > 0$ defaults at $t = 1$, the reputational costs for the CRA are very large ($C^{\text{early default}} > S^p$), such that the CRA does not assign a rating to firms it foresees defaulting at $t = 1$. If a firm with rating $R > 0$ defaults at $t = 2$, the CRA incurs a cost $C^R$ ($R = p, q$), with $S^p > S^q > C^p > C^q > 0$.

**Lemma 1** If $S^p - S^q \geq (1-q)(C^p - C^q)$, the equilibrium strategy of the CRA is to assign an inflated rating, as follows:

$$R(\theta) = \begin{cases} p \text{ if } \theta \geq \theta_1^* \\ 0 \text{ if } \theta < \theta_1^*. \end{cases} \tag{11}$$

**Proof of Lemma 1** To prove Lemma 1 we need to show that the CRA will not assign a rating $q$ in equilibrium, whenever $\frac{S^p - S^q}{C^p - C^q} \geq 1 - q$ holds. Suppose the CRA assigns a rating $q$ to a $\theta$-firm when $\theta \in (\theta_1, \theta_2)$. We will show that it is always profitable for the CRA to deviate and assign a rating $p$.

Consider the case in which investors believe that a rating $p$ implies that the firm has better fundamentals than a firm with rating $q$. In that case, if the CRA deviates and assigns rating $p$, more investors will buy the firm's bonds. This implies that if the firm does not default with a rating of $q$, it won't default when the CRA assigns a rating of $p$ either. At the same time, the condition $\frac{S^p - S^q}{C^p - C^q} \geq 1 - q$ implies that:

$$\frac{S^p - S^q}{C^p - C^q} \geq 1 - q \geq 1 - p, \text{since } \; p > q. \tag{12}$$

If the firm invests in the HR project when assigned a rating $p$, the CRA obtains a profit of $S^p - (1-q)C^p$. From (12) we obtain that $S^p - (1-q)C^p > S^q - (1-q)C^q$, implying that the CRA is better off by deviating and assigning a rating $p$ even if the firm invests in an HR project and defaults with probability $1-q$. Likewise, if the firm invests in an LR project, the CRA's profit is $S^p - (1-p)C^p$ and using (12) we obtain that $S^p - (1-p)C^p > S^q - (1-p)C^q$, implying that it is more profitable for the CRA to deviate and assign rating $p$.

Consider now the case in which investors do not believe that a rating $p$ implies that the firm has better fundamentals than a firm with rating $q$. Then there are some intervals of fundamentals where the rating is $p$ for $\theta \in (\theta_3, \theta_4)$ and $q$ for $\theta \in (\theta_1, \theta_2)$, with $\theta_3 < \theta_4 < \theta_1 < \theta_2$. If the CRA deviates and assigns a firm with fundamentals in interval $(\theta_1, \theta_2)$ a rating of $p$ instead of $q$, investors will believe that the fundamentals are worse, i.e., in interval $(\theta_3, \theta_4)$. However, firms in neither $(\theta_1, \theta_2)$ nor $(\theta_3, \theta_4)$ intervals will default early (as the CRA never assigns a rating different from zero to firms that it believes will default early). So firms with fundamentals in interval $(\theta_1, \theta_2)$ will not default early even if they receive a rating $p$. Given that from (12) the CRA has higher expected profits when assigning a rating $p$, the CRA will then deviate and prefer to assign a rating $p$.

Summing up the two cases, there is no equilibrium in which the CRA assigns a rating $q$ when (12) holds. $QED$

**Proof of Theoretical prediction 2.**

In the model with a CRA, the equilibrium is described by $(\theta_1^*, \theta_2^*, x^*)$, with the CRA assigning a rating $R = p$ if $\theta \geq \theta_1^*$, and $R = 0$ otherwise. When $R = 0$, no investor buys bonds, whereas, for $R = p$, investors buy the bonds if and only if their private signals $x$ are larger than $x^*$, where $x^*$ is obtained from the indifference condition of the marginal investor

$$\frac{\text{Prob}\left[\theta \geq \theta_2^* \mid \ x^*\right]}{\text{Prob}\left[\theta \geq \theta_1^* \mid \ x^*\right]} \times pF + \frac{\text{Prob}\left[\theta < \theta_2^* \mid \ x^*\right] - \text{Prob}\left[\theta < \theta_1^* \mid \ x^*\right]}{\text{Prob}\left[\theta \geq \theta_1^* \mid \ x^*\right]} \times qF = 1. \tag{13}$$

The firm invests in the HR project if $\theta_1^* \leq \theta < \theta_2^*$ and undertakes the LR project if $\theta \geq \theta_2^*$, where $\theta_1^*$ solves

$$K(\theta_1^*) = \theta_1^* + W\left(\theta_1^*\right) = 0, \tag{14}$$

and $\theta_2^*$ solves

$$K(\theta_2^*) = \theta_2^* + W\left(\theta_2^*\right) = I. \tag{15}$$

Same as before, we show that equations (13), (14), and (15) admit a unique solution. From Lemma 1, the CRA assigns only ratings $R = 0$ and $R = p$ in this equilibrium. Moreover, a rating of $R = 0$ is assigned when the CRA knows that the firm will default at $t = 1$

even with a rating of $p$. As such, the rating $R = 0$ is assigned for $\theta < \theta_1^*$, where $\theta_1^*$ is the threshold at which the firm is indifferent between defaulting early or investing in the HR project: $K(\theta_1^*) = \theta_1^* + W(\theta_1^*) = 0$.

Similarly, given that the firm's payoff is increasing in $\theta$, there must be a threshold $\theta_2^* > \theta_1^*$, such that the firm invests in the LR project for $\theta \geq \theta_2^*$ and in the HR for $\theta \in [\theta_1^*, \theta_2^*]$, where $\theta_2^*$ solves: $K(\theta_2^*) = \theta_2^* + W(\theta_2^*) = I$.

Finally, given the CRA's strategy, investors observing a rating of $R = p$ believe that the firm's true fundamentals are above $\theta_1^*$, which means that for any private signal $x_i$ their posterior distribution for $\theta$ is truncated from below by $\theta_1^*$. The indifference condition for the marginal investor becomes:

$$\frac{\text{Prob}\left[\theta \geq \theta_2^* \mid x^*\right]}{\text{Prob}\left[\theta \geq \theta_1^* \mid x^*\right]} \times pF + \frac{\text{Prob}\left[\theta < \theta_2^* \mid x^*\right] - \text{Prob}\left[\theta < \theta_1^* \mid x^*\right]}{\text{Prob}\left[\theta \geq \theta_1^* \mid x^*\right]} \times qF = 1. \tag{16}$$

Using the fact that $W(\theta) = \frac{\theta - \tilde{x} + \epsilon}{2\epsilon}$, equations (13), (14), and (15) in Theoretical Prediction 2 become:

$$\begin{cases} \theta_1^* + \frac{\theta_1^* - \tilde{x} + \epsilon}{2\epsilon} = 0 \\ \theta_2^* + \frac{\theta_2^* - \tilde{x} + \epsilon}{2\epsilon} = I \\ \frac{(x^* - \theta_2^* + \epsilon) \times pF + (\theta_2^* - \theta_1^*) \times qF}{x^* - \theta_1^* + \epsilon} = 1. \end{cases}$$

The unique solution $(x^*, \theta_1^*, \theta_2^*)$ to the system of equations above is:

$$\begin{cases} x^* = \frac{(p-q)IF}{pF-1} - \epsilon - 1 \\ \theta_1^* = \frac{x^* - \epsilon}{2\epsilon + 1} \\ \theta_2^* = \frac{x^* - \epsilon + 2\epsilon I}{2\epsilon + 1}. \end{cases}$$

*QED.*

# Appendix B: Additional empirical results

Table 10: Average number of investors and fundamentals

| Fundamentals | Baseline (1) | CRA (2) | Test 1 (3) | Test 2 (4) |
|---|---|---|---|---|
| $1^{st}$ quartile | 0.43 (0.56) | 0.24 (0.51) | 0.0246 | 0.248 |
| $2^{nd}$ quartile | 0.97 (1.12) | 0.46 (0.68) | 0.0005 | 0.021 |
| $3^{rd}$ quartile | 2.80 (1.40) | 3.44 (1.57) | 0.0063 | 0.248 |
| $4^{th}$ quartile | 4.66 (0.62) | 4.71 (0.51) | 0.5814 | 1 |

*Notes:* Columns (1)-(2) present the mean (standard deviation) of the number of subjects (per group) investing conditional on the treatment and quartiles of firm fundamentals. Test 1 in column (3) is a t-test of equality of means performed at the group level. Test 2 in column (4) is a non-parametric K-sample test on the equality of medians performed at the session level.

Table 11: Firm actions

| Treatment | Baseline | | | CRA | | | Non-parametric test (p-values) | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (1) vs (4) | (2) vs. (5) | (3) vs. (6) |
| Firm action | Default | HR | LR | Default | HR | LR | | | |
| Proportion of firms | 0.46 (0.06) | 0.21 (0.04) | 0.36 (0.06) | 0.47 (0.03) | 0.16 (0.09) | 0.43 (0.07) | 1 | 0.02 | 0.02 |
| Observations | 155 | 70 | 120 | 160 | 41 | 144 | 6 | 6 | 6 |

*Notes:* Non-parametric test is a K-sample test on the equality of medians performed at the session level that compares the proportion of firms with specific actions across the two treatments.

Table 12: Firm actions across quartiles of fundamentals

| Quartile | Firm action | Baseline (1) | CRA (2) | Difference (3) |
|---|---|---|---|---|
| 1 | Default | 100 | 100 | 0 |
| 2 | Default | 73 | 83 | 9 |
| | High risk | 35 | 20 | -15 |
| | Low risk | 11 | 0 | -11 |
| 3 | Default | 11 | 11 | 0 |
| | High risk | 58 | 43 | -15** |
| | Low risk | 43 | 72 | 29** |
| 4 | High risk | 6 | 0 | -6 |
| | Low risk | 99 | 100 | 1 |

*Notes:* The table shows in columns (1)-(2) the mean percentage of firm actions across quartiles of firm fundamentals. The statistical significance of the difference in column (3) is based on a non-parametric K-sample test on the equality of medians performed at the session level.***, ** , and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 13: Individual behaviour - Additional robustness tests

| | Baseline | | | | CRA | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Hint about IF | 0.010*** | 0.008*** | 0.004*** | 0.004*** | 0.012*** | 0.006*** | 0.004*** | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Belief IF | | 0.002 | | 0.000 | | 0.008*** | | 0.005*** |
| | | (0.001) | | (0.001) | | (0.001) | | (0.001) |
| Belief # investors | | | 1.131*** | 1.131*** | | | 1.047*** | 1.015*** |
| | | | (0.104) | (0.105) | | | (0.100) | (0.095) |
| Period | 0.002 | 0.003 | 0.003 | 0.003 | 0.014 | 0.022** | 0.002 | 0.007 |
| | (0.009) | (0.009) | (0.015) | (0.015) | (0.010) | (0.010) | (0.012) | (0.012) |
| Risk aversion | -0.239** | -0.231** | -0.086 | -0.085 | 0.028 | -0.090 | -0.014 | -0.060 |
| | (0.111) | (0.114) | (0.148) | (0.148) | (0.182) | (0.167) | (0.248) | (0.237) |
| Loss aversion | -0.207* | -0.203 | -0.212 | -0.212 | -0.340 | -0.248 | -0.313 | -0.285 |
| | (0.119) | (0.125) | (0.130) | (0.131) | (0.274) | (0.227) | (0.350) | (0.337) |
| Negative past experiences | 1.881*** | 1.674*** | 0.135 | 0.130 | 1.400*** | 0.455* | -0.217 | -0.607** |
| | (0.355) | (0.393) | (0.375) | (0.383) | (0.317) | (0.256) | (0.343) | (0.251) |
| Capital market | -1.165** | -1.142* | -0.785* | -0.788 | -0.077 | 0.160 | 0.019 | 0.001 |
| | (0.590) | (0.588) | (0.475) | (0.488) | (0.560) | (0.457) | (0.550) | (0.443) |
| Bank accounts | 0.218 | 0.154 | 0.689** | 0.687** | -0.013 | -0.021 | 0.349 | 0.300 |
| | (0.406) | (0.408) | (0.314) | (0.313) | (0.385) | (0.291) | (0.498) | (0.449) |
| Gender | 0.828* | 0.836* | 0.676* | 0.678* | 0.620 | 0.205 | 0.309 | 0.156 |
| | (0.451) | (0.471) | (0.372) | (0.373) | (0.572) | (0.564) | (0.380) | (0.378) |
| Observations | 1,725 | 1,725 | 1,725 | 1,725 | 1,725 | 1,725 | 1,725 | 1,725 |

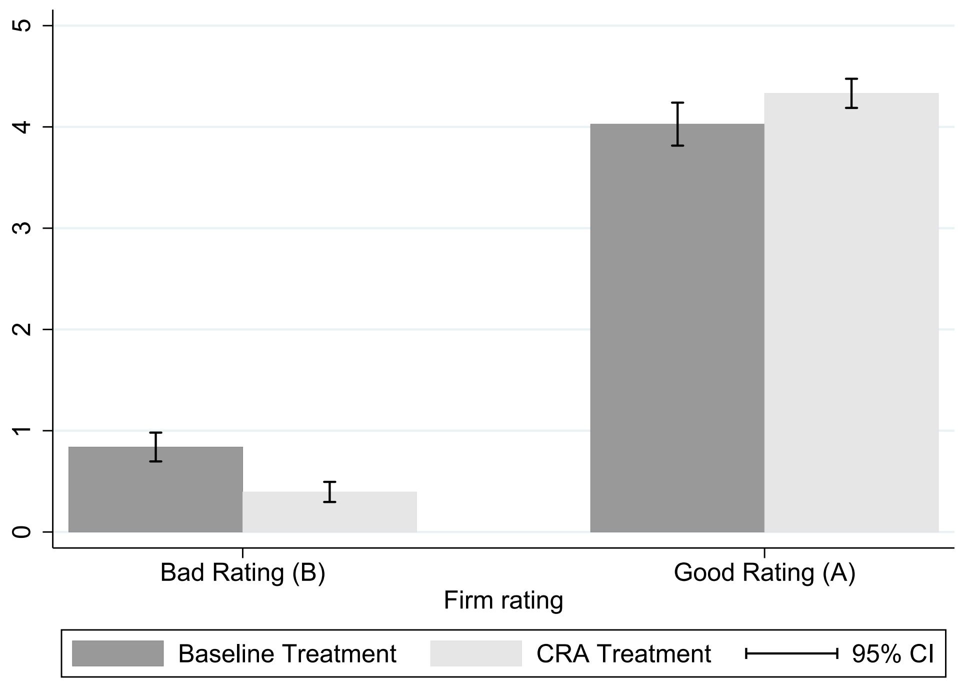
*Notes:* The table presents estimates from probit regressions where the dependent variable is an indicator equal to 1 if the participant invests. Columns (1)-(4) correspond to the Baseline treatment, while (5)-(8) correspond to the CRA, respectively. *Hint about IF* captures the private information about firm fundamentals. *Belief about IF* and *Belief # investors* capture the stated beliefs (as a number) about firm fundamentals and the other participants investing, respectively. *Risk/Loss aversion* are dummy variables equal to 1 if the participant was classified as risk/loss averse in the post-experiment questionnaire. *Negative past experiences* captures the average number of negative surprises in previous periods. *Capital market* is a dummy that equals 1 for subjects that report investing in capital markets. *Bank accounts* is a dummy that equals 1 for subjects with more than one bank account. *Gender* is a dummy that equals 1 for male participants. Standard errors clustered at the subject level are reported in parentheses. ***, ** , and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 14: Average number of participants investing (CRA Salient)

| Treatment | Baseline | | CRA Salient | | Tests (p-values) | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (1) vs. (3) | | (2) vs. (4) | |
| Hypothetical/ Observed rating | Rating A | Rating B | Rating A | Rating B | Test 1 | Test 2 | Test 1 | Test 2 |
| Invest | 4.03 | 0.83 | 4.485 | 0.317 | 0.02 | 0.025 | 0.00 | 0.053 |
| | (1.3) | (1.02) | (1.30) | (1.02) | | | | |
| Observations | 146 | 199 | 165 | 180 | 311 | 12 | 379 | 12 |

*Notes:* Columns (1)-(4) present the mean (standard deviation) of the number of subjects (per group) investing conditional on the treatment and observed (in the CRA Salient treatment)/hypothetical (in the Baseline treatment) rating. Test 1 is a t-test of equality of means performed at the group level. Test 2 is a non-parametric K-sample test on the equality of medians performed at the session level.

Figure 6: Average number of investors and ratings

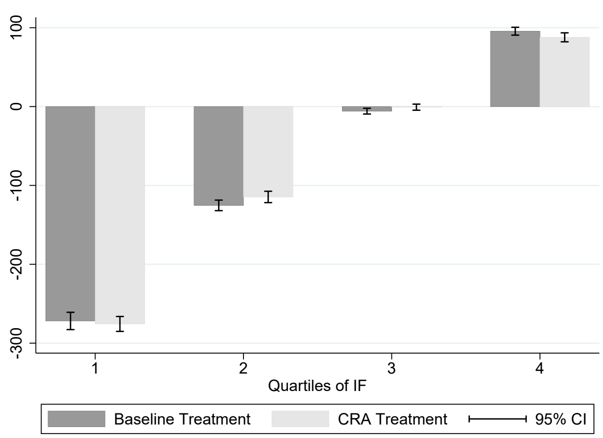


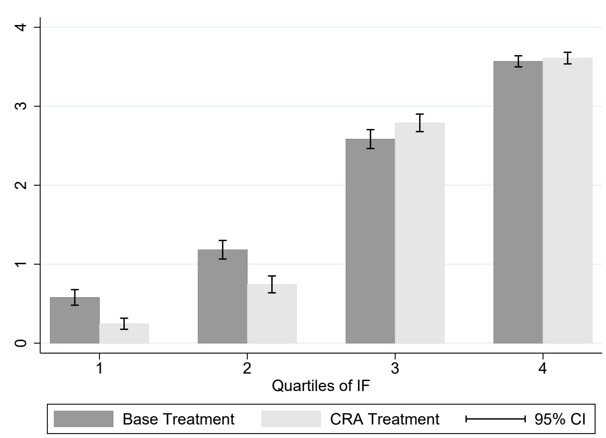

*Notes*: The figure shows the average number of investors for values of the fundamentals below (above) -31, which corresponds to Bad rating B (Good rating A) in the CRA treatment. The sample size is 690 groups across the two treatments. Whiskers mark the 95% confidence interval.

Figure 7: Beliefs about firm fundamentals and behaviour of others

(a) Average belief about IF

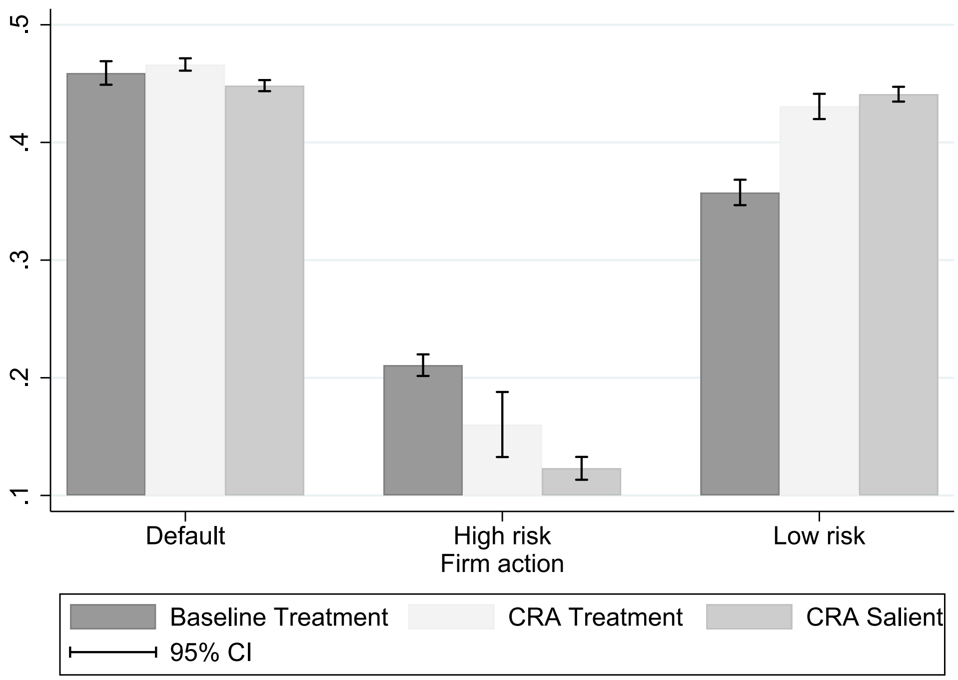
(b) Average belief about # investors




*Notes*: Panel (a) shows the average stated belief across individuals about the value of the firm's fundamentals for quartiles of IF. Panel (b) shows the average stated belief across individuals about the number of others investing for quartiles of IF. Whiskers mark the 95% confidence interval.

Figure 8: Firms' actions across treatments (with CRA Salient treatment)




*Notes*: The figure shows the proportion of firm defaults, and high and low-risk projects across the three treatments (including the CRA Salient treatment). The sample size is 1,035 unique groups of investors. Whiskers mark the 95% confidence interval.

Table 15: Ratings, investment behaviour, and beliefs (comparing the CRA and CRA Salient treatments)

| Dependent variable | $\mathbb{1}\{\text{Invest} = 1\}$ | | Belief fundamentals | | Belief number investors | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Hint about IF | 0.013*** | 0.006*** | 0.014*** | -0.001 | 0.008** | 0.008*** |
| | (0.002) | (0.001) | (0.002) | (0.002) | (0.004) | (0.001) |
| Rating A | 0.200 | | -0.002 | | 0.058 | |
| | (0.176) | | (0.174) | | (0.209) | |
| Rating B | | -0.212 | | 0.892 | | -0.280** |
| | | (0.185) | | (1.074) | | (0.123) |
| Period | 0.074*** | -0.037** | 0.039** | 0.076 | 0.063** | -0.041*** |
| | (0.014) | (0.015) | (0.016) | (0.047) | (0.027) | (0.010) |
| Observations | 1,640 | 1,810 | 1,640 | 1,810 | 1,640 | 1,810 |
| Number of subjects | 230 | 230 | 230 | 230 | 230 | 230 |

*Notes*: Columns (1)-(2) report estimates from probit regressions where the dependent variable is an indicator equal to 1 if a participant invests. Columns (3)-(4) present estimates from OLS regressions where the dependent variable is the stated belief about the value of the firm's internal funds (IF). Columns (5)-(6) report estimates from ordered logit regressions where the dependent variable is the stated belief about the number of participants that buy the bond. *Hint about IF* captures the private information about firm fundamentals. *Good (Bad) rating A (B)* is an indicator variable equal to 1 if the treatment is CRA Salient and the firm's IF are above (below) -31 and 0 if the treatment is the CRA treatment and the firm's IF are above (below) -31. Standard errors clustered at the subject level are reported in parentheses. ***, ** , and * indicate significance at the 1%, 5%, and 10% levels, respectively.

# Internet Appendix

# Appendix C: Experimental instructions

We present the experimental instructions for the CRA treatment. The instructions for the Baseline treatment are identical, except that any information concerning the credit rating is omitted.

**General instructions**

This is an experiment on financial decision-making. If you follow these instructions carefully, you can earn a considerable amount of money, which we will pay you at the end of this experiment. Please read the instructions carefully. Please do not talk or communicate with other participants. The use of mobile phones is not allowed. The rules are the same for all the participants. All your decisions and answers to questions remain anonymous.

The experiment consists of two parts: in Part 1, you will play a financial game with other participants. In Part 2, you will be asked to fill out several individual questionnaires. We will convert your experimental gains from Parts 1 and 2 into Euros at the end of the experiment and add a 7 Euro show-up fee to that amount.

If you have any questions during the experiment or difficulties in understanding these instructions, please raise your hand and wait for the experimenter to come to your cubicle and answer your questions privately.

Thank you for your participation!

**Part 1. An investment game**

**Background** In this part of the experiment, all participants will play the role of investors who must decide whether to invest in a firm or not. There are 15 rounds and you will make an investment decision in each of them. Each round is independent of the others. In each round, 5 participants are potential investors in the same firm (you and four others). The computer plays the role of the firm. Investors in your group will change randomly from round to round. You will not know which of the other participants belong to your group in a given round. Your payoff will depend on your own decision and on that of the other four investors in your group, as well as on the firm's action.

**Your decision** In each round, each investor is endowed with 100 Experimental Currency (EC) and will choose one of the following two decisions:

- NOT INVEST and you keep your initial 100 EC.
- INVEST and finance the firm with 100 EC. If you invest, your payoff depends on the firm's action. The firm can undertake one of the following three actions:
  - The firm can invest in a low-risk (LR) project, in which case you will obtain 200 EC with a probability of 90% and 0 with a probability of 10%.
  - The firm can invest in a high-risk (HR) project, in which case you will obtain 200 EC with a probability of 20% and 0 with a probability of 80%.
  - The firm can also default, in which case you will obtain 0 EC with 100% probability.

These payoffs are the same for all investors in your group. Now, we will explain how the firm's action is affected by your investment decision and that of the other members of your group.

**The firm's action**

In each round, the computer plays the firm's role and chooses automatically between the low-risk project (LR), the high-risk project (HR), and default, depending on how much financing the firm has available. The firm has two funding sources: its own funds (internal funds, denoted IF) and the external funds (denoted EF) provided by you and the other four investors. Details about the firm's IF are provided below (*Information section*). The firm's automatic decision is as follows:

- If the firm obtains 300 EC or more from both IF and EF (provided by all five investors), it undertakes the LR project.

- If the firm has less than 300 EC (but at least zero) financing from both IF and EF (provided by all five investors), it undertakes the HR project.
- If the firm has losses (i.e., IF are less than 0) and EF are lower than the losses, it defaults.

We summarize the firm's actions in the following table.

| **Financing** | **Firm's action** |
|---|---|
| $300 \leq IF + EF$ | LR project |
| $0 \leq IF + EF < 300$ | HR project |
| $IF + EF < 0$ | Default |

**Example:**

The table below provides an example of the different actions of the firm for hypothetical values of the internal and external funds available.

| | **Internal funds of the firm** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | -400 | | -300 | | -200 | | -100 | | 0 | | 100 | | 200 | |
| **Hypothetical number of players who invest** | Total Funds available to the firm | Firm's action | Total Funds available to the firm | Firm's action | Total Funds available to the firm | Firm's action | Total Funds available to the firm | Firm's action | Total Funds available to the firm | Firm's action | Total Funds available to the firm | Firm's action | Total Funds available to the firm | Firm's action |
| **0** | -400 | Default | -300 | Default | -200 | Default | -100 | Default | 0 | HR | 100 | HR | 200 | HR |
| **1** | -300 | Default | -200 | Default | -100 | Default | 0 | HR | 100 | HR | 200 | HR | 300 | LR |
| **2** | -200 | Default | -100 | Default | 0 | HR | 100 | HR | 200 | HR | 300 | LR | 400 | LR |
| **3** | -100 | Default | 0 | HR | 100 | HR | 200 | HR | 300 | LR | 400 | LR | 500 | LR |
| **4** | 0 | HR | 100 | HR | 200 | HR | 300 | LR | 400 | LR | 500 | LR | 600 | LR |
| **5** | 100 | HR | 200 | HR | 300 | LR | 400 | LR | 500 | LR | 600 | LR | 700 | LR |

## The credit rating agency

Before your decision and the firm's action, a *credit rating agency* assigns a rating to the firm. A credit rating is a grade that indicates the firm's ability to repay its investors. We will provide details below on how this rating is assigned.

## Information

The firm's IF consist of profits (or losses) from ongoing activities. These funds are known by the firm and the credit rating agency and unknown to any investor. In each round, the firm's IF are randomly selected from the interval [-400, 200]. Each number in this interval has the same probability of being drawn. The number is the same for all investors in your group. When you make your investment decision, you do not know the exact value of the firm's profits (or losses). However, before investing, you and all the other investors from your group receive information about the firm's IF from two sources:

1. A private hint about the firm's IF. The hint number is randomly selected from the interval:

   [True value of firm's IF-30, True value of firm's IF+30].

   All numbers in the interval have the same probability of being drawn. Hint numbers of different investors are drawn independently from the same interval. Note that each of the investors in your group receives a different hint, which is known only by the participant who receives it.

2. A public credit rating from the credit rating agency about the firm's ability to repay its creditors. The rating can be either A or B. All investors in your group observe the same rating. In each round, the rating agency uses a theoretical scoring model to predict the ability of the firm to repay. The model considers the firm's IF (which it knows perfectly) and how the rating might affect a hypothetical investor's decision and thus the total amount of funds available to the firm and its corresponding action. The rating agency decides on a rating as follows:

   - Rating A is assigned if the firm's IF are greater than or equal to -31. By giving this rating, the rating agency estimates that the firm will invest in the LR project, and investors have a 90% probability of being repaid.

   - Rating B is assigned if the firm's IF are lower than -31. By giving this rating, the rating agency estimates that the firm will default, and investors have a 0%

probability of being repaid.

Example:

Suppose that the firm's IF are 0. This amount is known to the firm and the rating agency but not to investors. The hints the five investors receive are in the range [-30, 30] and are equal to -30, 27, 19, -15, 1. The participant who receives hint -30 knows that the firm's IF must be between -60 and 0. The participant who receives hint 19 knows that the firm's IF must be between -11 and 49, etc.

All investors observe that the public credit rating of the firm is A, which implies that the firm's IF are greater than or equal to -31 and the rating agency estimates a probability of repayment of 90%. As explained above, this probability is only an estimation based on the theoretical scoring model used by the rating agency. The actual probability of repayment depends on how many investors finance the firm and the project that the firm undertakes.

Suppose that you receive a private hint of -15. This implies that the firm's IF must lie between [-45, 15]. You also observe the public rating A, which means that the firm's IF must be greater than or equal to -31. Therefore, using these two pieces of information, the possible range of the firm's IF must lie between [-31, 15]. Suppose you think, based on this information, that the firm's IF = -2. Given your beliefs about the firm's IF, the table below illustrates your payoff and probabilities from choosing between investing and not investing (conditional on the hypothetical number of other investors that decide to invest). (During the experiment, you will have access to a simulator similar to the table below).

| | **Do not invest** | | **Invest** | | | | |
|---|---|---|---|---|---|---|---|
| **Hypothetical number of *other* players who invest** | Probability of 100 EC payoff | Expected payoff (EC) | Total funds available to the firm | Firm's action | Probability of 200 EC payoff | Probability of 0 EC payoff | Expected payoff (EC) |
| **0** | 100% | 100 | -2+100=98 | HR | 20% | 80% | 40 |
| **1** | 100% | 100 | -2+200=198 | HR | 20% | 80% | 40 |
| **2** | 100% | 100 | -2+300=298 | HR | 20% | 80% | 40 |
| **3** | 100% | 100 | -2+400=398 | LR | 90% | 10% | 180 |
| **4** | 100% | 100 | -2+500=498 | LR | 90% | 10% | 180 |

## Your beliefs

Before making your investment decision, you will also be asked to indicate:

(a) what you think the true level of the firm's internal funds (IF) is (type a number)

(b) how many other investors you expect to invest and finance the firm (0, 1, 2, 3, or 4)

**Feedback**

After all participants in a given round take their decisions, you will learn the true level of the firm's IF, how many other players invested in the firm, the firm's action, and your potential payoff in ECs for this round.

**Your earnings**

One of the 15 rounds will be randomly chosen to determine your payoffs for Part 1 of the experiment. Therefore, you should carefully consider each decision, as it could be the one that is relevant for your total earnings from this part of the experiment. At the end of the entire experiment, you will learn which round has been selected to determine your payoff. Your earnings will be converted into Euros at the conversion rate of 15 EC= 1 Euro.

**Comprehension quiz**

Before starting Part I of the experiment, there will be a short comprehension quiz to check that you understood these instructions. The quiz is not incentivized.

**Part 2. Two individual tasks**

You will be asked to make several other decisions, which are answered individually and do not depend on the choices of other participants.

At the end of the second part, we will ask you for some personal information. The data is treated confidentially and will be used only for research purposes.

**Risk aversion**

You have to select ONE gamble that you would like to play from the gambles below (see Figure 9). Each gamble has two possible outcomes (Event A or Event B), each with 50%

chance of occurring. For example, if you select gamble 4 and Event A occurs, you will gain 21 points. If event B occurs, you will get 57 points. Your gains in points will be converted into Euros according to the following conversion rate: 20 points are equivalent to 1 Euro.

Figure 9: Risk aversion test

| Gamble | Event | Payoff in Points | Probabilities |
|---|---|---|---|
| 1 | A | 33 | 50% |
| | B | 33 | 50% |
| | | | |
| 2 | A | 29 | 50% |
| | B | 41 | 50% |
| | | | |
| 3 | A | 25 | 50% |
| | B | 49 | 50% |
| | | | |
| 4 | A | 21 | 50% |
| | B | 57 | 50% |
| | | | |
| 5 | A | 17 | 50% |
| | B | 65 | 50% |
| | | | |
| 6 | A | 7 | 50% |
| | B | 75 | 50% |

**Loss aversion**

For EACH gamble below, you have to choose whether you want to Accept or Reject it (see Figure 10). If you reject a gamble, your payoff is zero. Each gamble has two possible outcomes (Event A or Event B), each with a 50% probability of occurring. After you have made your choice, one of the gambles you accepted will be picked at random and you will be paid the outcome of that gamble. Your gains in points will be converted into Euros according to the conversion rate of 20 points for 1 Euro.

Figure 10: Loss aversion test

| Gamble | Event | Payoff in Points | Probabilities |
|---|---|---|---|
| 1 | A | 6 | 50% |
| | B | -2 | 50% |
| | | | |
| 2 | A | 6 | 50% |
| | B | -3 | 50% |
| | | | |
| 3 | A | 6 | 50% |
| | B | -4 | 50% |
| | | | |
| 4 | A | 6 | 50% |
| | B | -5 | 50% |
| | | | |
| 5 | A | 6 | 50% |
| | B | -6 | 50% |
| | | | |
| 6 | A | 6 | 50% |
| | B | -7 | 50% |

# Appendix D: Experimental sessions and screens

We summarize the experimental sessions and present several screenshots from Part I of the experiment.

Table 16: Experimental sessions

| Treatments | Number of Students | Date | Location |
|---|---|---|---|
| Baseline Treatment, Session 1 | 20 | March 2022 | ESADE |
| Baseline Treatment, Session 2 | 15 | March 2022 | ESADE |
| Baseline Treatment, Session 3 | 20 | March 2022 | ESADE |
| Baseline Treatment, Session 4 | 20 | April 2022 | Pompeu Fabra University |
| Baseline Treatment, Session 5 | 20 | April 2022 | Pompeu Fabra University |
| Baseline Treatment, Session 6 | 20 | April 2022 | Pompeu Fabra University |
| CRA Treatment, Session 1 | 20 | March 2022 | ESADE |
| CRA Treatment, Session 2 | 15 | March 2022 | ESADE |
| CRA Treatment, Session 3 | 20 | March 2022 | ESADE |
| CRA Treatment, Session 4 | 20 | April 2022 | Pompeu Fabra University |
| CRA Treatment, Session 5 | 20 | April 2022 | Pompeu Fabra University |
| CRA Treatment, Session 6 | 20 | April 2022 | Pompeu Fabra University |

Figure 11: Practice questions

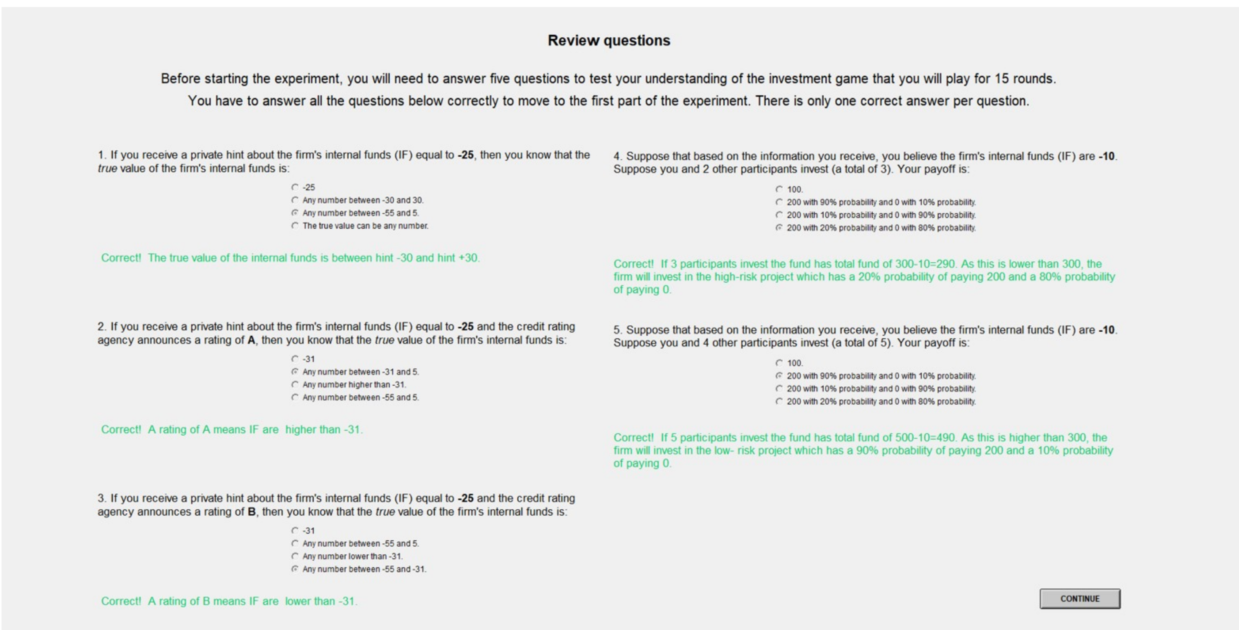


Figure 12: Decision screen 1

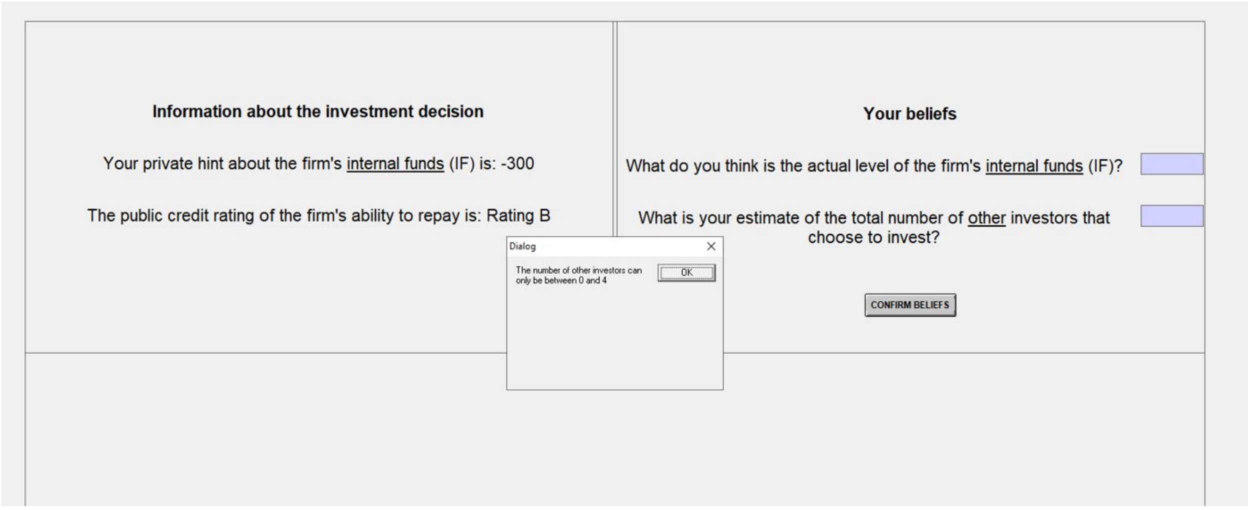



Figure 13: Decision screen 2