Financial Reporting and Credit Ratings: On the Effects of Competition in the Rating Industry and Rating Agencies' Gatekeeper Role*

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Abstract

This paper studies firms' financial reporting incentives in the presence of strategic credit rating agencies and how these incentives are affected by the level of competition in the rating industry and by rating agencies' role as gatekeepers to debt markets. We develop a model featuring an entrepreneur who raises capital in a perfectly competitive debt market. After publicly disclosing a financial report, the entrepreneur can purchase credit ratings from rating agencies who strategically choose their rating fees and rating inflation biases. We derive three core results. (i) More competition in the rating industry leads to stronger corporate misreporting incentives. Under imperfect rating agency competition, (ii) firms' misreporting and rating agencies' rating inflation biases are strategic complements, and (iii) agencies' gatekeeper role primarily undermines firms' misreporting incentives, which then affects rating agencies' strategies.

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1 Introduction

Credit ratings play a key role in firms' debt financing (Kliger and Sarig [2000]; Graham and Harvey [2001]; Tang [2009]). Firms have an inherent interest in influencing their credit ratings, where the manipulation of financial reporting may be a primary way to do so, as financial statements provide the basis for credit rating agencies' ("CRAs") rating process. The joint evidence of several archival papers is in line with the argument that firms distort their financial reports more prior to an initial rating or a credit rating change (Alissa et al. [2013]; Demirtas and Cornaggia [2013]; Jung et al. [2013]). However, evidence offered by Kraft [2015] also indicates that CRAs exhibit superior information processing abilities, implying that they may not be misled easily by firms' misreporting. The aim of this paper is to shed light on the possibly endogenous relationship between financial reporting and credit ratings by explicitly considering the unique features of the rating process and CRAs' strategic incentives.

A CRA's main objective is to generate income from selling credit ratings to debt-issuing firms in exchange for a fee that can be chosen strategically. In addition, because firms can privately observe the rating before making their purchase decision, they can be selective (a practice that is referred to as "ratings shopping"). As a consequence, CRAs face a conflict of interest and have incentives to inflate their ratings to boost rating fee income (Skreta and Veldkamp [2009]; Bolton, Freixas, and Shapiro [2012]; Sangiorgi and Spatt [2017]). Regulators and finance and law scholars have further highlighted the importance of two other critical factors that determine CRAs' decisions. First, competition in the rating industry influences CRAs' incentives, as it affects their ability to extract rents from firms through fees (Lizzeri [1999]). Second, the use of rating-based investor regulation and investors' self-imposed, rating-based investment policies establishes CRAs' role as gatekeepers to debt markets, which may also have implications for their behavior (Partnoy [1999], [2006]; Kisgen and Strahan [2010]).

In this paper, we study firms' financial reporting incentives in the presence of strategic CRAs and how these incentives are affected by the level of competition in the rating industry and CRAs' gatekeeper role. We develop a model featuring three types of players: a firm represented by an entrepreneur ("she") who seeks project financing by issuing debt, a debt market populated by Bayesian and naive investors who competitively set interest rates, and one or two CRAs that aim to sell credit ratings that are informative about the firm's type. Initially, the entrepreneur privately observes an imperfect signal about the project's outcome, which is a function of the firm's type, and must issue a financial report that need not truthfully disclose her private information. After the public disclosure of the financial report, CRAs strategically choose their rating fees. Then, each CRA privately observes the firm's type and develops a rating, which may be distorted by a strategically chosen inflation bias. Each CRA submits its rating privately to the entrepreneur, who then decides on whether to purchase the rating. If purchased, the rating is made public. Investors then observe the financial report and (purchased) credit ratings and determine the interest rate.

We derive three core results. First, we establish that competition in the rating industry strengthens the entrepreneur's misreporting incentives. These incentives are determined by the rent that she expects to receive from pursuing the project, net of the expected debt repayment (chosen by investors) and rating fees (chosen by CRAs), where a larger expected rent implies stronger misreporting incentives. The interest rates are influenced by both the firm's financial report and credit ratings. In equilibrium, the entrepreneur only purchases favorable credit ratings as only these lead to lower interest rates. We show that a monopolistic CRA chooses its rating fee such that it extracts the entire expected rent that is generated by providing a favorable rating. This leaves the entrepreneur indifferent between purchasing and not purchasing a favorable rating and consequently does not affect her financial reporting incentives. In contrast, with imperfect competition between multiple strategic CRAs, the ability of CRAs to extract rent is limited, due to a decreasing marginal information value of credit ratings and the entrepreneur's ability to shop around. CRAs respond by setting lower rating fees, leaving the entrepreneur with a larger expected rent. This in turn incentivizes her to misreporting more.

Next, we show that, under imperfect competition in the rating industry, the entrepreneur's manipulation and CRAs' rating inflation, both of which undermine the informativeness of financial reporting and credit ratings, respectively, are strategic complements, i.e., more informative financial reporting leads to more informative credit ratings and vice versa. This result can be best explained by considering the effects of changes in distortion costs. An increase in accounting manipulation costs leads to less manipulation and more informative financial reporting. This reduces the relative information value of credit ratings, incentivizing CRAs to set lower rating fees, and the lower rating fee reduces the marginal benefit of rating inflation. Similarly, as rating inflation costs increase, CRAs reduce their rating inflation efforts, making ratings more informative. A priori the entrepreneur expects to pay a higher rating fee for the more informative rating and a higher average cost of debt, both of which imply a smaller expected rent that she can retain in expectation. This weakens the entrepreneur's financial misreporting incentives.

Lastly, we consider the impact of CRAs' role as gatekeepers to debt markets on CRAs' and the entrepreneur's behavior. In the United States, credit ratings have been used to regulate certain institutional investors by limiting them to only invest in firms that can provide a sufficient number of investment-grade credit ratings. Furthermore, retirement funds often commit themselves to invest exclusively in investment-grade bonds (Kisgen and Strahan [2010]). This regulatory or self-imposed reliance on credit ratings has been criticized as one of the main sources for rating inflation leading up to the 2008 financial crisis. We implement this role by assuming that, to be eligible for raising funds from the debt market, the firm must provide a minimum number of favorable credit ratings. We show that a monopolistic CRA that acts as a gatekeeper can extract the entire expected rent from pursuing the project from the entrepreneur, which in turn incentivizes her to report truthfully. In contrast, with imperfect competition in the rating industry, the requirement to provide at least one favorable credit rating reduces the entrepreneur's expected rent (implying weaker financial misreporting incentives) without directly influencing CRAs' fee setting and rating inflation. However, the increased informativeness of financial reporting decreases the relative information value of ratings, leading the CRAs to set lower fees and choose a smaller inflation bias. We therefore show that, under imperfect competition in the rating industry, financial reporting is the key mechanism through which CRAs' gatekeeper role impacts the equilibrium.

Our paper derives testable empirical predictions regarding financial misreporting, rating inflation and rating fees. Our results should be of particular interest to securities regulators. Due to their central role during the financial crisis of 2008, rating agencies have been under increased scrutiny of regulators, and several policies have been discussed and/or implemented as attempts to undermine the power of individual CRAs. A first approach, which is at the core of the 2013 amendment to the EU's Regulation (EC) No 1060/2009, promotes increased competition in the rating industry by lowering the hurdle to enter the industry. This had also been the main purpose of the Credit Rating Agency Reform Act of 2006, which sought to increase the number of CRAs designated as nationally recognized statistical rating organizations (NRSROs). A second approach is to undermine CRAs' gatekeeper role. For example, the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (Dodd-Frank) requires federal agencies to remove all references to credit ratings in their investment strategies to reduce the reliance on ratings. We show that both approaches may have the unintended consequence of strengthening firms' misreporting incentives.

1.1 LITERATURE REVIEW

Our paper contributes to the literature on strategic information certifiers and how firms interact with them. One issue is whether a firm that purchases a service from a certifier does so before (ex ante) or after (ex post) privately observing the outcome of the respective service. The consequences of ex post vis-a-vis ex ante purchasing of certification services is highlighted by Marinovic and Sridhar [2015]. They study how the presence of a (monopolistic) information certifier affects a firm's voluntary disclosure strategy when the firm has to rely on the certifier for the disclosure. Their core result is that, given that the information precision of the certifier's signal is sufficiently low, disclosures through certifiers are more likely under the ex post setting than under the ex ante setting. Consistent with the current procedures in the credit rating industry, our focus is strictly on the *ex post* setting in which only favorable signals are purchased and publicly released in equilibrium. The main difference between our paper and that of Marinovic and Sridhar [2015] is that we do not consider disclosure through a certifier but the *joint* effects of disclosure by both firms and one or multiple competing CRAs. Another difference is that we allow CRAs to distort their information signals before offering them to the firm.

A particular certifier that naturally has received considerable attention in the accounting literature is the external auditor. Two main conflicts of interest are particularly studied that impair auditors' independence and thus the quality of their assurance. First, unfavorable audit outcomes may lead to the premature dismissal of an auditor and therefore to foregone future revenue (Magee and Tseng [1990]; Teoh [1992]). Second, auditors often offer non-audit services to their audit clients and may be inclined to be favorable in their assurance to increase the likelihood of future profits through non-audit services (Simunic [1984], Gigler and Penno [1995]).[1] The former is somewhat in line with the conflict of interest faced by CRAs since they are also paid by the firm and may

[1] Note that this source of conflict of interest is severely limited by regulations such as the Sarbanes-Oxley Act of 2002 ("SOX").

consider fee generation when providing their services. However, a notable difference is that firms cannot disclose financial reports without an auditor. In contrast, firms can disclose financial reports without credit ratings. In addition, the purchase of credit ratings is somewhat more discretionary, and firms often choose to purchase more than one credit rating.

CRAs, as a second main group of certifiers, have been mostly overlooked by the analytical accounting literature. However, there exists a notable literature in finance discussing the strategic incentives and decisions of CRAs that are embedded in an imperfectly competitive rating industry. This literature builds on the seminal work by Lizzeri [1999], who considers a setting in which a firm can purchase information from one or more competing certifiers before observing the outcome of the service (ex ante setting). In his paper, a monopolist certifier chooses a rather uninformative disclosure strategy and sets its fee such that it extracts the entire surplus from its service.[2] He furthermore shows that, when perfect competition among certifiers is introduced, the competing certifiers may choose to fully reveal their information in exchange for a minimum fee. His paper therefore predicts that competition undermines certifiers' ability to extract rents from clients, which in turn leads to more informative signals. Different from Lizzeri [1999], a number of papers in the CRA literature consider ex post rating purchase settings and thus issuers' opportunity to shop for ratings. Bolton, Freixas, and Shapiro [2012] argue that increasing the number of strategic CRAs exacerbates ratings shopping, which under certain conditions can lead to less informative credit ratings. Sangiorgi and Spatt [2017] show that opacity in the rating process contributes to the prevalence of ratings shopping that undermines CRAs' rent extraction ability. Skreta and Veldkamp [2009] show that larger asset complexity elevates issuers' ratings shopping. Our paper is generally in line with these papers in that rent extraction and allocation is at the center of our investigation. However, we additionally consider *endogenous financial reporting* by debt-issuing firms and show that the level of competition in the rating industry is an important determinant for firm's financial reporting incentives.

Our paper is therefore part of an emerging stream of literature that focuses on the strategic interaction of debt-issuing firms' information communication and CRA decision-making. Cohn, Rajan, and Strobl [2016] consider a monopolistic CRA's strategy to screen the information that is privately communicated by the issuer for manipulation. In their setting, the CRA receives an

[2] The equilibrium in Proposition 1 is generally in line with this observation.

exogenously given rating fee for a sold rating. They show that the issuer's disclosure strategy first increases and then decreases in the screening intensity of the CRA. Our setting differs from Cohn, Rajan, and Strobl [2016] in that we focus on CRAs' strategic rent extraction implemented by their fee setting as well as on their rating inflation while taking their information processing and acquisition as given. Another important difference is that we consider firms' *publicly* disclosed financial reporting and not their private communication with CRAs.

In this context, we also highlight an avenue through which CRAs' role as gatekeepers to debt markets affects their decisions, namely by affecting firms' reporting decisions. Opp, Opp, and Harris [2013] study a monopolistic CRA's information acquisition in a setting where ratings serve both an information and an investor-regulation role. They show that rating-contingent regulation influences CRA information acquisition and can increase or decrease rating informativeness. We show that, even when CRA information acquisition is assumed to be exogenous, rating-based investor regulation or self-imposed investment policies influence competing CRAs' behavior primarily by affecting firms' financial reporting decisions.

A last relevant stream of literature examines financial reporting and sell-side equity analysts. Mittendorf and Zhang [2005] use an agency framework to show that, in the presence of an analyst, an optimal contract provides additional incentives for a manager to misreport earnings guidance to motivate the analyst to initiate coverage of the firm. Arya and Mittendorf [2007] reason that the existence of analysts can motivate competing firms to disclose more information. While CRAs and analysts perform a similar role of providing information to capital markets, their incentives fundamentally differ because sell-side equity analysts either receive indirect compensation from their affiliated investment and underwriting business or direct compensation from select investors who purchase their reports, whereas CRAs are generally paid by (debt-issuing) firms.

The paper proceeds as follows. Section II describes the economic setting and characterizes the case with a monopolistic CRA. Section III solves the setting with imperfect CRA competition. Section IV analyzes the effects of CRA competition and CRAs' gatekeeper role. Section V discusses the implications of our findings, and Section VI concludes.

2 The Model

2.1 MODEL SETUP

We consider a one-period economy with three risk-neutral parties: an entrepreneur, who is the sole owner of a financially constrained firm, a debt market that holds the economy's entire supply of capital, and one or two strategic credit rating agencies. The entrepreneur has access to a risky investment project and wishes to issue debt to finance it. Investors in the debt market invest in exchange for a claim on the project's final cash flow, which takes the form of a repayment with interest. To receive financing, the entrepreneur must publicly disclose a financial report, after which she has the option to purchase credit ratings from the CRAs.

The firm can either be a bad type ($\alpha = b$) or a good type ($\alpha = g$), both of which are ex ante equally likely. Neither the entrepreneur nor the investors know the firm's type. The project outcome is a function of the firm's type: for the good type, the project is always successful and generates outcome $x > 0$, whereas for the bad type, the project succeeds in $\theta \in (0, 1)$ of the cases and defaults otherwise. The outcome of an unsuccessful project is 0. For the sake of simplicity, we assume that the firm is identical to the risky project, implying that, when the project defaults, the firm defaults. To be realized, the project requires an investment of \$1.[3] We additionally impose the assumption that the project's present value is sufficiently large (i.e., θ lies above a certain threshold). This ensures that the entrepreneur's expected utility is always positive in the presence of CRAs, motivating her to always pursue the project.

[PLEASE INSERT FIGURE 1 HERE]

The sequence of events is presented in Figure 1. In the initial stage ($t = 1$), the entrepreneur publicly discloses a report about the project outcome. The report is based on an imperfectly informative private signal about the project outcome, $S \in \{S_H, S_L\}$.[4] The signal's precision is denoted by $p \in \left(\frac{1}{2}, 1\right)$, i.e., $Pr(S_H|x) = Pr(S_L|0) = p$ and $Pr(S_H|0) = Pr(S_L|x) = 1 - p$. Since the project

[3] We therefore consider a setting with two states of nature. Classical debt contracting problems typically consider three states. However, this assumption would significantly increase the model complexity without changing the fundamental economics discussed in this paper. The assumption of a binary state space follows papers in the CRA literature, such as Boot, Milbourn, and Schmeits [2006], Bolton, Freixas, and Shapiro [2012], or Sangiorgi and Spatt [2017].

[4] This signal can thought of as a noisy representation of the value of a past project that is highly correlated with the current project's value.

outcome is assumed to be a function of the firm's type, the entrepreneur's private information is therefore also informative about the firm's default probability.[5] The report has two possible realizations, $R \in \{R_H, R_L\}$, which need not be a truthful disclosure of the entrepreneur's private signal. Intuitively, an entrepreneur prefers to report R_H, as this is associated with a lower cost of debt and higher expected profit for the entrepreneur. This leads her to report S_H truthfully, and provides incentives to misreport S_L as R_H. The entrepreneur's manipulation effort is captured by $m \in (0, 1)$, which is the probability that signal S_L is disclosed as report R_H and not as undesirable report R_L, i.e., $Pr(R_H|S_L) = m$. When manipulating the report, the entrepreneur incurs a private cost $m^2\mu/2$. $\mu > 0$ is assumed to be sufficiently large to ensure that there always exists an interior solution for the entrepreneur's manipulation. In choosing the level of manipulation m, the entrepreneur trades off the expected net benefit from realizing the project (expected project outcome minus expected debt repayment minus rating fees) with manipulation costs. We simplify our analysis by assuming that the debt market only invests in a firm with favorable report R_H.[6]

In the economy, there exist either one or two identical CRAs. After the public disclosure of the financial report R, which signals the entrepreneur's intention to issue debt, each CRA $i \in \{1, 2\}$ publicly chooses a rating fee F_i in $t = 2$.[7] Subsequently in $t = 3$, each CRA perfectly and costlessly infers the firm's type α from the financial report.[8] The CRAs then privately and simultaneously submit a signal about the firm's type α to the entrepreneur, which if purchased, is subsequently made public.[9] We refer to these signals as "credit ratings" and denote an unfavorable rating as B_i and a favorable one as G_i.[10] Intuitively, the entrepreneur has an incentive to purchase only favorable

[5]This is in line with the empirical evidence of Callen, Livnat, and Segal [2009].

[6]Note that a setting in which financing also occurs when R_L is disclosed only complicates the entrepreneur's manipulation problem without changing her fundamental incentives to upwardly manipulate unfavorable private information. The economic effects in such a setting are qualitatively identical to the ones obtained in this paper. A similar assumption is imposed by Laux and Stocken [2012], who also use a model structure with a binary reporting space.

[7]We assume that CRA i chooses the rating fee F_i before observing the firm's type and therefore does not condition on the firm's type in its choice of rating fee. This is purely for expositional purposes. It is later shown that the rating fee is derived from the entrepreneur's binding participation constraint, i.e., CRA i sets the same rating fee regardless of α. In practice, the rating fee is typically a percentage of the principal amount of the bond being issued and may vary according to the type of security being analyzed subject to a minimum fee.

[8]We implicitly assume that, in contrast to investors, CRAs see through the entrepreneur's manipulation in their inference of the firm's type. That CRAs derive better information about a firm's type from financial reports than investors is consistent with the evidence provided by Kraft [2015], who documents that CRAs are superior in extracting default risk-related information from firms' financial statements.

[9]Unsolicited credit ratings are standard in the corporate debt market [Becker and Milbourn 2011].

[10]The assumption of binary credit ratings is consistent with CRAs' classification of a firm's creditworthiness into investment or speculative grade.

ratings (G_i), as they yield a lower cost of debt, but does not have any incentive to purchase an unfavorable rating (B_i). In case a rating is purchased, the entrepreneur pays the rating fee F_i, and the rating is made public. The entrepreneur's preference for favorable ratings and the opportunity to shop for ratings establish a conflict of interest for the CRAs, incentivizing them to inflate ratings. To capture this conflict of interest, we assume that CRAs are not limited to truthful reporting and may resort to rating inflation to increase the likelihood of selling a rating to the entrepreneur. When CRA i observes $\alpha = g$, it truthfully discloses this information as favorable rating G_i. However, when the CRA observes that the firm's type is bad ($\alpha = b$), it can resort to rating inflation. Similar to the entrepreneur's manipulation, the rating inflation bias is modeled as a probability $s_i \in (0, 1)$ that CRA i issues a favorable rating G_i for a bad type firm, i.e., $Pr(G_i|\alpha = b) = s_i$. Rating inflation is costly and yields a disutility of $s_i^2\gamma/2$ (e.g., reputational costs), where $\gamma > 0$ is assumed to be sufficiently large to ensure that there always exists an interior solution for a CRA's rating inflation. Our assumptions regarding CRAs' incentives and decision variables as well as the entrepreneur's preference for favorable ratings comport with theoretical research (e.g., Bolton, Freixas, and Shapiro [2012]) and with empirical evidence on CRA behavior (e.g., Griffin and Tang [2012]). A probability tree for the suggested model setting is provided in Figure 2.

[PLEASE INSERT FIGURE 2 HERE]

In stage $t = 4$, investors observe the financial report R as well as the credit ratings if purchased. We denote the number of favorable ratings by $n \in \{0, 1, 2\}$. With regard to the structure of the debt market and the format of the transaction between the entrepreneur and the market, we follow the approach of Boot, Milbourn, and Schmeits [2006]. In particular, we consider an auction mechanism in which investors privately communicate their interest rate bids r to the entrepreneur. All investors in the market are atomistic and choose their bids such that they break even in expectation, conditional on financial report R_H and n favorable ratings. The debt market is composed of two types of investors, Bayesian (subscript u) and naive (subscript v), and the bids they submit are denoted by $r_{n,u}$ and $r_{n,v}$, respectively. Bayesian investors, who hold $\lambda \in (0, 1)$ of the capital, incorporate all available information into their bid and rationally conjecture strategic decisions made by the entrepreneur and CRAs, i.e., they rationally conjecture accounting manipulation, rating inflation, and the strategic purchasing of ratings. On the other hand, naive investors, who hold the residual

$1-\lambda$ of the capital, take the available information at face value and do not rationally conjecture the implications of other players' strategic decisions. Since the entrepreneur requires a total capital of \$1 to realize the investment project, she relies on funding from both groups of investors. We further limit λ to be sufficiently small to ensure that credit ratings have a decreasing information value for both the entrepreneur and the debt market under a CRA duopoly.[11] The assumption of the existence of a sufficiently large number of naive investors is standard in the credit rating literature and is important to establish the existence of different interest rates resulting from the purchase and issuance of $n \in \{0,1,2\}$ ratings (e.g., Skreta and Veldkamp [2009]; Bar-Isaac and Shapiro [2013]). Bayesian and naive investors therefore solve

$$Pr_u(x|.)(1+r_{n,u})\lambda \geq \lambda$$

and

$$Pr_v(x|.)(1+r_{n,v})\,(1-\lambda) \geq (1-\lambda)\,,$$

for $r_{n,u}$ and $r_{n,v}$, respectively. Note that, due to differences in investors' information processing abilities, they assess the probability of repayment denoted by $Pr_u(x|.)$ and $Pr_v(x|.)$ differently. For convenience, we denote the average interest rate conditional on report R_H and n favorable ratings as $r_n \equiv \lambda r_{n,u} + (1-\lambda)\,r_{n,v}$.

Lastly, we consider another important institutional feature in relation to credit ratings: CRAs' role as gatekeepers to debt markets. As discussed above, this role is established through two observations. First, prior to Dodd-Frank, credit ratings were used to regulate certain institutional investors. Second, large retirement and other mutual funds commit themselves to invest exclusively in investment-grade bonds. The Bayesian investors in our model can be considered as institutional investors, as they exhibit superior information processing as compared to naive investors. We study the effects of CRAs' gatekeeper role by assuming that, in the presence of one or two CRAs, the entrepreneur has to provide at least one favorable credit rating to receive funding from Bayesian investors. Without Bayesian investors' capital, the entrepreneur could not raise enough capital to pursue the project. We capture CRAs' gatekeeper role with indicator variable $\beta \in \{0,1\}$. $\beta = 1$

[11] As will be shown below, the entrepreneur prefers to first sell off debt to naive investors before selling to Bayesian investors since the former demand lower interest rates. With this in mind, it can be shown that, as long as there are enough naive investors in the market, our results hold even when the mass of Bayesian investors approaches infinity.

indicates that CRAs do not take on a gatekeeper role and the firm receives financing, regardless of whether it can show a favorable rating, while $\beta = 0$ indicates that a firm must provide at least one favorable credit rating to be eligible for financing.

All distributional assumptions are common knowledge. Conjectures are denoted with a hat, and the risk-free rate is normalized to zero. The equilibrium is defined as follows.

Definition of Equilibrium *An equilibrium consists of the entrepreneur's manipulation effort m and her rating purchasing decision, CRA i's rating fee F_i and rating inflation s_i, and the debt market's average interest rates r_n, such that:*

(i) Conditional on private information signal S, the entrepreneur chooses manipulation effort m to maximize the expected payoff from pursuing the investment project, net of debt repayments, rating fees, and manipulation costs, given rational conjectures of F_i, s_i, and r_n;

(ii) Conditional on financial report R, CRA i chooses rating fee F_i to maximize its expected revenue, net of rating inflation costs, given rational conjectures of the entrepreneur's credit rating preferences, m, F_j, s_j, and r_n, where $i \neq j$;

(iii) Conditional on financial report R and privately observed firm type α, CRA i chooses rating inflation s_i to maximize its expected revenue, net of rating inflation costs, given rational conjectures of the entrepreneur's credit rating preferences, m,F_j, s_j, and r_n, where $i \neq j$;

(iv) Conditional on private information signal S and private observation of credit rating $\{B_i, G_i\}$ from CRAs $i = 1, 2$, the entrepreneur purchases a credit rating from CRA $i = 1, 2$ only if this leads to a (weakly) larger expected utility, given F_i and her rational conjectures of s_i and r_n.

(v) Conditional on financial report R and publicly disclosed credit ratings from CRAs $i = 1, 2$, investors choose interest rate bids to break even in expectation. Bayesian investors rationally conjecture the entrepreneur's credit rating preferences, m and s_i, whereas naive investors do not incorporate other players' incentives and strategic decisions.

In equilibrium, all conjectures coincide with the actual decision variables.

2.2 EQUILIBRIUM WITH A MONOPOLISTIC RATING AGENCY

We begin our analysis by characterizing the unique equilibrium for the case with a monopolistic CRA.[12] For ease of exposition, we use subscript M for the endogenous variables in the monopolistic CRA setting and subscript D for the respective variables in the CRA duopoly setting discussed in the next section.[13]

We start our solution procedures by solving the debt market's problem and derive Bayesian (u) and naive (v) investors' interest rate bids for the cases with no purchased rating (based on information set $\{R_H\}$) and one purchased rating (based on information set $\{R_H, G\}$). Let us initially assume that there exist interior solutions for the entrepreneur's accounting manipulation m_M (which the CRA and the Bayesian investors conjecture as $\hat{m}_M$), the CRA's rating inflation s_M (which the entrepreneur and Bayesian investors conjecture as $\hat{s}_M$), and the CRA's rating fee F_M. Bayesian investors and the CRA also correctly conjecture that the entrepreneur would only purchase a favorable rating. The interest rates are as follows:

$$r_{0,u,M} = \frac{1-Pr_u(x|R_H)}{Pr_u(x|R_H)} \text{ where } Pr_u(x|R_H) = Pr(x|R_H, B) = \frac{\kappa(\hat{m}_M)\theta}{\kappa(\hat{m}_M)\theta + [1-\kappa(\hat{m}_M)](1+\theta)}$$

$$r_{0,v,M} = \frac{1-Pr_v(x|R_H)}{Pr_v(x|R_H)} \text{ where } Pr_v(x|R_H) = Pr(x|S_H) = \frac{p(1+\theta)}{p(1+\theta)+(1-p)(1-\theta)}$$

$$r_{1,u,M} = \frac{1-Pr_u(x|R_H,G)}{Pr_u(x|R_H,G)} \text{ where } Pr_u(x|R_H,G) = Pr(x|R_H,G) = \frac{\kappa(\hat{m}_M)(1+\hat{s}_M\theta)}{\kappa(\hat{m}_M)(1+\hat{s}_M\theta)+[1-\kappa(\hat{m}_M)]\hat{s}_M(1+\theta)}$$

$$r_{1,v,M} = \frac{1-Pr_v(x|R_H,G)}{Pr_v(x|R_H,G)} \text{ where } Pr_v(x|R_H,G) = Pr(x|S_H, \alpha = g) = 1$$

Note that $\kappa(\hat{m}_M) = Pr(x|R_H) = \frac{[p+(1-p)\hat{m}_M](1+\theta)}{[p+(1-p)\hat{m}_M](1+\theta)+[(1-p)+p\hat{m}_M](1-\theta)}$ is the posterior probability that the project succeeds, given the entrepreneur's report R_H and conjectured manipulation $\hat{m}_M$. Consequently, the average interest rates can be written as

$$r_{0,M} = \lambda\frac{[1-\kappa(\hat{m}_M)](1+\theta)}{\kappa(\hat{m}_M)\theta} + (1-\lambda)\frac{(1-p)(1-\theta)}{p(1+\theta)} \tag{1}$$

$$r_{1,M} = \lambda\frac{[1-\kappa(\hat{m}_M)]\hat{s}_M(1+\theta)}{\kappa(\hat{m}_M)(1+\hat{s}_M\theta)}, \tag{2}$$

First note that $r_{0,M} > r_{1,M}$ for all $\hat{m}_M, \hat{s}_M \in (0,1)$, i.e., the interest rate decreases with the provision of a favorable rating. This is because both Bayesian and naive investors revise their beliefs

[12] Note that all missing proofs and conditions are provided in the appendix.

[13] In this section, we further omit subscript $i = 1$ as there only exists one CRA.

regarding the project's success probability upwards, conditional upon observing a favorable credit rating. When no rating is observed, Bayesian investors correctly infer that the CRA's rating must have been unfavorable (B), since they are aware of the monopolistic CRA's rating solicitation and of the entrepreneur's rating preferences. In this case, they also reassess the information content of the financial report R_H. Note, too, that $\frac{\partial r_{0,M}}{\partial \hat{m}_M}, \frac{\partial r_{1,M}}{\partial \hat{m}_M} > 0$ for all $\hat{m}_M, \hat{s}_M \in (0,1)$. The observations that $r_{0,M}$ and $r_{1,M}$ increase in the conjectured level of manipulation $\hat{m}_M$ are intuitive, since the project's success probability, conditional on a favorable financial report R_H, decreases with increasing manipulation. A similar rationale holds true with respect to the CRA's conjectured level of rating inflation $\hat{s}_M$ in case of a favorable credit rating G, i.e., $\frac{\partial r_{1,M}}{\partial \hat{s}_M} > 0$ for all $\hat{m}_M, \hat{s}_M \in (0,1)$. In contrast, naive investors interpret a favorable rating as an indication that the firm is a good type, without considering the rating inflation incentives of the CRAs, and expect the project to be successful with probability one.

After solving the debt market's problem, we now characterize and solve the monopolistic CRA's rating fee and inflation problem. Formally, the problem can be written as follows:

$$\max_{F_M} Pr(G|R_H)F_M - Pr(\alpha = b|R_H)\frac{s_M^2\gamma}{2} \tag{3a}$$

subject to

$$Pr(x|S_H, G)\left[x - (1 + \hat{r}_{1,M})\right] - F_M \geq Pr(x|S_H, G)\beta\left[x - (1 + \hat{r}_{0,M})\right] \tag{3b}$$

$$Pr(x|S_L, G)\left[x - (1 + \hat{r}_{1,M})\right] - F_M \geq Pr(x|S_L, G)\beta\left[x - (1 + \hat{r}_{0,M})\right] \tag{3c}$$

$$\max_{s_M} s_M F_M - \frac{s_M^2\gamma}{2}, \tag{3d}$$

As the entrepreneur is only willing to purchase a favorable rating, the CRA earns a fee if and only if its rating is favorable. This gives the CRA incentives to inflate its rating when it observes that the firm is a bad type, i.e., $\alpha = b$, which is addressed in (3d). In addition, the CRA's problem includes two participation constraints, (3b) and (3c) (one for each signal realization $\{S_H, S_L\}$), to ensure that the entrepreneur is always willing to purchase a favorable rating. Note that constraint (3c) is stricter than constraint (3b) since $Pr(x|S_H, G) > Pr(x|S_L, G)$ for all $\hat{s}_M \in (0,1)$.

The optimization problem characterized by conditions (3a) to (3d) is solved by applying the first-order approach on (3d) and then solving (3a) by using a Lagrange multiplier on constraint

(3c). The resulting monopolistic CRAs' optimal rating fee and inflation bias are as follows:

$$F_M = Pr(x|S_L, G)\left\{\beta(\hat{r}_{0,M} - \hat{r}_{1,M}) + (1-\beta)\left[x - (1+\hat{r}_{1,M})\right]\right\} \tag{4}$$

$$s_M = \frac{F_M}{\gamma}, \tag{5}$$

where $Pr(x|S_L, G) = \frac{(1-p)(1+\hat{s}_M\theta)}{(1-p)(1+\hat{s}_M\theta)+p\hat{s}_M(1-\theta)}$.

It is straightforward to see from (5) that rating inflation increases with the size of the rating fee, representing the conflict of interest the CRA faces. The rating fee captures the rent the CRA extracts from the entrepreneur and is determined by two parts: the entrepreneur's beliefs (captured by $Pr(x|S_L, G)$) and the market's beliefs regarding the project's success probability. The latter affects the fee through the interest rates and determines how much surplus is created in expectation by the favorable rating. Both components can be shown to decrease with the conjectured level of rating inflation $\hat{s}_M \in (0, 1)$.

Lastly, the entrepreneur makes two decisions in our model: the level of manipulation effort and whether to purchase a rating. It is straightforward to show that the entrepreneur does not purchase an unfavorable rating since that would not improve her expected utility, i.e., an unfavorable rating has a strictly negative value for her. Additionally, it was shown above that the CRA sets its fee such that the entrepreneur is willing to purchase a favorable rating.

For the entrepreneur's manipulation decision, recall that she reports truthfully if she receives a favorable signal, $S = S_H$, leading to report R_H. However, contingent upon receiving an unfavorable signal S_L, the entrepreneur solves the following problem to determine the optimal disclosure manipulation effort m_M:

$$\max_{m_M} m_M \left\{Pr(x, G|S_L)\left[x - (1+\hat{r}_{1,M})\right] + Pr(x, B|S_L)\beta\left[x - (1+\hat{r}_{0,M})\right] - Pr(G|S_L)\hat{F}_M\right\} - \frac{m_M^2\mu}{2},$$

The solution to this problem, after enforcing the conjectures and plugging in F_M from (4), can be simplified and rearranged to

$$m_M = Pr(x|S_L)\frac{1}{\mu}\left\{\frac{1+s_M\theta}{1+\theta}\left[x-(1+r_{1,M})\right] + \frac{(1-s_M)\theta}{1+\theta}\beta\left[x-(1+r_{0,M})\right] - \frac{1+s_M}{1+\theta}F_M\right\}$$

$$= Pr(x|S_L)\frac{\beta}{\mu}\left[x - (1 + r_{0,M})\right], \quad (6)$$

Note that $Pr(x|S_L) = \frac{(1-p)(1+\theta)}{(1-p)(1+\theta)+p(1-\theta)}$. Given that $\mu > \overline{\mu}$ and $\gamma > \overline{\gamma}$, there exists a unique interior level of manipulation $m_M = m_M^* \in (0,1)$, a unique interior level of rating inflation $s_M = s_M^* \in (0,1)$, a unique positive rating fee $F_M = F_M^* > 0$, and unique interest rates $r_{0,M} = r_{0,M}^* > 0$ and $r_{1,M} = r_{1,M}^* > 0$. Thresholds $\overline{\gamma}$ and $\overline{\mu}$ are characterized in the appendix. Proposition 1 summarizes the unique equilibrium in the setting with a monopolistic CRA.

Proposition 1 *Given that $\mu > \overline{\mu}$ and $\gamma > \overline{\gamma}$, there exists a unique equilibrium for the case with a monopolistic CRA that has the following properties.*

(i) The entrepreneur reports R_H whenever $S = S_H$ and exerts manipulation effort $m_M^* \in (0,1)$ whenever $S = S_L$, where m_M^* is defined by (6).

(ii) The monopolistic CRA sets rating fee $F_M^* > 0$ as in (4).

(iii) The monopolistic CRA truthfully issues a favorable rating G whenever $\alpha = g$ and engages in rating inflation $s_M^* \in (0,1)$ in case $\alpha = b$, where s_M^* is defined by (5).

(iv) The entrepreneur only purchases a favorable credit rating (G) and refrains from purchasing an unfavorable rating (B).

(v) The debt market chooses average interest rates $r_{0,M}^* > 0$ and $r_{1,M}^* > 0$, as in (1) and (2), contingent upon information sets $\{R_H\}$ and $\{R_H, G\}$, respectively.

The equilibrium summarized in Proposition 1 has certain economic properties that require some elaboration. First of all, the entrepreneur's misreporting incentives crucially depend on the CRA's fee strategy. In general, a higher rating fee decreases the entrepreneur's expected utility from manipulation and therefore undermines her manipulation incentives. Throughout our paper, a CRA sets the fee such that the strictest of the entrepreneur's participation constraints is binding; for the monopoly case, this is constraint (3c), which makes the entrepreneur with signal S_L indifferent between obtaining a good rating or not.

How much of the rent is extracted by the CRA further depends on whether it serves as a gatekeeper to the debt market: when it does *not* act as a gatekeeper ($\beta = 1$), a monopolistic CRA extracts the rent generated from providing rating G, which is proportional to the difference

$(r^*_{0,M} - r^*_{1,M})$. Due to the CRA's fee setting strategy in this case, purchasing a rating does not increase the rent retained by the entrepreneur who observed an unfavorable signal S_L. This can be seen in condition (6), where her manipulation effort given $\beta = 1$ is proportional to $\Big[x - (1 + r^*_{0,M})\Big]$.

When the CRA acts as a gatekeeper ($\beta = 0$), the entrepreneur cannot access the debt market without at least one favorable credit rating. In this case, the CRA extracts more rent since the entrepreneur is willing to forego a larger portion of the rent to obtain a favorable rating. We show that the monopolistic CRA can extract the entire expected rent from realizing the project with a favorable rating G from an entrepreneur with private information S_L (which is proportional to $\Big[x - (1 + r^*_{1,M})\Big]$). Therefore the entrepreneur's expected utility when $S = S_L$ reduces to zero, and she is left indifferent between undertaking and not undertaking the project. Since there is no utility gain from engaging in costly manipulation, she reports truthfully ($m^*_M = 0$). The following corollary summarizes observations regarding the CRAs' gatekeeper role under the setting with a monopolistic CRA.

Corollary 1 *Under a CRA monopoly, the CRA's gatekeeper role ($\beta = 1 \to 0$) leads to*:

(i) higher rating fees ($\frac{dF^*_M}{d\beta} < 0$);

(ii) more rating inflation ($\frac{ds^*_M}{d\beta} < 0$)*; and*

(iii) less accounting manipulation ($\frac{dm^*_M}{d\beta} > 0$).

3 Equilibrium with Imperfect Competition in the Rating Industry

In this section, we analyze a setting with imperfect competition in the credit rating industry, where two CRAs compete for the rating business.[14] In this duopolistic rating industry setting, we assume that CRAs are ex ante identical (i.e., γ is the same for both CRAs), that they choose their rating fees and inflation biases simultaneously, and that they privately submit their ratings to the entrepreneur at the same time. As do Skreta and Veldkamp [2009], Bolton, Freixas, and Shapiro [2012], and Sangiorgi and Spatt [2017], we allow the entrepreneur to purchase two ($n = 2$), one ($n = 1$), or no rating ($n = 0$).

We solve the duopolistic CRA setting by backward induction and begin our solution procedures

[14]The introduction of a third or more CRAs would require the assumption of imperfect information as opposed to perfect type information. This would not fundamentally alter the results but would significantly increase model complexity.

by deriving Bayesian and naive investors' interest rate bids and the average interest rates for cases $n = 0, 1, 2$. For this, we assume that there exist interior solutions for the entrepreneur's manipulation effort $m_D \in (0,1)$, CRA 1's rating inflation $s_{1,D} \in (0,1)$ and CRA 2's rating inflation $s_{2,D} \in (0,1)$, with conjectures (held by Bayesian investors) $\hat{m}_D$, $\hat{s}_{1,D}$, and $\hat{s}_{2,D}$, respectively. As in the monopolistic CRA setting, Bayesian investors and CRAs correctly conjecture that the entrepreneur has a preference for favorable ratings. The interest rate conditional on no rating $r_{0,D}$ ($n = 0$) is functionally identical to $r_{0,M}$ presented in (1) where $\hat{m}_M \to \hat{m}_D$. For cases $n = 1$ and $n = 2$, the bids of Bayesian and naive investors are as follows:

$$r_{1,u,D} = \tfrac{1-Pr_u(x|R_H,G_i)}{Pr_u(x|R_H,G_i)} \text{ and } r_{2,u,D} = \tfrac{1-Pr_u(x|R_H,G_1,G_2)}{Pr_u(x|R_H,G_1,G_2)},$$

$$r_{1,v,D} = \tfrac{1-Pr_v(x|R_H,G_i)}{Pr_v(x|R_H,G_i)} \text{ and } r_{2,v,D} = \tfrac{1-Pr_v(x|R_H,G_1,G_2)}{Pr_v(x|R_H,G_1,G_2)},$$

where

$$Pr_u(x|R_H, G_i) = Pr(x|R_H, G_i, B_j) = \frac{\kappa(\hat{m}_D)\theta}{\kappa(\hat{m}_D)\theta + [1-\kappa(\hat{m}_D)](1+\theta)}$$

$$Pr_u(x|R_H, G_1, G_2) = Pr(x|R_H, G_1, G_2) = \frac{\kappa(\hat{m}_D)(1+\hat{s}_{1,D}\hat{s}_{2,D}\theta)}{\kappa(\hat{m}_D)(1+\hat{s}_{1,D}\hat{s}_{2,D}\theta) + [1-\kappa(\hat{m}_D)]\,\hat{s}_{1,D}\hat{s}_{2,D}(1+\theta)}$$

$$Pr_v(x|R_H, G_i) = Pr_v(x|R_H, G_1, G_2) = Pr(x|S_H, \alpha = g) = 1.$$

Consequently, the average interest rates can be written as

$$r_{1,D} = \lambda \frac{[1-\kappa(\hat{m}_D)](1+\theta)}{\kappa(\hat{m}_D)\theta} \tag{7}$$

$$r_{2,D} = \lambda \frac{[1-\kappa(\hat{m}_D)]\,\hat{s}_{1,D}\hat{s}_{2,D}(1+\theta)}{\kappa(\hat{m}_D)(1+\hat{s}_{1,D}\hat{s}_{2,D}\theta)}. \tag{8}$$

Note that $r_{0,D} > r_{1,D} > r_{2,D}$ for all $\hat{m}_D, \hat{s}_{1,D}, \hat{s}_{2,D} \in (0,1)$. That a second favorable rating creates value in our setting with binary ratings is a direct consequence of the presence of both Bayesian and naive investors. Naive investors favorably update their beliefs on observing one good rating, not accounting for the information generated by a nonpurchase of a second rating (explaining $r_{0,D} > r_{1,D}$). However, whether there are one or two favorable ratings is irrelevant to naive investors as they interpret any G_i as $\alpha = g$. In contrast, Bayesian investors infer from observing only one favorable rating (case $n = 1$) that the second rating must have been unfavorable. They therefore learn that the purchased favorable rating must be inflated, something they do not learn when both ratings are favorable (explaining $r_{1,D} > r_{2,D}$). We restrict parameter λ to be sufficiently small ($\lambda < \overline{\lambda}$) to establish a decreasing marginal informaton value of credit ratings, i.e., $r_{0,D} - r_{1,D} > r_{1,D} - r_{2,D}$.[15] It also can be shown that $\frac{\partial r_{0,D}}{\partial \hat{m}_D}, \frac{\partial r_{1,D}}{\partial \hat{m}_D}, \frac{\partial r_{2,D}}{\partial \hat{m}_D}, \frac{\partial r_{2,D}}{\partial \hat{s}_{1,D}}, \frac{\partial r_{2,D}}{\partial \hat{s}_{2,D}} > 0$ for all $\hat{m}_D, \hat{s}_{1,D}, \hat{s}_{1,D} \in (0,1)$ for reasons similar to those discussed in the monopolistic CRA setting in Section II.

In the CRA duopoly setting, each CRA solves a problem that resembles the one presented by conditions (3a) to (3d). However, the major difference to the case with a monopolistic CRA can be found in the entrepreneur's participation constraints: the presence of a second CRA j forces CRA i to also incorporate conjectures regarding j's credit rating – which can either be B_j or G_j – and vice versa, resulting in four instead of only two participation constraints. CRA i rationally conjectures the entrepreneur's manipulation effort $\hat{m}_D \in (0,1)$ and CRA j's rating inflation $\hat{s}_{j,D}(0,1)$, where $i \neq j$, as well as the debt market's interest rates $\hat{r}_{0,D} > \hat{r}_{1,D} > \hat{r}_{2,D} > 0$. CRA i's optimization problem can be formalized as follows:

$$\max_{F_{i,D}} Pr(G_i|R_H)F_{i,D} - Pr(\alpha = b|R_H)\frac{s_{i,D}^2\gamma}{2} \tag{9a}$$

subject to

$$Pr(x|S_H, G_i, B_j)\left[x - (1 + \hat{r}_{1,D})\right] - F_{i,D} \geq Pr(x|S_H, G_i, B_j)\beta\left[x - (1 + \hat{r}_{0,D})\right] \tag{9b}$$

$$Pr(x|S_L, G_i, B_j)\left[x - (1 + \hat{r}_{1,D})\right] - F_{i,D} \geq Pr(x|S_L, G_i, B_j)\beta\left[x - (1 + \hat{r}_{0,D})\right] \tag{9c}$$

$$Pr(x|S_H, G_i, G_j)\left[x - (1 + \hat{r}_{2,D})\right] - F_{i,D} \geq Pr(x|S_H, G_i, G_j)\left[x - (1 + \hat{r}_{1,D})\right] \tag{9d}$$

$$Pr(x|S_L, G_i, G_j)\left[x - (1 + \hat{r}_{2,D})\right] - F_{i,D} \geq Pr(x|S_L, G_i, G_j)\left[x - (1 + \hat{r}_{1,D})\right] \tag{9e}$$

$$\max_{s_{i,D}} s_{i,D}F_{i,D} - \frac{s_{i,D}^2\gamma}{2}, \tag{9f}$$

We can first rule out constraints (9b) and (9d) as they are not as strict as (9c) and (9e), respectively. In the appendix, we show that, given that λ lies below a unique threshold $\overline{\lambda}$, constraint (9c) is not as strict as constraint (9e). The assumption $\lambda < \overline{\lambda}$ assures that it is optimal for a CRA to set its rating

[15] A similar yet somewhat stricter parameter restriction is imposed in Bolton, Freixas, and Shapiro [2012] with Assumption 5.

fee such that, when the entrepreneur privately observes two favorable ratings, she has incentives to purchase both, i.e., the entrepreneur always has an incentive to purchase a second favorable rating.[16] Another possible strategy for CRA i is to charge a higher rating fee such that the entrepreneur is willing to purchase a favorable rating from CRA i when CRA j provides an unfavorable rating. The highest price that the CRA can charge in this case would equal the marginal value of a first favorable rating (as is the case in the monopolistic CRA setting). However, this cannot be feasible in equilibrium since, if this is the optimal strategy for CRA i, CRA j's optimal response would be to charge a slightly lower fee, such that when both CRAs present favorable ratings the entrepreneur will buy a rating from CRA j. This price competition will continue until both CRAs charge the marginal value of a second favorable rating, in which case the entrepreneur will be willing to purchase from both CRAs when both present favorable ratings.[17] We apply the first-order approach on (9f), leading to the functionally identical solution as under the setting with a monopolistic CRA (see (5)). Additionally, we use a Lagrange multiplier to show that the fee that maximizes CRA i's expected utility in (9a) is the one for which constraint (9e) is binding. The rating fee can therefore be expressed as follows:

$$F_{i,D} = Pr(x|S_L, G_1, G_2)(\hat{r}_{1,D} - \hat{r}_{2,D}), \tag{10}$$

where $Pr(x|S_L, G_1, G_2) = \frac{(1-p)(1+\hat{s}_{1,D}\hat{s}_{2,D}\theta)}{(1-p)(1+\hat{s}_{1,D}\hat{s}_{2,D}\theta)+p\hat{s}_{1,D}\hat{s}_{2,D}(1-\theta)}$. Since we assume that both CRAs are ex ante identical and move simultaneously, it must be the case that $s_{1,D} = s_{2,D} = s_D$ and that $F_{1,D} = F_{2,D} = F_D$. For expositional purposes, this is subsequently assumed for the conjectures formulated by the entrepreneur.

As before, the entrepreneur's rating purchase problem leads her to refrain from purchasing unfavorable ratings as they have a strictly negative value. Due to CRAs' fee decisions, the entrepreneur always purchases a favorable rating. For the entrepreneur's manipulation effort problem, we assume that there exist interior solutions for both the CRAs' rating inflation and fee decisions, which she rationally conjectures with $\hat{s}_D \in (0, 1)$ and $\hat{F}_D > 0$. Additionally, she conjectures interest rates

[16] This is in line with papers such as those by Boot, Milbourn, and Schmeits [2006], Skreta and Veldkamp [2009], or Bolton, Freixas, and Shapiro [2012].

[17] That the rating fee does not drop to the marginal cost of issuing a rating is due to two aspects of the setting: each rating agency can issue only one rating per firm, and the entrepreneur is allowed to buy both ratings. If one of these assumptions were relaxed, the price competition would continue until the rating fee equals the marginal cost, as is the case in standard Bertrand models with homogenous products.

$\hat{r}_{0,D} > \hat{r}_{1,D} > \hat{r}_{2,D} > 0$. The entrepreneur's problem determines m_D, which maximizes the expected payoff to the entrepreneur for the cases in which she obtains two, one, or no favorable rating, net of the rating fees when either or both ratings are favorable, and net of manipulation costs. The optimization problem conditional on S_L can be written as follows:

$$\begin{aligned}\max_{m_D} \quad & m_D \left\{Pr(x,G_1,G_2|S_L)\left[x-(1+\hat{r}_{2,D})\right] + 2Pr(x,G_i,B_j|S_L)\left[x-(1+\hat{r}_{1,D})\right]\right\} \\ & + m_D \left\{Pr(x,B_1,B_2|S_L)\beta\left[x-(1+\hat{r}_{0,D})\right] - \left[Pr(G_1|S_L)+Pr(G_2|S_L)\right]\hat{F}_D\right\} - \frac{m_D^2\mu}{2},\end{aligned}$$

where $Pr(x,G_1,G_2|S_L) = \frac{(1-p)(1+\hat{s}_D^2\theta)}{(1-p)(1+\theta)+p(1-\theta)}$, $Pr(x,G_i,B_j|S_L) = \frac{(1-p)\hat{s}_D(1-\hat{s}_D)\theta}{(1-p)(1+\theta)+p(1-\theta)}$, $Pr(x,B_1,B_2|S_L) = \frac{(1-p)(1-\hat{s}_D)^2\theta}{(1-p)(1+\theta)+p(1-\theta)}$, and $Pr(G_1|S_L) = Pr(G_2|S_L) = \frac{(1-p)(1+\hat{s}_D\theta)+p\hat{s}_D(1-\theta)}{(1-p)(1+\theta)+p(1-\theta)}$. The level of manipulation is solved for and, after enforcing all conjectures and substituting F_D from (10), the entrepreneur's manipulation effort can be simplified to

$$m_D = Pr(x|S_L)\frac{1}{\mu}\left\{\frac{\left\{1+\left[s_D^2+2s_D(1-s_D)+(1-s_D)^2\beta\right]\theta\right\}}{(1+\theta)}\left[x-(1+r_{0,D})\right] + \frac{\Phi}{(1+\theta)}\right\}, \quad (11)$$

where

$$\begin{aligned}\Phi \equiv\ & (1+s_D^2\theta)(r_{0,D}-r_{2,D}) + 2s_D(1-s_D)\theta(r_{0,D}-r_{1,D}) \\ & - 2\frac{(1+s_D^2\theta)\left[(1-p)(1+s_D\theta)+ps_D(1-\theta)\right]}{\left[(1-p)\left(1+s_D^2\theta\right)+ps_D^2\left(1-\theta\right)\right]}(r_{1,D}-r_{2,D}).\end{aligned}$$

Note that, in the appendix, we show that Φ is positive under the assumptions made. Given that $\mu > \overline{\mu}$, $\gamma > \overline{\gamma}$, and $\lambda < \overline{\lambda}$, it can be shown that there exists a unique equilibrium.

Proposition 2 summarizes the unique equilibrium with imperfect competition in the credit rating industry.

Proposition 2 *Given that $\mu > \overline{\mu}$, $\gamma > \overline{\gamma}$, and $\lambda < \overline{\lambda}$, there exists a unique equilibrium for the case with a duopolistic credit rating industry that has the following properties.*

(i) The entrepreneur reports R_H whenever $S = S_H$ and exerts manipulation effort $m_D^* \in (0,1)$ whenever $S = S_L$, where m_D^* is defined by (11).

(ii) CRA i sets rating fee $F_D^* > 0$ as in (10).

(iii) CRA i truthfully issues a favorable rating G_i whenever $\alpha = g$ while engaging in rating

inflation $s_D^* \in (0,1)$ *in case* $\alpha = b$*, where* s_D^* *is defined by (5).*

(iv) The entrepreneur only purchases a favorable credit rating (G_i) *and refrains from purchasing an unfavorable rating* (B_i)*.*

(v) The debt market chooses average interest rates $r_{0,D}^*$*,* $r_{1,D}^*$*, and* $r_{2,D}^*$ *as in (1), (7) and (8), contingent upon information sets* $\{R_H\}$*,* $\{R_H, G_i\}$ *and* $\{R_H, G_1, G_2\}$*, respectively.*

4 Analysis

In this section, we provide a discussion of the equilibrium established in Proposition 2. In particular, we first compare the case with imperfect competition between two CRAs with the monopolistic CRA case. Then we perform a comparative statics analysis for the imperfect CRA competition case.

4.1 THE EFFECTS OF COMPETITION IN THE RATING INDUSTRY

The equilibrium described in Proposition 2 differs in important ways from the one described in Proposition 1. The following proposition presents a first set of key results on how competition in the credit rating industry affects the rating agencies' and entrepreneur's decisions.

Proposition 3 *An increase in the level of competition in the credit rating industry leads to*:

(i) lower rating fees ($F_M^* > F_D^*$)*;*

(ii) less rating inflation ($s_M^* > s_D^*$)*; and*

(iii) more accounting manipulation ($m_M^* < m_D^*$)*.*

Proposition 3 (i) states that CRAs lower their fees with increased competition in the industry. A CRA chooses its fee such that the entrepreneur always has an incentive to purchase a favorable rating. In the duopoly case, this means a CRA chooses the fee such that the entrepreneur has an incentive to purchase a second favorable rating. Due to the decreasing marginal information value of credit ratings, they ceteris paribus choose a lower fee when there is competition. Since the primary benefit of rating inflation, namely fee generation, decreases, CRAs inflate less as competition increases (Proposition 3 (ii)). Therefore, in our setting, increased CRA competition limits CRAs' ability to extract rents from the entrepreneur and makes their ratings more informative.[18]

[18] That competition among information intermediaries yields more informative signals is in line with Lizzeri [1999].

However, in our setting, increasing CRA competition also affects the *entrepreneur*: since she retains a larger portion of the rent generated by favorable credit ratings, the benefit of accounting manipulation increases, and she responds by manipulating more (Proposition (iii)). More manipulation reduces the informativeness of the financial report and in turn increases the relative information value of a favorable credit rating. While this could increase the rating fee that the entrepreneur is willing to pay, our analysis shows that the competition effect dominates. Overall, more competition in the rating industry leads to lower rating fees, less rating inflation, and more accounting manipulation.

4.2 RENT ALLOCATION UNDER IMPERFECT COMPETITION IN THE RATING INDUSTRY

In Proposition 3, we established that competition in the rating industry affects the rent allocation between the entrepreneur and CRAs. In this subsection, we discuss how different factors influence the rent allocation in equilibrium. We focus on the case with imperfect competition in the rating industry as summarized in Proposition 2 and consider CRAs' rating inflation costs (γ), the debt market's characteristics (λ), and the entrepreneur's accounting manipulation costs (μ).

4.2.1 Rating Inflation Costs

We first consider how changes in rating inflation costs affect the equilibrium with imperfect CRA competition.

Corollary 2 *Under imperfect CRA competition, an increase in rating inflation costs* γ *leads to*:

(i) higher or lower rating fees ($\frac{dF_D^*}{d\gamma} \lesseqgtr 0$);

(ii) less rating inflation ($\frac{ds_D^*}{d\gamma} < 0$)*; and*

(iii) less accounting manipulation ($\frac{dm_D^*}{d\gamma} < 0$).

Intuitively, higher rating inflation costs lead to less rating inflation (Corollary 2 (ii)) and consequently to more informative credit ratings. The anticipated decrease in rating inflation affects the entrepreneur's manipulation decision ex ante. Conditional upon observing S_L, lower rating inflation decreases the entrepreneur's probability of obtaining favorable ratings. This decreases the entrepreneur's expected utility, as it implies a higher average interest rate, which consequently weakens her misreporting incentives (Corollary 2 (iii)).[19]

This establishes the existence of two direct countervailing effects for the CRAs' rating fee strategy: Conditional upon observing two favorable credit ratings, the entrepreneur's expected utility increases with lower rating inflation because of an upward revision of her own beliefs (captured by conditional probability $Pr(x|S_L, G_1, G_2)$). Moreover, given a level of accounting manipulation m_D^*, the value of a second favorable rating for Bayesian investors increases as rating inflation decreases.[20] These two effects suggest an increase in rating fees. However, there is a second countervailing effect in the CRAs' fee setting problem present through the entrepreneur's misreporting: less manipulation in financial reporting improves its informativeness ($\kappa(m_D^*)$ increases). As financial reporting becomes more informative, the information value of a second favorable rating for Bayesian investors decreases, i.e., the difference $r_{1,D}^* - r_{2,D}^*$ decreases. These two opposing effects explain the ambiguous result in Corollary 2 (i) regarding the rating fees. However, even if rating fees increased, this would not reverse the direct effect of an increased rating inflation cost leading to less rating inflation, as stated in Corollary 2 (ii).

4.2.2 Debt Market Characteristics

In our setting, the presence of Bayesian and naive investors and the restriction on the composition of the debt market ($\lambda < \overline{\lambda}$) establishes a decreasing marginal information value of credit ratings for both the entrepreneur and the debt market. The following corollary shows how the composition of the debt market in terms of naive versus Bayesian investors affects the equilibrium behavior of the entrepreneur and CRAs.

Corollary 3 *Under imperfect CRA competition, a higher portion λ of Bayesian investors in the debt market leads to*:

(i) higher rating fees ($\frac{dF_D^*}{d\lambda} > 0$);

(ii) more rating inflation ($\frac{ds_D^*}{d\lambda} > 0$)*; and*

(iii) more or less accounting manipulation ($\frac{dm_D^*}{d\lambda} \lesseqgtr 0$).

[19]That the entrepreneur's expected utility decreases in the costs of rating inflation is consistent with her preference for favorable ratings and thus her rating purchasing behavior.

[20]It is straighforward to see that the difference $r_{1,D}^* - r_{2,D}^* = \frac{r_{1,D}^*}{1+(s_D^*)^{2\theta}}$ unambiguoulsy decreases in s_D^* since $r_{1,D}^*$ is not a function of s_D^*.

Corollary 3 (i) and (ii) establish that CRAs choose higher rating fees and inflate ratings more when there are more Bayesian investors in the market. Recall that, in an imperfectly competitive CRA industry, the rating fee is set such that the entrepreneur is willing to purchase a second favorable rating. As can be seen in equation (10), the equilibrium rating fee is proportional to the difference between $r^*_{1,D}$ and $r^*_{2,D}$. In Section III, we have further shown that this difference is established by the interest rate bids of *Bayesian* investors, whereas naive investors are indifferent between observing one favorable rating or two. As the portion of Bayesian investors increases, the difference between $r^*_{1,D}$ and $r^*_{2,D}$ increases, allowing CRAs to increase their rating fees and thus extract a larger rent from the entrepreneur. As the rating fee increases, so does the incentive to inflate ratings, resulting in a higher rating inflation bias s^*_D, as stated in Corollary 3 (ii).

Corollary 3 (iii) states that an increase in the fraction of Bayesian investors can lead to an increase or decrease in financial misreporting. Intuitively, an increase in Bayesian investors increases overall interest rates, given a level of rating inflation. This decreases the entrepreneur's expected utility, which reduces her incentives to manipulate the financial report. Furthermore, for a given level of rating inflation, the increase in rating fees as stated in Corollary 3 (i) would result in the entrepreneur capturing a smaller portion of the expected rent. This also suggests that she has weaker incentives to manipulate the financial report. However, the increase in rating inflation, as seen in Corollary 3 (ii), provides a countervailing force in our model. Under Corollary 2, we have reasoned that higher rating inflation overall increases the entrepreneur's misreporting incentives by increasing the probability of receiving a favorable rating. As can be seen in Corollary 3 (iii), these countervailing effects on the entrepreneur's manipulation of financial reports render the overall association ambiguous.

4.2.3 Accounting Manipulation Costs

In the following corollary, we consider the consequences of an increase in the costs of accounting manipulation.

Corollary 4 *Under imperfect CRA competition, an increase in accounting manipulation costs* μ *leads to*:

(i) lower rating fees ($\frac{dF_D^*}{d\mu} < 0$);

(ii) less rating inflation ($\frac{ds_D^*}{d\mu} < 0$)*; and*

(iii) less accounting manipulation ($\frac{dm_D^*}{d\mu} < 0$).

When accounting manipulation is more costly, this reduces the entrepreneur's motivation to misreport (Corollary 4 (iii)). This in turn improves the information content of the financial report ($\kappa(m_D^*)$ increases). As the financial report becomes more informative, the incremental information value of favorable credit ratings decreases, implying that the rent that can be extracted by CRAs decreases. CRAs respond by lowering their fees, as stated in Corollary 4 (i). A lower fee reduces the benefits of rating inflation and discourages information distortion by CRAs (Corollary 4 (ii)).

4.3 RATING AGENCIES' GATEKEEPER ROLE

In this subsection, we examine how the CRAs' gatekeeper role affects equilibrium behavior in the case of imperfect CRA competition when debt-issuing firms can manipulate their financial reports. Indicator variable β captures the effects of CRAs' gatekeeper role, where $\beta = 0$ ($\beta = 1$) captures the case in which CRAs do (not) assume this role.

Proposition 4 *Under imperfect CRA competition, CRAs' gatekeeper role* ($\beta = 1 \rightarrow 0$) *leads to*:

(i) lower rating fees ($\frac{dF_D^*}{d\beta} > 0$);

(ii) less rating inflation ($\frac{ds_D^*}{d\beta} > 0$)*; and*

(iii) less accounting manipulation ($\frac{dm_D^*}{d\beta} > 0$).

In the setting with imperfect CRA competition, the CRAs' gatekeeper role influences the equilibrium strategies only through the entrepreneur's accounting manipulation decision. In particular, the entrepreneur's conditionally expected utility strictly decreases when CRAs assume a gatekeeper role since financing does not take place and the project cannot be undertaken without at least one favorable rating. The entrepreneur's expected utility is reduced by an amount equal to the expected value of realizing the project when no favorable rating is available. It follows that the entrepreneur chooses a lower level of manipulation when CRAs act as gatekeepers ($\beta = 0$), as compared to an environment where this is not the case ($\beta = 1$). Due to the higher informativeness of financial reporting, the incremental information value of favorable ratings decreases, forcing CRAs to lower their rating fees. This in turn discourages rating inflation, making ratings more informative.

The results in Proposition 4 (i) and (ii) are in stark contrast to the effects of the gatekeeper role in the setting with a monopolistic CRA, summarized under Corollary 1 (i) and (ii). There, the gatekeeper role allows the CRA to increase its rating fee to a level that corresponds to the entire surplus of financing and undertaking the project as assessed by an entrepreneur with private information S_L. The higher fee ultimately results in more rating inflation. The economic intuition behind these differences is that the gatekeeper role influences CRA rent extraction differently in a CRA monopoly, as compared to an imperfectly competitive CRA industry. In particular, when a monopolistic CRA acts as a gatekeeper, its ability to extract rents is increased. In contrast, under imperfect CRA competition, this is not the case as the primary way through which CRAs' gatekeeper role influences their decisions is through the entrepreneur's financial reporting decision. Under both settings, CRAs' gatekeeper role undermines financial misreporting incentives, albeit for different reasons. The gatekeeper role strenghtens a monopolistic CRA's rent extraction ability, reducing the expected rent of an entrepreneur with signal S_L to zero, as the CRA captures the entire rent generated by a realized project. Under imperfect CRA competition, the gatekeeper role reduces the entrepreneur's expected rent directly by preventing projects without a favorable rating from being financed, which results in less financial misreporting.

5 Discussion and Implications

Our paper's results can be reconciled with empirical evidence and additionally provide the basis for future empirical investigations. First, we highlight that financial misreporting and credit rating inflation are strategic complements under imperfect CRA competition (Corollaries 1, 2, and 4, and Proposition 4): Less manipulation (e.g., as a consequence of higher manipulation costs) improves the information content of financial reporting, relative to the information provided by credit ratings. CRAs have to charge a lower rating fee, which in turn decreases the incentive to inflate ratings. Conversely, less rating inflation (e.g., as a consequence of higher inflation costs) increases the information value of the credit rating, allowing CRAs to charge higher rating fees. This in turn leads to a lower expected utility of reporting manipulation and therefore to less manipulation. Therefore there exists a positive (negative) association between financial misreporting and credit rating favorability (informativeness). These results reconcile with the empirical findings of Jiang [2008], Demirtas and Cornaggia [2013], and Jung, Soderstrom, and Yang [2013]. Jiang [2008] provides empirical evidence that more favorable corporate financial information yields more favorable ratings by documenting that firms that meet or beat earnings targets are more likely to achieve a rating upgrade. Demirtas and Cornaggia [2013] document that firms intensify upward earnings management before an initial rating. Jung, Soderstrom, and Yang [2013] also provide evidence of firms managing earnings to influence their credit ratings. Their findings are consistent with firms strategically smoothing earnings to preserve or improve their credit ratings, as smoother earnings are perceived to imply a lower fundamental risk.

While a common explanation for these results is that CRAs fail to unravel earnings management in the issuer's financial statements, this seems to understate the sophistication of CRAs. Kraft [2015] documents that CRAs exhibit superior analytical skills in deriving default-risk-relevant information from financial statements. Our paper provides a more subtle explanation for this association: firms' manipulation of financial reports indirectly influences CRAs' rating inflation by affecting the relative informativeness of financial reporting and credit ratings, which then influences rating fees and ultimately rating inflation.

Our paper also sheds light on the impact of CRA competition on CRA's rating inflation incentives and issuers' disclosure decisions. In Proposition 3, we claim that increased CRA competition limits CRAs' ability to extract rents from the entrepreneur, which in turn reduces their rating inflation incentives. In contrast to this result, Becker and Milbourn [2011] document that the rise of Fitch to the position of the third main CRA led to an overall decline in rating quality. They reason that both Standard & Poor's and Moody's would have been willing to sacrifice long-term reputation for short-term market share by catering to firms' preferences for favorable ratings. The new entrant firm, Fitch, also increased rating inflation to become more competitive. A similar argument is proposed in the analytical paper of Bolton, Freixas, and Shapiro [2012], who show that increased CRA competition yields increased rating inflation. However, this result is based on the assumption that CRAs' reputational costs from rating inflation are smaller in a CRA duopoly than they are in a monopoly. To show the robustness of our paper's inference regarding the dependence of firms' disclosure behavior on CRAs' rent extraction, we could impose a similar assumption on the rating inflation cost parameter γ, i.e., $\gamma_M > \gamma_D$. When the difference between reputational costs in a CRA monopoly versus a duopoly is large enough, rating inflation increases, instead of decreasing, with CRA competition. However, it can be shown that our result that accounting manipulation increases with the intensity of competition in the credit rating industry (Proposition 3 (iii)) continues to hold. In fact, the additional assumption even strengthens this result due to the observation from Corollary 3 (iii) in that the entrepreneur's manipulation effort decreases in the costs of rating inflation. Therefore assuming $\gamma_M > \gamma_D$ must yield more financial misreporting. However, empirical evidence regarding the impact of changes of CRA competition on debt-issuing firms' reporting decisions is, to the best of our knowledge, still missing.

We also investigate CRAs' role as gatekeepers to debt markets (Partnoy [1999], [2006]). Two studies provide evidence in support of this role. Kisgen and Strahan [2010] examine the effects of a regulatory status change of CRA Dominion Bond Rating Service, when it received the status of an NRSRO in 2003. They document that the change in the regulatory status led to a decrease in bond yields of rated firms without changing the measurable informativeness of ratings. Bongaerts, Cremers, and Goetzmann [2012] document that Fitch, as the third main NRSRO, primarily acts as a tiebreaker in the sense that, when one rating by Standard & Poors or Moody's is speculative and the other investment grade, the bond issuance is overall seen as investment grade when Fitch issues an additional investment-grade rating. This is because the average rating determines the regulatory rating of an issuer. These findings support claims that regulatory reliance on credit ratings in corporate bond markets affects the cost of debt. To our knowledge, it is an open empirical question whether the recognition of Dominion as an NRSRO or the tiebreaker observation associated with Fitch's entrance into the market has implications for issuers' reporting behavior. This is an important question insofar as our model suggests that the regulatory reliance primarily affects issuers' disclosure behavior and the effects on rating fees and rating inflation are indirect consequences.

Our investigation should be of particular interest to regulators. First, regulators across the world have argued for an increase of CRA competition. For example, the general aim of the 2013 amendments to the EU's Regulation (EC) No 1060/2009 as well as the US Credit Rating Agency Reform Act of 2006 was to increase competition in the industry. Second, regulators have also been taking steps to undermine the gatekeeper role of CRAs. One example for the latter is Dodd-Frank, which requires federal agencies to remove all references to credit ratings in their investment strategies to reduce the regulatory reliance on ratings.[21] Our study shows that both regulatory initiatives should consider the associated unintended consequences of providing additional incentives for firms to engage in financial misreporting.

6 Conclusion

We study how the association between financial reporting and credit ratings is impacted by competition in the rating industry and CRAs' gatekeeper role. We find that more CRA competition motivates financial misreporting by debt-issuing firms and that firms' misreporting and rating agencies' rating inflation biases are strategic complements under imperfect competition in the rating industry. That is, more informative financial reporting leads to more informative credit ratings, and more informative credit ratings lead to more informative financial reporting. Finally, we show that CRAs' gatekeeper role affects the equilibrium differently depending on the level of competition in the rating industry. When a monopolistic CRA is a gatekeeper, this leads to lower financial misreporting but higher rating inflation and fees. However, when there is imperfect competition in the rating industry, the CRAs' gatekeeper role primarily affects the equilibrium through firms' misreporting incentives and only indirectly influences rating agencies' strategic decisions, resulting in less financial misreporting, less rating inflation and lower fees.

Our investigation should be of particular interest to regulators, as it highlights the potential unintended consequences of increasing competition in the rating industry as well as those of constraining CRAs' gatekeeper role. In addition, there are several avenues for future research. First, our paper's findings are based on imperfect competition between identical rating agencies. While this provides insight regarding the effects of competition between the top rating agencies , there are also smaller rating agencies, which may differ in their cost of rating inflation due to smaller litigation risk or reputational risk. Therefore it may be worthwhile examining a setting where rating agencies are not identical or a setting where a smaller agency enters the market with existing larger incumbents. Next, while our paper focuses on the initial rating in a one period model, further insight may be gained by extending the model to a multi-period setting where CRAs also provide a watchlist and revise their ratings once new information becomes available. Lastly, this paper studies the effects of

[21] Dodd-Frank includes a large variety of regulatory and legislative changes, making an isolation of effects regarding credit ratings and firm disclosure difficult.

CRAs' gatekeeper role with the simplifying assumption that the absence of a good rating precludes the firm from issuing debt. However, in practice, rating-based investor regulation and self-imposed, rating—based investment policies usually constrain large institutional investors, who behave like the Bayesian investors in our model. Therefore our setting corresponds to situations in which firms have large capital needs and must rely on the entirety of the capital market. However, there may be smaller Bayesian investors, which can invest regardless of whether the firm can provide one or more favorable ratings. Extending the model to allow for some correlation between the portion of Bayesian investors in the market and the effect of CRAs' gatekeeper role may provide additional insight into the interaction between CRAs' role as gatekeepers and firms' disclosure policies.

APPENDIX

Proof of Proposition 1

The equilibrium and its inherent effects are proven in a number of claims.

Claim 1: $\frac{\partial r_{0,M}}{\partial \hat{m}_M}, \frac{\partial r_{1,M}}{\partial \hat{m}_M} > 0$ and $\frac{\partial r_{1,M}}{\partial \hat{s}_M} > 0$

The first-order conditions of the average interest rates $r_{0,M}$ and $r_{1,M}$ with respect to $\hat{m}_M$ and $\hat{s}_M$ are as follows:

$$\begin{aligned}\frac{\partial r_{0,M}}{\partial \hat{m}_M} &= \frac{\partial r_{0,M}}{\partial \kappa(\hat{m}_M)} \frac{\partial \kappa(\hat{m}_M)}{\partial \hat{m}_M} \\ &= \left[-\lambda \frac{(1+\theta)}{\kappa(\hat{m}_M)^2 \theta}\right] \left[-\frac{(2p-1)(1-\theta^2)}{\{[p+(1-p)\hat{m}_M](1+\theta)+[1-p+p\hat{m}_M](1-\theta)\}^2}\right] > 0\end{aligned}$$

$$\begin{aligned}\frac{\partial r_{1,M}}{\partial \hat{m}_M} &= \frac{\partial r_{1,M}}{\partial \kappa(\hat{m}_M)} \frac{\partial \kappa(\hat{m}_M)}{\partial \hat{m}_M} \\ &= \left[-\lambda \frac{\hat{s}_M\,(1+\theta)}{\kappa(\hat{m}_M)^2 (1+\hat{s}_M\theta)}\right] \left[-\frac{(2p-1)(1-\theta^2)}{\{[p+(1-p)\hat{m}_M](1+\theta)+[1-p+p\hat{m}_M](1-\theta)\}^2}\right] > 0\end{aligned}$$

$$\frac{\partial r_{1,M}}{\partial \hat{s}_M} = \lambda \frac{[1-\kappa(\hat{m}_M)]\,(1+\theta)}{\kappa(\hat{m}_M)(1+\hat{s}_M\theta)^2} > 0.$$

Claim 2: Solution of CRA's optimization problem

The CRA's problem is presented by conditions (3a)–(3d). We apply the first-order approach on condition (3d), and the optimization yields the solution presented in (5). Further, we rule out participation constraint (3b) since constraint (3c) is tighter because $Pr(x|S_H, G) > Pr(x|S_L, G)$. We solve the optimization program by plugging in the solution from (5) into the maximization problem in (3a) and by using a Lagrange multiplier λ on condition (3c). The Lagrangian is as follows:

$$\mathcal{L} = \left\{ \frac{\kappa(\hat{m}_M)}{(1+\theta)} \left(1 + \frac{F_M}{\gamma}\theta\right) + \frac{F_M}{\gamma}[1-\kappa(\hat{m}_M)] \right\} F_M$$
$$- \lambda \left\{ F_M - \frac{(1-p)(1+\hat{s}_M\theta)}{(1-p)(1+\hat{s}_M\theta) + p\hat{s}_M(1-\theta)} [(1-\beta)(x-1) + (\beta\hat{r}_{0,M} - \hat{r}_{1,M})] \right\}.$$

Note that $Pr(G|R_H) = \left\{ \frac{\kappa(\hat{m}_M)(1+s_M\theta)}{(1+\theta)} + s_M[1-\kappa(\hat{m}_M)] \right\}$ with $s_M = \frac{F_M}{\gamma}$ and $Pr(\alpha = b|R_H) = [1-\kappa(\hat{m}_M)]$.

The first-order conditions of the Lagrangian with respect to F_M and λ are as follows:

$$\frac{\partial \mathcal{L}}{\partial F_M} = \left\{ \frac{\kappa(\hat{m}_M)}{(1+\theta)} \left(1 + \frac{2F_M}{\gamma}\theta\right) + \frac{2F_M}{\gamma}[1-\kappa(\hat{m}_M)] \right\} - \lambda = 0$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = -F_M + \frac{(1-p)(1+\hat{s}_M\theta)}{(1-p)(1+\hat{s}_M\theta) + p\hat{s}_M(1-\theta)} [(1-\beta)(x-1) + (\beta\hat{r}_{0,M} - \hat{r}_{1,M})] = 0.$$

Rearranging $\frac{\partial \mathcal{L}}{\partial F_M} = 0$ with respect to λ shows that, whenever $F_M > 0$, the Lagrange multiplier is positive, implying that the participation constraint (3c) must be binding. Rearranging $\frac{\partial \mathcal{L}}{\partial \lambda} = 0$ with respect to F_M yields the condition in (4).

Claim 3: Derivation of equilibrium condition (6)

The first-order condition of the entrepreneur's optimization problem can be rearranged to

$$m_M = \frac{1}{\mu} \left\{ Pr(x, G|S_L)[x - (1+\hat{r}_{1,M})] + Pr(x, B|S_L)\beta[x - (1+\hat{r}_{0,M})] - Pr(G|S_L)\hat{F}_M \right\}.$$

After enforcing all conjectures and plugging in the rating fee from (4), the above condition can be written as

$$m_M = \frac{Pr(x|S_L)}{\mu} \left\{ \frac{(1+s_M\theta)}{(1+\theta)}[x-(1+r_{1,M})] + \frac{(1-s_M)\theta}{(1+\theta)}\beta[x-(1+r_{0,M})] \right.$$
$$\left. - \frac{(1+s_M\theta)}{(1+\theta)} \{\beta(r_{0,M} - r_{1,M}) + (1-\beta)[x-(1+r_{0,M})]\} \right\}$$

since $Pr(x,G|S_L) = \frac{(1-p)(1+s_M\theta)}{(1-p)(1+\theta)+p(1-\theta)}$, $Pr(x,B|S_L) = \frac{(1-p)(1-s_M)\theta}{(1-p)(1+\theta)+p(1-\theta)}$, $Pr(G|S_L) = \frac{(1-p)(1+s_M\theta)+ps_M(1-\theta)}{(1-p)(1+\theta)+p(1-\theta)}$, and $Pr(x|S_L,G) = \frac{(1-p)(1+s_M\theta)}{(1-p)(1+s_M\theta)+ps_M(1-\theta)}$. This further simplifies to the condition presented in (6).

Claim 4: Proof of equilibrium uniqueness

We prove the uniqueness of the equilibrium in two steps. First observe that the condition in (6) is independent of s_M. (6) can be rearranged to

$$Z_M = Pr(x|S_L)\frac{\beta}{\mu}\left\{x - \left\{1 + \lambda\frac{[1-\kappa(m_M)]\,(1+\theta)}{\kappa(m_M)\theta} + (1-\lambda)\,\frac{(1-p)\,(1-\theta)}{p\,(1+\theta)}\right\}\right\} - m_M.$$

First note that the term in the bracket is unambiguously positive under the assumptions made. Next observe that Z_M monotonically decreases in m_M:

$$\frac{\partial Z_M}{\partial m_M} = Pr(x|S_L)\frac{\beta}{\mu}\lambda\frac{(1+\theta)}{\kappa(m_M)^2\theta}\frac{\partial\kappa(m_M)}{\partial m_M} - 1 < 0,$$

since $\frac{\partial\kappa(m_M)}{\partial m_M} < 0$. Moreover, the limits of $Z_M(m_M)$ when m_M approaches 0 and 1 are

$$\lim_{m_M\to 0} Z_M \to Pr(x|S_L)\frac{\beta}{\mu}\left\{x - \left[1 + \frac{(1-p)\,(1-\theta)}{p\,(1+\theta)}\right]\right\} > 0$$

$$\lim_{m_M\to 1} Z_M \to Pr(x|S_L)\frac{\beta}{\mu}\left\{x - \left[1 + \lambda\frac{(1-\theta)}{\theta} + (1-\lambda)\,\frac{(1-p)\,(1-\theta)}{p\,(1+\theta)}\right]\right\} - 1,$$

respectively. The limit $m_M \to 1$ is negative when μ is sufficiently large. An explicit condition on μ is derived in Claim 4 of the Proof of Proposition 2. It follows that there must exist a unique manipulation effort $m_M = m_M^* \in (0,1)$.

Now that the uniqueness of m_M^* is proven, we turn to prove the uniqueness of the CRA's choice variables, s_M^* and F_M^*. For this, we plug in the rating fee presented in (4) into condition (5) and define the following equilibrium condition:

$$\begin{aligned} Y_M = \frac{(1-p)(1+s_M\theta)}{(1-p)(1+s_M\theta)+ps_M\,(1-\theta)} &\left\{\beta\left[\frac{1}{1+s_M\theta}\Gamma(\kappa(m_M^*)) + (1-\lambda)\,\frac{(1-p)\,(1-\theta)}{p\,(1+\theta)}\right]\right. \\ &\left. + (1-\beta)\left[x - 1 - \frac{s_M\theta}{1+s_M\theta}\Gamma(\kappa(m_M^*)) - (1-\lambda)\,\frac{(1-p)\,(1-\theta)}{p\,(1+\theta)}\right]\right\} - s_M\gamma, \end{aligned}$$

where $\Gamma(\kappa(m_M^*)) = \lambda\frac{[1-\kappa(m_M^*)](1+\theta)}{\kappa(m_M^*)\theta}$. First observe that the sum of the bracket terms is always positive. Further, $Y_M(m_M^*, s_M)$ has the following properties with respect to s_M:

$$\frac{\partial Y_M}{\partial s_M} = -\left[1 + \frac{p s_M (1-\theta)}{(1-p)(1+s_M\theta) + p s_M (1-\theta)}\right]\gamma - \frac{(1-p)}{(1-p)(1+s_M\theta) + p s_M (1-\theta)} \frac{\theta}{(1+s_M\theta)} \Gamma(\kappa(m_M^*)) < 0$$

$$\lim_{s_M \to 0} Y_M \to \beta\left[\Gamma(\kappa(m_M^*)) + (1-\lambda)\frac{(1-p)(1-\theta)}{p(1+\theta)}\right] + (1-\beta)\left[x - 1 - (1-\lambda)\frac{(1-p)(1-\theta)}{p(1+\theta)}\right] > 0$$

$$\lim_{s_M \to 1} Y_M \to \frac{(1-p)(1+\theta)}{(1-p)(1+\theta) + p(1-\theta)} \left\{\beta\left[\frac{1}{1+\theta}\Gamma(\kappa(m_M^*)) + (1-\lambda)\frac{(1-p)(1-\theta)}{p(1+\theta)}\right] + (1-\beta)\left[x - 1 - \frac{\theta}{1+\theta}\Gamma(\kappa(m_M^*)) - (1-\lambda)\frac{(1-p)(1-\theta)}{p(1+\theta)}\right]\right\} - \gamma.$$

Note that $\frac{\partial Y_M}{\partial s_M} < 0$ for all $m_M^*, s_M \in (0,1)$ and the limit $s_M \to 0$ is positive for all $m_M^* \in (0,1)$. To ensure that the limit $s_M \to 1$ is negative for all $m_M^* \in (0,1)$ we impose the following sufficient condition on γ:

$$\gamma > \overline{\gamma} \equiv \frac{(1-p)(1+\theta)}{(1-p)(1+\theta) + p(1-\theta)}(x-1).$$

Given that both μ and γ are sufficiently large, there exists a unique rating inflation bias $s_M = s_M^* \in (0,1)$ and a unique rating fee $F_M = F_M^* > 0$. This proves the uniqueness of the obtained equilibrium solution.

Q.E.D.

Proof of Corollary 1

The effects regarding the gatekeeper role captured by variable β can be derived as follows using the implicit function theorem. The first-order condition of m_M^* with respect to β is

$$\frac{dm_M^*}{d\beta} = -\frac{\frac{\partial Z_M}{\partial \beta}}{\frac{\partial Z_M}{\partial m_M^*}} = -\frac{Pr(x|S_L)\frac{\beta}{\mu}\left[x - (1 + r_{0,M}^*)\right]}{-Pr(x|S_L)\frac{\beta}{\mu}\frac{\partial \Gamma(\kappa(m_M^*))}{\partial m_M^*} - 1} > 0.$$

The equilibrium condition implicitly defining s_M^*, Y_M, behaves as follows regarding β and m_M^*:

$$\frac{\partial Y_M}{\partial \beta} = -Pr(x|S_L, G)\left[x - (1 + r_{0,M}^*)\right] < 0$$

$$\frac{\partial Y_M}{\partial m_M^*} = Pr(x|S_L, G)\frac{\partial \Gamma(\kappa(m_M^*))}{\partial m_M^*}\frac{\beta(1+s_M^*\theta)-s_M^*\theta}{(1+s_M^*\theta)}.$$

Note that $\frac{\partial \Gamma(\kappa(m_M^*))}{\partial m_M^*} > 0$. Now the first-order condition of s_M^* with respect to β can be derived as follows:

$$\begin{aligned}\frac{ds_M^*}{d\beta} &= -\frac{\frac{\partial Y_M}{\partial \beta} + \frac{\partial Y_M}{\partial m_M^*}\frac{dm_M^*}{d\beta}}{\frac{\partial Y_M}{\partial s_M^*}} \\ &= \frac{Pr(x|S_L, G)\left[x-(1+r_{0,M}^*)\right]\left[1+\frac{(1-\beta)(1+s_M^*\theta)+s_M^*\theta}{(1+s_M^*\theta)}Pr(x|S_L)\frac{\beta}{\mu}\frac{\partial \Gamma(\kappa(m_M^*))}{\partial m_M^*}\right]}{\frac{\partial Y_M}{\partial s_M^*}\left[Pr(x|S_L)\frac{\beta}{\mu}\frac{\partial \Gamma(\kappa(m_M^*))}{\partial m_M^*}+1\right]} < 0.\end{aligned}$$

Further, from equation (5) it follows that $\frac{ds_M^*}{d\beta} = \frac{1}{\gamma}\frac{dF_M^*}{d\beta}$ implying that $\frac{dF_M^*}{d\beta} < 0$.

Q.E.D.

Proof of Proposition 2

The equilibrium in Proposition 2 is proven in a number of claims.

Claim 1: Solution of CRA i's optimization problem

The procedures to solve CRA i's optimization problem resemble the ones used in the Proof of Proposition 1. In this proof, we focus on deriving a sufficient condition regarding λ under which constraint (9e) is stricter than (9c). After some rearranging of both conditions, we limit λ such that the following inequality always holds true:

$$Pr(x|S_L, G_i, B_j)\left[(1-\beta)(x-1)+(\beta r_{0,D}-r_{1,D})\right] > Pr(x|S_L, G_1, G_2)(r_{1,D}-r_{2,D}).$$

More explicitly this condition can be written as follows:

$$\begin{aligned}&\frac{(1-p)\theta}{(1-p)\theta+p(1-\theta)}\left\{(1-\beta)\left\{x-\left[1+\lambda\frac{\left[1-\kappa(\hat{m}_D)\right](1+\theta)}{\kappa(\hat{m}_D)\theta}\right]\right\}+\beta\,(1-\lambda)\,\frac{(1-p)\,(1-\theta)}{p\,(1+\theta)}\right\} \\ &\qquad > \frac{(1-p)}{(1-p)(1+\hat{s}_{1,D}\hat{s}_{2,D}\theta)+p\hat{s}_{1,D}\hat{s}_{2,D}(1-\theta)}\lambda\frac{\left[1-\kappa(\hat{m}_D)\right](1+\theta)}{\kappa(\hat{m}_D)\theta}.\end{aligned}$$

It is straightforward to show that the left hand side decreases in β, implying that it is lowest for

$\beta = 1$. In this case, the condition reduces to

$$\frac{(1-p)\theta}{(1-p)\theta + p(1-\theta)}(1-\lambda)\frac{(1-p)(1-\theta)}{p(1+\theta)}$$
$$> \frac{(1-p)}{(1-p)(1+\hat{s}_{1,D}\hat{s}_{2,D}\theta) + p\hat{s}_{1,D}\hat{s}_{2,D}(1-\theta)}\lambda\frac{[1-\kappa(\hat{m}_D)](1+\theta)}{\kappa(\hat{m}_D)\theta}.$$

The right side decreases in $\hat{s}_{1,D}$ and $\hat{s}_{2,D}$ and increases in $\hat{m}_D$. It is therefore highest when $\hat{s}_{1,D}$,$\hat{s}_{2,D} = 0$ and $\hat{m}_D = 1$. After substituting these values, the condition can now be rearranged with respect to λ, leading to threshold $\overline{\lambda}$. Hence a sufficient condition for the above inequality to hold is $\lambda < \overline{\lambda}$, where the explicit threshold is

$$\overline{\lambda} \equiv \frac{\frac{(1-p)\theta}{(1-p)\theta+p(1-\theta)}\frac{(1-p)(1-\theta)}{p(1+\theta)}}{\frac{(1-\theta)}{\theta} + \frac{(1-p)\theta}{(1-p)\theta+p(1-\theta)}\frac{(1-p)(1-\theta)}{p(1+\theta)}}.$$

Claim 2: Proof that $\Phi > 0$

Substituting (1), (7), and (8) for $r_{0,D}$, $r_{1,D}$ and $r_{2,D}$, we can rewrite Φ as follows:

$$\Phi = \frac{(1-p)\left[(1+s_D^2\theta) + 2s_D(1-s_D)\theta\right](1-\theta)(1-\lambda)}{p(1+\theta)}$$
$$-\frac{(1+\theta)(1-\kappa)\lambda}{\theta\kappa}\left[2\frac{(1-p)(1+s_D\theta) + ps_D(1-\theta)}{(1-p)(1+s_D^2\theta) + ps_D^2(1-\theta)} - 1\right].$$

Taking the partial of Φ with respect to λ, we can see that it is monotonically decreasing in λ. Since Φ evaluated at the lower limit of λ is unambiguously positive, Φ is unambiguously positive for all $\lambda \in (0, \overline{\lambda})$.

Claim 3: Expressing m_D in terms of s_D

In a preperatory stage to prove the uniqueness of the equilibrium, we can re-express m_D in terms of s_D. First we enforce all conjectures. Next we can rewrite both $r_{0,D}$ and $r_{2,D}$ in terms of $r_{1,D}$:

$$r_{0,D} = r_{1,D} + (1-\lambda)\frac{(1-p)(1-\theta)}{p(1+\theta)}$$

$$r_{2,D} = r_{1,D}\frac{s_D^2\theta}{(1+s_D^2\theta)}.$$

The rating fee from (10) can then be expressed as follows:

$$F_D = \frac{(1-p)}{(1-p)(1+s_D^2\theta)+ps_D^2(1-\theta)} r_{1,D}.$$

The rating inflation is implicitly defined by

$$s_D = \frac{(1-p)}{(1-p)(1+s_D^2\theta)+ps_D^2(1-\theta)} \frac{r_{1,D}}{\gamma}.$$

This can be rearranged to

$$r_{1,D} = s_D\gamma \frac{(1-p)(1+s_D^2\theta)+ps_D^2(1-\theta)}{(1-p)},$$

which will be a useful property.

After some substitutions, the manipulation in (11) can now be rewritten as

$$\begin{aligned} m_D = {} & Pr(x|S_L)\frac{1}{\mu}\frac{\Phi}{(1+\theta)} + Pr(x|S_L)\frac{1}{\mu}\frac{\left\{1+\left[s_D^2+2s_D(1-s_D)+(1-s_D)^2\beta\right]\theta\right\}}{(1+\theta)} \\ & \left\{x - \left[1+(1-\lambda)\frac{(1-p)\,(1-\theta)}{p\,(1+\theta)} + s_D\gamma\frac{(1-p)(1+s_D^2\theta)+ps_D^2(1-\theta)}{(1-p)}\right]\right\}, \end{aligned}$$

where

$$\begin{aligned} \Phi = {} & \left\{1+\left[s_D^2+2s_D(1-s_D)\right]\theta\right\}(1-\lambda)\frac{(1-p)\,(1-\theta)}{p\,(1+\theta)} \\ & - \left\{2\frac{\left[(1-p)(1+s_D\theta)+ps_D(1-\theta)\right]}{\left[(1-p)(1+s_D^2\theta)+ps_D^2\,(1-\theta)\right]} - 1\right\} s_D\gamma\frac{(1-p)(1+s_D^2\theta)+ps_D^2(1-\theta)}{(1-p)}. \end{aligned}$$

m_D is now expressed solely as a function of s_D.

Claim 4: Properties of m_D with respect to s_D

Note that, following from Claim 2, we have established that $m_D > 0$. Next we analyze m_D as defined under Claim 3 with respect to s_D. The first order condition of m_D with respect to s_D is

$$\begin{aligned} \frac{\partial m_D}{\partial s_D} = {} & Pr(x|S_L)\frac{1}{\mu}\left\{\frac{2(1-s_D)(1-\beta)\theta}{(1+\theta)}\left[x-(1+r_{0,D})\right] + \frac{1}{(1+\theta)}\frac{\partial\Phi}{\partial s_D}\right\} \\ & - Pr(x|S_L)\frac{1}{\mu}\left\{\frac{\left\{1+\left[s_D^2+2s_D(1-s_D)+(1-s_D)^2\beta\right]\theta\right\}}{(1+\theta)}\gamma\frac{(1-p)(1+3s_D^2\theta)+3ps_D^2(1-\theta)}{(1-p)}\right\}, \end{aligned}$$

where

$$\frac{\partial \Phi}{\partial s_D} = 2(1-s_D)\theta\,(1-\lambda)\,\frac{(1-p)\,(1-\theta)}{p\,(1+\theta)}$$
$$-\frac{2r_{1,D}}{\left[(1-p)\,(1+s_D^2\theta)+ps_D^2\,(1-\theta)\right]^2}\Bigg\{\left[(1-p)\theta+ps_D(1-\theta)\right]\left[(1-p)(1+s_D^2\theta)+ps_D^2\,(1-\theta)\right]$$
$$-\left[(1-p)(1+s_D\theta)+ps_D(1-\theta)\right]\left[2(1-p)s_D\theta+2ps_D\,(1-\theta)\right]\Bigg\}$$
$$-\left\{2\frac{\left[(1-p)(1+s_D\theta)+ps_D(1-\theta)\right]}{\left[(1-p)(1+s_D^2\theta)+ps_D^2\,(1-\theta)\right]}-1\right\}\gamma\frac{(1-p)(1+3s_D^2\theta)+3ps_D^2(1-\theta)}{(1-p)}.$$

It can be shown that $\frac{\partial m_D}{\partial s_D}<0$ when $\lambda<\overline{\lambda}$. m_D must therefore be highest when $s_D \to 0$. The limit of m_D as s_D approaches zero is

$$\lim_{s_D\to 0} m_D \to Pr(x|S_L)\frac{1}{\mu}\left\{\frac{(1+\beta\theta)}{(1+\theta)}(x-1)-\frac{\beta\theta}{(1+\theta)}\,(1-\lambda)\,\frac{(1-p)\,(1-\theta)}{p\,(1+\theta)}\right\}.$$

This limit is smaller than unity and $m_D \in (0,1)$ for any $s_D \in (0,1)$ if

$$\mu > \overline{\mu} \equiv Pr(x|S_L)\left\{\frac{(1+\beta\theta)}{(1+\theta)}(x-1)-\frac{\beta\theta}{(1+\theta)}\,(1-\lambda)\,\frac{(1-p)\,(1-\theta)}{p\,(1+\theta)}\right\}.$$

Claim 5: Proof of equilibrium uniqueness

As we have established m_D as a function of s_D, to prove the uniqueness of the equilibrium, we only have to show the uniqueness of s_D. Rearranging the expression in Claim 3, we can rewrite the function that implicitly defines s_D as

$$Z_D = F_D - s_D\gamma = \frac{(1-p)}{(1-p)(1+s_D^2\theta)+ps_D^2(1-\theta)}r_{1,D} - s_D\gamma.$$

Conveniently $r_{1,D}$ is only a function of m_D^* and not s_D. The partial derivative of the right side with respect to s_D is unambiguously negative ($\frac{\partial Z_D}{\partial s_D}<0$). Furthermore, Z_D is increasing in $r_{1,D}$ ($\frac{\partial Z_D}{\partial r_{1,D}}>0$). As we have already established that $\frac{\partial r_{1,D}}{\partial m_D}>0$ and $\frac{\partial m_D}{\partial s_D}<0$, it follows that $\frac{dZ_D}{ds_D} = \frac{\partial Z_D}{\partial s_D}+\frac{\partial Z_D}{\partial r_{1,D}}\frac{\partial r_{1,D}}{\partial m_D}\frac{\partial m_D}{\partial s_D}<0$, i.e., Z_D is monotonically decreasing in s_D. Finally, when we evaluate Z_D at the limits of s_D, it is straightforward to show that Z_D is positive when $s_D \to 0$ and negative when $s_D \to 1$ as long as $\gamma > \overline{\gamma}$. Therefore there exists a unique inflation bias $s_D^* \in (0,1)$, rating fee

$F^*_D > 0$ and manipulation $m^*_D \in (0,1)$ as well as unique interest rates $r^*_{0,D} > r^*_{1,D} > r^*_{2,D} > 0$ when $\mu > \overline{\mu}$, $\lambda < \overline{\lambda}$ and $\gamma > \overline{\gamma}$.

Q.E.D.

Proof of Proposition 3

The first claim we prove is that $m^*_M < m^*_D$. The two manipulation levels are defined by conditions (6) and (11). When $\Phi = 0$ and $\beta = 1$, it would follow that $m^*_M = m^*_D$ since $r^*_{0,M} = r^*_{0,D}$ and are functionally identical and increasing in m^*_M, m^*_D. However, we have shown in Claim 2 in the proof of Proposition 2 that $\Phi > 0$ for all $m^*_M, s^*_D \in (0,1)$, due to the assumption that $\lambda < \overline{\lambda}$. While an increasing Φ and thus an increasing m^*_D results in $r^*_{0,M} < r^*_{0,D}$, it can also be shown that $\frac{\partial r^*_{0,D}}{\partial m^*_D} < 1$, implying that the net effect of an increasing Φ on m^*_D is always positive. This proves that $m^*_M < m^*_D$ for the case $\beta = 1$. Further, note, that when $\beta = 0$, $m^*_M = 0$. Since $m^*_D > 0$, it also follows that $m^*_M < m^*_D$ when $\beta = 0$.

Next we prove the claims that $F^*_M > F^*_D$ and $s^*_M > s^*_D$. Let us first consider the case of $\beta = 1$. In the equilibrium proof of the duopoly setting, we restricted parameter λ such that inequality

$$Pr(x|S_L, G_i, B_j)(r^*_{0,D} - r^*_{1,D}) > Pr(x|S_H, G_1, G_2)(r^*_{1,D} - r^*_{2,D})$$

is always fulfilled to ensure that the equilibrium rating fee is the one defined in condition (10). The equilibrium fee in the monopoly CRA setting is defined by condition (4). To show that $F^*_M > F^*_D$ it is therefore sufficient to show that

$$Pr(x|S_L, G)(r^*_{0,M} - r^*_{1,M}) \geq Pr(x|S_L, G_i, B_j)(r^*_{0,D} - r^*_{1,D}).$$

It is straightforward to show that $Pr(x|S_L, G) > Pr(x|S_L, G_i, B_j)$ for all $s^*_M \in (0,1)$. Next, we compare $(r^*_{0,M} - r^*_{1,M})$ and $(r^*_{0,D} - r^*_{1,D})$ which can both be explicitly written as follows:

$$(r^*_{0,M} - r^*_{1,M}) = \lambda \frac{[1 - \kappa(m^*_M)]\,(1+\theta)}{\kappa(m^*_M)(1 + s^*_M\theta)\theta} + (1-\lambda)\,\frac{(1-p)\,(1-\theta)}{p\,(1+\theta)}$$

$$(r^*_{0,D} - r^*_{1,D}) = (1-\lambda)\,\frac{(1-p)\,(1-\theta)}{p\,(1+\theta)}.$$

Since the first term in $(r^*_{0,M} - r^*_{1,M})$ is always positive for all $m^*_M, s^*_M \in (0,1)$, it follows that $(r^*_{0,M} - r^*_{1,M}) > (r^*_{0,D} - r^*_{1,D})$. This proves that $F^*_M > F^*_D$ and further that $s^*_M > s^*_D$ in case $\beta = 1$. As for case $\beta = 0$, it is sufficient to note that the monopolistic CRA's fee is larger than that in case $\beta = 1$, whereas $Pr(x|S_L, G_i, B_j)(r^*_{0,D} - r^*_{1,D})$ stays the same in a duopoly. This proves that $F^*_M > F^*_D$ and further that $s^*_M > s^*_D$ in case $\beta = 0$.

Q.E.D.

Proof of Corollary 2

For the proofs of the corollaries, we make use of the implicit function theorem. The first order condition of s^*_D with respect to γ is

$$\frac{ds^*_D}{d\gamma} = -\frac{\frac{\partial Z_D}{\partial \gamma} + \frac{\partial Z_D}{\partial r^*_{1,D}}\frac{\partial r^*_{1,D}}{\partial m^*_D}\frac{\partial m^*_D}{\partial \gamma}}{\frac{\partial Z_D}{\partial s^*_D} + \frac{\partial Z_D}{\partial r^*_{1,D}}\frac{\partial r^*_{1,D}}{\partial m^*_D}\frac{\partial m^*_D}{\partial s^*_D}}.$$

$\frac{\partial Z_D}{\partial \gamma} = -s^*_D < 0$, and it can also be shown that $\frac{\partial m^*_D}{\partial \gamma} < 0$. Since the denominator is also negative, it therefore follows that $\frac{ds^*_D}{d\gamma} < 0$.

The first-order condition of m^*_D with respect to γ is

$$\frac{dm^*_D}{d\gamma} = \frac{\partial m^*_D}{\partial \gamma} + \frac{\partial m^*_D}{\partial s^*_D}\frac{ds^*_D}{d\gamma} = -\frac{\frac{\partial m^*_D}{\partial s^*_D}\frac{\partial Z_D}{\partial \gamma} - \frac{\partial m^*_D}{\partial \gamma}\frac{\partial Z_D}{\partial s^*_D}}{\frac{\partial Z_D}{\partial s^*_D} + \frac{\partial Z_D}{\partial r^*_{1,D}}\frac{\partial r^*_{1,D}}{\partial m^*_D}\frac{\partial m^*_D}{\partial s^*_D}}.$$

The condition is proportional to $\frac{\partial m^*_D}{\partial s^*_D}\frac{\partial Z_D}{\partial \gamma} - \frac{\partial m^*_D}{\partial \gamma}\frac{\partial Z_D}{\partial s^*_D}$. It is algebraically tedious but possible to show that the condition is negative for all $\lambda < \overline{\lambda}$, i.e.,$\frac{dm^*_D}{d\gamma} < 0$.

Lastly, the effect of F^*_D with respect to γ is

$$\begin{aligned}\frac{dF^*_D}{d\gamma} &= \frac{\partial F^*_D}{\partial r^*_{1,D}}\frac{\partial r^*_{1,D}}{\partial m^*_D}\frac{\partial m^*_D}{\partial \gamma} + \left(\frac{\partial F^*_D}{\partial s^*_D} + \frac{\partial F^*_D}{\partial r^*_{1,D}}\frac{\partial r^*_{1,D}}{\partial m^*_D}\frac{\partial m^*_D}{\partial s^*_D}\right)\frac{ds^*_D}{d\gamma} \\ &= -\frac{\gamma\frac{\partial F^*_D}{\partial r^*_{1,D}}\frac{\partial r^*_{1,D}}{\partial m^*_D}\frac{\partial m^*_D}{\partial \gamma} - s^*_D\left(\frac{\partial F^*_D}{\partial s^*_D} + \frac{\partial F^*_D}{\partial r^*_{1,D}}\frac{\partial r^*_{1,D}}{\partial m^*_D}\frac{\partial m^*_D}{\partial s^*_D}\right)}{\frac{\partial Z_D}{\partial s^*_D} + \frac{\partial Z_D}{\partial r^*_{1,D}}\frac{\partial r^*_{1,D}}{\partial m^*_D}\frac{\partial m^*_D}{\partial s^*_D}}.\end{aligned}$$

Note that $\frac{\partial Z_D}{\partial r^*_{1,D}} = \frac{\partial F^*_D}{\partial r^*_{1,D}}$ and $\frac{\partial Z_D}{\partial s^*_D} = \frac{\partial F^*_D}{\partial s^*_D} - \gamma$. $\frac{dF^*_D}{d\gamma}$ can be positive or negative since $\frac{\partial F^*_D}{\partial r^*_{1,D}}\frac{\partial r^*_{1,D}}{\partial m^*_D}\frac{\partial m^*_D}{\partial \gamma} < 0$

and $\left(\frac{\partial F_D^*}{\partial s_D^*} + \frac{\partial F_D^*}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial s_D^*}\right) < 0$, i.e., $\frac{dF_D^*}{d\gamma} \lesseqgtr 0$.

Q.E.D.

Proof of Corollary 3

The first-order condition of s_D^* with respect to λ is

$$\frac{ds_D^*}{d\lambda} = -\frac{\frac{\partial Z_D}{\partial \lambda} + \frac{\partial Z_D}{\partial r_{1,D}^*}\left(\frac{\partial r_{1,D}^*}{\partial \lambda} + \frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial \lambda}\right)}{\frac{\partial Z_D}{\partial s_D^*} + \frac{\partial Z_D}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial s_D^*}}.$$

The condition is proportional to $\frac{\partial Z_D}{\partial \lambda} + \frac{\partial Z_D}{\partial r_{1,D}^*}\left(\frac{\partial r_{1,D}^*}{\partial \lambda} + \frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial \lambda}\right)$. First note that $\frac{\partial Z_D}{\partial \lambda} = 0$ and that $\frac{\partial r_{1,D}^*}{\partial \lambda} = \frac{\left[1-\kappa(m_D^*)\right](1+\theta)}{\kappa(m_D^*)\theta} > 0$, and we have already established that $\frac{\partial Z_D}{\partial r_{1,D}^*}, \frac{\partial r_{1,D}^*}{\partial m_D^*} > 0$. The partial of m_D^* as defined under the Proof of Proposition 2 Claim 3 with respect to λ is

$$\frac{\partial m_D^*}{\partial \lambda} = Pr(x|S_L)\frac{(1-p)(1-s_D^*)^2\beta\theta\,(1-\theta)}{p\,(1+\theta)^2\,\mu} > 0.$$

It follows that $\frac{ds_D^*}{d\lambda} > 0$. Therefore rating inflation s_D^* increases in the relative number of Bayesian investors.

The overall effect of m_D^* with respect to λ can be derived as follows:

$$\frac{dm_D^*}{d\lambda} = \frac{\partial m_D^*}{\partial \lambda} + \frac{\partial m_D^*}{\partial s_D^*}\frac{ds_D^*}{d\lambda} = -\frac{\frac{\partial m_D^*}{\partial s_D^*}\frac{\partial Z_D}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial \lambda} - \frac{\partial m_D^*}{\partial \lambda}\frac{\partial Z_D}{\partial s_D^*}}{\frac{\partial Z_D}{\partial s_D^*} + \frac{\partial Z_D}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial s_D^*}}.$$

This expression is ambiguous since $\frac{\partial m_D^*}{\partial s_D^*}\frac{\partial Z_D}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial \lambda} < 0$ and $\frac{\partial m_D^*}{\partial \lambda}\frac{\partial Z_D}{\partial s_D^*} < 0$, i.e., $\frac{dm_D^*}{d\lambda} \lesseqgtr 0$.

Lastly, the effect of F_D^* with respect to λ is

$$\begin{aligned}\frac{dF_D^*}{d\lambda} &= \left[\frac{\partial F_D^*}{\partial \lambda} + \frac{\partial F_D^*}{\partial r_{1,D}^*}\left(\frac{\partial r_{1,D}^*}{\partial \lambda} + \frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial \lambda}\right)\right] + \left(\frac{\partial F_D^*}{\partial s_D^*} + \frac{\partial F_D^*}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial s_D^*}\right)\frac{ds_D^*}{d\lambda} \\ &= \frac{\partial Z_D}{\partial r_{1,D}^*}\left(\frac{\partial r_{1,D}^*}{\partial \lambda} + \frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial \lambda}\right)\left(1 - \frac{\frac{\partial F_D^*}{\partial s_D^*} + \frac{\partial F_D^*}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial s_D^*}}{\frac{\partial F_D^*}{\partial s_D^*} - \gamma + \frac{\partial F_D^*}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial s_D^*}}\right) > 0.\end{aligned}$$

Note that $\frac{\partial F_D^*}{\partial \lambda} = \frac{\partial Z_D}{\partial \lambda} = 0$, $\frac{\partial Z_D}{\partial r_{1,D}^*} = \frac{\partial F_D^*}{\partial r_{1,D}^*}$, and $\frac{\partial Z_D}{\partial s_D^*} = \frac{\partial F_D^*}{\partial s_D^*} - \gamma$.

Q.E.D.

Proof of Corollary 4

The first-order condition of s_D^* with respect to μ can be derived as follows:

$$\frac{ds_D^*}{d\mu} = -\frac{\frac{\partial Z_D}{\partial \mu} + \frac{\partial Z_D}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial \mu}}{\frac{\partial Z_D}{\partial s_D^*} + \frac{\partial Z_D}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial s_D^*}}.$$

It is straightforward to show that $\frac{\partial m_D^*}{\partial \mu} < 0$ and that $\frac{\partial Z_D}{\partial \mu} = 0$. It therefore follows that $\frac{ds_D^*}{d\mu} < 0$.

The effect of m_D^* with respect to μ is

$$\frac{dm_D^*}{d\mu} = \frac{\partial m_D^*}{\partial \mu} + \frac{\partial m_D^*}{\partial s_D^*}\frac{ds_D^*}{d\mu} = \frac{\frac{\partial m_D^*}{\partial \mu}\frac{\partial Z_D}{\partial s_D^*}}{\frac{\partial Z_D}{\partial s_D^*} + \frac{\partial Z_D}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial s_D^*}} < 0.$$

Lastly, the effect of F_D^* with respect to μ is

$$\begin{aligned}\frac{dF_D}{d\mu} &= \left(\frac{\partial F_D^*}{\partial \mu} + \frac{\partial F_D^*}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial \mu}\right) + \left(\frac{\partial F_D^*}{\partial s_D^*} + \frac{\partial F_D^*}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial s_D^*}\right)\frac{ds_D^*}{d\mu} \\ &= -\frac{\gamma\frac{\partial F_D^*}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial \mu}}{\frac{\partial Z_D}{\partial s_D^*} + \frac{\partial Z_D}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial s_D^*}} < 0.\end{aligned}$$

Note that $\frac{\partial F_D^*}{\partial \mu} = 0$, $\frac{\partial Z_D}{\partial r_{1,D}^*} = \frac{\partial F_D^*}{\partial r_{1,D}^*}$, and $\frac{\partial Z_D}{\partial s_D^*} = \frac{\partial F_D^*}{\partial s_D^*} - \gamma$.

Q.E.D.

Proof of Proposition 4

The first-order condition of s_D^* with respect to β is derived as follows:

$$\frac{ds_D^*}{d\beta} = -\frac{\frac{\partial Z_D}{\partial \beta} + \frac{\partial Z_D}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial \beta}}{\frac{\partial Z_D}{\partial s_D^*} + \frac{\partial Z_D}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial s_D^*}}.$$

Since $\frac{\partial Z_D}{\partial \beta} = 0$ and $\frac{\partial m_D^*}{\partial \beta} = Pr(x|S_L)\frac{(1-s_D^*)^2\theta}{\mu(1+\theta)}\left[x - (1 + r_{0,D}^*)\right] > 0$, it follows that $\frac{ds_D^*}{d\beta} > 0$.

The effect of m_D^* with respect to β is

$$\frac{dm_D^*}{d\beta} = \frac{\partial m_D^*}{\partial \beta} + \frac{\partial m_D^*}{\partial s_D^*}\frac{ds_D^*}{d\beta} = \frac{\frac{\partial m_D^*}{\partial \beta}\frac{\partial Z_D}{\partial s_D^*}}{\frac{\partial Z_D}{\partial s_D^*} + \frac{\partial Z_D}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial s_D^*}} > 0.$$

After doing some rearranging, the effect of F_D^* with respect to β can be simplified to

$$\frac{dF_D^*}{d\beta} = -\frac{\gamma \frac{\partial F_D^*}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial \beta}}{\frac{\partial Z_D}{\partial s_D^*} + \frac{\partial Z_D}{\partial r_{1,D}^*}\frac{\partial r_{1,D}^*}{\partial m_D^*}\frac{\partial m_D^*}{\partial s_D^*}} > 0.$$

Q.E.D.

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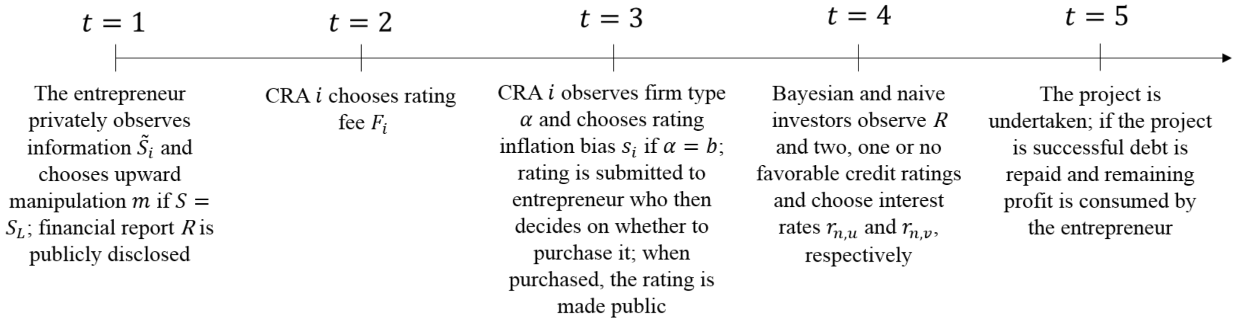

Figure 1: Timeline

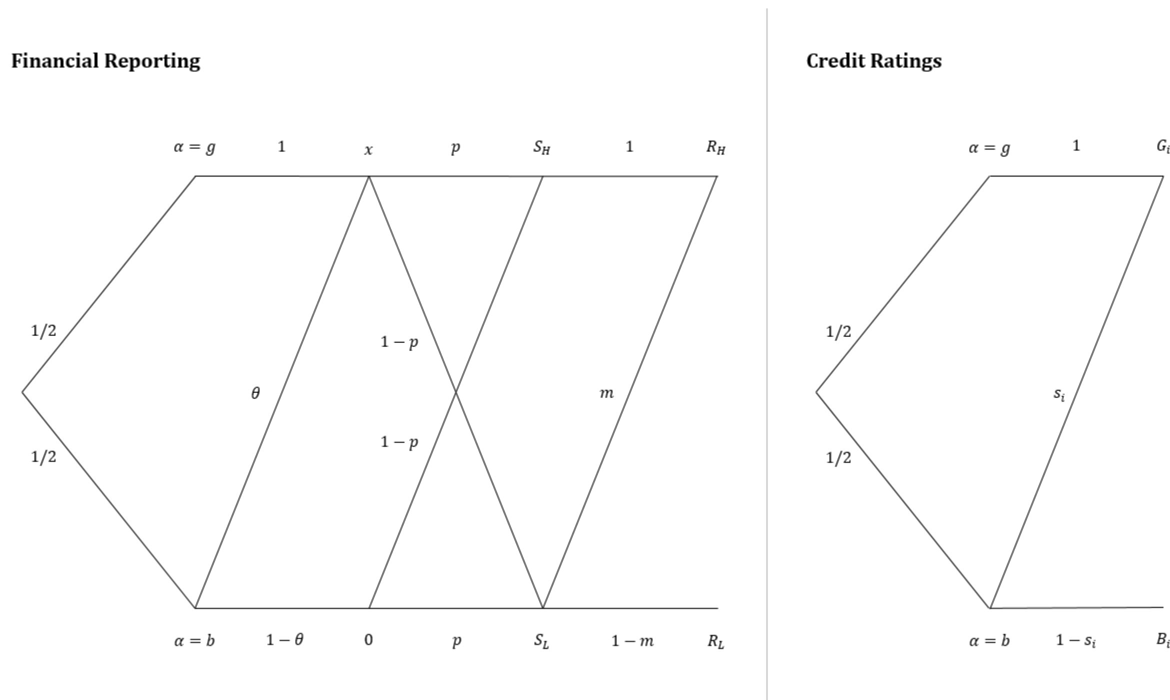

Figure 2: Probability Structure