

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

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March 7, 2019

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 seeks project financing from a perfectly competitive debt market. After publicly disclosing a financial report, the entrepreneur can purchase credit ratings from rating agencies that strategically choose their rating fees and rating inflation. We derive the following core results. (i) More rating industry competition leads to stronger corporate misreporting incentives if ratings are sufficiently precise or if rating agencies assume a gatekeeper role. Under imperfect rating industry competition, (ii) agencies' gatekeeper role primarily weakens firms' misreporting incentives, which then influences rating agencies' strategies, and (iii) firms' misreporting and rating agencies' rating inflation can be strategic complements when agencies assume a gatekeeper role. (iv) Regulatory initiatives aimed at increasing rating industry competition or at weakening rating agencies' gatekeeper role improve investment efficiency as long as corporate misreporting incentives are not significantly strengthened.

Keywords: corporate disclosure, credit rating, rating inflation, investor regulation, competition

JEL: D80, G12, G24, G28, M41

*Accepted by Haresh Sapra. We appreciate the helpful comments and suggestions from an anonymous referee, Tim Baldenius, Jannis Bischof, Thomas Bourveau, Hui Chen, Edwige Cheynel, Ron Dye, Jonathan Glover, Suresh Govindaraj, Moritz Hiemann, Kenji Matsui, Matt Pinnuck, Ulf Schiller, Jordan Schoenfeld, Naomi Soderstrom, Jeroen Suijs, and Alfred Wagenhofer, as well as from workshop and conference participants at Columbia University, Hong Kong University of Science and Technology, Rutgers University, University of Basel, University of Graz, University of Mannheim, University of Melbourne, University of Zürich, the 2016 EIASM Workshop of Accounting and Economics in Tilburg, the 2017 FARS Midyear Meeting in Charlotte, and the 53rd Annual (2018) *Journal of Accounting Research* Conference.

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1 Introduction

Credit ratings play a key role in firms' debt financing, and evidence shows that more favorable ratings lead to a lower cost of debt (Kliger and Sarig [2000], Graham and Harvey [2001], Tang [2009]). Given the well-known links between financing, investing, and reporting, firms' reporting incentives may therefore crucially depend on their credit ratings. The joint evidence of several archival papers comports with the argument that firms distort their financial reports more before an initial rating or a credit rating change (Jiang [2008], Alissa et al. [2013], Jung, Soderstrom, and Yang [2013]). These papers interpret their findings as firms using financial reporting to influence credit ratings. However, evidence by Kraft [2015] indicates that credit rating agencies (CRAs) exhibit superior information processing abilities and may not be easily misled by firms' misreporting when extracting risk-related information from financial statements. The aim of this paper is to reconcile these two arguments and illuminate the possibly endogenous relationship between financial reporting and credit ratings by explicitly considering some of the unique features of the rating process and CRAs' strategic incentives.

Like most other businesses, CRAs' main objective is to generate income. They do so by selling credit ratings to debt-issuing firms in exchange for a fee they strategically choose. CRAs face a conflict of interest between providing informative ratings to investors and catering to issuers' preference for favorable ratings. This conflict arises either because firms can privately observe the rating before making their purchase decision such that they can be selective (a practice commonly referred to as "ratings shopping") or through repeated interactions between CRAs and issuers. As a consequence, CRAs may have incentives to inflate their ratings to boost fee income (Skreta and Veldkamp [2009], Bolton, Freixas, and Shapiro [2012], Sangiorgi and Spatt [2017]). Regulators and scholars in finance and law have further highlighted the importance of two other critical factors that influence CRAs' decisions. First, competition in the rating industry shapes CRAs' incentives, as it affects their ability to extract rents from issuers through fees (Lizzeri [1999]). Second, credit ratings were used to regulate certain institutional investors by requiring them to only invest in firms with investment-grade ratings. Furthermore, retirement funds often commit to investing only in investment-grade debt (Kisgen and Strahan [2010]). This regulatory or self-imposed reliance on credit ratings, establishing the gatekeeper role of CRAs to debt markets (Partnoy [1999], [2006]),

has been implicated as one of the main sources of rating inflation leading up to the 2008 Global Financial Crisis.

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 debt financing to undertake a risky project; a debt market populated by investors, who competitively set interest rates; and one or two CRAs, which aim to sell credit ratings to the entrepreneur. Initially, the entrepreneur privately observes a signal about her firm's type, where the firm type co-determines the project's outcome, and must issue a financial report that need not truthfully disclose her private information. After disclosure of the financial report, CRAs strategically set their fees. Each CRA then privately observes an imperfect signal about the project outcome and develops a rating that may be distorted through rating inflation. Each CRA privately submits its rating to the entrepreneur, who then decides on whether to purchase the rating. If purchased, the rating is made public. Investors determine the interest rate after observing the financial report and the purchased ratings.

We derive a number of novel insights. First, we establish that, absent CRAs' gatekeeper role, increases in the intensity of competition in the rating industry can strengthen or weaken firms' misreporting incentives, depending on the information quality of credit ratings. Corporate misreporting incentives are determined by the rent that the entrepreneur expects to receive from pursuing the project, net of the expected debt repayment (where interest rates are chosen by investors) and rating fees (which are chosen by CRAs). A larger expected rent implies stronger misreporting incentives. The interest rates investors choose are influenced by both the firm's financial report and CRAs' credit ratings. In equilibrium, the entrepreneur only purchases favorable 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 from providing a favorable rating, leaving the entrepreneur with a relatively low rent. In contrast, with imperfect competition between multiple strategic CRAs, the ability of CRAs to extract rents is constrained, and they are forced to lower their fees. This leaves the entrepreneur with a larger expected rent, as she retains a part of the value that is created by favorable ratings, incentivizing her to misreport more. However, a countervailing force is present through investor price protection. Rational investors conjecture that the lack of fa-

avorable ratings indicates that the ratings that were offered to the entrepreneur, but not purchased, must have been unfavorable. In the presence of multiple CRAs, this inference becomes stronger, driving up the expected cost of debt and reducing the entrepreneur's misreporting incentives. The relative strength of both effects is a function of the precision of credit ratings, where sufficiently high precision implies a weak price protection effect, thus resulting in more intense rating industry competition leading to increased financial misreporting by firms. If rating precision is sufficiently low, then the price protection effect dominates the constraining effects of more intense competition, weakening corporate misreporting incentives.

Next, we consider the impact of CRAs' role as gatekeepers to debt markets. We implement this role by assuming that, to be eligible to raise debt, the firm must provide at least one favorable credit rating. We show that a monopolistic CRA acting as a gatekeeper can extract the entire expected rent from pursuing the project from the entrepreneur, which in turn incentivizes the latter to report truthfully. In contrast, under duopolistic competition, the entrepreneur's misreporting is the central mechanism through which CRAs' gatekeeper role impacts the equilibrium. When at least one favorable rating must be provided, project financing becomes less likely. This reduces the entrepreneur's expected utility from misreporting without directly affecting CRAs' fee setting and rating inflation. Consequently, we predict that weakening CRAs' gatekeeper status leads to more financial misreporting. Further, the decreased informativeness of financial reporting increases the relative information value of ratings, enabling CRAs to set higher fees, which motivates them to intensify rating inflation. Additionally, we show that, when CRAs are gatekeepers, more rating industry competition unambiguously increases firms' misreporting incentives as it effectively eliminates the price protection effect.

Furthermore, our analyses reveal that, under imperfect industry competition, the entrepreneur's misreporting and CRAs' rating inflation endogenously interact, even if the private information of CRAs is not directly influenced by corporate misreporting. Our results in this respect can be best explained by considering the effects of changes in respective distortion costs. An increase in accounting manipulation costs leads to more informative financial reporting. This reduces the relative information value of credit ratings, forcing CRAs to set lower fees, which in turn reduces their rating inflation incentives. In contrast, as rating inflation costs increase, CRAs reduce their rating inflation efforts, making ratings more informative. A priori, the entrepreneur's expected

surplus from receiving favorable ratings increases, strengthening her misreporting incentives. When CRAs act as gatekeepers, an additional countervailing effect arises, as rating inflation increases the likelihood of project financing, which strengthens the entrepreneur's misreporting incentives. We show that, given that manipulation costs are sufficiently large, the latter effect dominates, implying that firms' misreporting and CRAs' rating inflation are strategic complements. Thus we predict that more scrutiny on CRAs not only improves rating quality but, given a sufficient level of scrutiny on corporate reporting, also improves financial reporting quality.

Lastly, our paper derives several results regarding investment efficiency. Due to their central role during the 2008 Global Financial Crisis, CRAs have been under increased scrutiny by regulators, and several policies have been discussed or implemented to reduce the market 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 by lowering the hurdle to enter the industry. This also was the main purpose of the US Credit Rating Agency Reform Act of 2006, which sought to increase the number of CRAs designated as nationally recognized statistical rating organizations (NRSROs). We show that increased rating industry competition can impair investment efficiency by exacerbating firms' misreporting incentives. A second policy approach is to weaken CRAs' gatekeeper status. 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. In this regard, we show that the direct effect of ridding CRAs' gatekeeper status on investment efficiency is unambiguously positive, as more positive NPV projects are undertaken. However, this also leads to more financial misreporting, which reduces investment efficiency. We show that, as long as firms' misreporting is sufficiently constrained, investment efficiency increases when CRAs lose their gatekeeper status. Overall, these results emphasize that both policy approaches to regulate the rating industry may have unintended consequences with respect to issuers' reporting 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 or after privately observing the outcome of the respective service. This is highlighted by Marinovic

and Sridhar [2015], who study how the presence of a (monopolistic) information certifier affects a firm's voluntary disclosure strategy when the firm must rely on the certifier for 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. 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 CRAs, and we allow both firms and CRAs to distort their information.

A particular certifier that naturally has received considerable attention in the accounting literature is the external auditor. Two main conflicts of interest in particular have been 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 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]). The former is somewhat in line with the conflict of interest faced by CRAs, since they are also compensated by the firm. However, a notable difference is that public firms cannot disclose financial reports without an auditor, whereas they can provide financial statements without credit ratings. In addition, the purchase of credit ratings is more discretionary, due to the ex post purchasing of ratings, and firms often choose to purchase more than one credit rating.

CRAs, as a second main group of certifiers in financial markets, have been mostly overlooked by the analytical accounting literature. However, there exists a notable literature in economics and finance discussing their 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. 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. He shows that competition may undermine 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 where issuers have the 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 asset complexity elevates issuers' ratings shopping. Our paper is generally in line with these papers in that rent extraction and allocation are at the center of our investigation. However, we additionally consider *endogenous financial reporting* by debt issuers and show that competition in the rating industry is an important determinant of firm's financial reporting incentives.

Another paper that focuses on the strategic interaction of firms' information communication and CRA decision-making is by Cohn, Rajan, and Strobl [2018], who consider a monopolistic CRA's strategy to screen the information that is privately communicated by the issuer. In their setting, the CRA is assumed to report truthfully. They show that the issuer's manipulation incentives first increase and then decrease in the CRA's screening intensity. Our setting differs 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' *public* disclosure as opposed to their private communication with CRAs.

We also highlight an avenue through which CRAs' role as gatekeepers to debt markets affects their decisions, namely by affecting firms' reporting. 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 investment policies influence competing CRAs' behavior primarily by affecting firms' reporting decisions. We further highlight a novel benefit of CRAs' gatekeeper role, namely better financial reporting.

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 manipulate 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 both provide information to capital markets, their incentives fundamentally differ. CRAs

are generally paid by issuers, whereas sell-side equity analysts either receive indirect compensation from their affiliated investment and underwriting businesses or direct compensation from select investors who purchase their reports.

The paper proceeds as follows. Section 2 describes the setting and characterizes the case of a monopolistic CRA. Section 3 solves the setting with imperfect competition in the rating industry. Section 4 analyzes the effects of CRA competition, and Section 5 studies the effects of CRAs' gatekeeper role. Section 6 discusses the implications and the robustness of our findings, and Section 7 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 CRAs. The entrepreneur has access to a risky investment project and wishes to issue debt to finance it. Investors provide capital in exchange for a claim to the project's final cash flow, which takes the form of a repayment including interest. To receive capital, the entrepreneur must publicly disclose a financial report, after which she can purchase credit ratings from the CRAs.

The firm can be one of two types: a good type (g) with probability $\alpha \in (0, 1)$ or a bad type (b) with probability $(1 - \alpha)$. The project outcome is a function of the firm's type. For the good type, the project always succeeds and generates outcome $x > 0$, whereas for the bad type, the project succeeds in $\theta \in (0, 1)$ of the cases and fails otherwise, in which case the outcome is 0. For the sake of simplicity, the firm is identical to the risky project, implying that, when the project defaults, the firm defaults.¹ To be realized, the project requires an investment of \$1. We impose standard assumptions regarding the net present value (NPV) of the project in that projects undertaken by good-type firms have a strictly positive NPV ($x - 1 > 0$), whereas projects undertaken by bad-type

¹We therefore consider a setting with two states of nature. Traditional debt contracting problems typically consider three states. However, this assumption would significantly increase 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].

firms have a strictly negative NPV ($\theta x - 1 < 0$). In addition, the ex ante NPV of the project is assumed to be strictly positive, that is

$$[\alpha + (1 - \alpha)\theta]x - 1 > 0. \quad (1)$$

The sequence of events is presented in Figure 1. In the initial stage ($t = 1$), the entrepreneur perfectly observes her firm's type and publicly discloses a report based on her private information.² The report has two possible realizations, $R \in \{R_H, R_L\}$, which need not be a truthful disclosure of her private information. Intuitively, an entrepreneur reports type g truthfully as R_H , since this increases investors' assessment of the posterior likelihood of project success and lowers the cost of debt, leaving the entrepreneur with a higher expected rent from undertaking the project. However, this also provides incentives to misreport type b as R_H . That financial reports carry information about firms' default risk comports with empirical evidence by Callen, Livnat, and Segal [2009], among others. One can think of financial reports as information about the performance, risk, or volatility of projects already undertaken, which, in the aggregate, are an imperfect predictor for the success probability of the new project.

The entrepreneur's manipulation effort is captured by $m \in [0, 1)$, which is the probability that b is disclosed as report R_H and not as undesirable report R_L , i.e., $Pr(R_H|b) = m$. When manipulating the report, the entrepreneur privately incurs manipulation costs in the amount of $m^2\mu/2$. μ is assumed to be positive and sufficiently large to ensure that there always exists an interior solution for the entrepreneur's manipulation strategy. In choosing the level of manipulation m , the entrepreneur trades off the expected net benefit from realizing the project for lower capital costs against manipulation costs.

[PLEASE INSERT FIGURE 1 HERE]

In the economy, there exist either one or two ex ante identical CRAs. After the public disclosure of the financial report R , each CRA $i \in \{1, 2\}$ publicly chooses fees $F_{i,H}$ and $F_{i,L}$ in $t = 2$ for providing a rating to a firm whose financial report was R_H and R_L , respectively.³ In $t = 3$, each

²Imperfect information does not fundamentally alter the economics in place but introduces more complexity to the model.

³We assume that CRA i chooses the rating fee F_i before observing any private information. 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 its private information. In practice, the 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. Hence there exists significant flexibility in setting rating fees (Beatty et al.

CRA generates an imperfect signal $S_i \in \{S_{i,G}, S_{i,B}\}$ about the firm's project outcome with precision $Pr(S_{i,G}|x) = Pr(S_{i,B}|0) = q \in (.5, 1)$. The CRAs then privately and simultaneously submit a signal about the project's success probability to the entrepreneur, which, if purchased, is made public.^{4,5} We refer to these signals as credit ratings and denote an unfavorable rating as B_i and a favorable one as G_i .⁶ Allowing the entrepreneur to view a rating before purchasing it captures issuers' ability to shop for ratings. Intuitively, the entrepreneur purchases a favorable rating (G_i) but not an unfavorable one (B_i), as only the former yields a lower cost of debt. If a rating is purchased, the entrepreneur pays a fee, and the rating is made public. We denote the number of purchased, favorable ratings by $n \in \{0, 1, 2\}$.

The entrepreneur's preference for favorable ratings and the opportunity to purchase ratings after observing them establish a conflict of interest for the CRAs. 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 $S_{i,G}$, it truthfully discloses this information as favorable rating G_i . However, when the CRA observes $S_{i,B}$, it can resort to rating inflation. Similar to the entrepreneur's manipulation, rating inflation is modeled as probabilities $s_{i,H}, s_{i,L} \in [0, 1)$ that CRA i issues a favorable rating G_i after observing unfavorable signal $S_{i,B}$. $s_{i,H} = Pr(G_i|S_{i,B}, R_H)$ and $s_{i,L} = Pr(G_i|S_{i,B}, R_L)$ depend on the financial report realizations R_H and R_L respectively, since CRAs make their rating inflation decision after financial reports are made public. The public financial report influences investors' valuation, which then influences CRAs' fee setting decision and ultimately their rating inflation incentives. Rating inflation is privately costly to CRAs and yields inflation costs of $s_i^2\gamma/2$ (e.g., reputational or litigation costs). γ is assumed to be positive and sufficiently large to ensure that there always exists an interior solution for a CRA's rating inflation decision. 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 any purchased credit ratings.

[2018]).

⁴Self-solicited credit ratings are common in the corporate debt market (Becker and Milbourn [2011]).

⁵CRAs disclosing information about the project's success probability is institutionally in line with issue ratings. However, our results should also carry over to the case of issuer ratings, which would be more in line with disclosing information about the firm's type.

⁶The assumption of binary credit ratings is consistent with CRAs' classification of a firm's creditworthiness into investment or speculative grade.

We denote interest rates, conditional on report R_H (R_L) and n favorable ratings, as $r_{n,H}$ ($r_{n,L}$). All investors in the market are Bayesian and atomistic and formulate interest rates such that they break even in expectation. 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 purchase decision, CRA i 's rating fees $F_{i,H}$ and $F_{i,L}$ and rating inflation $s_{i,H}$ and $s_{i,L}$, and the debt market's interest rates $r_{n,H}$ and $r_{n,L}$, such that:*

- (i) *Conditional on observing the firm's type, the entrepreneur chooses m to maximize her expected utility, given rational conjectures of $F_{i,H}$, $F_{i,L}$, $s_{i,H}$, $s_{i,L}$, $r_{n,H}$ and $r_{n,L}$;*
- (ii) *Conditional on financial report R , CRA i chooses $F_{i,H}$ and $F_{i,L}$ to maximize its expected revenue, net of rating inflation costs, given rational conjectures of the entrepreneur's credit rating preferences, m , $F_{j,H}$, $F_{j,L}$, $s_{j,H}$, $s_{j,L}$, $r_{n,H}$ and $r_{n,L}$, where $i \neq j$;*
- (iii) *Conditional on financial report R and imperfect signal S_i , CRA i chooses $s_{i,H}$ and $s_{i,L}$ to maximize its expected revenue net of rating inflation costs, given rational conjectures of the entrepreneur's credit rating preferences, m , $F_{j,H}$, $F_{j,L}$, $s_{j,H}$, $s_{j,L}$, $r_{n,H}$ and $r_{n,L}$, where $i \neq j$;*
- (iv) *Conditional on privately observing the firm type and credit rating $\{B_i, G_i\}$ from CRA i , the entrepreneur purchases a credit rating from CRA i only if this leads to a (weakly) larger expected utility, given $F_{i,H}$ or $F_{i,L}$ and her rational conjectures of $s_{i,H}$, $s_{i,L}$, $r_{n,H}$ and $r_{n,L}$;*
- (v) *Conditional on financial report R and publicly disclosed credit ratings $\{B_i, G_i\}$ from CRAs $i = 1, 2$, investors choose $r_{n,H}$ and $r_{n,L}$ to break even in expectation, given $F_{i,H}$ and $F_{i,L}$ and rational conjectures of the entrepreneur's credit rating preferences, m , $s_{i,H}$, and $s_{i,L}$.*

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

2.2 DISCUSSION OF KEY MODEL ASSUMPTIONS REGARDING RATING AGENCIES

CRAs' private information. In our model, CRAs observe private information signals S_i as a result of the rating process. These signals can be understood as the incremental information CRAs generate beyond the financial report. On the one hand, CRAs may derive more information from financial reports than investors. This is consistent with the evidence provided by Kraft [2015], who

documents that CRAs are superior in extracting risk-related information from financial statements. On the other hand, CRAs also aggregate and reinterpret industry-level and macroeconomic risk information as well as perform analyses to assess a firm's competitive position. This information is then used to derive a firm's business risk profile in addition to its financial risk profile, where the latter relies on financial reports (Standard & Poor's [2014], [2018]).⁷ Assuming that CRAs' private information is exogenously given is a necessary abstraction to focus on CRAs' conflict of interest and the entrepreneur's misreporting incentives. In subsection 6.2, we discuss how an endogenous consideration of the rating process can be modeled and how this influences our inference.

CRAs' conflict of interest. CRAs face a conflict of interest, due to the entrepreneur's preference for favorable ratings and her ability to selectively purchase ratings after observing them. That the entrepreneur can selectively purchase ratings is a simplification of a complex and sometimes lengthy negotiation process between firms and CRAs in which it is standard procedure for the CRAs to frequently meet with a firm's management and discuss key issues for the firm's credit rating (Standard & Poor's [2014], [2018]). During these negotiations, some information about future ratings may be revealed. In addition, both S&P (Rating Evaluation Service) and Moody's (Rating Assessment Service) offer unrated firms consulting services to assess their current creditworthiness, which may reveal information about future ratings. Evidence by Kronlund [2017] is consistent with ratings shopping in corporate debt markets.

Even if selective purchasing of ratings were not an issue, similar, if not identical, conflicts of interest arise for two other reasons. First, even if the issuer does not directly learn about the preliminary rating, as long as the rent that a CRA can extract from the issuer is greater with a favorable rating (G_i) than with an unfavorable one (B_i)—and this is supported by the evidence provided by Beatty et al. [2018]—the CRA faces a conflict of interest, as the rating fee is revealing about the underlying rating. Second, while our model captures the issuer-CRA interaction in a one-period model, in practice this interaction is more a relationship over multiple periods, since the purchase of a credit rating is not a one-time event but entails continuous monitoring and updating. This is compensated by the payment of periodic fees to the CRAs. Under these circumstances, a CRA has an incentive to cater to the issuer to maintain the relationship and secure future business

⁷CRAs may also receive private information from firms' managers that is not available to other capital market participants (Jorion, Liu, and Shi [2005]).

(Griffin, Nickerson, and Tang [2013]). As long as issuing a low rating in the first period decreases a CRA's business in the future, a conflict of interest exists, which prompts rating inflation.

Overall, our assumptions regarding CRAs' incentives and decision variables as well as the entrepreneur's preference for favorable ratings comport with theoretical research (e.g., Skreta and Veldkamp [2009], Bolton, Freixas, and Shapiro [2012], Sangiorgi and Spatt [2017]) and with empirical evidence (e.g., Jorion, Liu, and Shi [2005], Becker and Milbourn [2009], Griffin and Tang [2012], Griffin, Nickerson, and Tang [2013], Kronlund [2017], Beatty et al. [2018]).

2.3 EQUILIBRIUM WITH A MONOPOLISTIC RATING AGENCY

We begin our analysis by characterizing the unique equilibrium for the case with a monopolistic CRA. All omitted proofs and conditions are provided in the appendix. We use subscript M for the endogenous variables in the monopolistic setting and subscript D in the duopoly setting discussed in the next section. In this section, we omit subscript i as there only exists one CRA.

We start by solving the debt market's problem and derive interest rates for the cases with no purchased rating and one purchased rating for financial reports R_H ($r_{0,H,M}$ and $r_{1,H,M}$) and R_L ($r_{0,L,M}$ and $r_{1,L,M}$), respectively. Let us initially assume that there exist non-maximal solutions for the entrepreneur's manipulation m_M (which the CRA and investors conjecture as $\hat{m}_M$), the CRA's rating inflation $s_{H,M}$ and $s_{L,M}$ (which the entrepreneur and investors conjecture as $\hat{s}_{H,M}$ and $\hat{s}_{L,M}$), and the CRA's rating fees $F_{H,M}$ and $F_{L,M}$. Investors and the CRA also correctly conjecture that the entrepreneur would only purchase a favorable rating. As investors choose interest rates to break even, the interest rate with no purchased rating for financial report R_H is solved for as follows:

$$r_{0,H,M} = \frac{1 - Pr(x|R_H)}{Pr(x|R_H)} = \frac{(1 - \alpha)(1 - \theta)\hat{m}_M}{[\alpha + (1 - \alpha)\theta\hat{m}_M]} \frac{q}{(1 - q)}.$$

Interest rates $r_{1,H,M}$, $r_{0,L,M}$ and $r_{1,L,M}$ are solved for in the same manner and can be found as (11)–(13), along with the respective probabilities for each information set, in the appendix. First note that interest rates decrease with the provision of a favorable rating for both financial report scenarios ($r_{0,H,M} > r_{1,H,M}$ and $r_{0,L,M} > r_{1,L,M}$ for all $\hat{m}_M, \hat{s}_{H,M}, \hat{s}_{L,M} \in [0, 1)$). This is because, conditional upon observing a favorable rating, investors revise their beliefs regarding the project's success probability upwards. When no rating is observed, they correctly infer that the CRA's

private information must have been unfavorable (S_B), since they are aware of the CRA's rating solicitation and the entrepreneur's preference for favorable ratings. Note, too, that interest rates $r_{0,H,M}$ and $r_{1,H,M}$ increase in the conjectured level of manipulation $\hat{m}_M$ (i.e., $\frac{\partial r_{0,H,M}}{\partial \hat{m}_M}, \frac{\partial r_{1,H,M}}{\partial \hat{m}_M} > 0$ for all $\hat{m}_M, \hat{s}_{H,M} \in [0, 1)$), since investors discount a favorable financial report R_H more when they expect the report to be manipulated with a higher probability. A similar rationale holds true with respect to the conjectured level of the CRA's rating inflation $\hat{s}_{H,M}$ and $\hat{s}_{L,M}$ in case of a favorable credit rating G (i.e., $\frac{\partial r_{1,H,M}}{\partial \hat{s}_{H,M}}, \frac{\partial r_{1,L,M}}{\partial \hat{s}_{L,M}} > 0$ for all $\hat{m}_M, \hat{s}_{H,M}, \hat{s}_{L,M} \in [0, 1)$).

Before we formally state the CRA's problem, we analyze when investment occurs in equilibrium, as this crucially influences the CRA's rating fee and the entrepreneur's manipulation strategies. Investment is driven by the standard NPV assumptions we impose, which reduce to a feasible range of success outcome $x \in \left(\frac{1}{\alpha + (1-\alpha)\theta}, \frac{1}{\theta}\right)$. The entrepreneur invests when investors observe $\{R_H, G\}$ and demand interest rate $r_{1,H,M}$ (i.e., $x - (1 + \hat{r}_{1,H,M}) > 0$) but does not invest in case $\{R_L, B\}$ (i.e., $x - (1 + \hat{r}_{0,L,M}) < 0$). Whether investment occurs in cases $\{R_H, B\}$ and $\{R_L, G\}$ depends on the parametric circumstances. To ensure that the entrepreneur always has an incentive to pursue the investment project when she discloses R_H , we impose the assumption that the type distribution α is sufficiently large such that it lies above threshold value $\bar{\alpha}$. The threshold is formally stated in the appendix. If $\alpha > \bar{\alpha}$, investment also occurs under the $\{R_H, B\}$ case. As for the $\{R_L, G\}$ case, we show in the appendix that whether investment happens in this case is irrelevant for the entrepreneur's manipulation strategy, due to CRA rent extraction.

We now characterize and solve the CRA's rating fee and inflation problem for both cases, R_H and R_L . Formally, the CRA's problem in the R_H case can be written as follows:

$$\max_{F_{H,M}} Pr(G|R_H)F_{H,M} - Pr(S_B|R_H)\frac{s_{H,M}^2\gamma}{2} \quad (2a)$$

subject to

$$Pr(x|g, G)[x - (1 + \hat{r}_{1,H,M})] - F_{H,M} \geq Pr(x|g, G)[x - (1 + \hat{r}_{0,H,M})] \quad (2b)$$

$$Pr(x|b, G)[x - (1 + \hat{r}_{1,H,M})] - F_{H,M} \geq Pr(x|b, G)[x - (1 + \hat{r}_{0,H,M})] \quad (2c)$$

$$\max_{s_{H,M}} s_{H,M}F_{H,M} - \frac{s_{H,M}^2\gamma}{2}. \quad (2d)$$

As the entrepreneur will purchase only a favorable rating, the CRA earns a fee if and only if its

rating is favorable. This incentivizes the CRA to inflate its rating when it observes an unfavorable signal S_B , which is addressed in (2d). In addition, the CRA's problem includes two participation constraints, (2b) and (2c), one for each firm type $\{g, b\}$. The stricter condition (2c) provides the relevant participation constraint that ensures that the entrepreneur is always willing to purchase a favorable rating, regardless of her private information since $Pr(x|g, G) > Pr(x|b, G)$.⁸

The optimization problem characterized by conditions (2a) to (2d) is solved by applying the first-order approach on (2d) and then solving (2a) by using a Lagrange multiplier on constraint (2c). The monopolistic CRA's optimal rating fee and inflation bias are as follows:

$$F_{H,M} = Pr(x|b, G)(\hat{r}_{0,H,M} - \hat{r}_{1,H,M}), \quad (3)$$

$$s_{H,M} = \frac{F_{H,M}}{\gamma}. \quad (4)$$

From (4) it follows that the determining factor for rating inflation is the size of the fee. The fee captures the rent the CRA extracts from the entrepreneur and is determined by two parts: the entrepreneur's beliefs (captured by $Pr(x|b, G)$) and the debt market's beliefs regarding the project's success probability. The latter affects the fee through interest rates $\hat{r}_{0,H,M}$ and $\hat{r}_{1,H,M}$ 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 $\hat{s}_{H,M} \in [0, 1)$.

Given that investment occurs in the $\{R_L, G\}$ case, the CRA's problem in the R_L case is similar to that in the R_H case. A main difference is that there only exists one participation constraint, as an unfavorable report R_L can only occur when the entrepreneur observed signal b but her manipulation attempt failed. The characterization of and solution to the CRA's problem in the R_L case can be found in the appendix.

Lastly, the entrepreneur makes two decisions in our model: the level of manipulation effort and whether to purchase a rating. She does not purchase an unfavorable rating since that would not improve her expected utility. Additionally, it was shown above that the CRA sets its fee such that the entrepreneur will always purchase a favorable rating. For the entrepreneur's manipulation decision, recall that she reports truthfully if she observes that the firm is a good type (g), leading to report R_H . However, contingent upon learning that the firm is a bad type (b), the entrepreneur solves the

⁸We therefore focus on a pooling equilibrium, rather than a separating equilibrium in which the rating purchase decisions signals the firm type.

following problem to determine the optimal manipulation effort m_M , given that investment does not occur in case $\{R_L, G\}$:⁹

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

The entrepreneur's misreporting incentives crucially depend on the CRA's fee. In general, a higher fee decreases the entrepreneur's expected utility and therefore undermines her misreporting incentives. The solution to the entrepreneur's problem, after enforcing the conjectures and inserting $F_{H,M}$ from (3), can be simplified and rearranged to

$$m_M = \frac{\theta}{\mu} [x - (1 + r_{0,H,M})]. \quad (5)$$

We assume that parameters μ and γ are sufficiently large to ensure that there always exists a unique nonmaximal level of manipulation $m_M = m_M^* \in (0, 1)$, unique nonmaximal levels of rating inflation $s_{H,M} = s_{H,M}^*$, $s_{L,M} = s_{L,M}^* \in [0, 1)$, unique, weakly positive rating fees $F_{H,M} = F_{H,M}^* > 0$ and $F_{L,M} = F_{L,M}^* \geq 0$, and unique interest rates $r_{0,H,M} = r_{0,H,M}^* > 0$, $r_{1,H,M} = r_{1,H,M}^* > 0$, $r_{0,L,M} = r_{0,L,M}^* > 0$ and $r_{1,L,M} = r_{1,L,M}^* > 0$. Proposition 1 summarizes the unique equilibrium in the setting with a monopolistic CRA.

Proposition 1 *Under the assumptions made, there exists a unique equilibrium for the case with a monopolistic CRA that has the following properties.*

- (i) *The entrepreneur reports R_H whenever g and exerts manipulation effort $m_M^* \in (0, 1)$ whenever b , where m_M^* is defined by (5).*
- (ii) *The monopolistic CRA sets rating fees $F_{H,M}^* > 0$ and $F_{L,M}^* \geq 0$ as in (3) and (15), respectively.*
- (iii) *The monopolistic CRA truthfully issues a favorable rating G whenever S_G and engages in rating inflation $s_{H,M}^*, s_{L,M}^* \in [0, 1)$ whenever S_B , where $s_{H,M}^*$ and $s_{L,M}^*$ are defined by (4) and (16), respectively.*

⁹Note that, even when investment occurs if manipulation is unsuccessful (R_L) and the CRA provides a favorable rating (G), the entrepreneur's expected utility in this scenario is zero, as the CRA extracts the entire surplus from project investment. Formally, it can be shown that the following equality holds:

$$Pr(x, G|b) [x - (1 + \hat{r}_{1,L,M})] - Pr(G|b) \hat{F}_{L,M} = 0.$$

Hence, regardless of whether investment occurs in case $\{R_L, G\}$, this does not influence the entrepreneur's manipulation strategy.

(iv) The entrepreneur refrains from purchasing an unfavorable rating (B) and purchases a favorable rating (G) in case of R_H . She may or may not purchase a favorable rating in case of R_L .

(v) The debt market chooses interest rates $r_{0,H,M}^*$, $r_{1,H,M}^*$, $r_{0,L,M}^*$, and $r_{1,L,M}^*$, as in (10) through (13), respectively.

3 Equilibrium with Imperfect Competition in the Rating Industry

In this section, we analyze a setting with imperfect competition, where two CRAs compete.¹⁰ In this duopolistic setting, we that CRAs are ex ante identical (i.e., q and γ are the same for both CRAs), that they choose their fees and inflation strategies simultaneously, and that they privately submit their ratings to the entrepreneur at the same time. In addition, we focus on a symmetric equilibrium. 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 ratings ($n = 0$).

We solve the duopolistic setting by backward induction and begin with deriving investors' interest rates for cases $n = 0, 1, 2$ and both financial report realizations, R_H and R_L . For this, we conjecture that there exist non-maximal solutions for the entrepreneur's manipulation effort $m_D \in [0, 1)$, CRA 1's rating inflation strategies $s_{1,H,D}, s_{1,L,D} \in [0, 1)$ and CRA 2's rating inflation $s_{2,H,D}, s_{2,L,D} \in [0, 1)$, with investors' conjectures $\hat{m}_D, \hat{s}_{1,H,D}, \hat{s}_{1,L,D}, \hat{s}_{2,H,D}$ and $\hat{s}_{2,L,D}$, respectively. As in the monopolistic setting, investors and CRAs correctly conjecture that the entrepreneur prefers favorable ratings.

The resulting interest rates $r_{0,H,D}, r_{1,H,D}, r_{2,H,D}, r_{0,L,D}, r_{1,L,D}$, and $r_{2,L,D}$ can be found in the appendix as (17)–(22). A first property is that interest rates decrease as the number of favorable ratings increase (i.e., $r_{0,H,D} > r_{1,H,D} > r_{2,H,D}$ and that $r_{0,L,D} > r_{1,L,D} > r_{2,L,D}$ for all $\hat{m}_D, \hat{s}_{1,H,D}, \hat{s}_{1,L,D}, \hat{s}_{2,H,D}$, and $\hat{s}_{2,L,D} \in [0, 1)$). That a second favorable rating creates value in our setting with binary ratings is a direct consequence of the noise in credit ratings introduced by both imperfect private information and rating inflation. Investors infer from observing only one favorable rating (case $n = 1$) that the second rating must have been unfavorable. They therefore learn that

¹⁰The introduction of a third or more CRAs would not fundamentally alter the results but would significantly increase model complexity.

the purchased favorable rating is more likely to be inflated, something they do not learn when both ratings are favorable (explaining $r_{1,H,D} > r_{2,H,D}$). Another important property that arises endogenously in this setting is the strictly decreasing marginal information value of credit ratings (i.e., $r_{0,H,D} - r_{1,H,D} > r_{1,H,D} - r_{2,H,D}$ and $r_{0,L,D} - r_{1,L,D} > r_{1,L,D} - r_{2,L,D}$ for all $\hat{m}_D, \hat{s}_{1,H,D}, \hat{s}_{1,L,D}, \hat{s}_{2,H,D}$, and $\hat{s}_{2,L,D} \in [0, 1)$). This will be important for CRAs' equilibrium fee setting.¹¹ In addition, interest rates increase as conjectures about accounting manipulation and rating inflation increase for the same reasons discussed in the monopolistic CRA setting in Section II.

Equilibrium project investment decisions in the presence of a CRA duopoly are as follows. First, the entrepreneur invests in the project in case $\{R_H, G_1, G_2\}$, that is, when the financial report is R_H and she receives two favorable credit ratings. She will refrain from investing in the project in cases $\{R_L, G_1, B_2\}$ and $\{R_L, B_1, B_2\}$. Whether investment occurs in cases $\{R_H, G_1, B_2\}$, $\{R_H, B_1, B_2\}$, and $\{R_L, G_1, G_2\}$ depends on the parametric circumstances. As in the monopolistic setting, we assume that $\alpha > \bar{\alpha}$ such that the entrepreneur undertakes the project in cases $\{R_H, G_1, B_2\}$ and $\{R_H, B_1, B_2\}$. Again, we can show that whether investment occurs in case $\{R_L, G_1, G_2\}$ is without consequence to the entrepreneur's manipulation strategy.

In the duopolistic setting, each CRA solves a problem that resembles the one presented by conditions (2a) to (2d). CRA i rationally conjectures the entrepreneur's manipulation effort $\hat{m}_D \in (0, 1)$ and CRA j 's rating inflation $\hat{s}_{j,H,D}, \hat{s}_{j,L,D} \in [0, 1)$, where $i \neq j$, as well as the debt market's interest rates $\hat{r}_{0,H,D}, \hat{r}_{1,H,D}, \hat{r}_{2,H,D}, \hat{r}_{0,L,D}, \hat{r}_{1,L,D}$, and $\hat{r}_{2,L,D}$. CRA i 's optimization problem in the R_H case can be formalized as follows after omitting non-binding conditions (see appendix):

$$\max_{F_{i,H,D}} Pr(G_i|R_H)F_{i,H,D} - Pr(S_B|R_H)\frac{s_{i,H,D}^2\gamma}{2} \quad (6a)$$

subject to

$$Pr(x|b, G_1, G_2)[x - (1 + \hat{r}_{2,H,D})] - F_{i,H,D} \geq Pr(x|b, G_1, G_2)[x - (1 + \hat{r}_{1,H,D})] \quad (6b)$$

$$\max_{s_{i,H,D}} s_{i,H,D}F_{i,H,D} - \frac{s_{i,H,D}^2\gamma}{2}. \quad (6c)$$

¹¹Related research typically considers perfect information endowment of CRAs and a capital market populated by Bayesian and naive investors. A central assumption to obtain a strictly decreasing marginal information value of credit ratings is that the number of naive investors in the market is sufficiently high (e.g., Skreta and Veldkamp [2009], Bolton, Freixas, and Shapiro [2012], Bar-Isaac and Shapiro [2013]). However, as we demonstrate, imperfect information on the side of CRAs also generates a strictly decreasing marginal rating information value.

The major difference between CRA i 's optimization problem in the duopolistic setting, as compared to the monopolistic setting, is the entrepreneur's participation constraints: the presence of CRA j forces CRA i to also incorporate conjectures regarding j 's rating — which can either be B_j or G_j — resulting in four, instead of only two, participation constraints. Due to the decreasing marginal information value of credit ratings, constraint (6b) is the strictest participation constraint, which ensures that the entrepreneur prefers to purchase a credit rating, given her information sets. Setting the fee to satisfy constraint (6b) assures that, when the entrepreneur privately observes two favorable ratings, she always has the incentive to purchase both and thus to purchase a second favorable rating, regardless of her private information. Another possible strategy for CRA i is to charge a higher fee such that the entrepreneur will 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 (similar to the case in the monopolistic 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 buys a rating from CRA j but not from CRA i . This price competition continues until both CRAs charge the marginal value of a second favorable rating, in which case the entrepreneur will purchase from both CRAs when both present favorable ratings.¹²

We apply the first-order approach on (6c), leading to the functionally identical solution of rating inflation as under the monopolistic setting (see (4)). Additionally, we use a Lagrange multiplier to show that the fee that maximizes CRA i 's expected utility in (6a) is the one for which constraint (6b) is binding. The rating fee can therefore be expressed as follows:

$$F_{i,H,D} = Pr(x|b, G_1, G_2)(\hat{r}_{1,H,D} - \hat{r}_{2,H,D}). \quad (7)$$

Since we assume that both CRAs are ex ante identical, move simultaneously, and focus on a symmetric equilibrium, it must be the case that $s_{1,H,D} = s_{2,H,D} = s_{H,D}$ and that $F_{1,H,D} = F_{2,H,D} = F_{H,D}$.

CRA i 's problem in the R_L case resembles that in the R_H case except that the participation

¹²That the 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 did not hold, the price competition would continue until the rating fee equals the marginal cost, as is the case in standard Bertrand models with homogeneous products.

constraints reflect the fact that investment does not occur in cases $\{R_L, G_1, B_2\}$, $\{R_L, B_1, G_2\}$ and $\{R_L, B_1, B_2\}$ and that R_L implies that the firm must be type b . Now, the entrepreneur purchases favorable ratings only if she receives two and if $[x - (1 + \hat{r}_{2,L,D})] > 0$ such that she benefits from undertaking the project. If either of these conditions is not fulfilled, the entrepreneur does not purchase any ratings and refrains from investing altogether. From the solution to CRA i 's problem in the R_L case, which can be found in the appendix, we can see that, as in the monopolistic setting, the CRAs can extract the entire expected surplus from pursuing the investment project in the duopoly setting when the financial report is R_L and investment occurs.

For the entrepreneur's manipulation effort problem, we assume that there exist nonmaximal solutions for CRAs' rating inflation levels and weakly positive solutions of their fees. The entrepreneur rationally conjectures them with $\hat{s}_{H,D}, \hat{s}_{L,D} \in [0, 1)$, $\hat{F}_{H,D} > 0$ and $\hat{F}_{L,D} \geq 0$.¹³ Additionally, she conjectures interest rates $\hat{r}_{0,H,D} > \hat{r}_{1,H,D} > \hat{r}_{2,H,D} > 0$ and $\hat{r}_{0,L,D} > \hat{r}_{1,L,D} > \hat{r}_{2,L,D} > 0$. The entrepreneur's problem determines m_D , which maximizes her expected payoff for the cases in which she obtains two, one, or no favorable ratings, net of manipulation costs and net of the fees when either or both ratings are favorable.¹⁴ After omitting irrelevant terms, the resulting optimization problem, conditional on observing type b , can be written as follows:¹⁵

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

The level of manipulation is solved for, and, after enforcing all conjectures and substituting $F_{H,D}$ from (7), the entrepreneur's manipulation effort can be simplified to

$$m_D = \frac{\theta}{\mu} [x - (1 + r_{0,H,D})] + \frac{\theta}{\mu} \Phi, \quad (8)$$

where $\Phi > 0$ represents the entrepreneur's expected retained surplus from favorable credit ratings. Φ is explicitly stated in the appendix.

¹³To improve expositional clarity, we already let the entrepreneur conjecture that both CRAs choose the same strategies, due to our focus on a symmetric equilibrium.

¹⁴As we have shown above, when manipulation fails (with probability $1 - m_D$) and R_L is reported, either no investment occurs or the CRAs extract the entire expected surplus from pursuing the project. This makes the entrepreneur indifferent between investment or not when R_L is reported, as her expected return from pursuing the investment becomes zero. Therefore we again omit the case when manipulation is unsuccessful in the following entrepreneur's problem.

¹⁵The conditional probabilities are as follows: $Pr(x, G_1, G_2|b) = \theta [q + (1 - q)\hat{s}_{H,D}]^2$, $Pr(x, G_i, B_j|b) = \theta [q + (1 - q)\hat{s}_{H,D}] (1 - q)(1 - \hat{s}_{H,D})$, $Pr(x, B_1, B_2|b) = \theta (1 - q)^2 (1 - \hat{s}_{H,D})^2$, $Pr(G_1, G_2|b) = \theta [q + (1 - q)\hat{s}_{H,D}]^2 + (1 - \theta) [(1 - q) + q\hat{s}_{H,D}]^2$, $Pr(G_i, B_j|b) = \theta [q + (1 - q)\hat{s}_{H,D}] (1 - q)(1 - \hat{s}_{H,D}) + (1 - \theta) [(1 - q) + q\hat{s}_{H,D}] q(1 - \hat{s}_{H,D})$.

Given that μ and γ are sufficiently large, there exists a unique, symmetric equilibrium which is summarized in Proposition 2.

Proposition 2 *Under the assumptions made, there exists a unique, symmetric equilibrium for the case with a duopolistic credit rating industry that has the following properties.*

- (i) *The entrepreneur reports R_H whenever g and exerts manipulation effort $m_D^* \in (0, 1)$ whenever b , where m_D^* is defined by (8).*
- (ii) *CRA $i \in \{1, 2\}$ sets rating fees $F_{H,D}^* > 0$ and $F_{L,D}^* \geq 0$ as in (7) and (26), respectively.*
- (iii) *CRA $i \in \{1, 2\}$ truthfully issues a favorable rating G_i whenever it observes $S_{i,G}$, and engages in rating inflation $s_{H,D}^*, s_{L,D}^* \in [0, 1)$ in case it observes $S_{i,B}$, where $s_{H,D}^*$ and $s_{L,D}^*$ are defined by (4) and (25).*
- (iv) *The entrepreneur refrains from purchasing an unfavorable rating (B_i) and purchases a favorable rating (G_i) in case of R_H . She may or may not purchase favorable ratings in case $\{R_L, G_1, G_2\}$ and does not purchase favorable ratings in cases $\{R_L, G_i, B_j\}$ and $\{R_L, B_1, B_2\}$.*
- (v) *The debt market chooses interest rates $r_{0,H,D}^*, r_{1,H,D}^*, r_{2,H,D}^*, r_{0,L,D}^*, r_{1,L,D}^*$, and $r_{2,L,D}^*$, as in (17) through (22), respectively.*

4 The Effects of Competition in the Rating Industry

In this section, we provide a discussion of the equilibria established in Propositions 1 and 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 competition case. In addition, we provide some insights with respect to the effect of CRA competition on investment efficiency. Since we have already established that investment and credit ratings, in case of financial report R_L , do not affect the equilibrium accounting manipulation decision, we focus on the case with R_H , to facilitate our discussion.

4.1 The Effects of Competition in the Rating Industry

The following proposition presents a first key result on how competition in the rating industry affects the entrepreneur's misreporting incentives.

Proposition 3 *An increase in the intensity of competition in the rating industry impacts accounting manipulation as follows.*

(i) *Accounting manipulation increases ($m_M^* < m_D^*$) if credit ratings are sufficiently precise ($q > \bar{q}$ and $\gamma > \bar{\gamma}$).*

(ii) *Accounting manipulation decreases ($m_M^* > m_D^*$) if credit ratings are sufficiently noisy ($q < \bar{q}$ or $\gamma < \bar{\gamma}$).*

Thresholds $\bar{q} \in (.5, 1)$ and $\bar{\gamma} > 0$ are uniquely defined.

Proposition 3 establishes that accounting manipulation can increase or decrease in the intensity of competition in the rating industry, depending on the precision of credit ratings. This ambiguous result arises from two countervailing economic effects, which can best be explained by comparing the equilibrium conditions (implicitly) defining accounting manipulation in both cases:

$$m_M^* = \frac{\theta}{\mu} [x - (1 + r_{0,H,M}^*)],$$

$$m_D^* = \frac{\theta}{\mu} [x - (1 + r_{0,H,D}^*)] + \frac{\theta}{\mu} \Phi.$$

First, increasing competition directly affects the entrepreneur's expected retained rent from favorable ratings. In the monopolistic case, the CRA can extract the entirety of the rent generated by a favorable rating. However, more competition limits CRAs' ability to extract rents from the entrepreneur, due to the strictly decreasing marginal information value of ratings. This allows the entrepreneur to retain a part of the expected surplus from favorable ratings, which in turn strengthens her misreporting incentives. This surplus is represented by the unambiguously positive term $\frac{\theta}{\mu} \Phi$.

More intense competition further has an interesting side effect that counters the effect related to CRA rent extraction: an increase in the number of CRAs leads to an increase in the interest rate when only financial report R_H but no favorable rating is disclosed. This is due to investor price protection, as investors know that CRAs self-solicit ratings and they further rationally conjecture that both nonpurchased ratings must have been unfavorable. This effect can best be seen when comparing interest rates $r_{0,H,M}^*$ and $r_{0,H,D}^*$:

$$r_{0,H,M}^* = \frac{(1 - \alpha)(1 - \theta)m_M^*}{[\alpha + (1 - \alpha)\theta m_M^*]} \frac{q}{(1 - q)},$$

$$r_{0,H,D}^* = \frac{(1-\alpha)(1-\theta)m_D^*}{[\alpha + (1-\alpha)\theta m_D^*]} \frac{q^2}{(1-q)^2}.$$

Assuming for a moment that $m_M^* = m_D^*$, it is straightforward to show that $r_{0,H,M}^* < r_{0,H,D}^*$ since $\frac{q}{(1-q)} < \frac{q^2}{(1-q)^2}$ whenever $q \in (.5, 1)$. Thus all else equal this price protection effect weakens the entrepreneur's misreporting incentives by decreasing her expected surplus from undertaking the project.

The overall effects of competition in the rating industry are obtained by comparing effective expected interest rates $r_{0,H,M}^*$ and $r_{0,H,D}^* - \Phi$. In Proposition 3, we show that, when both the private information quality of CRAs is sufficiently large ($q > \bar{q}$) and rating inflation is sufficiently constrained by high marginal inflation costs ($\gamma > \bar{\gamma}$), the effect of constraining CRA rent extraction dominates the price protection effect. This observation obtains because more precise ratings increase the entrepreneur's expected surplus from favorable ratings, thus increasing the net benefit of manipulation.

The following proposition shows how competition affects CRAs' strategies.

Proposition 4 *An increase in the intensity of competition in the credit rating industry impacts rating fees and rating inflation as follows.*

- (i) *Rating fees and rating inflation may increase or decrease ($F_{H,M}^* > F_{H,D}^*$ and $s_{H,M}^* > s_{H,D}^*$) if credit ratings are sufficiently precise ($q > \bar{q}$ and $\gamma > \bar{\gamma}$).*
- (ii) *Rating fees and rating inflation unambiguously decrease ($F_{H,M}^* \leq F_{H,D}^*$ and $s_{H,M}^* \leq s_{H,D}^*$) if credit ratings are sufficiently noisy ($q < \bar{q}$ or $\gamma < \bar{\gamma}$).*

The effects of competition on rating fees $F_{H,M}^*$ and $F_{H,D}^*$ and inflation effort levels $s_{H,M}^*$ and $s_{H,D}^*$ are mixed. This is due to two main forces that influence CRA equilibrium strategies. First, as already elaborated above, CRAs choose lower rating fees as a response to more intense competition, due to competition constraining their rent extraction. As the expected fee CRAs generate from rating inflation decreases, so does their incentive to engage in rating inflation. The observations that intensified competition limits CRAs' ability to extract rents and that ratings become more informative are in line with Lizzeri [1999].

A potentially countervailing force is introduced through the endogenous consideration of accounting manipulation. In Proposition 3 (i), we show that accounting manipulation increases with competition intensity if ratings are sufficiently precise. If accounting manipulation increases, financial reports become less informative, which *ceteris paribus* increases the relative information value of credit ratings. This motivates CRAs to increase their fees and to inflate their ratings more. Hence the increase in accounting manipulation counters the direct effects of competition and strengthens CRAs' ability to extract rents, leading to the ambiguous result in Proposition 4 (i). In contrast, if the entrepreneur's misreporting incentives become weaker with intensifying competition (Proposition 3 (ii)), this further constrains the CRAs' ability to extract rents, resulting in the result stated in Proposition 4 (ii).

4.2 RENT ALLOCATION UNDER IMPERFECT COMPETITION IN THE RATING INDUSTRY

Under Propositions 3 and 4, we have established that competition in the rating industry affects the rent allocation between the entrepreneur and CRAs. In this subsection, we discuss how information distortion costs influence the rent allocation and equilibrium strategies. We focus on the case with imperfect competition, as summarized in Proposition 2, and consider CRAs' rating inflation costs (γ) 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 1 *Under imperfect rating industry competition, an increase in rating inflation costs (γ) leads to:*

- (i) a higher rating fee $F_{H,D}^*$ ($\frac{dF_{H,D}^*}{d\gamma} > 0$);
- (ii) less rating inflation $s_{H,D}^*$ ($\frac{ds_{H,D}^*}{d\gamma} < 0$); and
- (iii) more accounting manipulation m_D^* ($\frac{dm_D^*}{d\gamma} > 0$).

Intuitively, higher rating inflation costs lead to less rating inflation (Corollary 1 (ii)) and consequently to more informative ratings. The anticipated decrease in rating inflation affects the

entrepreneur's manipulation decision such that her expected utility, conditional on b , includes a trade-off between two effects related to rating inflation, both of which are contained in surplus Φ . First, more informative ratings lead to a greater reduction in the interest rates associated with either one or two favorable ratings. The entrepreneur therefore retains a larger fraction of the surplus in expectation, increasing her incentives to manipulate the financial report. The second countervailing effect comes from a lower likelihood of obtaining favorable ratings. As less rating inflation decreases the probability of obtaining a favorable rating, the expected interest rate increases, and the entrepreneur expects to retain a smaller surplus. This decreases the entrepreneur's incentive to manipulate the financial report. Corollary 1 (iii) shows that the information effect dominates the probability effect, leading to more accounting manipulation, as the costs of rating inflation increase.

Corollary 1 (i) states that the rating fee in the R_H case increases in rating inflation costs. The rationale behind this result is based on the informativeness of credit ratings, relative to the financial report. For a given m_D^* , the entrepreneur is willing to pay a higher fee for more informative favorable ratings, because they decrease interest rates more sharply. In addition, as a higher γ leads to more accounting manipulation (Corollary 1 (iii)), this further increases the relative informativeness of the credit ratings, making ratings all the more valuable, enabling CRAs to set higher fees. Note that the increase in the fee also provides a countervailing force to the effects underlying the results in Corollary (ii) and (iii): a higher fee makes rating inflation more appealing to CRAs while reducing the entrepreneur's misreporting incentives. However, our analysis shows that this effect is not strong enough to turn the direction of either of these results.

4.2.2 Accounting Manipulation Costs

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

Corollary 2 *Under imperfect rating industry competition, an increase in accounting manipulation costs (μ) leads to:*

- (i) a lower rating fee $F_{H,D}^*$ ($\frac{dF_{H,D}^*}{d\mu} < 0$);
- (ii) less rating inflation $s_{H,D}^*$ ($\frac{ds_{H,D}^*}{d\mu} < 0$); and
- (iii) less accounting manipulation m_D^* ($\frac{dm_D^*}{d\mu} < 0$).

When accounting manipulation becomes costlier, this reduces the entrepreneur's incentive to manipulate her financial report (Corollary 2 (iii)). This improves the information content of financial report R_H . As the financial report becomes more informative, the incremental information value of favorable credit ratings decreases, constraining the rent that can be extracted by CRAs. CRAs respond by lowering their fees, as stated in Corollary 2 (i). The lower fee reduces CRAs' payoff from inflating ratings, discouraging information distortion by CRAs (Corollary 2 (ii)).

4.3 EFFICIENCY CONSIDERATIONS RELATED TO RATING INDUSTRY COMPETITION

Intensifying competition in the rating industry not only influences the entrepreneur's and CRAs' information reporting but also ex ante investment efficiency, as measured by the expected NPV of realized projects. We again focus on the R_H case and assume that investment does not occur in cases $\{R_L, G\}$ and $\{R_L, G_1, G_2\}$ for the monopolistic and the duopolistic rating industry, respectively.¹⁶ For a level of manipulation $m^* \in \{m_M^*, m_D^*\}$, the expected NPV of realized projects is as follows:

$$[\alpha + (1 - \alpha)\theta m^*](x - 1) - (1 - \alpha)(1 - \theta)m^*.$$

Note that, due to the NPV assumptions imposed in our paper, the NPV of realized projects is unambiguously positive. The main loss of efficiency occurs due to the entrepreneur's manipulation m^* , because more manipulation leads to a higher likelihood that bad type projects are realized. Therefore the effect of competition on investment efficiency is inversely proportional (i.e., they have opposite signs) to its effect on the entrepreneur's misreporting incentives outlined in Proposition 3. The next corollary summarizes the corresponding results.

Corollary 3 *An increase in the intensity of competition in the credit rating industry impacts investment efficiency as follows.*

- (i) *Investment efficiency decreases if credit ratings are sufficiently precise ($q > \bar{q}$ and $\gamma > \bar{\gamma}$).*
- (ii) *Investment efficiency increases if credit ratings are sufficiently noisy ($q < \bar{q}$ or $\gamma < \bar{\gamma}$).*

¹⁶ A sufficient condition such that investment does not occur in either setting is $\theta < \frac{(1-q)^2}{(1-q)+q(qx-1)}$. This condition is henceforth imposed.

5 The Effects of Rating Agencies' Gatekeeper Role

In this section, we consider the impact of an important institutional feature of the rating industry: CRAs' role as gatekeepers to debt markets. This role is established by two institutional observations. First, prior to Dodd-Frank, credit ratings were used to regulate certain institutional investors by prohibiting them from investing in securities with a regulatory rating of speculative grade. Second, large retirement and other mutual funds commit themselves to invest exclusively in investment-grade debt, imposing similar internal policies as the ones mandated for other investment companies.

We study the effects of CRAs' gatekeeper role by assuming that, in the presence of one or two CRAs, the entrepreneur must provide at least one favorable rating to receive capital from investors. CRAs' gatekeeper role therefore influences equilibrium investment, as it prevents some projects from being funded, even when the entrepreneur would want to undertake them.

5.1 THE GATEKEEPER ROLE IN A MONOPOLISTIC RATING INDUSTRY

We first show the effects of the gatekeeper role in a monopolistic rating industry. If the entrepreneur must provide a favorable credit rating to receive funding, this changes both her rating purchase decision in case of R_H and her manipulation decision. Recall that the CRA considers the rating purchase decision in its fee setting problem as a set of constraints. With the gatekeeper role, the (binding) constraint is

$$Pr(x|b, G) [x - (1 + \hat{r}_{1,H,M})] - F_{H,M} \geq 0,$$

instead of (2c), since investors do not provide capital to the entrepreneur when they do not observe a favorable rating, in which case the conditionally expected utility for the entrepreneur becomes zero. The resulting rating fee $F_{H,M}$ when the CRA assumes a gatekeeper role is therefore

$$F_{H,M} = Pr(x|b, G) [x - (1 + \hat{r}_{1,H,M})].$$

The entrepreneur's accounting manipulation problem becomes

$$\max_{m_M} m_M \left\{ Pr(x, G|b) [x - (1 + \hat{r}_{1,H,M})] - Pr(G|b) \hat{F}_{H,M} \right\} - \frac{m_M^2 \mu}{2}.$$

We show in the appendix that there exists a unique equilibrium in this setting. The following lemma provides an important observation in regard to this equilibrium.

Lemma 1 *When a monopolistic CRA acts as a gatekeeper, this leads to truthful disclosure by the entrepreneur (i.e., $m_M^* = 0$).*

Lemma 1 states that, when a monopolistic CRA acts as a gatekeeper, the entrepreneur does not have incentives to misreport. Given the gatekeeper role, the CRA can extract the entire expected rent from realizing the project from an entrepreneur with type information b . This rent is proportional to $\left[x - (1 + r_{1,M}^*)\right]$. Therefore the expected utility of an entrepreneur who observes b reduces to zero, making her indifferent about project investment. Since there is no utility gain from engaging in costly manipulation, she reports truthfully ($m_M^* = 0$).

A comparison of the equilibria with and without the gatekeeper role in a monopolistic rating industry yields the following insights.

Proposition 5 *Under a rating industry monopoly, the CRA losing its gatekeeper status leads to*

- (i) *a lower rating fee $F_{H,M}^*$;*
- (ii) *less rating inflation $s_{H,M}^*$; and*
- (iii) *more accounting manipulation m_M^* .*

The rationale behind the results in Proposition 5 is as follows. When a monopolistic CRA assumes a gatekeeper role, it not only extracts the rent generated by favorable rating G , which is proportional to the difference $(r_{0,M}^* - r_{1,M}^*)$, but also the residual rent proportional to $\left[x - (1 + r_{0,H,M}^*)\right]$. In contrast, when the monopolistic CRA loses its status as a gatekeeper, while it still extracts the rent generated from providing rating G , the entrepreneur now retains the residual rent. Consistent with this rationale, if the CRA loses its gatekeeper status, it sets a lower fee (Proposition 5 (i)), which decreases its rating inflation incentives (Proposition 5 (ii)). While the entrepreneur reports truthfully if the CRA is a gatekeeper (Lemma 1), the entrepreneur develops incentives to misreport once the CRA loses its gatekeeper status, as she retains the residual rent (Proposition 5 (iii)).

5.2 THE GATEKEEPER ROLE IN AN IMPERFECTLY COMPETITIVE RATING INDUSTRY

Next, we examine how the CRAs' gatekeeper role affects equilibrium behavior in the case with imperfect rating industry competition. Note that, the gatekeeper role directly affects CRAs' fee setting problem if and only if the rating fee results from a comparison between the entrepreneur's expected utilities of one or two favorable ratings against no favorable rating, as is the case in the monopolistic CRA case. However, in the case with imperfect rating industry competition, the fee is determined by participation constraint (6b) and thus by the marginal value of the second rating. Therefore, in contrast to the monopolistic case, the gatekeeper role does not change CRAs' fee setting in the case with imperfect competition.¹⁷ As will become clear below, the main mechanism through which the CRAs' gatekeeper role affects the equilibrium is the entrepreneur's manipulation.

The entrepreneur solves a problem similar to the one in Section III, which leads to the following equilibrium condition after enforcing all conjectures:¹⁸

$$m_D = \frac{\theta}{\mu} [1 - (1 - q)^2(1 - s_{H,D})^2] [x - (1 + r_{0,H,D})] + \frac{\theta}{\mu} \Phi \quad (9)$$

As before, the aggregation term Φ captures the expected surplus retained by the entrepreneur resulting from rating industry competition. In the appendix, we show that there exists a unique equilibrium in this setting. In the following proposition, we present the core results related to the impact of the gatekeeper role on the equilibrium with imperfect rating industry competition.

Proposition 6 *Under imperfect rating industry competition, CRAs losing their gatekeeper status leads to:*

- (i) *higher rating fees $F_{H,D}^*$;*
- (ii) *more rating inflation $s_{H,D}^*$; and*
- (iii) *more accounting manipulation m_D^* .*

In the setting with imperfect competition in the rating industry, CRAs' gatekeeper role influences

¹⁷Note that this logic continues to hold for cases with more than two CRAs. For example, in a scenario with three CRAs, where an issuer is required to provide at least two favorable ratings such that the regulatory rating is investment grade, the fee is set by comparing the expected utilities of the cases with three or two favorable ratings, due to the strictly decreasing marginal information value of credit ratings and price competition. Therefore CRAs' gatekeeper role would not affect the fee setting and rating inflation problem with more than two CRAs either.

¹⁸Note that the equilibrium condition is written with $r_{0,H,D}$, even though no investment occurs in this case due to the gatekeeper role. This is done for expositional purposes only to enable a straightforward comparison between the cases with and without the gatekeeper role.

the equilibrium strategies only through the entrepreneur's accounting manipulation decision. In particular, the entrepreneur's conditionally expected utility strictly increases when CRAs lose their gatekeeper status, since the project can now also be financed without a favorable rating. The entrepreneur's expected utility increases by an amount equal to the expected value of realizing the project without a favorable rating. It follows that the entrepreneur chooses a higher level of manipulation (Proposition 6 (iii)). As financial reporting becomes less informative, the incremental information value of favorable ratings increases, enabling CRAs to increase their rating fees. This in turn encourages rating inflation, making ratings also less informative.

The results in Proposition 6 (i) and (ii) contrast with the effects of the gatekeeper role in the setting with a monopolistic CRA, summarized in Proposition 5 (i) and (ii). 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 rating industry. In particular, when a monopolistic CRA acts as a gatekeeper, the CRA can increase its rating fee to extract the entire expected surplus of undertaking the project as assessed by an entrepreneur with information endowment b . The higher fee ultimately results in more rating inflation. In contrast, under imperfect CRA competition, the primary way through which CRAs' gatekeeper role influences their decisions is through the entrepreneur's manipulation decision without directly influencing CRAs' fees and inflation. Overall, Proposition 6 presents an unanticipated benefit of CRAs' gatekeeper role—better information from both firms and CRAs. CRAs' gatekeeper role stemming from investors' reliance on ratings has been criticized for contributing to rating inflation, which played a crucial role in the recent financial crisis. However, the results in Proposition 6 not only contradict this criticism but also show that the gatekeeper role can actually increase the informativeness of both credit ratings and financial reports.

In the following corollary, we re-examine the result from Proposition 3 on how a change in rating industry competition impacts the entrepreneur's misreporting incentives for the case where CRAs are gatekeepers to debt markets.

Corollary 4 *Given that CRAs are gatekeepers, an increase in the intensity of competition in the credit rating industry leads to a strict increase in accounting manipulation ($m_M^* < m_D^*$).*

In contrast to the case without CRAs' gatekeeper role, Corollary 4 establishes that an increase in

the intensity of competition in the rating industry unambiguously increases misreporting incentives when CRAs act as gatekeepers. Under Proposition 3, we have established the existence of two countervailing effects of competition: one related to competition limiting CRAs' ability to extract rents and another related to investors charging a higher interest rate when no favorable rating is provided. It is the second effect that does *not* arise when CRAs act as gatekeepers, since investment does not occur without a favorable rating, resulting in the entrepreneur not internalizing this second effect.

Finally, we re-examine the comparative statics results in Corollaries 1 and 2, given CRAs' role as gatekeepers. It can be shown that the associations in Corollary 1 (i) and (ii) and Corollary 2 continue to hold, even when CRAs assume a gatekeeper role. However, the following corollary restates the result in Corollary 1 (iii) for the current case.

Corollary 5 *Given that CRAs are gatekeepers and accounting manipulation costs are sufficiently large ($\mu > \bar{\mu}_1$), accounting manipulation and rating inflation are strategic complements.*

If CRAs act as gatekeepers, there are two countervailing effects associated with rating inflation in the entrepreneur's manipulation strategy in condition (9). The first effect was discussed under Corollary 1: higher rating-inflation costs lead to less rating inflation and thus to more informative ratings, which in turn increases the expected rating-generated surplus (Φ) retained by the entrepreneur. This leads her to misreport more when ratings are less distorted. However, the gatekeeper role gives rise to another countervailing effect, which is captured by the conditional probability $Pr(x|b) = \theta [1 - (1 - q)^2(1 - s_{H,D})^2]$: while the entrepreneur is always willing to pursue a project as long as she reports R_H , with CRAs as gatekeepers investment does not occur if she does not receive a favorable rating, reducing her utility from misreporting. The more ratings are inflated, the smaller this foregone expected utility is, and the entrepreneur's incentive to misreport strengthens.

Which of the two effects is stronger depends on the circumstances. Corollary 5 shows that, as long as accounting manipulation is constrained by sufficiently large manipulation costs, $\mu > \bar{\mu}_1$, manipulation unambiguously decreases in rating inflation costs γ and thus increases in rating inflation. This means that, as long as financial reporting is sufficiently informative and the information content of favorable ratings is sufficiently limited, the investment effect of rating inflation dominates the effect on the expected rating-generated surplus. Together with Corollary 2 (ii), it follows that

accounting manipulation and rating inflation are strategic complements.

5.3 EFFICIENCY CONSIDERATIONS RELATED TO RATING AGENCIES' GATEKEEPER ROLE

In a last step of our analysis, we discuss the implications of CRAs' gatekeeper role for ex ante investment efficiency in an imperfectly competitive rating industry. The next proposition summarizes our finding.

Proposition 7 *For a given $s_{H,D} \in (0, 1)$ and given that accounting manipulation costs are sufficiently large ($\mu > \bar{\mu}_2$), investment efficiency increases when CRAs lose their gatekeeper status. Investment efficiency can increase or decrease otherwise.*

The rationale behind the result in Proposition 7 is as follows. Eliminating CRAs' gatekeeper role contributes to investment efficiency. If investment is not limited to projects with favorable ratings, the efficiency gain from financing a good type project (case $\{g, R_H, B_1, B_2\}$) outweighs the efficiency loss from financing a bad one that was successfully misreported as a good type by the entrepreneur (case $\{b, R_H, B_1, B_2\}$). However, a countervailing information-related effect arises through misreporting: according to Proposition 6 (iii), the removal of CRAs' gatekeeper role strengthens the entrepreneur's misreporting incentives. Increased misreporting reduces efficiency as bad type projects, which have a negative NPV, are more likely to receive financing. In Proposition 7, we show that, for a fixed $s_{H,D} \in (0, 1)$, there exists a unique threshold $\bar{\mu}_2$ such that, if the entrepreneur's manipulation costs are sufficiently high ($\mu > \bar{\mu}_2$), the latter effect is sufficiently moderated so that investment efficiency unambiguously increases when CRAs lose their status as gatekeepers.¹⁹

6 Discussion and Implications

6.1 IMPLICATIONS

Our paper's results can be reconciled with empirical evidence and additionally provide the basis for future empirical investigations. First, we show that more corporate misreporting leads to more rating

¹⁹Note that in Proposition 7 we treat rating inflation $s_{H,D}$ as exogenously given to focus on the primary effects associated with stripping the gatekeeper role from CRAs. Considering endogenous rating inflation $s_{H,D}^*$ significantly increases complexity of the proof without leading to further key insights.

inflation (Corollary 2). This association reconciles with the empirical findings of Jiang [2008], Alissa et al. [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. Alissa et al. [2013] provide evidence that better financial performance leads to a positive rating change, and Jung, Soderstrom, and Yang [2013] provide findings 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 firms manage earnings to influence CRAs' information and that CRAs fail to unravel earnings management in firms' financial statements, this seems to understate their sophistication. 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: more corporate financial misreporting (e.g., as a consequence of lower manipulation costs) makes financial reports less informative, relative to credit ratings. As the value of a favorable rating increases, CRAs can charge a higher fee, which in turn increases their incentive to inflate ratings.

Our paper further highlights how financial misreporting and rating inflation endogenously interact in the presence of an imperfectly competitive rating industry. Regarding the impact of increased public scrutiny on CRAs' rating inflation (e.g., an increase in rating inflation costs), our model predicts that firms may respond by decreasing accounting manipulation if manipulation costs are sufficiently high. This observation can then be viewed as indirect evidence of the gatekeeper role of CRAs (Corollary 5). To our knowledge, systematic evidence on this part of the endogenous association is still missing. The increased scrutiny on CRAs resulting from the recent financial crisis and their increased litigation risk may provide a feasible setting to study the effects of increased rating inflation costs on CRAs' behavior as well as on firms' misreporting.

Our paper also illuminates the impact of competition in the rating industry on CRAs' rating inflation incentives and issuers' reporting decisions. Under Propositions 3 and 4, we argue that increased competition limits CRAs' ability to extract rents from the entrepreneur, which in turn reduces their inflation incentives. This can then lead to more corporate misreporting. Empirical evidence regarding the impact of competition in the rating industry on issuers' reporting decisions is, to the best of our knowledge, still missing. However, prior literature has documented how

competition in the rating industry may affect rating quality. Becker and Milbourn [2011] show 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 were willing to sacrifice long-term reputation for short-term market share by catering to firms’ preferences for favorable ratings. The entrant, Fitch, also increased rating inflation to become more competitive.²⁰ Our paper provides an alternative explanation: if more intense competition leads to more misreporting—as is the case either when ratings are sufficiently precise (Proposition 3 (i)) or when CRAs are gatekeepers (Corollary 4)—this leads to an increase in the relative informativeness of credit ratings. This then counters the effect of competition on CRAs’ ability to extract rents. If this effect is strong enough, this would lead to more rating inflation and thus lower rating quality, even when marginal rating inflation costs are held constant.

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, which received the status of an NRSRO in 2003. They document that the change 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, if one rating by Standard & Poor’s 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. 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. This is an important question insofar as our model suggests that regulatory reliance primarily affects issuers’ disclosure behavior and the effects on rating fees and rating inflation are indirect consequences.

Our investigation should also be of interest to regulators. First, regulators across the world have argued for an increase in rating industry competition. The general aim of the 2013 amendments to

²⁰ A similar argument is proposed in Bolton, Freixas, and Shapiro [2012], who show that increased CRA competition yields increased rating inflation. Their result is based on the assumption that CRAs’ reputational costs from rating inflation are smaller in a duopoly than in a monopoly.

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. We show that more competition can strengthen firms’ misreporting incentives, which then impairs investment efficiency. Second, regulators have also taken steps to undermine the gatekeeper status of CRAs. One example 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 We show that the direct effect of weakening the gatekeeper role on investment efficiency is beneficial, as positive NPV projects are more likely to be undertaken. This corresponds to the spirit of the mentioned regulation. However, the removal of the gatekeeper role also induces more corporate misreporting, which has a detrimental effect on investment efficiency. Thus there exists an unanticipated benefit of CRAs’ gatekeeper role, namely better information provided by firms. Overall, our study implies that regulators should consider the unintended consequences of potentially strengthening issuers’ misreporting incentives.

6.2 ROBUSTNESS DISCUSSION

In our model we impose a number of simplifying assumptions. In the following, we provide a discussion of the robustness of our inferences.

Unsolicited credit ratings and the reporting of receipt of indicative ratings by issuers. The CRAs in our investigation offer ratings to issuers that are only made public if those ratings are purchased. This implies that unfavorable ratings are never made public. For U.S. corporate bonds, unsolicited ratings, which are not purchased but are nevertheless made public, are relatively rare. However, after the financial crisis of 2007–2008, government agencies have encouraged CRAs to provide more unsolicited ratings (Acharya et al. [2010]). Another measure that has been proposed by the SEC—but not adopted by Dodd-Frank—is the disclosure of the receipt of indicative ratings (Sangiorgi and Spatt [2017]). Neither the disclosure of an unsolicited unfavorable rating, nor disclosure of the receipt of an indicative rating, has implications in our setting, as investors rationally conjecture that an unobserved rating must have been unfavorable.²²

Rating-contingent accounting manipulation costs. In our model, we assume that the entrepreneur’s

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

²²Fulghieri, Strobl, and Xia [2014] study a setting in which CRAs observe information about an issuer’s project and thus offer a rating to the issuer only with a probability. In this case, the disclosure of unsolicited credit ratings has implications for equilibrium behavior.

manipulation costs ($m^2\mu/2$) are independent of ratings. However, the manipulation costs, which are imposed by mechanisms such as investor litigation or public enforcement, may vary, depending on the credit ratings that are issued. As an example, consider the potential implications of credit ratings for investor litigation. On the one hand, the expected costs of manipulation may be higher for firms with unfavorable ratings (which is inferred by rational investors from a rating nonpurchase), as unfavorable ratings increase the posterior probability of investors to litigate. On the other hand, the expected costs of misreporting may be higher for firms with favorable credit ratings, since in this case, investors rely more on the entrepreneur's report and demand lower capital returns, increasing the damage that investors can claim in court. Overall, while it would be interesting to consider rating-contingent manipulation costs, it is difficult to conclude whether expected manipulation costs would be larger or smaller for favorable ratings, compared to unfavorable ratings, without imposing more structure in regards to the mechanism that generates such costs. Thus we limit the scope of our paper to how credit ratings influence an entrepreneur's *benefit* of misreporting and not how they influence her costs. We leave this to future research.

Endogenous CRA information processing and acquisition. Our study focuses on strategic rating inflation and its implications for firms' misreporting incentives. We hold the rating process constant and assume that the incremental private information S_i derived by CRAs is exogenously given and that its quality q is independent from manipulation m^* . An endogenous consideration of the rating process is a nontrivial exercise and ideally includes two simultaneous processes, which derive two signals, one about the firm's financial risk profile and a second about its business risk profile (Standard and Poor's [2014]). The former is derived from financial report R and can be modeled as a certification or screening technology that attempts to uncover the manipulation contained in the report (Cohn, Rajan, and Strobl [2018]). The latter corresponds more to an information acquisition mechanism. Both screening and information acquisition, which may be jointly referred to as information generation, are costly. With endogenous CRA information, the private information S_i would result from the aggregation of both signals.

Endogenous information generation considers a trade-off between generating information that is valuable for investors and the entrepreneur and information generation costs. In equilibrium, the information generation strategy would incorporate accounting manipulation m^* after observing favorable report R_H , as both the likelihood of obtaining and selling a favorable rating and the

likelihood of incurring rating inflation costs are tied to the firm's fundamentals.²³ Turning to the robustness of our results, given a level of manipulation m , intensifying competition in the rating industry not only undermines CRAs' incentives to inflate ratings but also to generate information. It is an open question whether this increases or decreases the informativeness of ratings; we leave this to future research. As for CRAs' gatekeeper role, the CRAs' expected payoff is unaffected by the removal because, regardless of the gatekeeper role, CRAs do not receive a payoff if they do not provide a favorable rating. Therefore the entrepreneur's misreporting remains the sole mechanism through which the gatekeeper role affects the equilibrium under imperfect rating industry competition.

Reputational and litigation considerations of CRAs. Throughout the paper, we assume that CRAs' rating inflation costs, $s_i^2\gamma/2$, do not vary (i) across different levels of competition in the rating industry, (ii) depending on other CRAs' ratings in an imperfectly competitive rating industry, or (iii) with the likelihood of issuer default and thus across different financial report realizations. It is a nontrivial question whether rating inflation costs increase or decrease with CRA competition. Bolton, Freixas, and Shapiro [2012] assume that CRAs' reputational costs from rating inflation are smaller in a duopoly than in a monopoly, i.e., $\gamma_M > \gamma_D$. This assumption co-determines their claim that rating inflation increases with rating industry competition. Corollary 1 shows that a decrease in rating inflation costs leads to more rating inflation and less manipulation. Therefore the consideration of differential costs influences our inference with respect to the effects of CRA competition on manipulation, as summarized in Proposition 3. In particular, this effect may reinforce the price protection effect, supporting a negative impact of rating industry competition on accounting manipulation.

When CRAs' rating inflation costs reflect their future competitive position in an imperfectly competitive rating industry, these costs may also be influenced by the ratings other CRAs provide. For instance, in our duopolistic setting in which one CRA's rating was unfavorable but the other was favorable, the CRA providing the latter may face higher costs of rating inflation than in the case in which both CRAs provided favorable ratings. Because both CRAs act simultaneously in our model, considering reputation costs that depend on the other CRA's ratings introduces uncertainty about the reputation or litigation costs into the CRAs' decision problem. From CRA i 's perspective,

²³It is CRAs' updating and the dependence of q on m^* that would significantly increase model complexity.

the higher the anticipated rating inflation by CRA j , the lower the expected reputation cost. In equilibrium, rating inflation by both CRAs may therefore become strategic complements, impairing the information content of all favorable ratings. The consequences of such a scenario resemble those discussed above under point (i).

As for (iii), suppose a CRA incurs reputational costs only if it issues a favorable rating for a project that fails. Since the posterior likelihood of default is larger for an issuer with R_L than R_H (i.e., $Pr(0|R_L, S_{i,B}) > Pr(0|R_H, S_{i,B})$ for all $m \in (0, 1)$), CRAs' expected rating inflation costs would be higher for an issuer that provided unfavorable financial report R_L , as compared to the case with favorable financial report R_H . This does not affect the entrepreneur's misreporting incentives, since we have shown that the R_L case does not influence her incentives. Further, it can be shown that CRAs' responses to changes in manipulation (Corollary 2 (i) and (ii)) are unaffected by this assumption.

Rating agencies' gatekeeper role and corporate investment. We study the effects of CRAs' gatekeeper role with the simplifying assumption that the absence of a favorable 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 but not others. Because large institutional investors hold much of the market's capital by definition, removing them should have implications for liquidity.²⁴ This, in turn, impairs the cost of debt, leaving issuers with a smaller positive or even negative expected rent, where, in the latter case, the project is not undertaken. As long as the gatekeeper role reduces the rent retained by firms, most of our results continue to hold.

7 Conclusion

We study firms' financial reporting incentives in the presence of strategic CRAs and how these incentives are affected by changes in the intensity of rating industry competition and CRAs' role as gatekeepers to debt markets. We find that more intense rating industry competition increases or decreases corporate misreporting incentives, depending on the information precision of credit ratings and on whether CRAs act as gatekeepers. In addition, we show that CRAs' gatekeeper role affects the equilibrium differently, depending on the level of competition in the rating industry. When a

²⁴Note that we do not consider liquidity effects in our model, as we assume perfect investor competition.

monopolistic CRA loses its gatekeeper status, this leads to more financial misreporting but lower rating inflation and fees. However, for an imperfectly competitive rating industry, we predict that CRAs losing their gatekeeper status leads to more misreporting, more rating inflation, and higher fees. We further show that, in the presence of an imperfectly competitive rating industry, where CRAs do not assume the gatekeeper role, increased scrutiny on CRAs results in more informative credit ratings but less informative financial reporting. In contrast, when CRAs are gatekeepers, increased scrutiny on CRAs can, under certain conditions, also lead to more informative financial reporting, implying that corporate financial misreporting and rating inflation are strategic complements. Finally, our investigation should be of interest to regulators, as it highlights potential unintended consequences of increasing competition in the rating industry as well as those of weakening of CRAs' gatekeeper role. We show that investment efficiency may decline with intensifying competition or ridding CRAs of their gatekeeper status, due to the effects on firms' misreporting incentives.

There are several promising avenues for future research. First, our paper's findings are based on imperfect competition between identical CRAs. While this provides insight regarding the effects of competition between the top CRAs, there are also smaller CRAs, which may differ in their rating inflation costs, due to smaller (or higher) litigation or reputational risk. Therefore it may be worthwhile to examine settings where CRAs are not identical or where a smaller CRA enters a market with larger incumbents. Second, 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 watch list and revise their ratings once new information becomes available. This is particularly important in light of rating-based debt covenants (Bhanot and Mello [2006], Manso, Strulovici, and Tchistyi [2010]). In addition, we remain largely silent about debt contracting efficiency considerations. One avenue for future research could be to investigate the relative efficiency of accounting-based and rating-based debt covenants when both debt issuers and CRAs strategically report or distort information. Third, we hold the information processing of CRAs constant and focus on the interaction between firms' misreporting and CRAs' fee setting and rating inflation. However, CRAs not only acquire information but also process it. They do so in a semi-public way in that they perform adjustments to financial statement information in the rating process. While some of these adjustments lead to more conservative raw ratings, other adjustments lead to more

aggressive ones.²⁵ This observation is puzzling insofar as more conservative private information a priori reduces the likelihood of a favorable rating and thus of selling a rating to a firm. Overall, there exist considerable avenues for future research on the interaction between corporate disclosure, credit ratings, and debt contracting.

Appendix

PROOF OF PROPOSITION 1

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

Claim 1: The interest rates are obtained by substituting the following probabilities into the interest rate calculations:

$$\begin{aligned} Pr(x|R_H) &= Pr(x|R_H, B) = \frac{[\alpha + (1-\alpha)\theta\hat{m}_M](1-q)}{[\alpha + (1-\alpha)\theta\hat{m}_M](1-q) + (1-\alpha)(1-\theta)\hat{m}_M q}, \\ Pr(x|R_H, G) &= \frac{[\alpha + (1-\alpha)\theta\hat{m}_M][q + (1-q)\hat{s}_{H,M}]}{[\alpha + (1-\alpha)\theta\hat{m}_M][q + (1-q)\hat{s}_{H,M}] + (1-\alpha)(1-\theta)\hat{m}_M[(1-q) + q\hat{s}_{H,M}]}, \\ Pr(x|R_L) &= Pr(x|b, B) = \frac{\theta(1-q)}{\theta(1-q) + (1-\theta)q}, \\ Pr(x|R_L, G) &= Pr(x|b, G) = \frac{\theta[q + (1-q)\hat{s}_{L,M}]}{\theta[q + (1-q)\hat{s}_{L,M}] + (1-\theta)[(1-q) + q\hat{s}_{L,M}]}. \end{aligned}$$

The resulting interest rates are as follows:

$$r_{0,H,M} = \frac{1 - Pr(x|R_H)}{Pr(x|R_H)} = \frac{(1-\alpha)(1-\theta)\hat{m}_M}{[\alpha + (1-\alpha)\theta\hat{m}_M]} \frac{q}{(1-q)}, \quad (10)$$

$$r_{1,H,M} = \frac{1 - Pr(x|R_H, G)}{Pr(x|R_H, G)} = \frac{(1-\alpha)(1-\theta)\hat{m}_M}{[\alpha + (1-\alpha)\theta\hat{m}_M]} \frac{[(1-q) + q\hat{s}_{H,M}]}{[q + (1-q)\hat{s}_{H,M}]}, \quad (11)$$

$$r_{0,L,M} = \frac{1 - Pr(x|R_L)}{Pr(x|R_L)} = \frac{(1-\theta)}{\theta} \frac{q}{(1-q)}, \quad (12)$$

$$r_{1,L,M} = \frac{1 - Pr(x|R_L, G)}{Pr(x|R_L, G)} = \frac{(1-\theta)}{\theta} \frac{[(1-q) + q\hat{s}_{L,M}]}{[q + (1-q)\hat{s}_{L,M}]}. \quad (13)$$

Claim 2: Solutions to the CRA's optimization problems

The CRA's problem when the financial report is R_H is presented by conditions (2a)–(2d). We apply the first-order approach on condition (2d), and the optimization yields the solution presented in (4). Further, we rule out participation constraint (2b) since constraint (2c) is tighter because

²⁵Significant theoretical research on the association between accounting conservatism and debt contracting includes Gigler et al. [2009] and Li [2013].

$Pr(x|g, G) > Pr(x|b, G)$. We solve the optimization program by inserting the solution from (4) into the maximization problem in (2a) and by using a Lagrange multiplier λ on condition (2c). The Lagrangian is

$$\mathcal{L} = \frac{[\alpha + (1-\alpha)\theta\hat{m}_M][q + (1-q)\frac{F_{H,M}}{\gamma}] + (1-\alpha)(1-\theta)\hat{m}_M[(1-q) + q\frac{F_{H,M}}{\gamma}]}{[\alpha + (1-\alpha)\hat{m}_M]} F_{H,M} - \frac{[\alpha + (1-\alpha)\theta\hat{m}_M](1-q) + (1-\alpha)(1-\theta)\hat{m}_M q}{[\alpha + (1-\alpha)\hat{m}_M]} \frac{F_{H,M}^2}{2\gamma} - \lambda [F_{H,M} - Pr(x|b, G) (\hat{r}_{0,H,M} - \hat{r}_{1,H,M})]$$

since $Pr(G|R_H) = \frac{[\alpha + (1-\alpha)\theta\hat{m}_M][q + (1-q)s_{H,M}] + (1-\alpha)(1-\theta)\hat{m}_M[(1-q) + qs_{H,M}]}{[\alpha + (1-\alpha)\hat{m}_M]}$ with $s_{H,M} = \frac{F_{H,M}}{\gamma}$ and $Pr(S_B|R_H) = \frac{[\alpha + (1-\alpha)\theta\hat{m}_M](1-q) + (1-\alpha)(1-\theta)\hat{m}_M q}{[\alpha + (1-\alpha)\hat{m}_M]}$.

The first-order conditions of the Lagrangian with respect to $F_{H,M}$ and λ are as follows:

$$\frac{\partial \mathcal{L}}{\partial F_{H,M}} = \frac{[\alpha + (1-\alpha)\theta\hat{m}_M][q + (1-q)\frac{F_{H,M}}{\gamma}] + (1-\alpha)(1-\theta)\hat{m}_M[(1-q) + q\frac{F_{H,M}}{\gamma}]}{[\alpha + (1-\alpha)\hat{m}_M]} - \lambda = 0,$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = -[F_{H,M} - Pr(x|b, G) (\hat{r}_{0,H,M} - \hat{r}_{1,H,M})] = 0$$

where

$$Pr(x|b, G) = \frac{\theta[q + (1-q)\hat{s}_{H,M}]}{\theta[q + (1-q)\hat{s}_{H,M}] + (1-\theta)[(1-q) + q\hat{s}_{H,M}]}.$$

Rearranging $\frac{\partial \mathcal{L}}{\partial F_{H,M}} = 0$ with respect to λ shows that the Lagrange multiplier is always positive as long as $F_{H,M} > 0$, implying that the participation constraint (2c) must be binding. Rearranging $\frac{\partial \mathcal{L}}{\partial \lambda} = 0$ with respect to $F_{H,M}$ yields the condition in (3).

The monopolistic CRA's problem in the R_L case is similar to the R_H case except that now there only exists one participation constraint as an unfavorable report R_L can only occur when the entrepreneur observed signal b . The CRA therefore considers the following participation constraint:

$$Pr(x|b, G) [x - (1 + \hat{r}_{1,L,M})] - F_{L,M} \geq 0. \quad (14)$$

Note that participation constraint (14) reflects the observation that investment does not occur when $\{R_L, B\}$, in which case the entrepreneur's expected utility is 0. In addition, the CRA can only obtain a positive rating fee (and thus provide a rating in the first place) if and only if $[x - (1 + \hat{r}_{1,L,M})] > 0$, which holds only under some circumstances. Using similar solution procedures as before, the solution to the CRA's problem in the R_L case is as follows:

$$F_{L,M} = \max \left\{ 0, \frac{\theta [q + (1 - q) \hat{s}_{L,M}]}{\theta [q + (1 - q) \hat{s}_{L,M}] + (1 - \theta) [(1 - q) + q \hat{s}_{L,M}]} [x - (1 + \hat{r}_{1,L,M})] \right\}, \quad (15)$$

$$s_{L,M} = \frac{F_{L,M}}{\gamma}. \quad (16)$$

The CRA's fee setting strategy when the financial report is R_L implies that the entrepreneur's expected utility in this case is zero.²⁶

Claim 3: Derivation of equilibrium condition (5)

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

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

Enforcing all conjectures and inserting the rating fee from (3), the above condition can be written as

$$m_M = \frac{1}{\mu} \left\{ Pr(x|b) x - Pr(x, G|b)(1 + \hat{r}_{1,H,M}) - Pr(x, B|b)(1 + \hat{r}_{0,H,M}) - Pr(G|b) Pr(x|b, G) (\hat{r}_{0,H,M} - \hat{r}_{1,H,M}) \right\}.$$

Note that $Pr(x, G|b) = \theta [q + (1 - q) s_{H,M}]$, $Pr(x, B|b) = \theta (1 - q) (1 - s_{H,M})$, and $Pr(G|b) = \theta [q + (1 - q) s_{H,M}] + (1 - \theta) [(1 - q) + q s_{H,M}]$. Since $Pr(x, G|b) = Pr(G|b) Pr(x|b, G)$, this further simplifies to the condition presented in (5).

Claim 4: Proof of equilibrium uniqueness

We prove the uniqueness of the equilibrium in two steps. First observe that the condition in (5) is independent of $s_{H,M}$. (5) can be rearranged to

$$Z_M = \theta [x - (1 + r_{0,H,M})] - \mu m_M = 0.$$

The term in the bracket is unambiguously positive under the assumptions made. Next observe that

²⁶ A sufficient condition under which CRAs offer ratings to the entrepreneur under both the monopoly and the duopoly setting in case R_L is $x > \frac{\theta q + (1 - \theta)(1 - q)}{\theta q}$. This condition is stricter than the NPV assumption in (1).

Z_M monotonically decreases in m_M :

$$\frac{\partial Z_M}{\partial m_M} = -\theta \frac{\partial r_{0,H,M}}{\partial m_M} - \mu < 0$$

since $\frac{\partial r_{0,H,M}}{\partial m_M} > 0$. Moreover, the limits of $Z_M(m_M)$ when m_M approaches 0 and 1 are

$$\lim_{m_M \rightarrow 0} Z_M = \theta(x - 1) > 0$$

$$\lim_{m_M \rightarrow 1} Z_M = \theta \left\{ x - \left[1 + \frac{(1 - \alpha)(1 - \theta)}{[\alpha + (1 - \alpha)\theta]} \frac{q}{(1 - q)} \right] \right\} - \mu,$$

respectively. The limit of Z_M when $m_M \rightarrow 1$ is negative when μ is sufficiently large. An explicit condition on μ is derived in Claim 5 of the Proof of Proposition 2. It follows that there must exist a unique manipulation effort $m_M = m_M^* \in (0, 1)$.

Next, we prove the uniqueness of the CRA's choice variables, $s_{H,M}$, $s_{L,M}$, $F_{H,M}$ and $F_{L,M}$. First consider the R_H case. For this, we insert the rating fee presented in (3) into condition (4) and rearrange to define the following equilibrium condition:

$$Y_{H,M} = \frac{(1 - \alpha)(1 - \theta)m_M^*}{[\alpha + (1 - \alpha)\theta m_M^*]} \frac{\theta(2q - 1)}{(1 - q)\{\theta[q + (1 - q)s_{H,M}] + (1 - \theta)[(1 - q) + qs_{H,M}]\}} - s_{H,M}\gamma = 0.$$

Observe that the first term is always positive. Further, $Y_{H,M}(m_M^*, s_{H,M})$ has the following properties with respect to $s_{H,M}$:

$$\frac{\partial Y_{H,M}}{\partial s_{H,M}} = -\frac{(1 - \alpha)(1 - \theta)m_M^*}{[\alpha + (1 - \alpha)\theta m_M^*]} \frac{\theta(2q - 1)[\theta(1 - q) + (1 - \theta)q]}{(1 - q)\{\theta[q + (1 - q)s_{H,M}] + (1 - \theta)[(1 - q) + qs_{H,M}]\}^2} - \gamma < 0,$$

$$\lim_{s_{H,M} \rightarrow 0} Y_{H,M} = \frac{(1 - \alpha)(1 - \theta)m_M^*}{[\alpha + (1 - \alpha)\theta m_M^*]} \frac{\theta(2q - 1)}{(1 - q)\{\theta q + (1 - \theta)(1 - q)\}} > 0,$$

$$\lim_{s_{H,M} \rightarrow 1} Y_{H,M} = \frac{(1 - \alpha)(1 - \theta)m_M^*}{[\alpha + (1 - \alpha)\theta m_M^*]} \frac{\theta(2q - 1)}{(1 - q)} - \gamma.$$

Note that $\frac{\partial Y_{H,M}}{\partial s_{H,M}} < 0$ for all $m_M^*, s_{H,M} \in (0, 1)$ and that the limit of $Y_{H,M}$ when $s_{H,M} \rightarrow 0$ is positive for all $m_M^* \in (0, 1)$. To ensure that the limit of $Y_{H,M}$ when $s_{H,M} \rightarrow 1$ is negative for all $m_M^* \in (0, 1)$, the costs of rating inflation, γ , need to be sufficiently large which is the case by assumption. Given that both μ and γ are sufficiently large, there exist a unique rating inflation $s_{H,M} = s_{H,M}^* \in (0, 1)$

and unique rating fee $F_{H,M} = F_{H,M}^* > 0$.

Lastly, we prove the uniqueness of the CRA's strategies in the R_L case. We insert the rating fee from (15) into (16) to define the equilibrium condition

$$Y_{L,M} = \frac{\theta[q+(1-q)s_{L,M}]}{\theta[q+(1-q)s_{L,M}]+(1-\theta)[(1-q)+qs_{L,M}]} \left\{ x - \left\{ 1 + \frac{(1-\theta)}{\theta} \frac{[(1-q)+qs_{L,M}]}{q+(1-q)s_{L,M}} \right\} \right\} \\ -s_{L,M}\gamma = 0.$$

Observe that condition $Y_{L,M}$ is only a function in $s_{L,M}$ and has the following properties:

$$\frac{\partial Y_{L,M}}{\partial s_{L,M}} = -\frac{\theta(1-\theta)(2q-1)}{\{\theta[q+(1-q)s_{L,M}]+(1-\theta)[(1-q)+qs_{L,M}]\}^2} x - \gamma < 0,$$

$$\lim_{s_{L,M} \rightarrow 0} Y_{L,M} = \frac{\theta q}{\theta q + (1-\theta)(1-q)} \left\{ x - \left[1 + \frac{(1-\theta)(1-q)}{\theta q} \right] \right\},$$

$$\lim_{s_{L,M} \rightarrow 1} Y_{L,M} = -\gamma < 0.$$

The limit of $Y_{L,M}$ when $s_{L,M} \rightarrow 1$ is unambiguously negative since the entrepreneur does not invest when ratings are uninformative (which is the case when $s_{L,M} \rightarrow 1$) due to the NPV assumption in (1). Hence rating inflation in the R_L case is never maximal regardless of the size of γ . In addition, when x is large enough such that $x > \left[1 + \frac{(1-\theta)(1-q)}{\theta q} \right]$, i.e., investment is profitable with $\{R_L, G\}$ when $s_{L,M} = 0$, then the limit of $Y_{L,M}$ when $s_{L,M} \rightarrow 0$ is positive and there exist unique interior rating inflation $s_{L,M} = s_{L,M}^* \in (0, 1)$ and rating fee $F_{L,M} = F_{L,M}^* > 0$. If $x \leq \left[1 + \frac{(1-\theta)(1-q)}{\theta q} \right]$ then $s_{L,M} = s_{L,M}^* = 0$ and $F_{L,M} = F_{L,M}^* = 0$. This proves the uniqueness of the obtained equilibrium solution.

Q.E.D.

PROOF OF PROPOSITION 2

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

Claim 1: The interest rates in the duopolistic credit rating industry setting are as follows:

$$r_{0,H,D} = \frac{(1-\alpha)(1-\theta)\hat{m}_D}{[\alpha+(1-\alpha)\theta\hat{m}_D]} \frac{q^2}{(1-q)^2}, \quad (17)$$

$$r_{1,H,D} = \frac{(1-\alpha)(1-\theta)\hat{m}_D}{[\alpha+(1-\alpha)\theta\hat{m}_D]} \frac{[(1-q)+q\hat{s}_{i,H,D}]}{[q+(1-q)\hat{s}_{i,H,D}]} \frac{q}{(1-q)}, \quad (18)$$

$$r_{2,H,D} = \frac{(1-\alpha)(1-\theta)\hat{m}_D}{[\alpha + (1-\alpha)\theta\hat{m}_D]} \frac{[(1-q) + q\hat{s}_{1,H,D}][(1-q) + q\hat{s}_{2,H,D}]}{[q + (1-q)\hat{s}_{1,H,D}][q + (1-q)\hat{s}_{2,H,D}]}, \quad (19)$$

$$r_{0,L,D} = \frac{(1-\theta)}{\theta} \frac{q^2}{(1-q)^2}, \quad (20)$$

$$r_{1,L,D} = \frac{(1-\theta)}{\theta} \frac{[(1-q) + q\hat{s}_{i,L,D}]}{[q + (1-q)\hat{s}_{i,L,D}]} \frac{q}{(1-q)}, \quad (21)$$

$$r_{2,L,D} = \frac{(1-\theta)}{\theta} \frac{[(1-q) + q\hat{s}_{1,L,D}][(1-q) + q\hat{s}_{2,L,D}]}{[q + (1-q)\hat{s}_{1,L,D}][q + (1-q)\hat{s}_{2,L,D}]}. \quad (22)$$

Claim 2: Threshold $\bar{\alpha}$

The threshold initiating investment in case $\{R_H, B_1, B_2\}$ is implicitly defined by the following condition:

$$x = 1 + \frac{(1-\bar{\alpha})(1-\theta)}{[\bar{\alpha} + (1-\bar{\alpha})\theta]} \frac{q^2}{(1-q)^2}.$$

This condition follows from setting $m_D = 1$ in $r_{0,H,D}$. When $\alpha > \bar{\alpha}$, then both $x > 1 + r_{0,H,M}$ and $x > 1 + r_{0,H,D}$ hold and investment always occurs for a high report R_H .

Claim 3: Solution of CRA i 's optimization problems

The procedures to solve CRA i 's optimization problems resemble the ones used in the Proof of Proposition 1. CRA i 's optimization problem when the financial report is R_H is given in (6a)-(6c). The full set of constraints for CRA i 's optimization problem when the financial report is R_H is as follows:

$$Pr(x|g, G_i, B_j) [x - (1 + \hat{r}_{1,H,D})] - F_{i,H,D} \geq Pr(x|g, G_i, B_j) [x - (1 + \hat{r}_{0,H,D})], \quad (23a)$$

$$Pr(x|b, G_i, B_j) [x - (1 + \hat{r}_{1,H,D})] - F_{i,H,D} \geq Pr(x|b, G_i, B_j) [x - (1 + \hat{r}_{0,H,D})], \quad (23b)$$

$$Pr(x|g, G_1, G_2) [x - (1 + \hat{r}_{2,H,D})] - F_{i,H,D} \geq Pr(x|g, G_1, G_2) [x - (1 + \hat{r}_{1,H,D})], \quad (23c)$$

$$Pr(x|b, G_1, G_2) [x - (1 + \hat{r}_{2,H,D})] - F_{i,H,D} \geq Pr(x|b, G_1, G_2) [x - (1 + \hat{r}_{1,H,D})]. \quad (23d)$$

Note that we omit j 's rating fee $F_{j,H,D}$ on both sides of inequalities (23c) and (23d). We can first rule

out constraints (23a) and (23c), as they are not as strict as (23b) and (23d), respectively. Moreover, constraint (23b) is not as strict as constraint (23d), due to the decreasing marginal information value of credit ratings. Therefore, the only constraint we have to consider is (6b).

By inserting the solution from (4) into the maximization problem in (6a) and using a Lagrange multiplier λ on condition (6b), we get the following Lagrangian:

$$\mathcal{L} = \frac{[\alpha + (1-\alpha)\theta\hat{m}_D] \left[q + (1-q) \frac{F_{i,H,D}}{\gamma} \right] + (1-\alpha)(1-\theta)\hat{m}_D \left[(1-q) + q \frac{F_{i,H,D}}{\gamma} \right]}{[\alpha + (1-\alpha)\hat{m}_D]} F_{i,H,D} \\ - \frac{[\alpha + (1-\alpha)\theta\hat{m}_D](1-q) + (1-\alpha)(1-\theta)\hat{m}_D q}{[\alpha + (1-\alpha)\hat{m}_D]} \frac{F_{i,H,D}^2}{2\gamma} - \lambda [F_{i,H,D} - Pr(x|b, G_i, G_j) (\hat{r}_{1,H,D} - \hat{r}_{2,H,D})].$$

The first-order condition of the Lagrangian with respect to $F_{i,H,D}$ is similar to the monopolistic CRA case and it can be shown that whenever $F_{i,H,D} > 0$ the Lagrange multiplier is positive, implying that the participation constraint (6b) must be binding. Therefore, we can write out $F_{i,H,D}$ as in (7)

$$\text{where } Pr(x|b, G_1, G_2) = \frac{\theta[q + (1-q)\hat{s}_{1,H,D}][q + (1-q)\hat{s}_{2,H,D}]}{\theta[q + (1-q)\hat{s}_{1,H,D}][q + (1-q)\hat{s}_{2,H,D}] + (1-\theta)[(1-q) + q\hat{s}_{1,H,D}][(1-q) + q\hat{s}_{2,H,D}]}.$$

CRA i 's optimization problem when the financial report is R_L is as follows (given the conjecture that investment occurs in the $\{R_L, G_1, G_2\}$ case):

$$\max_{F_{i,L,D}} Pr(G_i, G_j | R_L) F_{i,L,D} - Pr(S_B | R_L) \frac{s_{i,L,D}^2 \gamma}{2}, \quad (24a)$$

subject to

$$Pr(x|b, G_1, G_2) [x - (1 + \hat{r}_{2,L,D})] - F_{i,L,D} - F_{j,L,D} \geq 0, \quad (24b)$$

$$\max_{s_{i,L,D}} s_{i,L,D} Pr(G_j | R_L, S_{i,B}) F_{i,L,D} - \frac{s_{i,L,D}^2 \gamma}{2}. \quad (24c)$$

Applying similar solution procedures, we obtain the following solutions:

$$F_{i,L,D} = \max \{0, Pr(x|b, G_1, G_2) [x - (1 + \hat{r}_{2,L,D})] - F_{j,L,D}\},$$

$$s_{i,L,D} = \frac{Pr(G_j | R_L, S_{i,B}) F_{i,L,D}}{\gamma}, \quad (25)$$

where $Pr(x|b, G_1, G_2)$ was given above, and $Pr(G_j | R_L, S_{i,B}) = \frac{\theta(1-q)[q + (1-q)\hat{s}_{j,L,D}] + (1-\theta)q[(1-q) + q\hat{s}_{j,L,D}]}{\theta(1-q) + (1-\theta)q}$.

In a symmetric equilibrium it must be the case that, after enforcing all conjectures regarding CRA j 's strategies, $s_{i,L,D} = s_{j,L,D} = s_{L,D}$ and $F_{i,L,D} = F_{j,L,D} = F_{L,D}$ with

$$F_{L,D} = \max \left\{ 0, Pr(x|b, G_1, G_2) \frac{[x - (1 + \hat{r}_{2,L,D})]}{2} \right\}. \quad (26)$$

Claim 4: Proof that $\Phi > 0$

First note that

$$\begin{aligned} \Phi \equiv & [q + (1 - q) s_{H,D}]^2 [(r_{0,H,D} - r_{1,H,D}) - (r_{1,H,D} - r_{2,H,D})] \\ & + 2 [q + (1 - q) s_{H,D}] (1 - q) (1 - s_{H,D}) (r_{0,H,D} - r_{1,H,D}) \\ & - 2 \frac{\{\theta [q + (1 - q) s_{H,D}] (1 - q) (1 - s_{H,D}) + (1 - \theta) [(1 - q) + q s_{H,D}] q (1 - s_{H,D})\} [q + (1 - q) s_{H,D}]^2}{\theta [q + (1 - q) s_{H,D}]^2 + (1 - \theta) [(1 - q) + q s_{H,D}]^2} (r_{1,H,D} - r_{2,H,D}). \end{aligned}$$

Substituting (17), (18), and (19) for $r_{0,H,D}$, $r_{1,H,D}$ and $r_{2,H,D}$, we can simplify Φ to

$$\begin{aligned} \Phi = & \frac{(1 - \alpha)(1 - \theta) m_D}{[\alpha + (1 - \alpha) \theta m_D]} \frac{(2q - 1)^2 \left\{ [(1 - q) + q s_{H,D}]^2 + \theta (1 - s_{H,D}) \{ (2q - 1)(1 - s_{H,D}) + 2q [(1 - q) + q s_{H,D}] \} \right\}}{(1 - q)^2 \left\{ \theta [q + (1 - q) s_{H,D}]^2 + (1 - \theta) [(1 - q) + q s_{H,D}]^2 \right\}}. \end{aligned}$$

It is straightforward to see that $\Phi > 0$. It is useful to further rewrite the manipulation condition as follows:

$$\theta \left\{ x - \left\{ 1 + \frac{(1 - \alpha)(1 - \theta) m_D}{[\alpha + (1 - \alpha) \theta m_D]} \Psi \right\} \right\} - \mu m_D = 0,$$

with

$$\begin{aligned} \Psi \equiv & \frac{q^2}{(1 - q)^2} \\ & - \frac{(2q - 1)^2 \left\{ [(1 - q) + q s_{H,D}]^2 + \theta (1 - s_{H,D}) \{ (2q - 1)(1 - s_{H,D}) + 2q [(1 - q) + q s_{H,D}] \} \right\}}{(1 - q)^2 \left\{ \theta [q + (1 - q) s_{H,D}]^2 + (1 - \theta) [(1 - q) + q s_{H,D}]^2 \right\}} > 0. \end{aligned}$$

Claim 5: Limits

In a first step, we define the following equilibrium conditions:

$$Z_D = \theta \left\{ x - \left\{ 1 + \frac{(1 - \alpha)(1 - \theta) m_D}{[\alpha + (1 - \alpha) \theta m_D]} \Psi \right\} \right\} - \mu m_D = 0,$$

$$Y_{H,D} = \frac{(1 - \alpha)(1 - \theta) m_D}{[\alpha + (1 - \alpha) \theta m_D]} \frac{\theta (2q - 1) [(1 - q) + q s_{H,D}]}{(1 - q) \left\{ \theta [q + (1 - q) s_{H,D}]^2 + (1 - \theta) [(1 - q) + q s_{H,D}]^2 \right\}} - s_{H,D} \gamma = 0,$$

$$\begin{aligned} Y_{L,D} = & \frac{1}{2} \frac{\theta [q + (1 - q) s_{L,D}]^2}{\theta [q + (1 - q) s_{L,D}]^2 + (1 - \theta) [(1 - q) + q s_{L,D}]^2} \left\{ x - \left\{ 1 + \frac{(1 - \theta) [(1 - q) + q s_{L,D}]^2}{\theta [q + (1 - q) s_{L,D}]^2} \right\} \right\} \\ & - s_{L,D} \gamma = 0. \end{aligned}$$

Condition Z_D is obtained from rearranging (8). $Y_{H,D}$ is from inserting the rating fee from (7) into (4) and $Y_{L,D}$ is from inserting the rating fee from (26) into (25). For the R_L case, since it is straightforward that $s_{L,D} = 0$ and $F_{L,D} = 0$ when $x - (1 + \hat{r}_{2,L,D}) \leq 0$, condition $Y_{L,D}$ is written under the condition that $x - (1 + \hat{r}_{2,L,D}) > 0$.

First, consider the limits of Z_D with respect to m_D :

$$\lim_{m_D \rightarrow 0} Z_D = \theta(x - 1) > 0,$$

$$\lim_{m_D \rightarrow 1} Z_D = \theta \left\{ x - \left[1 + \frac{(1 - \alpha)(1 - \theta)}{\alpha + (1 - \alpha)\theta} \frac{q^2}{(1 - q)^2} \right] + \Phi|_{m_D \rightarrow 1} \right\} - \mu.$$

The latter limit is negative for all $s_{H,D} \in [0, 1)$ when μ is sufficiently large.

Next, the limits of $Y_{H,D}$ with respect to $s_{H,D}$ are as follows:

$$\lim_{s_{H,D} \rightarrow 0} Y_{H,D} = \frac{(1 - \alpha)(1 - \theta)m_D}{[\alpha + (1 - \alpha)\theta m_D]} \frac{\theta(1 - q)(2q - 1)}{(1 - q) \left\{ \theta q^2 + (1 - \theta)(1 - q)^2 \right\}} > 0,$$

$$\lim_{s_{H,D} \rightarrow 1} Y_{H,D} = \frac{(1 - \alpha)(1 - \theta)m_D}{[\alpha + (1 - \alpha)\theta m_D]} \frac{\theta(2q - 1)}{(1 - q)} - \gamma.$$

The former limit is unambiguously positive for all $m_D \in (0, 1)$. The latter limit is negative whenever γ is sufficiently large. A sufficient condition can be found in Claim 4 of the Proof of Proposition 1.

Lastly, the limits of $Y_{L,D}$ with respect to $s_{L,D}$ are

$$\lim_{s_{L,D} \rightarrow 0} Y_{L,D} = \frac{1}{2} \frac{\theta q^2}{\theta q^2 + (1 - \theta)(1 - q)^2} \left\{ x - \left[1 + \frac{(1 - \theta)(1 - q)^2}{\theta} \right] \right\},$$

$$\lim_{s_{L,D} \rightarrow 1} Y_{L,D} = -\gamma < 0.$$

Note that the former limit is unambiguously positive when $x > \left[1 + \frac{(1 - \theta)(1 - q)^2}{\theta} \right]$. In the monopolistic CRA case, we assumed that $x > \left[1 + \frac{(1 - \theta)(1 - q)}{\theta} \right]$ which is stricter than the condition in this case. The second limit is unambiguously negative because the entrepreneur would not invest with uninformative ratings due to the NPV assumption in (1). It follows that given the conditions on μ and γ , there exist solutions to the equilibrium conditions Z_D , $Y_{H,D}$, and $Y_{L,D}$ such that $m_D \in (0, 1)$, $s_{H,D} \in [0, 1)$ and $s_{L,D} \in [0, 1)$, respectively. We prove the uniqueness of these solutions in the following claim.

Claim 6: Proof of equilibrium uniqueness

We prove the uniqueness of the solution in two steps. First, we show that m_D , $F_{H,D}$ and $s_{H,D}$ are unique by application of the inverse function theorem. For this proof it is sufficient to show that

the determinant of the matrix of partials of Z_D and $(Y_{H,D}/s_{H,D})$ with respect to m_D and $s_{H,D}$, the Jacobian matrix, is non-zero such that it is invertible. The Jacobian is defined as follows:

$$J = \begin{pmatrix} \frac{\partial Z_D}{\partial m_D} & \frac{\partial Z_D}{\partial s_{H,D}} \\ \frac{\partial (Y_{H,D}/s_{H,D})}{\partial m_D} & \frac{\partial (Y_{H,D}/s_{H,D})}{\partial s_{H,D}} \end{pmatrix}.$$

The determinant of J is

$$Det(J) = \frac{\partial Z_D}{\partial m_D} \frac{\partial (Y_{H,D}/s_{H,D})}{\partial s_{H,D}} - \frac{\partial Z_D}{\partial s_{H,D}} \frac{\partial (Y_{H,D}/s_{H,D})}{\partial m_D}.$$

The partials are as follows:

$$\frac{\partial Z_D}{\partial m_D} = -\theta \frac{\alpha(1-\alpha)(1-\theta)}{[\alpha+(1-\alpha)\theta m_D]^2} \frac{q^2}{(1-q)^2} - \mu + \theta \frac{\alpha(1-\alpha)(1-\theta)}{[\alpha+(1-\alpha)\theta m_D]^2} \frac{(2q-1)^2 \left\{ [(1-q)+qs_{H,D}]^2 + \theta(2q-1)(1-s_{H,D})^2 + 2\theta q[(1-q)+qs_{H,D}](1-s_{H,D}) \right\}}{(1-q)^2 \left\{ \theta[q+(1-q)s_{H,D}]^2 + (1-\theta)[(1-q)+qs_{H,D}]^2 \right\}} < 0.$$

$$\frac{\partial Z_D}{\partial s_{H,D}} = -\theta \frac{(1-\alpha)(1-\theta)m_D}{[\alpha+(1-\alpha)\theta m_D]} \frac{2\theta(2q-1)^2 \left\{ \theta(1+q^2)(1-s_{H,D})^2 + 2q(1-s_{H,D})s_{H,D} + (1-\theta)q[1+3(1-q)](1-s_{H,D})^2 - 1 + 2s_{H,D} \right\}}{(1-q)^2 \left\{ \theta[q+(1-q)s_{H,D}]^2 + (1-\theta)[(1-q)+qs_{H,D}]^2 \right\}} < 0,$$

$$\frac{\partial (Y_{H,D}/s_{H,D})}{\partial m_D} = \frac{\alpha(1-\alpha)(1-\theta)}{[\alpha+(1-\alpha)\theta m_D]^2} \frac{\theta(2q-1)[(1-q)+qs_{H,D}]}{(1-q)s_{H,D} \left\{ \theta[q+(1-q)s_{H,D}]^2 + (1-\theta)[(1-q)+qs_{H,D}]^2 \right\}} > 0,$$

$$\frac{\partial (Y_{H,D}/s_{H,D})}{\partial s_{H,D}} = -\frac{(1-\alpha)(1-\theta)m_D}{[\alpha+(1-\alpha)\theta m_D]} \frac{\theta(2q-1) \left\{ [(1-q)+qs_{H,D}]^2 [(1-q)+2qs_{H,D}] + \theta(2q-1) \left\{ (1-q) - 3(1-q)s_{H,D}^2 - 2qs_{H,D}^3 \right\} \right\}}{(1-q)s_{H,D}^2 \left\{ \theta[q+(1-q)s_{H,D}]^2 + (1-\theta)[(1-q)+qs_{H,D}]^2 \right\}^2} < 0.$$

Therefore, $Det(J) > 0$, implying the uniqueness of $m_D = m_D^* \in (0, 1)$, $s_{H,D} = s_{H,D}^* \in (0, 1)$ and $F_{H,D} = F_{H,D}^* > 0$.

Second, we show that $F_{L,D}$ and $s_{L,D}$ are unique. We rewrite $Y_{L,D}$ in descending power of variable $s_{L,D}$:

$$\begin{aligned} Y_{L,D} = & s_{L,D}^3 (1-q)^2 [q^2 - \theta q + \theta(1-q)] \left\{ 2\gamma \frac{[\theta(1-q)+(1-\theta)q]}{(1-q)^2} - \theta \left\{ x - \left[1 + \frac{(1-\theta)}{\theta} \frac{q^2}{(1-q)^2} \right] \right\} \right\} \\ & + s_{L,D}^2 q(1-q) [3q^2 - (1+2\theta)(2q-1)] \left\{ 4\gamma \frac{[\theta(1-q)+(1-\theta)q]}{[3q^2-(1+2\theta)(2q-1)]} - \theta \left\{ x - \left[1 + \frac{(1-\theta)}{\theta} \frac{[3q^2-2\theta(2q-1)+2\theta]}{[3q^2-(1+2\theta)(2q-1)]} \right] \right\} \right\} \\ & + s_{L,D} q^2 \left\{ 2\theta(2q-1)(x-1) - \theta \left\{ x - \left[1 + \frac{(1-\theta)}{\theta} \frac{(1-q)^2}{q^2} \right] \right\} + 2\gamma \frac{[\theta q^2 + (1-\theta)(1-q)^2][\theta(1-q)+(1-\theta)q]}{q^2} \right\} \\ & - q(1-q) [(1-\theta)(2q-1) + q^2(1-\theta x)]. \end{aligned}$$

In this function there is only one sign change. The expressions following $s_{L,D}^3$ and $s_{L,D}^2$ are unambiguously positive due to the NPV assumptions, whereas the last expression is negative; the

expression after $s_{L,D}$ can be positive or negative. According to Descartes' rule of signs, this implies that there is at most one positive root in $s_{L,D}$. Together with the limits in Claim 4 it must be the case that there exist unique $s_{L,D} = s_{L,D}^* \in [0, 1)$ and $F_{L,D} = F_{L,D}^* \geq 0$. This proves the uniqueness of the equilibrium characterized in Proposition 2.

Q.E.D.

PROOF OF PROPOSITION 3

We begin our proof by explicitly solving for m_M^* from equation (5):

$$m_M^* = \frac{\varphi - \left\{ \alpha\mu - (1-\alpha)\theta^2 \left\{ x - \left[1 + \frac{(1-\theta)}{\theta} \frac{q}{(1-q)} \right] \right\} \right\}}{2(1-\alpha)\theta\mu},$$

where $\varphi = \sqrt{\left\{ \alpha\mu - (1-\alpha)\theta^2 \left\{ x - \left[1 + \frac{(1-\theta)}{\theta} \frac{q}{(1-q)} \right] \right\} \right\}^2 + 4\alpha(1-\alpha)\theta^2\mu(x-1)}$.

We now evaluate the manipulation condition Z_D from the CRA duopoly setting at $m_D^* = m_M^*$. Since Z_D evaluated at m_D^* is zero and $\frac{\partial Z_D}{\partial m_D^*} < 0$, if Z_D evaluated at m_M^* is larger (smaller) than zero, this would imply that $m_M^* < m_D^*$ ($m_M^* > m_D^*$):

$$Z_D = \left[\frac{q}{(1-q)} - \Psi \right] \frac{(1-\theta) \left\{ \varphi - \left\{ \alpha\mu - (1-\alpha)\theta^2 \left\{ x - \left[1 + \frac{(1-\theta)}{\theta} \frac{q}{(1-q)} \right] \right\} \right\} \right\}}{\left\{ \alpha\mu + (1-\alpha)\theta^2 \left\{ x - \left[1 + \frac{(1-\theta)}{\theta} \frac{q}{(1-q)} \right] \right\} \right\} + \varphi},$$

where

$$\left[\frac{q}{(1-q)} - \Psi \right] = \frac{(2q-1) \left\{ \theta(2q-1)^2(1-s_{H,D}^*)^2 - [(1-q) + qs_{H,D}^*]^2 \right\}}{(1-q) \left\{ \theta \left[q + (1-q)s_{H,D}^* \right]^2 + (1-\theta) \left[(1-q) + qs_{H,D}^* \right]^2 \right\}}.$$

The sign of Z_D is proportional to $\Omega \equiv \theta(2q-1)^2(1-s_{H,D}^*)^2 - [(1-q) + qs_{H,D}^*]^2$. This condition has the following properties with respect to $s_{H,D}^*$ (and thus indirectly to γ):

$$\frac{\partial \Omega}{\partial s_{H,D}^*} = -2\theta(2q-1)^2(1-s_{H,D}^*) - 2q[(1-q) + qs_{H,D}^*] < 0,$$

$$\lim_{s_{H,D}^* \rightarrow 0} \Omega = \theta(2q-1)^2 - (1-q)^2,$$

$$\lim_{s_{H,D}^* \rightarrow 1} \Omega = -1 < 0.$$

Ω evaluated at $s_{H,D}^* \rightarrow 0$ can be positive or negative. In particular, it is positive when $q > \bar{q} \equiv \frac{1+\sqrt{\theta}}{1+2\sqrt{\theta}}$

implying that there exists a level of $s_{H,D}^* \in (0, 1)$ that satisfies $\Omega = 0$. This further implies the existence of a unique threshold $\bar{\gamma} > 0$ since $\frac{\partial s_{H,D}^*}{\partial \gamma} < 0$. Therefore, the condition is positive if $q > \bar{q}$ and $\gamma > \bar{\gamma}$, in which case $m_M^* < m_D^*$. When either $q < \bar{q}$ or $\gamma < \bar{\gamma}$, then the condition is unambiguously negative and $m_M^* > m_D^*$.

Q.E.D.

PROOF OF PROPOSITION 4

We begin this proof by rearranging the equilibrium conditions which implicitly define rating inflation in the monopolistic CRA setting and duopolistic CRA setting with respect to γ . From this it follows that

$$\begin{aligned} & \frac{(1-\alpha)(1-\theta)m_M^*}{[\alpha+(1-\alpha)\theta m_M^*]} \frac{\theta(2q-1)}{(1-q)} \frac{1}{s_{H,M}^* \left\{ \theta \left[q + (1-q)s_{H,M}^* \right] + (1-\theta) \left[(1-q) + qs_{H,M}^* \right] \right\}} \\ &= \frac{(1-\alpha)(1-\theta)m_D^*}{[\alpha+(1-\alpha)\theta m_D^*]} \frac{\theta(2q-1)}{(1-q)} \frac{[(1-q) + qs_{H,D}^*]}{s_{H,D}^* \left\{ \theta \left[q + (1-q)s_{H,D}^* \right]^2 + (1-\theta) \left[(1-q) + qs_{H,D}^* \right]^2 \right\}}. \end{aligned}$$

Now assume that $m_M^* = m_D^*$. The above condition reduces to

$$\begin{aligned} & \frac{1}{s_{H,M}^* \left\{ \theta \left[q + (1-q)s_{H,M}^* \right] + (1-\theta) \left[(1-q) + qs_{H,M}^* \right] \right\}} \\ &= \frac{[(1-q) + qs_{H,D}^*]}{s_{H,D}^* \left\{ \theta \left[q + (1-q)s_{H,D}^* \right]^2 + (1-\theta) \left[(1-q) + qs_{H,D}^* \right]^2 \right\}}. \end{aligned}$$

The left hand side and the right hand side decrease in $s_{H,M}^*$ and $s_{H,D}^*$, respectively. Using a proof by contradiction, it is straightforward to show that $s_{H,M}^* > s_{H,D}^*$ and that $F_{H,M}^* > F_{H,D}^*$ whenever $m_M^* = m_D^*$. Further terms $\frac{(1-\alpha)(1-\theta)m_M^*}{[\alpha+(1-\alpha)\theta m_M^*]}$ and $\frac{(1-\alpha)(1-\theta)m_D^*}{[\alpha+(1-\alpha)\theta m_D^*]}$ increase in m_M^* and m_D^* , respectively. From this it follows that whenever $m_M^* \geq m_D^*$, then it must be true that $s_{H,M}^* > s_{H,D}^*$ and that $F_{H,M}^* > F_{H,D}^*$. Conditions for which $m_M^* \geq m_D^*$ holds are provided in Proposition 3.

Q.E.D.

PROOF OF COROLLARIES 1 AND 2

For the proofs of the corollaries, we make use of a multivariable version of the implicit function theorem. For an arbitrary variable $a \in \{\gamma, \mu\}$ the comparative statics can be derived as follows:

$$J \begin{pmatrix} \frac{dm_D^*}{da} \\ \frac{ds_{H,D}^*}{da} \end{pmatrix} = - \begin{pmatrix} \frac{\partial Z_D}{\partial a} \\ \frac{\partial(Y_{H,D}/s_{H,D}^*)}{\partial a} \end{pmatrix},$$

where J is the Jacobian matrix from the Proof of Proposition 2. Solving simultaneously for $\frac{dm_D^*}{da}$ and $\frac{ds_{H,D}^*}{da}$ yields

$$\begin{aligned} \frac{dm_D^*}{da} &= \frac{\frac{\partial Z_D}{\partial s_{H,D}^*} \frac{\partial(Y_{H,D}/s_{H,D}^*)}{\partial a} - \frac{\partial(Y_{H,D}/s_{H,D}^*)}{\partial s_{H,D}^*} \frac{\partial Z_D}{\partial a}}{Det(J)}, \\ \frac{ds_{H,D}^*}{da} &= \frac{\frac{\partial(Y_{H,D}/s_{H,D}^*)}{\partial m_D^*} \frac{\partial Z_D}{\partial a} - \frac{\partial Z_D}{\partial m_D^*} \frac{\partial(Y_{H,D}/s_{H,D}^*)}{\partial a}}{Det(J)}. \end{aligned}$$

In addition, the first-order condition of $F_{H,D}^*$ with respect to arbitrary variable a is

$$\frac{dF_{H,D}^*}{da} = \frac{\partial F_{H,D}^*}{\partial m_D^*} \frac{dm_D^*}{da} + \frac{\partial F_{H,D}^*}{\partial s_{H,D}^*} \frac{ds_{H,D}^*}{da}.$$

First, we do an analysis with respect to γ . The partials of both equilibrium conditions with respect to γ are $\frac{\partial(Y_{H,D}/s_{H,D}^*)}{\partial \gamma} = -1$ and $\frac{\partial Z_D}{\partial \gamma} = 0$, and we have already shown above that $\frac{\partial Z_D}{\partial s_{H,D}^*} < 0$, $\frac{\partial(Y_{H,D}/s_{H,D}^*)}{\partial s_{H,D}^*} < 0$, $\frac{\partial(Y_{H,D}/s_{H,D}^*)}{\partial m_D^*} > 0$, $\frac{\partial Z_D}{\partial m_D^*} < 0$, and that $Det(J) > 0$. This implies that $\frac{dm_D^*}{d\gamma} > 0$ and $\frac{ds_{H,D}^*}{d\gamma} < 0$. Further $\frac{dF_{H,D}^*}{d\gamma} > 0$ since $\frac{\partial F_{H,D}^*}{\partial m_D^*} > 0$ and $\frac{\partial F_{H,D}^*}{\partial s_{H,D}^*} < 0$.

The partials of both equilibrium conditions with respect to μ are $\frac{\partial(Y_{H,D}/s_{H,D}^*)}{\partial \mu} = 0$ and $\frac{\partial Z_D}{\partial \mu} = -m_D^*$. This implies that $\frac{dm_D^*}{d\mu} < 0$ and $\frac{ds_{H,D}^*}{d\mu} < 0$. Further the first order condition of $F_{H,D}^*$ with respect to μ can be rearranged to the following:

$$\begin{aligned} \frac{dF_{H,D}^*}{d\mu} &= -\frac{\frac{\partial Z_D}{\partial \mu}}{Det(J)} \left\{ \frac{\partial F_{H,D}^*}{\partial m_D^*} \frac{\partial(Y_{H,D}/s_{H,D}^*)}{\partial s_{H,D}^*} - \frac{\partial F_{H,D}^*}{\partial s_{H,D}^*} \frac{\partial(Y_{H,D}/s_{H,D}^*)}{\partial m_D^*} \right\} \\ &= -\frac{\frac{\partial Z_D}{\partial \mu}}{Det(J)} \left\{ -\frac{(1-\alpha)^2(1-\theta)^2 m_D^*}{[\alpha + (1-\alpha)\theta m_D^*]^3} \frac{\alpha \theta^2 (2q-1)^2 [(1-q) + q s_{H,D}^*]^2}{(1-q)^2 (s_{H,D}^*)^2 \{ \theta [q + (1-q)s_{H,D}^*]^2 + (1-\theta)[(1-q) + q s_{H,D}^*]^2 \}} \right\} < 0. \end{aligned}$$

Q.E.D.

PROOF OF COROLLARY 3

The proof follows directly from the Proof of Proposition 3.

Q.E.D.

PROOF OF LEMMA 1 AND PROPOSITION 5

In this proof, we derive the equilibrium solution under the condition that the entrepreneur is required to provide a favorable rating in order to obtain financing. The monopolistic CRA solves a slightly different optimization problem in the R_H case than the one under Proposition 1. The main difference lies in the entrepreneur's participation constraint: Since investment does not occur in case $\{R_H, B\}$, constraint (2c) becomes:

$$Pr(x|b, G) [x - (1 + \hat{r}_{1,H,M})] - F_{H,M} \geq 0.$$

In equilibrium, the rating fee is $F_{H,M} = Pr(x|b, G) [x - (1 + \hat{r}_{1,H,M})]$.

The entrepreneur now solves the following problem:

$$\begin{aligned} \max_{m_M} & \left\{ Pr(x, G|b) [x - (1 + \hat{r}_{1,H,M})] - Pr(G|b) \hat{F}_{H,M} \right\} \\ & + (1 - m_M) \left\{ Pr(x, G|b) [x - (1 + \hat{r}_{1,L,M})] - Pr(G|b) \hat{F}_{L,M} \right\} - \frac{m_M^2 \mu}{2}. \end{aligned}$$

As with the R_L case, the CRA now extracts the entire surplus from providing a favorable rating also in the R_H case, implying that in equilibrium $m_M^* = 0$. The equilibrium uniqueness proof follows the one in the proof of Proposition 1. The observation that $m_M^* = 0$ in the gatekeeper variant of the monopolistic CRA setting further proves the statement in Proposition 5 (iii).

Next, we prove the claims that rating fee $F_{H,M}^*$ and rating inflation $s_{H,M}^*$ increase when the CRA acts as a gatekeeper. In the gatekeeper variant, the equilibrium rating fee is as follows:

$$F_{H,M}^* = \frac{\theta [q + (1 - q) s_{H,M}^*]}{\theta [q + (1 - q) s_{H,M}^*] + (1 - \theta) [(1 - q) + q s_{H,M}^*]} (x - 1).$$

In addition, the rating inflation is implicitly defined by condition (4).

We prove the statements by contradiction and assume that the rating inflation is the same under both model solutions. Rearranging (4) with respect to γ and then inserting the respective rating fee leads to the following equation:

$$\frac{\theta[q+(1-q)s_{H,M}^*]}{s_{H,M}^*\{\theta[q+(1-q)s_{H,M}^*]+(1-\theta)[(1-q)+qs_{H,M}^*]\}}(x-1) \\ = \frac{(1-\alpha)(1-\theta)m_M^*}{[\alpha+(1-\alpha)\theta m_M^*]} \frac{\theta(2q-1)}{(1-q)s_{H,M}^*\{\theta[q+(1-q)s_{H,M}^*]+(1-\theta)[(1-q)+qs_{H,M}^*]\}},$$

where the left hand side is for the gatekeeper variant, and the right hand side is for the base model without the gatekeeper role. Note that both the left and the right hand side decrease in $s_{H,M}^*$. It can be shown that, under the NPV assumptions and the additional assumption that $\alpha > \bar{\alpha}$, this equation can never hold and the left hand side is always greater than the right hand side for all $m_M^* \in (0,1)$. It must therefore be true that $s_{H,M}^*$ is larger in the gatekeeper variant of the model which, for condition (4) to hold, must imply that $F_{H,M}^*$ is higher in the gatekeeper variant as well.

Q.E.D.

PROOF OF PROPOSITION 6

First, we derive the equilibrium solution and prove its uniqueness. Under imperfect CRA competition, the gatekeeper role only affects the entrepreneur's expected utility in case R_H and thus her manipulation decision, but does not directly affect CRAs' fee setting and rating inflation. We denote the presence (absence) of the gatekeeper role with indicator variable $\beta = 0$ ($\beta = 1$). Now consider the conditionally expected utility of the entrepreneur who observes b from the setting in Section 3 (before enforcing conjectures):

$$m_D \{ \beta Pr(x, B_1, B_2|b) [x - (1 + \hat{r}_{0,H,D})] + 2Pr(x, G_i, B_j|b) [x - (1 + \hat{r}_{1,H,D})] \} \\ + m_D \left\{ Pr(x, G_1, G_2|b) [x - (1 + \hat{r}_{2,H,D})] - 2Pr(G_1, G_2|b) \hat{F}_{H,D} - 2Pr(G_i, B_j|b) \hat{F}_{H,D} \right\} \\ - \frac{m_D^2 \mu}{2}.$$

When CRAs act as gatekeepers ($\beta = 0$), investment does not occur if no favorable rating is provided. This means that the investment project is not undertaken in case $\{R_H, B_1, B_2\}$, setting the expected surplus in this case to zero, i.e., $Pr(x, B_1, B_2|b) [x - (1 + \hat{r}_{0,H,D})] = 0$. Solving the entrepreneur's new optimization problem results in the equilibrium strategy featured in condition

(9) when $\beta = 0$. Since $[x - (1 + r_{0,H,D})] > 0$ and $\Phi > 0$, it must be the case that $m_D > 0$ or otherwise condition (9) cannot hold. In addition, the limits are straightforward to derive and under the conditions provided under the Proofs of Propositions 1 and 2 on μ and γ , this implies that $m_D, s_{H,D} \in (0, 1)$. All proofs in the R_L case follow the one under Proof of Proposition 2.

Next, we prove the uniqueness of the equilibrium solution. For this, we first rearrange condition $Y_{H,D} = 0$ in the following way:

$$\frac{(1 - \alpha)(1 - \theta)m_D}{[\alpha + (1 - \alpha)\theta m_D]} = \frac{\gamma(1 - q)s_{H,D} \left\{ \theta[q + (1 - q)s_{H,D}]^2 + (1 - \theta)[(1 - q) + qs_{H,D}]^2 \right\}}{\theta(2q - 1)[(1 - q) + qs_{H,D}]}.$$

Replacing $\frac{(1-\alpha)(1-\theta)m_D}{[\alpha+(1-\alpha)\theta m_D]}$ in $r_{0,H,D}$ and Φ in the entrepreneur's equilibrium condition (9) for which we set $\beta = 0$ and simplifying leads to

$$m_D = \frac{\theta}{\mu} \left\{ [1 - (1 - q)^2(1 - s_{H,D})^2] (x - 1) - \Gamma \right\},$$

where

$$\begin{aligned} \Gamma &\equiv [1 - (1 - q)^2(1 - s_{H,D})^2] r_{0,H,D} - \Phi \\ &= \frac{\gamma s_{H,D} \{ (2q - 1) + q[1 - q(1 - q)(1 - s_{H,D})^2] \} [(1 - q) + qs_{H,D}]}{\theta(2q - 1)} \\ &\quad + \frac{\gamma s_{H,D} \theta(2q - 1)(1 - s_{H,D}) \{ (2q - 1)(1 - s_{H,D}) + q(1 + s_{H,D})[1 + (1 - q)(1 - s_{H,D})] \}}{\theta(2q - 1)} \end{aligned}$$

represents the expected effective cost of capital the entrepreneur pays in case the project is successful.

The above expression explicitly defines m_D as a function of $s_{H,D}$. Since m_D is a function of $s_{H,D}$, it is sufficient to show that $s_{H,D}$ is unique. For this we compute the first order condition of $Y_{H,D}/s_{H,D}$ with respect to $s_{H,D}$ under consideration of $\frac{\partial m_D}{\partial s_{H,D}}$:

$$\frac{dY_{H,D}/s_{H,D}}{ds_{H,D}} = \frac{\partial Y_{H,D}/s_{H,D}}{\partial s_{H,D}} + \frac{\partial Y_{H,D}/s_{H,D}}{\partial m_D} \frac{\partial m_D}{\partial s_{H,D}} = \frac{\partial Y_{H,D}/s_{H,D}}{\partial s_{H,D}} \left\{ 1 + \frac{\frac{\partial Y_{H,D}/s_{H,D}}{\partial m_D}}{\frac{\partial Y_{H,D}/s_{H,D}}{\partial s_{H,D}}} \frac{\partial m_D}{\partial s_{H,D}} \right\}.$$

We have already established in the Proof of Proposition 2 that $\frac{\partial(Y_{H,D}/s_{H,D})}{\partial s_{H,D}} < 0$ and that $\frac{\partial(Y_{H,D}/s_{H,D})}{\partial m_D} > 0$. The partial of m_D with respect to $s_{H,D}$ is

$$\frac{\partial m_D}{\partial s_{H,D}} = \frac{\theta}{\mu} \left\{ 2(1-q)^2(1-s_{H,D})(x-1) - \frac{\partial \Gamma}{\partial s_{H,D}} \right\}.$$

It is tedious but possible to show that $\frac{\partial \Gamma}{\partial s_{H,D}} > 0$. Hence, $\frac{\partial m_D}{\partial s_{H,D}}$ can be positive or negative. Finally,

$$\begin{aligned} & \frac{\frac{\partial Y_{H,D}/s_{H,D}}{\partial m_D}}{\frac{\partial Y_{H,D}/s_{H,D}}{\partial s_{H,D}}} = \\ & - \frac{\alpha}{[\alpha + (1-\alpha)\theta m_D]} \frac{1}{m_D} \frac{\theta(2q-1)s_{H,D}[(1-q)+qs_{H,D}]\{\theta[q+(1-q)s_{H,D}]^2 + (1-\theta)[(1-q)+qs_{H,D}]^2\}}{\theta(2q-1)\{(1-q)+qs_{H,D}\}^2[(1-q)+2qs_{H,D}] + \theta(2q-1)\{(1-q)-3(1-q)s_{H,D}^2-2qs_{H,D}^3\}}. \end{aligned}$$

By inserting the above expression of m_D into $\frac{1}{m_D}$ and simplifying, it can be shown that $\frac{dY_{H,D}/s_{H,D}}{ds_{H,D}} < 0$. Note that this can also be shown to hold true when $\beta = 1$. This implies that there exist unique solutions for $m_D = m_D^* \in (0, 1)$, $s_{H,D} = s_{H,D}^* \in (0, 1)$, and $F_{H,D} = F_{H,D}^* \in (0, 1)$.

Now we are ready to prove the results stated in Proposition 6. The partial of equilibrium condition $Y_{H,D}/s_{H,D}$ with respect to β simply is

$$\frac{\partial Y_{H,D}/s_{H,D}^*}{\partial m_D^*} \frac{\partial m_D^*}{\partial \beta} > 0,$$

where $\frac{\partial m_D^*}{\partial \beta} = \frac{Pr(x, B_1, B_2|b)[x-(1+r_{0,H,D}^*)]}{\mu} > 0$. From the implicit function theorem it follows that $\frac{ds_{H,D}^*}{d\beta} > 0$. In addition, it must therefore hold that $\frac{dF_{H,D}^*}{d\beta} > 0$ and that

$$\begin{aligned} \frac{dm_D^*}{d\beta} &= \frac{\partial m_D^*}{\partial \beta} + \frac{\partial m_D^*}{\partial s_{H,D}} \frac{ds_{H,D}^*}{d\beta} = \frac{\partial m_D^*}{\partial \beta} + \frac{\partial m_D^*}{\partial s_{H,D}^*} \left(- \frac{\frac{dY_{H,D}/s_{H,D}^*}{d\beta}}{\frac{\partial Y_{H,D}/s_{H,D}^*}{\partial s_{H,D}^*}} \right) \\ &= \frac{\partial m_D^*}{\partial \beta} + \frac{\partial m_D^*}{\partial s_{H,D}^*} \left(- \frac{\frac{\partial Y_{H,D}/s_{H,D}^*}{\partial m_D^*} \frac{\partial m_D^*}{\partial \beta}}{\frac{\partial Y_{H,D}/s_{H,D}^*}{\partial s_{H,D}^*} + \frac{\partial Y_{H,D}/s_{H,D}^*}{\partial m_D^*} \frac{\partial m_D^*}{\partial s_{H,D}^*}} \right) = \frac{\partial m_D^*}{\partial \beta} \left(\frac{\frac{\partial Y_{H,D}/s_{H,D}^*}{\partial s_{H,D}^*}}{\frac{\partial Y_{H,D}/s_{H,D}^*}{\partial s_{H,D}^*} + \frac{\partial Y_{H,D}/s_{H,D}^*}{\partial m_D^*} \frac{\partial m_D^*}{\partial s_{H,D}^*}} \right) > 0. \end{aligned}$$

Q.E.D.

PROOF OF COROLLARY 4

The statement in Corollary 4 follows from Lemma 1 where we establish that $m_M^* = 0$ as well as the observation that $m_D^* > 0$ established under Proposition 6.

Q.E.D.

PROOF OF COROLLARY 5

In a first step, we confirm the result in Corollary 1 (ii) by deriving $\frac{ds_{H,D}^*}{d\gamma}$:

$$\frac{ds_{H,D}^*}{d\gamma} = - \frac{\frac{dY_{H,D}/s_{H,D}^*}{d\gamma}}{\frac{dY_{H,D}/s_{H,D}^*}{ds_{H,D}^*}}.$$

Since $\frac{dY_{H,D}/s_{H,D}^*}{ds_{H,D}^*} < 0$, it must be true that

$$\frac{ds_{H,D}^*}{d\gamma} \propto \frac{dY_{H,D}/s_{H,D}^*}{d\gamma} = -1 + \frac{\partial Y_{H,D}/s_{H,D}^*}{\partial m_D^*} \frac{\partial m_D^*}{\partial \gamma} < 0,$$

where

$$\begin{aligned} \frac{\partial m_D^*}{\partial \gamma} = & - \frac{s_{H,D}^* \{ (2q-1) + q[1-q(1-q)(1-s_{H,D}^*)^2] \} [(1-q) + qs_{H,D}^*]}{\theta \mu (2q-1)} \\ & - \frac{s_{H,D}^* \{ \theta(2q-1)^2(1-s_{H,D}^*)^2 + \theta(2q-1)(1-s_{H,D}^*)q(1+s_{H,D}^*)[1+(1-q)(1-s_{H,D}^*)] \}}{\theta \mu (2q-1)} < 0. \end{aligned}$$

Next, we consider the overall effect of a change in γ on m_D^* by analyzing the original equilibrium condition with respect to $s_{H,D}^*$ when $\beta = 0$. This condition can be rewritten to

$$Z_{D,\beta=0} = \theta \{ [1 - (1-q)^2(1-s_{H,D}^*)^2] [x - (1+r_{0,H,D}^*)] + \Phi \} - m_D^* \mu = 0.$$

The partial of the left-hand side with respect to $s_{H,D}^*$ simply becomes

$$\frac{\partial Z_{D,\beta=0}}{\partial s_{H,D}^*} = \theta \left\{ 2(1-q)^2(1-s_{H,D}^*) [x - (1+r_{0,H,D}^*)] + \frac{\partial \Phi}{\partial s_{H,D}^*} \right\}.$$

Note that in the Proof of Proposition 2 we have shown that $\frac{\partial \Phi}{\partial s_{H,D}^*} < 0$. Next, we insert $\frac{(1-\alpha)(1-\theta)m_D^*}{[\alpha+(1-\alpha)\theta m_D^*]} = \frac{\gamma(1-q)s_{H,D}^* \{ \theta[q+(1-q)s_{H,D}^*]^2 + (1-\theta)[(1-q)+qs_{H,D}^*]^2 \}}{\theta(2q-1)[(1-q)+qs_{H,D}^*]}$ in $r_{0,H,D}^*$. The limit of $\frac{\partial Z_{D,\beta=0}}{\partial s_{H,D}^*}$ as $\mu \rightarrow \infty$ is

$$\lim_{\mu \rightarrow \infty} \triangleq \lim_{m_D^* \rightarrow 0, s_{H,D}^* \rightarrow 0} \frac{\partial Z_{D,\beta=0}}{\partial s_{H,D}^*} = 2\theta(1-q)^2(x-1) > 0.$$

The lower limit as $m_D^* \rightarrow 1$ can be positive or negative. Lastly, it is possible to show that

$$\lim_{s_{H,D}^* \rightarrow 0} \frac{\partial^2 Z_{D,\beta=0}}{\partial (s_{H,D}^*)^2} < 0.$$

This implies that there must exist a level of μ , which we denote as $\bar{\mu}_1$, such that if $\mu > \bar{\mu}_1$ and consequently m_D^* is sufficiently small, $\frac{\partial Z_{D,\beta=0}}{\partial s_{H,D}^*} > 0$ must hold, and thus $\frac{dm_D^*}{d\gamma} < 0$.

Q.E.D.

PROOF OF PROPOSITION 7

Ex ante investment efficiency for $\beta \in \{0, 1\}$ is

$$IE = [\alpha + (1 - \alpha)m_D^*\theta] \left[1 - (1 - \beta)(1 - q)^2(1 - s_{H,D}^*)^2 \right] (x - 1) - (1 - \alpha)m_D^*(1 - \theta) \left[1 - (1 - \beta)q^2(1 - s_{H,D}^*)^2 \right].$$

Recall that due to the NPV assumptions imposed in this paper, namely $(x - 1) > 0$ and $\alpha > \bar{\alpha}$, it is straightforward to show that, for a given m_D^* and $s_{H,D}^*$, investment efficiency is larger without the gatekeeper role, i.e.,

$$\frac{\partial IE}{\partial \beta} = [\alpha + (1 - \alpha)m_D^*\theta] (1 - q)^2(1 - s_{H,D}^*)^2(x - 1) - (1 - \alpha)m_D^*(1 - \theta)q^2(1 - s_{H,D}^*)^2 > 0.$$

In addition, observe that, given the condition $\theta < \frac{(1-q)^2}{(1-q)+q(qx-1)}$, which leads to strict non-investment in case $\{R_L, G_1, G_2\}$, investment efficiency always decreases in m_D^* and weakly increases in $s_{H,D}^*$, i.e.,

$$\frac{\partial IE}{\partial m_D^*} = (1 - \alpha) \{ \theta [1 - (1 - \beta)(1 - q)^2(1 - s_{H,D}^*)^2] (x - 1) - (1 - \theta) [1 - (1 - \beta)q^2(1 - s_{H,D}^*)^2] \} < 0,$$

$$\frac{\partial IE}{\partial s_{H,D}^*} = 2(1 - \beta)(1 - s_{H,D}^*) \{ [\alpha + (1 - \alpha)m_D^*\theta] (1 - q)^2(x - 1) - (1 - \alpha)m_D^*(1 - \theta)q^2 \} \geq 0.$$

For the following analysis, we fix $s_{H,D}$ and treat it as an exogenous variable. The effect of a change of β on investment efficiency is

$$\frac{dIE}{d\beta} \Big|_{s_{H,D}} = \frac{\partial IE}{\partial \beta} \Big|_{s_{H,D}} + \frac{\partial IE}{\partial m_D^*} \Big|_{s_{H,D}} \frac{dm_D^*}{d\beta} \Big|_{s_{H,D}}.$$

Note that

$$\frac{dm_D^*}{d\beta}|_{s_{H,D}} = -\frac{\frac{\partial Z_D}{\partial \beta}|_{s_{H,D}}}{\frac{\partial Z_D}{\partial m_D^*}|_{s_{H,D}}},$$

where

$$Z_D = \theta \{ [1 - (1 - \beta)(1 - q)^2(1 - s_{H,D})^2] [x - (1 + r_{0,H,D}^*)] + \Phi \} - \mu m_D^* = 0,$$

$$\frac{\partial Z_D}{\partial \beta}|_{s_{H,D}} = \theta(1 - q)^2(1 - s_{H,D})^2 [x - (1 + r_{0,H,D}^*)] > 0,$$

$$\frac{\partial Z_D}{\partial m_D^*}|_{s_{H,D}} = -\theta \left\{ [1 - (1 - \beta)(1 - q)^2(1 - s_{H,D})^2] \frac{q^2}{(1 - q)^2} \frac{(1 - \alpha)(1 - \theta)\alpha}{[\alpha + (1 - \alpha)\theta m_D^*]^2} - \frac{\partial \Phi}{\partial m_D^*} \right\} - \mu < 0.$$

After rewriting, it must follow that

$$\frac{dIE}{d\beta}|_{s_{H,D}} \propto \Lambda \equiv \frac{\partial IE}{\partial \beta}|_{s_{H,D}} \left(-\frac{\partial Z_D}{\partial m_D^*}|_{s_{H,D}} \right) + \frac{\partial IE}{\partial m_D^*}|_{s_{H,D}} \frac{\partial Z_D}{\partial \beta}|_{s_{H,D}}.$$

It can be shown that $\lim_{\mu \rightarrow \infty} \Lambda = \infty$ and that $\frac{d\Lambda}{d\mu} > 0$. Hence there must exist a unique value $\bar{\mu}_2 > 0$ such that if $\mu > \bar{\mu}_2$, $\frac{dIE}{d\beta}|_{s_{H,D}} > 0$.

Q.E.D.

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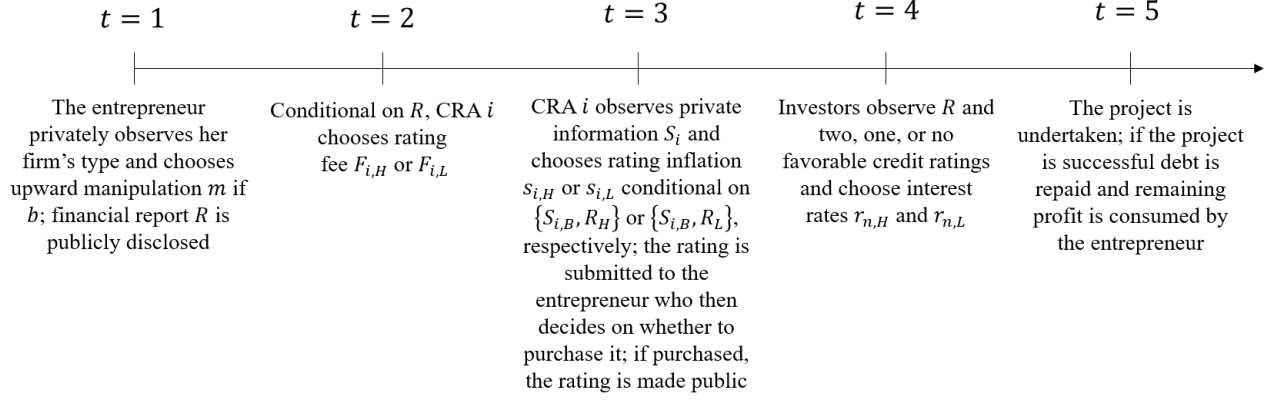


Figure 1: Timeline

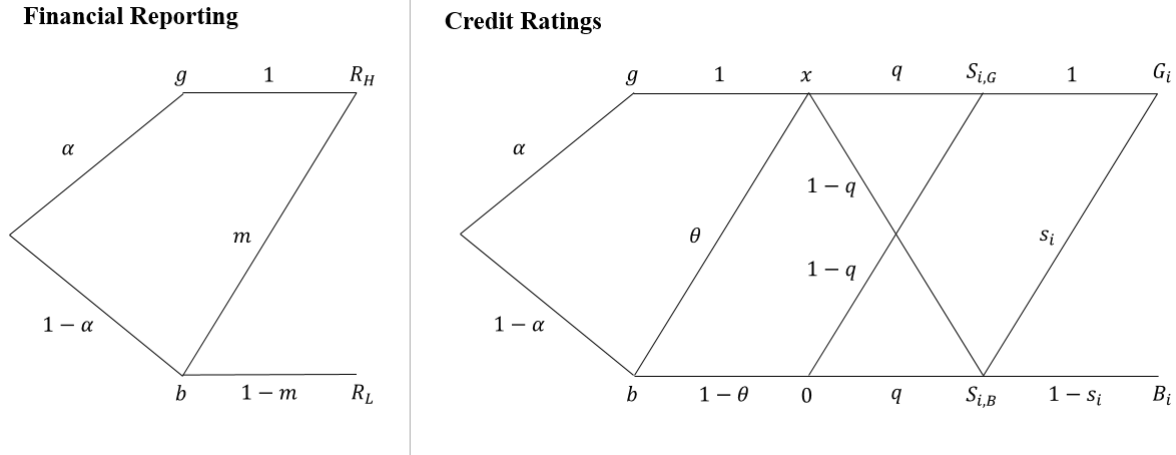


Figure 2: Probability Structure