

# Natural Barrier to Entry in the Credit Rating Industry<sup>1</sup>

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## **Abstract**

We present an infinite horizon model that studies the competition between a relatively ineffective incumbent Credit Rating Agency (CRA) and a sequence of entrant CRAs that are potentially more effective but whose ability in appraising default risk is unproven at the time they enter the market. We show that free entry competition in the credit rating business fails in selecting the most competent CRA as long as two conditions are met. First, investors and issuers trust the incumbent CRA to provide a sincere, although imperfect, assessment of issuers' default risk. Second, CRAs cannot charge higher fees for low rating than for high rating. Under these conditions a rather incompetent CRA can dominate the market without being worried about potentially more competent entrants. We derive policy implications.

**Key Words:** Credit Rating, Entry Barrier, Reputation, Credit Constraint, Private Information

**JEL Codes:** D82, G29, L11, L13, L15

# 1 Introduction

Credit Rating Agencies (CRAs) are considered a central culprit in the recent financial turmoil and today's emerging consensus is that reforming the credit rating industry is necessary to guarantee more reliable ratings. In this paper we investigate whether the opening of the credit rating business to more competition can lead to a better rating service. To this purpose we present a theoretical model of competition between an incumbent and a sequence of entrants in the credit rating industry. We show that issuers' and investors' trust in the incumbent's ratings represents a natural barrier to entry<sup>1</sup> that hinders potentially more accurate CRAs from entering the credit rating business and replacing the less efficient incumbent. The impossibility of selecting accurate CRAs through competition can help explain the questionable accuracy in the ratings preceding the recent financial crisis.

A striking fact about the credit rating industry is its persistent fewness of incumbents (White, 2002). According to Coffee (2006)

"Since early in the 20th century, credit ratings have been dominated by a duopoly - Moody's Investors Services, Inc. (Moody's) and Standard&Poor's Ratings Services (Standard & Poor's)." (Coffee, p.284).

Even though one admits that the Securities and Exchange Commission (SEC)'s awarding, since 1973, of "Nationally Recognized Statistical Ratings Organizations" (NRSROs) status only to a small number of CRAs created an *artificial barrier to entry*, the persistent level of concentration before the promulgation of NRSRO status suggests that a *natural barrier to entry* would exist in the market even in the absence of the artificial barrier to entry. Furthermore, the SEC itself attributes paucity of NRSROs to a natural barrier to entry.<sup>2</sup> Scarcity of applications to the status of NRSRO is also at odds with the high profitability of the credit rating business.<sup>3</sup> Our paper identifies a mechanism that generates such a natural entry barrier.

For this purpose, we consider a stylized model of infinite horizon in which each period an incumbent CRA faces competition from an entrant randomly selected from a pool of

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<sup>1</sup>By the natural barrier to entry, we mean the barrier that exists in the absence of the artificial barrier to entry generated by the NRSRO regulation (explained below in the introduction).

<sup>2</sup>In a hearing held on April 2, 2003 on rating agencies before the Capital Markets Subcommittee of the House of Financial Services Committee, Annette Nazareth (director of the division of market regulation for the SEC) said, "Again, we think that there are some natural barriers to entry here. There have not been that many applications." See page 20 at <http://financialservices.house.gov/media/pdf/108-18.pdf>

<sup>3</sup>On average, between 1995 and 2000, Moody's annual net income amounted to 41.1% of its total assets (White, 2002).

ex ante identical potential entrant CRAs. What we have in mind is that the original incumbent such as Moody's or S&P's has been in the market for long time and has demonstrated its ability, albeit imperfect, in assessing default risk. On the other hand, an entrant is either more or less skilled than the incumbent but it has not yet been given opportunities to make ratings and therefore to prove its expertise.

Each period, there is a short-lived firm who needs to issue debt to finance a risky project. The issuer can hire a CRA to assess the quality of the project and hence the default risk of the debt. Each period an incumbent CRA and an entrant CRA compete in fees to attract the issuer. The more reliable the rater, the higher the issuer's expected profit. Thus, when choosing between hiring an incumbent and an entrant CRA, the issuer takes into account both the difference in their rating fees and in the reliability of their ratings.

If requested to rate a project, a CRA receives a private signal regarding the quality of the project and is free to give a rating that may or not reflect this private signal. The first period incumbent is called the original incumbent. The precision of its signal (which defines the reputation of the original incumbent) is imperfect, constant and known to everybody,<sup>4</sup> whereas an entrant CRA can be either perfectly accurate (i.e. it receives perfect signals) or inaccurate (i.e. it receives completely noisy signals)<sup>5</sup> and its type is unknown to everybody (including to the entrant itself). An entrant CRA's reputation is defined as the public belief about its being of accurate type, coincides with the expected accuracy of its signal and can evolve as agents compare the CRA's ratings with the actual performances of the rated projects. A CRA's survival in the credit rating business is determined by a credit constraint implying that no CRA can stay indefinitely in business without generating a strictly positive profit. Thus, an entrant's survival depends on its ability to build up reputation for providing a more accurate rating than the incumbent.

We first characterize the socially optimal experimentation policy when the signal of each CRA is public information. We find that it is preferable to always hire the original incumbent instead of optimally experimenting with entrants if and only if the incumbent's accuracy is sufficiently larger than entrants' ex-ante reputation. Secondly, we compare this policy with the market outcome induced by free competition given that CRAs' signals are private information and that CRAs' fees cannot be contingent on the rating, as was proposed in the Cuomo plan.<sup>6</sup> There are multiple equilibria in the competitive market

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<sup>4</sup>See Section 5.1 for the extension to the case in which the incumbent's accuracy is unknown.

<sup>5</sup>See Section 5.4 for the extension to the case of general distribution of an entrant's true accuracy.

<sup>6</sup>The Cuomo plan, which is an agreement between New York State Attorney General Andrew Cuomo and the three main CRAs, requires that the issuers pay CRAs upfront for their rating, not contingent on the report. See "For Cuomo, Financial Crisis Is His Political Moment" by Michael Powell, Danny Hakim

because the rating policy adopted by a CRA depends on the public's (i.e. issuers' and investors') self-fulfilling expectations.<sup>7</sup> Therefore, we focus on equilibria that are in line with the real world fact that incumbents' ratings do affect investors' behavior more than ratings from new comers in the credit rating business. In our framework this happens as long as an incumbent adopts the rating policy to always truthfully reveal its private signal.<sup>8</sup> For this class of equilibria, we show that there never is any experimentation of entrants. In other words, as long as the public trusts the original incumbent to provide sincere ratings, the incumbent will dominate the CRA business even when it would be socially optimal to experiment with entrants. Therefore, our results suggest that the public's trust in the incumbent is a source of a natural barrier to entry in the credit rating business.

The driving force of the result is the reputational conflict of interest faced by an entrant. In order to survive it is crucial for the entrant to build up its reputation. So a possibility for the entrant could be to offer rating fees sufficiently low to induce the issuer to hire it, then the entrant can gather information and issue a rating that, if validated by the project outcome, will increase its reputation. Note however that the entrant's reputation can change only if the entrant's rating policy is to give ratings that are correlated with private signals. Only in this case the observation of a project's outcome and rating allows the public to revise its belief about the actual accuracy of the entrant's signal. The stronger this correlation, the stronger the impact of the rating on investors' behavior and the gain in reputation when the rating is validated by the project outcome. Consider rating policies that are informative enough to induce no implementation of projects with low rating. These policies are not credible for the entrant because a low rating leads to no outcome and hence cannot increase the entrant's reputation, whereas, with some positive probability, a high rating will. Similarly, any rating policy such that different ratings lead to substantially different expected reputations and hence different continuation payoffs is not credible. Thus, the only credible rating policies for an entrant are those whose information content is so little that gain in reputation is not strong enough to overtake the original incumbent's reputation.

We also consider the case where CRAs are allowed to charge fees that are contingent on the ratings.<sup>9</sup> We find that the reputational conflict of interest can be eliminated if an entrant CRA is allowed to charge a fee contingent on low rating that is significantly higher

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and Louise Story in New York Times (March 21, 2009).

<sup>7</sup>For instance, there always exists a babbling equilibrium where the public correctly expects any given CRA (be it the incumbent or an entrant) to always report ratings that are non-informative.

<sup>8</sup>A CRA's rating policy is defined as a, possibly stochastic, mapping from private signals into ratings.

<sup>9</sup>This is not allowed by the Cuomo plan.

than a fee contingent on high rating. The larger fee in case of low rating compensates the entrant CRA for the lack of reputation gain. This leads to an equilibrium where all CRAs credibly commit to a truthful rating policy. We find that in this equilibrium, there is socially excessive experimentation of entrants; the original incumbent is replaced for some levels of parameters for which it would be socially optimal not to hire entrants. Furthermore, because a low rating leads to no issuance of debt, it might be difficult to actually implement this "pay-if-you-are-bad" fee schedule as an issuer might not have enough funds to pay for the high fee associated with low rating. The switch from the issuer-pays pricing to investor-pays pricing can help mitigating this problem but does not necessarily eliminate the barrier to entry. Furthermore, the Cuomo plan combined with no rating shopping, policies that have been proposed to rule out rating inflation, are not effective in eliminating the natural barrier to entry either (see Section 7 for a discussion of policy implications).

Even though there are many papers on strategic information transmission by experts,<sup>10</sup> much less has been written on industrial organization of the market of information intermediaries. Lizzeri (1999) considers certification intermediaries who can commit to a disclosure policy and find that a monopoly intermediary reveals only whether quality is above a minimal standard while competition leads to full revelation of quality.<sup>11</sup> Ottaviani and Sørensen (2006a) consider a setting without commitment to a disclosure policy and find that competition generates some bias in information revelation.<sup>12</sup> Faure-Grimaud, Peyrache and Quesada (2009) analyze the conditions under which a rating intermediary finds it optimal to provide a buyer with the option to hide rating and identify competition as a necessary condition. Farhi, Lerner and Tirole (2010) study competition among certifiers when each certifier can commit to a disclosure policy that includes whether to hide or not a given rating as in Faure-Grimaud et al. (2010); in addition, they allow for the buyer of certification to have a second chance by going to a less demanding certifier. All these papers consider static models and none of them addresses entry issue; we study entry barrier in an infinite horizon model. Our result is also related to Strausz (2005) who addresses a source of natural monopoly that is different from ours. He analyzes the problem of a certifier that can be captured (i.e. bribed) by its customers, but after accepting a bribe it completely loses its credibility with future customers. He shows that the certifier

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<sup>10</sup>For instance, our paper is related to the literature on cheap talk under career concerns (Holmström 1999, and Sharfstein and Stein, 1990) or reputational concerns (Ottaviani and Sørensen, 2006 a,b,c).

<sup>11</sup>Doherty, Kartasheva and Phillips (2009) extend the analysis to static competition among rating agencies.

<sup>12</sup>Similarly, Mariano (2010) find that, in a two-period model, competition between two symmetric credit rating agencies leads to rating inflation.

can resist bribes only if it is patient enough and its payoff from honest certification is high enough. The latter condition however is only satisfied when the certifier is a monopolist.

Some recent papers have offered explanations of the failure of the credit rating industry. Mathis, McAndrews and Rochet (2009) present a model of reputation à la Benabou and Laroque (1992) and study how a monopolistic opportunistic CRA can build reputation for being committed to truthfully revealing its private signal regarding the quality of an issuer's project.<sup>13</sup> They show that when a large fraction of the CRA's income comes from rating complex projects, as soon as the CRA's reputation for being committed is strong enough, it is optimal for an opportunistic CRA to be too lax in its rating. Skreta and Veldkamp (2009) (and Sangiorgi, Sokobin and Spatt, 2009) consider a static model with naive investors where an issuer can engage in rating shopping (i.e., it can solicit multiple ratings and disclose only some of them). They show that for complex assets, the issuer will disclose only best ratings generating a rating inflation even if CRAs are assumed to truthfully report their signals. Bolton, Freixas and Shapiro (2009) consider a static model with rating shopping where CRAs can manipulate their ratings but suffer an exogenous reputation cost for misreporting. They find that when there is a large enough fraction of naive investors, a duopoly rating industry is less efficient than a monopoly.<sup>14</sup> Moreover, all the above papers assume that an issuer pays a rating fee only if it decides to disclose a rating to investors. On the contrary, we consider a setting with flat fees and without rating shopping in which all investors are rational and identify a natural entry barrier in the credit rating industry.

Our result that reputational concerns undermine an entrant CRA's ability to generate positive profit is reminiscent of the findings of Morris (2001), Ely and Välimäki (2003) and Ely, Fudenberg and Välimäki, (2008) that the attempt to avoid bad reputation reduces the reliability of an expert. In these models, a bad type (expert) strictly prefers to report one advice independently of its private signal. The good type's willingness to separate itself from the bad type leads to choose actions that hurt its clients (the short-run players). In our model, types regard the precision of an expert's private signal and not its preferences over recommendations. More importantly, no long-run player is born with private information about its type and hence there is no longing for separation. Negative effects of reputational concerns on entrant CRAs come from the presence of competition and credit constraint. Differently from Ely and Välimäki (2003), failure to

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<sup>13</sup>Bar-Issac and Shapiro (2010) consider a model of reputation based on grim-trigger strategies that incorporate economic shocks and show that CRA accuracy may be countercyclical.

<sup>14</sup>Boot, Milbourn and Schmeits (2006) take a different approach and study the role that a rating agency can have as a coordination device in the presence of multiple equilibria.

select an accurate CRA occurs no matter what the discount rate level. Furthermore, our model allows for money transfers from the CRAs to issuers, while it is unclear whether the result of Ely and Välimäki (2003) would be robust if transfers are possible.

The paper is organized as follows. Section 2 presents the model. Section 3 studies two benchmarks: the social optimum and the monopoly case. Section 4 studies the market equilibrium with non-contingent fees. In Section 5, we perform four extensions. First, we study the case of an original incumbent with unknown accuracy. Second, we study the case of longer periods a CRA can survive without generating profits. Third, we consider the case of multiple ratings per issuer. Fourth, we discuss the case of general distribution of entrant's accuracy. In section 6, we analyze the market equilibrium when contingent rating fees are allowed. Section 7 contains some policy implications and concludes. All the proofs are in the Appendix.

## 2 The model

### 2.1 Issuers and investors

We consider an economy of infinite horizon and we model issuers and investors as in Mathis, McAndrews and Rochet (2009). In each period  $t = 1, \dots$ , there is a short-lived cashless firm, named issuer  $t$ , who wants to issue a security for financing an investment project. We normalize the cost of the project to 1. Let  $\tilde{X}_t \in \{X, 0\}$  denote the return from the project of issuer  $t$ . With probability  $\mu = 1/2$ , the project is of good quality and  $\tilde{X}_t = X > 1$ . With probability  $1 - \mu$  the project is of bad quality and  $\tilde{X}_t = 0$ . The project's quality is unknown to everybody including to the issuer itself. Returns of issuers' projects are independently and identically distributed.

Investors are risk neutral and competitive. We normalize the market interest rate of a risk-free bond to zero. In the absence of any additional information about the project, the project will be financed and implemented only if  $\mu X - 1 \geq 0$ . In this instance investors' required interest rate on the corporate bond is  $(1 - \mu)/\mu$  leaving  $X - 1/\mu$  to the issuer's shareholders if the project is successful and 0 otherwise.

### 2.2 Credit Rating Agencies (CRAs)

Issuer  $t$  can hire a CRA  $i$  to rate its bonds. In order to provide a rating the CRA  $i$  has to gather public as well as confidential information about the issuer  $t$ 's project by meeting its executives and analyzing the firm's investment project. These activities have a cost  $c \geq 0$  for the CRA and generates a private signal  $\tilde{s}_{i,t} \in \{G, B\}$  regarding issuer  $t$ . We assume

that there is no moral hazard on  $c$ .<sup>15</sup> After observing  $\tilde{s}_{i,t}$ , CRA  $i$  will give a rating  $r_{i,t}$  that will be either *high* ( $r_{i,t} = G$ ) or *low* ( $r_{i,t} = B$ ). Because we assume ratings are always disclosed, rating shopping is impossible. We assume that  $c$  is large enough to induce the issuer to buy only one rating. In Section 5.3, we consider an extension to multiple ratings per issuer.

### 2.2.1 Accuracy and Reputation

There are two kinds of rating agencies: the original incumbent and a pool of infinite number of ex ante identical potential entrants. Let CRA  $I$  denote the original incumbent. Let  $\lambda_I$  denote *the accuracy of the original incumbent's private signal* or, with some abuse of terminology, *the original incumbent's reputation*. Formally, the probability that the original incumbent's private signal  $\tilde{s}_{I,t}$  reflects the true quality of time  $t$  project is  $\Pr(\tilde{s}_{I,t} = G | \tilde{X}_t = X) = \Pr(\tilde{s}_{I,t} = B | \tilde{X}_t = 0) = 1/2 + \lambda_I/2$ . We assume that the original incumbent's signal is informative but not perfect, that is  $0 < \lambda_I < 1$ . The parameter  $\lambda_I$  is fixed and common knowledge.<sup>16</sup>

In each period an entrant CRA is randomly chosen from the pool of infinitely many potential entrant CRAs. With probability  $\lambda_E$  (with probability  $1 - \lambda_E$ ), time  $t$  entrant CRA is of accurate type (of inaccurate type). Entrants types are independently and identically distributed. An accurate (inaccurate) entrant receives a signal that is always more (less) precise than the original incumbent's one. Namely, an accurate type receives the signal  $G$  whenever the project is good and the signal  $B$  otherwise. An inaccurate CRA's signal is not informative about the project's quality and equals  $G$  or  $B$  with probability  $1/2$  regardless of the true value of  $\tilde{X}_t$ . The type of an entrant CRA is unknown to everybody including to the entrant itself.<sup>17</sup> Thus the parameter  $\lambda_E$  can be interpreted either as the initial expected accuracy of an entrant's signal or *its initial reputation*.

Let  $\mu_{s_t}(\lambda)$  denote the probability that period  $t$  project is of good quality given that a CRA with reputation  $\lambda$  received signal  $s_t \in \{G, B\}$ . Formally,

$$\begin{aligned}\mu_G(\lambda) &:= \Pr(\tilde{X}_t = X | \tilde{s}_t = G) = (1 + \lambda)/2, \\ \mu_B(\lambda) &:= \Pr(\tilde{X}_t = X | \tilde{s}_t = B) = (1 - \lambda)/2.\end{aligned}$$

<sup>15</sup>The issuer can check whether at least part of the cost is incurred. This assumption is common in Bolton, Freixas and Shapiro (2009), Mathis McAndrews and Rochet (2009), Skreta and Veldkamp (2009).

<sup>16</sup>This assumption is not crucial as we illustrate in Section 5.1.

<sup>17</sup>The implicit assumption here is that for a new CRA to test the quality of its technology, it is necessary to access non-public information about projects, i.e. information that is only available upon being hired by issuers.

In the absence of CRAs, the social surplus in period  $t$  is  $\max\{0, \mu X - 1\}$ . Clearly it is socially optimal to hire a CRA only if its reputation is large enough to affect investors' decision to finance or not the project. When the project is implemented if and only if the CRA's signal is  $G$ , the social surplus upon hiring a CRA  $i$  is  $\frac{1}{2}(\mu_G(\lambda_{i,t})X - 1) - c$ . Let  $\lambda_{\min}$  be defined such that

$$\frac{1}{2}(\mu_G(\lambda_{\min})X - 1) - c = \max\{0, \mu X - 1\}.$$

We assume that the original incumbent's reputation is not smaller than the initial reputation of each entrant and that any CRA's initial reputation is above the minimum necessary to justify, from a social planner's perspective, the investment of  $c$  to generate the CRA's private signal:

$$\mathbf{A1:} \quad \lambda_I \geq \lambda_E > \lambda_{\min}.$$

### 2.2.2 Rating policies

Consider the CRA that is hired by time  $t$  issuer and receives private signal  $\tilde{s}_t \in \{G, B\}$ . This CRA need not necessarily issue a rating  $r \in \{G, B\}$  that coincides with its private signal. A rating policy for a CRA is a mapping from its private signal into a distribution over the possible ratings. Since there are only two possible signals and ratings, a rating policy is defined by a function  $R : \{G, B\} \rightarrow [0, 1]$  that maps the CRA's signal  $s$  into the probability of assigning a high rating:

$$R(s) = \Pr(r = G | \tilde{s}_t = s) = 1 - \Pr(r = B | \tilde{s}_t = s).$$

In a subgame perfect Bayesian equilibrium, the rating policy that is actually adopted by CRA  $i$  is the one maximizing its continuation payoff. Let  $V_t(r, s_{i,t})$  denote CRA  $i$ 's equilibrium expected continuation payoff at the end of period  $t$ , i.e. after having received a private signal  $s_{i,t}$  and given a rating of  $r$ , but before observing the outcome of the project. Then the rating policy adopted by CRA  $i$  in period  $t$  must satisfy the following two relations

$$R(s_{i,t}) > 0 \Rightarrow G \in \arg \max_{r \in \{G, B\}} V_t(r, s_{i,t}) \tag{1}$$

$$G \notin \arg \max_{r \in \{G, B\}} V_t(r, s_{i,t}) \Rightarrow R(s_{i,t}) = 0. \tag{2}$$

In equilibrium, the public, i.e. issuers and investors, correctly anticipates the rating policy that each CRA will adopt if hired. That is, if a CRA with reputation  $\lambda$  adopts

rating policy  $R$  and gives a project a rating of  $r$ , then investors will finance it only if  $X\mu_r^R(\lambda) \geq 1$  where  $\mu_r^R(\lambda) := \Pr(\tilde{X}_t = X \mid r, R)$ , that is

$$\begin{aligned}\mu_G^R(\lambda) &= \frac{1}{2} + \frac{R(G) - R(B)}{2(R(G) + R(B))}\lambda, \\ \mu_B^R(\lambda) &= \frac{1}{2} - \frac{R(G) - R(B)}{2(2 - R(G) - R(B))}\lambda.\end{aligned}$$

Without loss of generality, we shall focus on rating policies satisfying  $R(G) \geq R(B)$  implying that a low rating is no better news than a high rating. Hence  $\mu_r^R(\lambda)$  satisfies

$$\mu_B(\lambda) \leq \mu_B^R(\lambda) \leq \mu \leq \mu_G^R(\lambda) \leq \mu_G(\lambda).$$

The informativeness of the rating policy increases with the correlation between the private signal and the rating that can be measured by  $R(G) - R(B)$ . For example, when the CRA truthfully reports its signal,  $R(G) - R(B)$  is maximum and equals 1. Let  $\bar{R}$  denote the truthful rating policy:  $\mu_G^{\bar{R}}(\lambda) = \mu_G(\lambda)$  and  $\mu_B^{\bar{R}}(\lambda) = \mu_B(\lambda)$ . On the contrary,  $R(G) = R(B)$  indicates that the CRA's rating is babbling and in this case  $\mu_G^R(\lambda) = \mu_B^R(\lambda) = \mu$ . Overall, the accuracy of a rating increases with both the accuracy  $\lambda$  of the rater's signal and the informativeness of its rating policy  $R$ .

### 2.2.3 CRAs' stage payoff

In each period  $t$ , two CRAs (for instance, CRA  $i$  and CRA  $j$ ) compete in fees to be hired by period  $t$  issuer. If the issuer hires no CRA, its expected payoff is  $\underline{u} := \max\{0, \mu X - 1\}$ . If the issuer hires CRA  $i$ , it will have to pay the rating fee  $f_{i,t}$  regardless of the rating that the CRA gives. This case of fixed fee corresponds to the fee scheme under the Cuomo plan.<sup>18</sup> Considering that a project is financed only if its expected payoff conditional on rating exceeds 1, the expected payoff of period  $t$  issuer from hiring CRA  $i$  is

$$\begin{aligned}u(f_{i,t}, R_{i,t}, \lambda_{i,t}) &= -f_{i,t} + \Pr(r_{i,t} = G) \max\left\{\mu_G^{R_{i,t}}(\lambda_{i,t})X - 1, 0\right\} \\ &\quad + \Pr(r_{i,t} = B) \max\left\{\mu_B^{R_{i,t}}(\lambda_{i,t})X - 1, 0\right\},\end{aligned}\tag{3}$$

where  $R_{i,t}$  is the rating policy that CRA  $i$  is expected to adopt in period  $t$ . Note that  $u$  is non-decreasing in  $\lambda_{i,t}$  and  $R_{i,t}(G)$  and non-increasing in  $R_{i,t}(B)$ . By choosing the most accurate rater, the issuer first, maximizes the chances of implementing a good project while reducing its financing cost, second, it minimizes the chances of implementing a bad

<sup>18</sup>Our results are robust if we allow a CRA to charge a positive fee contingent on the good rating in addition to the fixed fee, which corresponds to the situation before the Cuomo plan.

project. Thus, if two CRAs charge the same fee, then the issuer will prefer the CRA who will provide the most accurate rating. The following Lemma shows that, the stage payoff of the hired CRA is positive if and only if the public expects this CRA to give a rating that is more accurate than its competitor's one and sufficiently accurate to induce the hiring of the CRA. Formally,

**Lemma 1** *Consider a one-period game. If CRA  $i$  wins the competition with CRA  $j$  for rating period  $t$  issuer, and the public expects CRA  $i$  and  $j$  to adopt rating policies  $R_{i,t}$  and  $R_{j,t}$ , respectively, then*

(i) *CRA  $i$ 's payoff in  $t$  equals:*

$$u(c, R_{i,t}, \lambda_{i,t}) - \max \{u(c, R_{j,t}, \lambda_{j,t}), \underline{u}\} \leq (\lambda_{i,t} - \lambda_{\min}) \frac{X}{4} \quad (4)$$

(ii) *CRA  $j$ 's payoff is nil.*

Note that a CRA  $i$ 's stage payoff in  $t$  increases (decreases) with its (its competitor's) reputation and the informativeness of its (its competitor's) rating policy.

#### 2.2.4 Evolution of reputation

The original incumbent has fixed reputation  $\lambda_I$  as the imperfect precision of its private signals is commonly known. Consider a CRA  $i$  different from the original incumbent, and let  $\lambda_i$  be its reputation for being of accurate type. Suppose such CRA adopts rating policy  $R$  to rate period  $t$  project. At the end of period  $t$ , the public updates its belief about the CRA  $i$ 's accuracy by comparing the outcome of the project, if any, with the rating  $r_{i,t}$  and by taking into account the rating policy  $R$ . The updated *public* reputation of the CRA  $i$  is given by

$$\lambda_{\omega_t}^R := \Pr(\text{CRA } i \text{ is of accurate type} \mid \omega_t, R)$$

where  $\omega_t$  is one of the following five possible events:

- $\omega_t = S^G$  : the project was financed with the CRA  $i$ 's high rating and it succeeded;
- $\omega_t = F^G$  : the project was financed with the CRA  $i$ 's high rating and it failed,
- $\omega_t = S^B$  : the project was financed with the CRA  $i$ 's low rating and it succeeded;
- $\omega_t = F^B$  : the project was financed with the CRA  $i$ 's low rating and it failed;
- $\omega_t = N$  meaning that the project was not financed.

When the CRA  $i$  ( $\neq I$ ) adopts the truthful rating policy  $\bar{R}$ , we have  $\lambda_{SG}^{\bar{R}} = \lambda_{FB}^{\bar{R}} = \frac{2\lambda_i}{\lambda_i+1} > \lambda_i$  and  $\lambda_{SB}^{\bar{R}} = \lambda_{FG}^{\bar{R}} = 0$ . We shall denote  $\lambda_i^+ := \frac{2\lambda_i}{\lambda_i+1}$  and  $\lambda_E^+ := \frac{2\lambda_E}{\lambda_E+1}$  and assume:

**A2:**  $\lambda_E^+ > \lambda_I$ .

A2 means that if an entrant, when hired, adopts the truthful rating policy, then in the event that its rating correctly predicts the project outcome, its reputation overtakes that of the original incumbent.<sup>19</sup>

Note that for any rating policy satisfying  $R(G) \geq R(B)$ , the entrant's reputation cannot suffer (gain) from issuing a rating that is confirmed (contradicted) by the actual quality of the project. The maximum increase and decrease in reputation however are attained when the rating policy is truthful. On the contrary, if the project is not implemented or the rating policy is babbling, then the public can learn nothing regarding the CRA's type. Note also that after observing outcome  $\omega_t$ , a CRA's private belief about its accuracy need not coincide with its public reputation  $\lambda_{\omega_t}^R$ . More precisely, if the outcome of the project is (not) predicted by its private signal, the CRA's private belief of being accurate is  $\lambda_i^+$  (resp. 0).

## 2.3 Credit constraint and a simple survival rule for CRAs

We assume that, because of a credit constraint, no CRA can stay in the business for too long without generating strictly positive profits. Assumptions A3(i) and A3(ii) provide simple survival rules that capture this idea. In Section 5.2, we show that our result is robust to introducing more general survival rules.

**A3(i):** An active CRA that does not generate a positive profit over two consecutive periods must exit the market by the end of the second of the two periods. When this happens, the exit is definitive and the surviving CRA, if any, becomes the next period incumbent CRA. An exiting CRA is replaced by a new active entrant from the pool of potential entrants.

**A3(ii):** If a CRA active in period  $t$  expects to generate no profit in the future, it will exit the market at the end of period  $t$ .

Note that in our model one period corresponds to the average maturity of an issuer's debt that for the US corporate bonds is of 10 years<sup>20</sup>. Thus, the survival rule in Assump-

<sup>19</sup>Since  $\lambda_E^+ > \lambda_E$ , A2 is equivalent to  $\lambda_E > \lambda_I/(2 - \lambda_I)$  and A1 and A2 are satisfied if and only if  $\max\{\lambda_{\min}, \lambda_I/(2 - \lambda_I)\} < \lambda_E \leq \lambda_I$ .

<sup>20</sup>Between 1996 and 2009, the average maturity of U.S. corporate bond was of 9.6 years (Source: Thomson Reuters).

tion A3(i) implies that a CRA can stay in business up to two decades without generating any positive profit. The last part of A3(i) says that a CRA's exit is followed by a new entrant's entry. In other words, a new entrant enters only if there is an exiting CRA. A3(ii) is justified by the fact that in the real world, a CRA has to sustain some fixed annual cost to be present in the market.

### 3 Two benchmarks

In this section we present two benchmarks. First, we characterize the hiring strategy that would maximize social welfare if CRAs' signals were publicly observable. Second, we characterize the equilibrium payoff for the original incumbent and for an entrant when each of them is in a monopolistic position.

#### 3.1 Socially optimal experimentation

In this subsection we study the problem of a social planner who can decide which CRA to hire (in each period) to maximize social welfare under the assumption that, once hired, a CRA's private signal becomes public information. The alternative is between having all projects rated by the original incumbent or optimally experimenting with entrants. Since each CRA's reputation is above  $\lambda_{\min}$  and signals are publicly observable, only a project that receives a good signal will be implemented. This implies that only events  $S^G$ ,  $F^G$  and  $N$  can happen. Thus the optimal way of experimenting with entrants consists in: (i) continuing to have projects rated by the entrant CRA of  $t = 1$  as long as it does not realize an  $F^G$  event, (ii) if the CRA realizes an  $F^G$  event, replacing it with a new entrant with fresh reputation  $\lambda_E$  who should rate projects until an event  $F^G$  happens etc. This guarantees that eventually an entrant of accurate type will be recruited and will rate all following projects. Let  $W_E(\lambda_E)$  denote the social welfare obtained by optimally experimenting with entrants. Let  $W_I$  denote social welfare from having the original incumbent  $I$  with known accuracy  $\lambda_I$  rate the infinite sequence of projects. These payoffs are normalized by  $1/(1 - \delta)$  where  $\delta$  is the discount factor. Experimenting with entrants is socially preferred to consistently hiring the original incumbent if and only if  $W_E(\lambda_E) > W_I$ . We have:

**Proposition 1** *Consider the benchmark in which the social planner can decide which CRA to hire in each period and each hired CRA's signal is public information. Then,*

experimenting with the entrants is socially optimal if and only if

$$\lambda_I < \lambda_E + \frac{\delta \lambda_E (1 - \lambda_E)}{4(1 - \delta) + \delta \lambda_E} := \lambda_I^*(\lambda_E). \quad (5)$$

Not surprisingly as  $\delta$  goes to 1, condition (5) becomes  $\lambda_I < 1$  for  $\lambda_E > 0$  implying that if agents are very patient it is always socially optimal to experiment with entrants and eventually identify one accurate type even when this can take a lot of time.

## 3.2 Monopoly

In this subsection we consider the benchmark of monopoly: either the original incumbent or an entrant is the monopolist. We assume CRAs' signals are private information. In what follows, we show that there are equilibria where investors expect the monopolist CRA to adopt the truthful rating policy and this policy is indeed optimal for the CRA.

When the original incumbent is the monopolist, as it has no reputational concern, a fixed fee induces it to truthfully reveal its signal. Hence, the monopolist stays indefinitely in the market and realizes the maximum profit of  $(\lambda_I - \lambda_{\min}) X/4$  per period.

Suppose now that an entrant is the monopolist. Then, its reputation can evolve over time. Let  $\lambda_t (> \lambda_{\min})$  represent its reputation in the beginning of period  $t$ . Given truthful rating policy, at the end of period  $t$ , its reputation will move to  $\lambda_t^+$ ,  $\lambda_t$  and 0 in event  $S^G$ ,  $N$  and  $F^G$ , respectively. When  $\lambda_{t+1} = 0$ , the monopolist is known to be inaccurate and hence cannot generate any profit from  $t+1$  on. Considering that the ex ante probabilities of these events are  $\Pr(S^G) = \frac{\lambda_t + 1}{4}$ ,  $\Pr(N) = 1/2$  and  $\Pr(F^G) = \frac{1 - \lambda_t}{4}$ , the monopolist's equilibrium payoff  $V^M(\lambda_t)$  must satisfy the following functional equation

$$V^M(\lambda_t) = (1 - \delta) (\lambda_t - \lambda_{\min}) \frac{X}{4} + \delta \left( \frac{\lambda_t + 1}{4} V^M(\lambda_t^+) + \frac{1}{2} V^M(\lambda_t) \right), \quad (6)$$

that gives

$$V^M(\lambda_t) = \frac{X}{4 - 3\delta} \left( \frac{4 - 3\delta - \delta \lambda_{\min}}{4} \lambda_t - (1 - \delta) \lambda_{\min} \right). \quad (7)$$

We now show that the monopolist has an incentive to truthfully report its signal. First, if the public expects the monopolist to adopt the truth-telling policy, a low rating leads to no implementation of the project and in this case the monopolist's reputation remains unchanged leading to a continuation payoff of  $V^M(\lambda_t)$ . Suppose that he received a good signal and truthfully reports it. Then, its continuation payoff is  $\frac{1 + \lambda_t}{2} V^M(\lambda_t^+)$ . Suppose that he received a bad signal but reports a high rating. Then, its continuation payoff is  $\frac{1 - \lambda_t}{2} V^M(\lambda_t^+)$ . Therefore, truth-telling is an equilibrium if the following incentive

constraints hold:

$$\frac{1 - \lambda_t}{2} V^M(\lambda_t^+) \leq V^M(\lambda_t) \leq \frac{1 + \lambda_t}{2} V^M(\lambda_t^+), \quad (8)$$

which is satisfied for any  $\delta \in [0, 1]$  and for any  $\lambda_t \geq \lambda_{\min}$ . Summarizing, we have:

**Proposition 2** *Consider a monopoly benchmark where either the original incumbent or an entrant is the monopolist. Then, there is an equilibrium in which each period the monopolist truthfully reveals its private signal.*

## 4 Competition

In this section we analyze the equilibrium of the CRA entry game when each hired CRA's signal is its private information. Note first that there are trivial equilibria where any arbitrarily given CRA cannot enter or survive in the credit rating business because issuers and investors expect the CRA to adopt the babbling rating policy. From Lemma 1, it follows that in such equilibria the CRA stage payoff cannot be positive as issuers would not pay to obtain a rating that will have no effect on investors. Also as the CRA is not taken seriously, the public belief about the CRA's accuracy cannot evolve. Hence, the CRA's continuation payoff  $V_t$  is nil for any time  $t$ , reputation  $\lambda_t$ , rating  $r$ , and signal  $s$ . Thus the babbling rating policy is optimal for the CRA (in that it satisfies conditions (1) and (2)) and is consistent with what the public expects from the CRA. Also, by arbitrarily fixing which CRA is expected to babble and when, one can build all sorts of equilibria spanning from situations where no CRA is ever hired, to cases where any arbitrary chosen CRA (be it an entrant or the original incumbent) enjoys a monopoly position.

In what follows we restrict our attention to equilibria satisfying two plausible properties. First, since all entrants are ex-ante identical, we focus on equilibria where, at the time they first arrive in the market all entrants are expected to adopt the same rating policy, denoted  $R_E$ . Second, as it happens in the real world, an incumbent rating should affect investors' decision and its effect should not be weaker than that of a new entrant. This is true for all possible  $R_E$  if the incumbent gives a sincere rating. This is summarized by the following condition:

**Relevance of the incumbent's rating (RIR):** In equilibrium any incumbent adopts the truthful policy as long as its reputation  $\lambda_t$  is not smaller than the entrant's one,  $\lambda_E$ . At the time of entry all CRAs adopt the same rating policy  $R_E$ .

Consider the competition between the original incumbent and an entrant CRA  $i$  in period  $t$ . Observe first that, in period  $t$  the entrant cannot generate any strictly positive

profit. To see this point, note first that condition RIR and  $\lambda_E \leq \lambda_I$  implies that the public expects the incumbent rating to be at least as informative as the entrant's. Thus according to Lemma 1, even if period  $t$  issuer hires the entrant, the entrant's profit cannot be positive. However the entrant could be willing to sustain a loss in  $t$  as by rating issuer  $t$  he could increase its reputation and gain a positive profit in  $t + 1$ . By contrast, if the entrant expects that it cannot realize a positive profit in period  $t + 1$ , then it will exit the market at the end of period  $t$ , from A3(ii).

We first study the subgame that starts after the entrant wins the competition and has to decide how to rate the issuer. Let  $V^R(\omega_t, s_t)$  denote the entrant's continuation payoff from  $t + 1$  on given that in period  $t$ , it received signal  $s_t \in \{G, B\}$ , that the public expected it to adopt the rating policy  $R$ , and that the event  $\omega_t$  was realized.

The following Lemma shows that, after winning the competition with the original incumbent to rate issuer  $t$ , the period  $t$  entrant's equilibrium continuation payoff  $V^R(\omega_t, s_t)$  is zero for all  $\omega_t$  and  $s_t$ . Formally,

**Lemma 2** *Consider the subgame that starts after the period  $t$  entrant wins the competition to rate issuer  $t$  and receives a private signal  $s_t$ . In all equilibria satisfying condition RIR, we have  $V^R(\omega_t, s_t) = 0$  for all  $s_t \in \{G, B\}$  and all  $\omega_t \in \{S^G, F^G, S^B, F^B, N\}$  occurring with positive probability.*

This result follows from the entrant CRA's fundamental conflict between giving an informative rating and trying to improve its reputation. After period  $t$  entrant rated a project, if its reputation does not increase, then also in  $t + 1$  it cannot make positive profits. Thus, the CRA exits the market at the end of period  $t$ . Hence the CRA has an incentive to issue the rating that maximizes its expected reputation conditional on its private signal. Since implementing the project is pivotal to increasing the CRA's reputation, the CRA will never issue a rating preventing the implementation of the project if it can issue another rating that induces investors to finance the project. In fact, if a project is implemented with a high rating, there is some positive probability that the project is successful even if the CRA's signal is bad. This implies that in equilibrium, an entrant's rating cannot affect the investors' decision to finance or not the project. If the project is never implemented, the CRA will never improve its reputation and will have to exit the market. If the project is always implemented, then the entrant rating policy must be such that the negative information contained in a low rating is not strong enough to deter investment in the project. For this to happen it must be that a low rating is sometimes issued even when the CRA's signal is good. In other words, the rating policy is such that, upon receiving a

good signal, the CRA gives both good and bad ratings with strictly positive probabilities. This requires the CRA who received a good signal to be indifferent between giving a good or a low rating, which is possible only if the CRA's expected continuation payoff does not depend on the rating. However, such a rating policy also implies that the CRA gain in reputation from giving a high rating to a successful project is larger than the reputation gain from giving a low rating to a project that fails. Hence, the indifference condition holds only if in both outcomes the entrant's new reputation is not sufficient to replace the incumbent that implies that the entrant's continuation payoff must be nil for all ratings.

Lemma 2 has a direct consequence on an entrant's ability to attract its first issuer away from the original incumbent. When the period- $t$  entrant sets its fees to compete with the original incumbent, it cannot pledge any future profit and the minimum fee it can charge is  $c$ . The original incumbent then can set fees larger than  $c$  and nevertheless be hired thanks to the fact that its ratings are more informative than the entrant's one. Therefore, the original incumbent will always be hired by the issuer:

**Proposition 3** *Under assumptions A1, A2, A3(i)-(ii) and the Cuomo plan, in all equilibria satisfying condition RIR, no experimentation of any entrant occurs and the original incumbent dominates the market forever.*

## 5 Extensions

### 5.1 Varying reputation incumbent

We consider the case where the original incumbent's accuracy is not known and, like an entrant, can either be of accurate or of inaccurate type. Let  $\lambda_I > \lambda_E$  be the initial belief that the incumbent is of accurate type. We show that equilibria satisfying condition RIR exist, and have the property that no experimentation is possible. We also provide an upper and a lower bound for the incumbent equilibrium payoff. Within this framework, the most favorable situation for the new incumbent is when the public believes that all new entrants always babble implying that the incumbent enjoys a monopoly position. The worst situation is when the public believes that also the new entrants will adopt the truthful rating policy.<sup>21</sup> Then we have

**Proposition 4** *If the incumbent's true accuracy is unknown and its (public and private) reputation is  $\lambda_I > \lambda_E$ , then under assumptions A1, A2, A3(i)-(ii) and the Cuomo plan, equilibria satisfying condition RIR exist and are such that*

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<sup>21</sup>The entrant can commit to use the truthful rating policy only if  $\lambda_I \geq \lambda_E^+$ , so in a SPE the lower bound cannot be reached when  $\lambda_E \leq \lambda_I < \lambda_E^+$ .

In period  $t$  the incumbent is hired and adopts the truthful rating policy. Its equilibrium payoff  $V(\lambda_{It})$  satisfies

$$\widehat{V}(\lambda_{It}) := \frac{X}{4 - 3\delta} \left( \frac{4 - 3\delta - \delta\lambda_E}{4} \lambda_{It} - (1 - \delta)\lambda_E \right) \leq V(\lambda_{It}) \leq V^M(\lambda_{It}).$$

The equilibrium payoff of period  $t$  entrant is 0.

Proposition 2 and Proposition 4 basically suggest that regardless of facing competition or not, an incumbent can commit to the truthful rating policy. Therefore, allowing the original incumbent's reputation to vary will not affect our results.

## 5.2 General survival rules

We now consider an extension of the model that relaxes the assumptions on the survival rules of CRAs. In each period, CRAs can rate a new project that has maturity  $T \geq 1$  periods, i.e. if the project is implemented, its outcome is observed  $T$  periods after the implementation. We relax the assumptions regarding the survival dynamics:

**A4 (i):** An active CRA that does not generate a positive profit over a finite number  $n \geq 2$  of consecutive periods must exit the market by the end of the  $n$ -th period.

**A4 (ii):** If a CRA active in period  $t$  expects to generate no profit in the future, it will exit the market at the end of period  $t$ .

In addition, we maintain assumption A2 that one successful prediction is enough to boost an entrant's reputation above that of the original incumbent. More precisely, we assume that when adopting the truthful rating policy, the entrant's reputation becomes at least  $\lambda_E^+ > \lambda_I$  if the entrant's rating corresponds to the project outcome for at least one issuer and the entrant's ratings have never been contradicted by the outcomes of the other projects. We focus on the case  $\mu X < 1$  implying that in the absence of rating the project is not implemented.

The following proposition extends the result of Proposition 3 to the less stringent survival constraints A4 (i)-(ii).

**Proposition 5** *Under assumptions A1, A2 and A4 (i)-(ii) and the Cuomo plan and  $\mu X < 1$ ,<sup>22</sup> in all equilibria satisfying condition RIR, no experimentation of any entrant occurs and the original incumbent dominates the market forever.*

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<sup>22</sup>Proposition 5 extends to the case of  $\mu X > 1$  under an additional assumption that whenever the first rating does not coincide with the realized outcome of the rated project, the entrant is replaced with a new entrant. Then, the proof of Lemma 5 can be applied to  $n \geq 2$ .

The argument is simple. Entrant  $t$  can now be active from  $t$  till  $t + n - 1$  without generating profit. The case  $n \leq T$  is trivial since even if time  $t$  entrant rates time  $t$  issuer, the project outcome will not be observed before the entrant has to exit the market and hence the entrant cannot improve its reputation. Consider the case  $n > T$  and  $T = 1$ , that is, if implemented, a project generates its outcome after one period. This is the set-up allowing the entrant to build up its reputation the fastest. If in equilibrium the time  $t$  entrant provides the first rating to the issuer of time  $t + n - 2$ , then its continuation payoff is nil. In fact, entrant  $t$  has its last opportunity to rate an issuer whose outcome will be observed before  $t + n - 1$  and by applying an argument similar to that of Proposition 3 one can show that the entrant's expected continuation payoff cannot be positive. Thus, either the entrant has rated another issuer before  $t + n - 2$  or its continuation payoff is nil. But this implies that if time  $t$  entrant has not rated any issuer until time  $t + n - 3$ , then the implementation of the project of period  $t + n - 3$  is also pivotal and the same argument applies. Further backward induction implies that implementing time  $t$  project is pivotal for building up the reputation of time  $t$  entrant and hence it will immediately exit the market as it cannot expect any positive profit.

### 5.3 Multiple ratings

Consider now the case in which  $c$  is low enough that an issuer can obtain a rating from each CRA. The timing we consider within period  $t$  is such that first, two competing CRAs of period  $t$  simultaneously propose their fees to issuer  $t$ . Second, issuer  $t$  decides the CRAs from whom to obtain rating, if any. Third, the CRAs are informed of the issuer choice and give their ratings. If both CRAs are asked, they give ratings simultaneously. Hence, a CRA's rating policy might change depending on whether the issuer is also rated by its competitor but the issued rating is not contingent on the one issued by the competitor. Fourth, the decision to implement or not the issuer's project is made and the outcome of the implemented project is realized.

If the issuer chooses to be rated by only one CRA, then the entrant cannot survive, either because it is not hired or because Proposition 3 applies (and hence the entrant cannot build up its reputation). Consider then the case where the issuer hires both CRAs. Surprisingly, the original incumbent can make the survival of entrant impossible by reducing the informativeness of its ratings. The intuition is simple. Suppose that when the issuer hires both CRAs the original incumbent adopts a babbling strategy. Then the public will ignore the original incumbent's rating and the entrant will face the

same conflict of interests that it faces when it is the only hired CRA.<sup>23</sup> On the contrary, if the issuer only hires the original incumbent, then this can safely provide a truthful rating. We have:

**Proposition 6** *Consider the case in which  $c$  is low enough that an issuer can obtain a rating from each CRA. Under assumptions A1, A2 and A3 (i)-(ii) and the Cuomo plan, in all equilibria satisfying condition RIR whenever the original incumbent is hired alone, no experimentation of any entrant occurs and the original incumbent dominates the market forever. More precisely, in all equilibria where issuer  $t$  hires both entrant  $t$  and the original incumbent, the entrant's continuation payoff is nil and hence the entrant exits immediately, implying that experimentation is impossible; in all other equilibria, entrant  $t$  is never hired.*

## 5.4 General distribution of types

We briefly discuss the case of a general distribution of the entrant's signal precision. Let  $\tilde{\lambda}_E$  represent the true accuracy of an entrant of which the density function is given by  $f(\cdot)$  with support  $[0, 1]$ . Let  $\lambda_E = E(\tilde{\lambda}_E)$  the initial expected accuracy. Consider the case in which the signal is public information and let  $\lambda_E^+ = E\{\tilde{\lambda}_E \mid \omega = S^G\} = E\{\tilde{\lambda}_E \mid \omega = F^B\}$  represent the updated expectation about the entrant's accuracy after one successful prediction. Then, define A1 and A2 with respect to  $\lambda_E$  and  $\lambda_E^+$ . Finally, consider the main case in which signals are private information and define the value function of an entrant in the sub-game in which entrant  $t$  is chosen to rate issuer  $t$  as  $V^R(\omega_t, s_t) = V(\lambda_{pub}^R(\omega_t, s_t), \lambda_{pri}^R(\omega_t, s_t))$  for all  $s_t \in \{G, B\}$  and all  $\omega_t \in \{S^G, F^G, S^B, F^B, N\}$  where  $\lambda_{pub}^R(\omega_t, s_t)$  represents the public's expectation about the entrant's accuracy and  $\lambda_{pri}^R(\omega_t, s_t)$  represents the entrant's expectation about its own accuracy. Then, it is easy to see that as long as  $V(\cdot, \cdot)$  is non-decreasing in  $\lambda_{pub}^R$  and in  $\lambda_{pri}^R$  the proofs of Lemma 2, Propositions 3, carry over to the general distribution of the entrant's type. Thus there is no experimentation with entrant CRA.

## 6 Contingent Fees

In this session we study the equilibrium of the entry game when CRAs are allowed to charge rating fees that are contingent on the rating note: one for high rating ( $f_G$ ), another

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<sup>23</sup>Actually, the original incumbent need not adopt the babbling strategy, but it suffices to reduce enough its ratings' informativeness to make a high rating from the entrant pivotal to the implementation of the project.

for low rating ( $f_B$ ). We show that in this case, any CRA can commit to the truthful rating policy and that an entrant can replace the original incumbent provided that the latter's reputation is not too high. The argument articulates in two steps. Consider competition between the original incumbent and period  $t$  entrant. First, period  $t$  entrant can propose an incentive compatible fee scheme that associates a low rating with a fee that is higher than the fee charged for a high rating. In fact, if period- $t$  issuer chooses the entrant and the latter is expected to adopt the truthful rating policy, the project will be financed if and only if it receives a high rating. The higher fee for a low rating compensates the entrant for the lack of gain in reputation due to the non-implementation of the project, and makes credible its commitment to the truthful rating. The fee for a high rating is lower but if a high rating is followed by a good outcome  $\tilde{X}_t = X$ , then the entrant's reputation jumps to  $\lambda_E^+ > \lambda_I$  and the entrant replaces the original incumbent who has to exit the market from A3(ii).<sup>24</sup> From this point on, the phase with a varying reputation incumbent starts and continuation strategies and payoffs are given by Proposition 4. This in turn implies that period  $t$  entrant can pledge positive future profits to lower its fee and attract period  $t$  issuer. The issuer will prefer the entrant as long as the the original incumbent's reputation is not too large compared with that of the entrant. Formally, define  $\lambda_I^{**}(\lambda_E) (> \lambda_E)$  as the  $\lambda_I$  solving the following equation

$$(1 - \delta)(\lambda_I - \lambda_E) \frac{X}{4} = \delta \frac{\lambda_E + 1}{4} \widehat{V}(\lambda_E^+).$$

Note  $\lambda_I^{**}(\lambda_E) > \lambda_I^*(\lambda_E)$ . Then we have:

**Proposition 7** *Under assumption A1, A2 and A3 (i)-(iii), if each CRA can condition its fee to its rating, there exists an equilibrium such that;*

(i) *If  $\lambda_I \geq \lambda_I^{**}(\lambda_E)$ , no experimentation of any entrant occurs: competition leads the original incumbent to rate all projects and its equilibrium payoff is*

$$V_I := (1 - \delta)(\lambda_I - \lambda_E) \frac{X}{4} - \delta \frac{\lambda_E + 1}{4} \widehat{V}(\lambda_E^+) \geq 0$$

*whereas the equilibrium payoff of period  $t$  entrant is equal to 0.*

(ii) *If  $\lambda_I < \lambda_I^{**}(\lambda_E)$ , then experimentation of the entrant occurs during the first period: the first entrant is hired and the original incumbent exits the market at the end of period 1. The entrant's expected payoff is*

$$V_E = -V_I > 0.$$

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<sup>24</sup>This is because the original incumbent generated no revenue in  $t$  and it cannot generate any positive profit in  $t + 1$  by competing with a CRA that has a stronger reputation.

*The first period entrant fees are such that  $f_G < f_B$ . The game eventually reaches a steady state where the incumbent has the accurate type.*

We have three remarks. First, the above proposition suggests that, in order to generate some endogenous experimentation of entrant CRAs, rating fees should not be fixed as suggested in the Cuomo plan. Furthermore, the current practice of charging higher fees when the rating is positive is opposite to what could open the credit rating market to the competition of entrants. Only by charging fees that are higher for low rating compared to the fee charged for high rating, an entrant can credibly commit to disclose its private signal and build the reputation necessary to remain in the business.

Second, from a social welfare perspective, contingent fees lead to over-experimentation whenever  $\lambda_I^*(\lambda_E) < \lambda_I < \lambda_I^{**}(\lambda_E)$ . That is to say, an entrant CRA could replace the original incumbent even when the entrant's initial reputation is too small to justify the experimentation from a social welfare perspective. The intuition for this result is simple. From a social planner perspective, experimentation is optimal only if it generates a level of expected social welfare that is larger than the strictly positive social welfare obtained when consistently hiring the incumbent. This happens only if the entrant expected accuracy is not too small when compared to the known accuracy of the incumbent. On the other hand, in the market equilibrium, from the entrant's perspective, the two alternatives are either to replace the incumbent or realize zero profit. Thus, an entrant's incentive to replace the incumbent is stronger than the social planner's incentive to replace the incumbent. The remedy to over-experimentation can be obtained by imposing a legal lower bound to the entrant average fee.

**Proposition 8** *Under assumption A1, A2, A3(i)-(iii), suppose that each CRA can condition its fee to its rating. Then, socially optimal experimentation is attained by the market if each entrant's expected fee is not allowed to be below the following lower bound:*

$$\frac{1}{2}(f_G + f_B) \geq (\lambda_E - \lambda_I^*(\lambda_E)) \frac{X}{4} + c \quad (9)$$

where  $\lambda_E - \lambda_I^*(\lambda_E) < 0$  from (5).

Third, this "pay if you are bad" contingent fee scheme can be difficult to implement ex-post. Namely, in case of low rating the project is not implemented and the entrant's continuation payoff is nil as its reputation has not improved. Incentive compatibility constraint requires that rating fee  $f_B$  must be large enough to compensate the entrant for the expected continuation payoff obtained when giving a high rating. In other words,

an issuer who received a low rating from an entrant CRA not only will not be able to raise the money necessary to finance the project but in addition it will have to pay the entrant a fee that corresponds to a fraction of the entrant's expected present value of the profit obtained when it receives a good signal and possibly replace the incumbent. More precisely, considering that in equilibrium  $\frac{1}{2}(f_G + f_B) = (\lambda_E - \lambda_I) \frac{X}{4} + c$ , the incentive compatibility constraint to report truthfully a bad signal (see (17) in the Appendix) is

$$f_B \geq (\lambda_E - \lambda_I) \frac{X}{4} + c + \frac{1}{2} \frac{\delta}{1 - \delta} \mu_B(\lambda_E) V^{\bar{R}}(S^G, B),$$

which is unbounded when  $\delta$  tends to 1. Thus, "pay if you are bad" contingent fee is not an equilibrium if the issuer's internal funds are bounded when compared to the entrant's potential profit.

## 7 Conclusion and policy implications

Reputational concern is often argued as the key force guaranteeing the well-functioning of the credit rating market by reducing conflict of interest of incumbent CRAs. For instance, according to Standard & Poor's testimony to SEC's public hearing (held on November 15, 2002),

"Most importantly, the ongoing value of Standard & Poor's credit ratings business is wholly dependent on continued market confidence in the credibility and reliability of its credit ratings. No single issuer fee or group of fees is important enough to risk jeopardizing the agency's reputation and its future."<sup>25</sup>

Our analysis provides a theoretical ground to this argument. It is by maintaining the public's confidence in their commitment to truthful ratings that today's incumbents CRA might have secured their dominant position and neutralized threats from potentially more effective entrant CRAs. In other words, a cause of the natural barrier to entry in the credit rating business is the public's confidence that the incumbent provides a sincere, albeit imperfect, rating. The recent rumors and scandals about the incumbent CRAs' rating practices are casting doubts on the sincerity of these ratings.<sup>26</sup> According to our model the fading of the public' confidence in the incumbent rating is a necessary condition to generate a credible threat to the original incumbent. Not surprisingly after many years of paucity of applications, recently new CRAs are entering the market and envisaging

<sup>25</sup><http://www.sec.gov/news/extra/credrate/standardpoors.htm>

<sup>26</sup>See, for instance, "Triple-A-Failure," by Roger Lowenstein, New York Times Magazine, April 27, 2008.

to apply to the NRSRO status.<sup>27</sup> Still, according to our model, nothing guarantees that these new entrants will gain the trust of the public that is necessary to survive in the business. Below we provide some directions for policies that might help the settling of more effective CRAs.

First, our model suggests that eliminating institutional barriers to entry such as the NRSRO accreditation is not enough to facilitate entry. We show that entry might remain impossible even in the absence of such an accreditation requirement. Quite to the opposite, such accreditation can help increasing public's trust in entrant's rating technology. However the accreditation alone does not guarantee that the entrants will be sincere in their ratings and/or that the public will believe them. This leads to our second policy implication. In order to gain the public's confidence that an entrant's rating will be truthful, entrant CRAs should be allowed to charge contingent fees that are higher for low rating than for high rating. This is the exact opposite of today's incumbents' practice.<sup>28</sup>

The Cuomo plan (i.e. no contingent fee) combined with no rating shopping has been proposed to eliminate incumbent CRAs' conflict of interest by Bolton, Freixas and Shapiro (2009): it would also eliminate rating inflation in Mathis, McAndrews and Rochet (2009) and in Skreta and Veldkamp (2009). These authors also find that changing from the issuer-pays pricing to the investor-pays pricing can solve both the (incumbents') conflict of interest and the rating inflation although the investor-pays pricing can create its own problem of free-riding among investors. Unfortunately, none of these policies can eliminate the barriers to entry. For instance, the switch to the investor-pays pricing does not remove the reputational conflict of interest of an entrant CRA facing truthful incumbent.<sup>29</sup> However, if the pay-if-you-are-bad fee schedule cannot be implemented with financially constrained issuers under the issuer-pay pricing, it could be feasible under the investor-pays pricing.

Recent theoretical papers on the credit rating business have shown that CRAs' tendency to be too lax and/or issuers' predilection for publishing only good ratings can lead to inflated ratings. In our model, even though CRAs can manipulate their ratings, there are equilibria where the incumbent CRA truthfully reports its signal. Hence our explanation of recent rating inflation relates to the possibility that inaccurate CRAs dominate

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<sup>27</sup>A new entrant in the European market is COFACE. Recently Wall Street analyst Meredith Whitney announced to the Financial Times its plan to create a new CRA and apply for the NRSRO status.

<sup>28</sup>According to Coffee (2008) in a recent congressional testimony: "Today, the rating agencies receives one fee to consult with a client, explain its model, and indicate the likely outcome of the rating process; then, it receives a second fee to actually deliver the rating (if the client wishes to go forward once it has learned the likely outcome). The result is that the client can decide not to seek the rating if it learns that it would be less favorable than it desires; the result is a loss of transparency to the market."

<sup>29</sup>The proof of Lemma 2 applies to the investor-pays pricing and hence Proposition 3 applies as well.

the market. In fact, an inaccurate CRA can make two types of errors: give a high rating to a bad security or a low rating to a good security. When the public trusts the rater, only high rating securities tend to be issued. Hence, the error we should observe in data are of the first type, resulting in an observation of rating inflation. Our paper is a first step toward understanding the lack of entry in the credit rating market. It is worthwhile to study other factors (different from entrants' conflicts of interest) that generate entry barrier in this market.

## 8 Appendix

### Proof of Lemma 1

Let  $i$  and  $j$  be the two CRAs competing to rate period  $t$  issuer. Let  $f_{i,t}$  and  $f_{j,t}$  be the CRAs' fees. Let  $R_{i,t}$  and  $R_{j,t}$  be the rating policies that the public expects each CRA to implement. Thus the issuer profit maximization leads to select the CRA that solves

$$\max \{u(f_{i,t}, R_{i,t}, \lambda_{i,t}), u(f_{j,t}, R_{j,t}, \lambda_{j,t}), \underline{u}\}. \quad (10)$$

When the solution of (10) is  $\underline{u}$ , no CRA is hired. Suppose that CRA  $i$  is hired. In equilibrium, CRA  $j$  sets the fee  $f_{j,t}$  not larger than  $c$  and realizes zero profit since it is not hired. CRA  $i$  charges the fee such that the issuer is indifferent between hiring CRA  $i$  and the second best option, i.e. either hiring the CRA  $j$  or hiring no CRA. That implies  $f_{i,t}$  is such that  $\max \{u(c, R_{j,t}, \lambda_{j,t}), \underline{u}\} = u(f_{i,t}, R_{i,t}, \lambda_{i,t})$ . After investing  $c$ , CRA  $i$ 's stage payoff is at most  $f_{i,t} - c$ , that is positive only if the l.h.s. of (4) is positive. A CRA's payoff is maximized when it faces no competition and is believed to provide a truthful rating. This payoff equals the r.h.s. of (4) that correspond to the case  $R_{i,t} = \bar{R}$  and  $R_{j,t} = \underline{R}$ .  $\square$

### Proof of Proposition 1

From A1 and the fact that the signal is publicly observable, we know that only projects that receive a good signal will be implemented. Let us consider  $W_I$ . The ex ante probability that in any given period  $t$  the CRA  $I$ 's signal is  $G$  is  $1/2$ . The probability that a project is good given CRA  $I$  received a good signal is  $\mu_G(\lambda_I) = \frac{1+\lambda_I}{2}$ . Thus,

$$W_I = \frac{1}{2} \left( \frac{1+\lambda_I}{2} X - 1 \right). \quad (11)$$

When optimally experimenting with entrants, if  $\lambda \geq \lambda_E$  is the current reputation of the CRA hired at  $t$ , we have:  $\Pr(\omega_t = S^G) = \frac{1+\lambda}{4}$ ,  $\Pr(\omega_t = N) = 1/2$  and  $\Pr(\omega_t = F^G) = \frac{1-\lambda}{4}$ . Thus, the average social welfare  $W_E$  satisfies the following recursive equation:

$$W_E(\lambda) = (1 - \delta) \frac{1}{2} \left( \frac{1+\lambda}{2} X - 1 \right) + \delta \left( \frac{1+\lambda}{4} W_E(\lambda^+) + \frac{1}{2} W_E(\lambda) + \frac{1-\lambda}{4} W_E(\lambda_E) \right).$$

Solving this equation gives

$$W_E(\lambda) = \frac{1}{2} \left( \frac{2(1-\delta)(1+\lambda) + \delta\lambda_E}{4(1-\delta) + \delta\lambda_E} X - 1 \right), \quad (12)$$

which is strictly increasing in  $\lambda$ . The comparison of  $W_I$  and  $W_E(\lambda)$  provides the threshold  $\lambda_I^*(\lambda_E)$ . Note that because of A1,  $W_I$  and  $W_E(\lambda_E)$  are always greater than the social welfare obtained in the absence of CRAs.  $\blacksquare$

## Proof of Proposition 2

The proposition immediately follows from the discussion in Section 3.2.

## Proof of Lemma 2

We decompose  $V^R(\omega_t, s_t)$  into two parts

$$V^R(\omega_t, s_t) = (1 - \delta)\pi_{t+1}^R(\omega_t, s_t) + \delta V_2^R(\omega_t, s_t),$$

where  $\pi_{t+1}^R(\omega_t, s_t)$  is the entrant's expected profit in  $t + 1$  and  $V_2^R(\omega_t, s_t)$  is the expected continuation payoff starting from  $t + 2$ . Let  $\lambda_\omega^R$  be the entrant's public reputation at the beginning of time  $t + 1$ , given  $\omega_t = \omega$  and let  $\hat{\lambda}_{\omega,s}$  be the entrant's private belief of being accurate given  $(\omega_t, s_t) = (\omega, s)$ . Then in any equilibria satisfying condition RIR, we have:

**Property i)**  $V^R(\omega_t, s_t) \geq 0$ .

**Property ii)**  $V^R(\omega_t, s_t) = 0$  whenever  $\lambda_\omega^R \leq \lambda_I$ .

Property i) holds because the entrant can always exit the market at no cost. Property ii) holds because  $\lambda_\omega^R \leq \lambda_I$  and RIR imply that in  $t + 1$  the original incumbent is expected to give a more accurate rating than time  $t$  entrant. Hence from Lemma 1,  $\pi_{t+1}^R(\omega, s) \leq 0$ . For the same reasons,  $\lambda_E \leq \lambda_I$  implies that entrant  $t$  cannot generate profit in period  $t$ . Hence, from A3(i) the entrant must exit in  $t+2$  yielding  $V_2^R(\omega_t, s_t) = 0$  and  $V^R(\omega_t, s_t) \leq 0$ . The equality follows from Property i).

We have the following lemma regarding  $\pi_{t+1}^R$ .

**Lemma 3** Under A3(ii), for any given  $\omega_t \in \{S^G, F^G, S^B, F^B, N\}$ ,

(i) If  $\pi_{t+1}^R(\omega_t, s_t) = 0$ , then the period  $t$  entrant with the private signal  $s$  exits the market at the end of  $t$  and hence  $V^R(\omega_t, s_t) = 0$ .

(ii) It is impossible to have “ $\pi_{t+1}^R(\omega_t, s_t) > 0$  and  $\pi_{t+1}^R(\omega_t, s'_t) = 0$ ” for  $s_t \neq s'_t$ .

**Proof:** (i) Considering that at time  $t$  the entrant has not realized a positive profit, the proof is a straightforward consequence of A3(ii).

(ii) Consider for instance  $\pi_{t+1}^R(\omega_t, G) > 0$  and  $\pi_{t+1}^R(\omega_t, B) = 0$ . Let  $f_{t+1} > c$  be the fee that the entrant with  $s = G$  charges in period  $t + 1$ . Then, the entrant with  $s = B$  can charge the same fee and realize  $\pi_{t+1}^R(\omega, B) > 0$ , which is a contradiction. The same logic applies to the case of  $\pi_{t+1}^R(\omega_t, G) = 0$  and  $\pi_{t+1}^R(\omega_t, B) > 0$ .  $\square$

Lemma 3(ii) implies that we have either “ $V^R(\omega_t, G) > 0$  and  $V^R(\omega_t, B) > 0$ ” or “ $V^R(\omega_t, G) = V^R(\omega_t, B) = 0$ ”.

**Lemma 4** *If and  $X\mu < 1$ , then in any equilibrium satisfying Properties i)-ii), it must be  $V^R(\omega_t, s_t) = 0$  for all  $(\omega_t, s_t)$  occurring with positive probability.*

**Proof:** Since  $X\mu < 1$ , a low rating from the entrant prevents the implementation of the project. Hence a low rating implies  $\omega_t = N$ ,  $\lambda_N^R = \lambda_E \leq \lambda_I$  and a nil continuation payoff because of Property ii). If a high rating leads to no implementation of the project as well (i.e.  $X\mu_G^R(\lambda_E) < 1$ ), then the entrant's continuation payoff is nil for any rating and hence our result is proven.

Therefore, suppose  $X\mu_G^R(\lambda_E) \geq 1$  such that a high rating leads to implementation of the project with positive probability  $p > 0$ . Then, given a signal  $s_t$ , the entrant's expected continuation payoff from reporting a high rating is given by:

$$p\mu_s(\lambda_E)V^R(S^G, s_t) + p(1 - \mu_s(\lambda_E))V^R(F^G, s_t) + (1 - p)V^R(N, s_t).$$

For  $\omega_t \in \{F^G, N\}$ , it results  $\lambda_{\omega_t}^R \leq \lambda_E < \lambda_I$ , hence  $V^R(\omega_t, s) = 0$  from Property ii). From Lemma 3(ii), either “ $V^R(S^G, G) > 0$  and  $V^R(S^G, B) > 0$ ” or “ $V^R(S^G, G) = V^R(S^G, B) = 0$ ”. If  $V^R(S^G, G) = V^R(S^G, B) = 0$ , the result is proven since the continuation payoff from reporting a high rating is nil for both signals. Consider therefore the case of  $V^R(S^G, G) > 0$  and  $V^R(S^G, B) > 0$ . Since  $\mu_G(\lambda_E) > 0$  and  $\mu_B(\lambda_E) > 0$ , the continuation payoff from reporting a high rating is strictly positive for both signals and hence the entrant would always report a high rating. In other words, the entrant's rating strategy is babbling, which implies that the project will never be implemented from  $X\mu < 1$ . This contradicts the assumption  $X\mu_G^R(\lambda_E) \geq 1$ .  $\square$

Now observe that any equilibria satisfying condition RIR has the following additional properties.

**Property iii)**  $V^R(S^G, G) \geq V^R(S^G, B)$  and  $V^R(F^B, B) \geq V^R(F^B, G)$ .

**Property iv)** If  $\hat{\lambda}_{\omega, s} = \hat{\lambda}_{\omega', s'}$ ,  $\lambda_{\omega}^R < \lambda_{\omega'}^R$  and  $V^R(\omega, s) > 0$ , then  $V^R(\omega', s') > V^R(\omega, s)$ .

To interpret Property iii), note first that after observing an outcome of the project that confirms (resp. contradicts) its private signal, the entrant's private belief of being accurate is  $\hat{\lambda}_{\omega_t, s_t} = \lambda_E^+$  (resp.  $\hat{\lambda}_{\omega_t, s_t} = 0$ ). For instance, if  $(\omega_t, s_t) = (S^G, G)$ , the entrant attaches probability  $\lambda_E^+$  of being accurate, whereas if  $(\omega_t, s_t) = (S^G, B)$  the entrant realizes that its signals are not informative. Consider the following deviation. After observing  $(\omega_t, s_t) = (S^G, G)$ , the entrant behaves as if it observed  $(\omega_t, s_t) = (S^G, B)$  and hence ignores its private signals henceforth. Since the other market participants' strategies do not depend on the entrant's private information  $s_t$ , the entrant's deviation payoff is  $V^R(S^G, B)$  that cannot be larger than its equilibrium payoff  $V^R(S^G, G)$ , implying Property iii). Property iv) states that if the entrant becomes an incumbent, then its continuation payoff increase

in its reputation. Note that  $V^R(\omega, s) > 0$  implies that time  $t$  entrant becomes the new incumbent after event  $\omega_t = \omega$ . For Property ii) its reputation satisfies  $\lambda_\omega^R > \lambda_I$ . Hence condition RIR requires that it will adopt the truthful rating strategy until, possibly, an event  $F^G$  will force the CRA to exit the market. Fix any continuation history  $h(T) = \{\omega_{t+1}, \omega_{t+2}, \dots, \omega_{t+T}\}$  and let  $\lambda_{t+T}(\omega_t)$  be the CRA's public reputation at the end of this history. Then  $\lambda_\omega^R \leq \lambda_{\omega'}^R$  implies  $\lambda_{t+T}(\omega) \leq \lambda_{t+T}(\omega')$ . At time  $t + T + 1$ , if the CRA is out of business, its stage payoff is 0; otherwise, it is  $u(c, \bar{R}, \lambda_{t+T}(\omega_t)) - \max\{u(f_E, R_E, \lambda_E), \underline{u}\}$ , which is increasing in  $\lambda_{t+T}(\omega_t)$ . Taking the expectation across all continuation history and considering that at time  $t$  the CRA private belief of being accurate is the same as  $\hat{\lambda}_{\omega, s} = \hat{\lambda}_{\omega', s'}$ , we can conclude that  $V^R(\omega', s') \geq V^R(\omega, s)$ .

Then we have

**Lemma 5** *If  $X\mu > 1$ , then in any equilibrium satisfying Properties i)-iv), it must be  $V^R(\omega_t, s_t) = 0$  for all  $(\omega_t, s_t)$  occurring with positive probability.*

**Proof:** Since  $X\mu > 1$ , a high rating from the entrant always induces the implementation of the project. We have to distinguish two cases:  $X\mu_B^R(\lambda_E) < 1$  or  $X\mu_B^R(\lambda_E) > 1$ . In the first case, the proof of Lemma 4 can be applied to obtain a contradiction: babbling and  $X\mu > 1$  imply that the project is always implemented, which contradicts  $X\mu_B^R(\lambda_E) < 1$ .

Therefore, we consider  $X\mu_B^R(\lambda_E) > 1$ , that is, a low rating leads to implementation of the project. For  $\omega_t \in \{S^B, F^G, N\}$  it results  $\lambda_{\omega_t}^R \leq \lambda_E < \lambda_I$ , hence  $V^R(\omega_t, s) = 0$  for Property ii). Note that since  $R(G) \geq R(B)$ , it must be that the entrant does not strictly prefer to report a rating opposite to its signal. This translates into the following incentive compatibility constraints:

$$\mu_G(\lambda_E)V^R(S^G, G) \geq (1 - \mu_G(\lambda_E))V^R(F^B, G) \quad (13)$$

$$(1 - \mu_B(\lambda_E))V^R(F^B, B) \geq \mu_B(\lambda_E)V^R(S^G, B) \quad (14)$$

Recall that  $\mu_G(\lambda_E) = (1 - \mu_B(\lambda_E)) = (1 + \lambda_E)/2$  and  $\mu_B(\lambda_E) = (1 - \mu_G(\lambda_E)) = (1 - \lambda_E)/2$ .

1. It cannot be that (13) is strict. If it is strict, the entrant strictly prefers to truthfully report a good signal and reports  $B$  with positive probability only after receiving a signal  $B$ . As a consequence  $\mu_B^R(\lambda_E) = \mu_B(\lambda_E)$ , and  $\lambda_E > \lambda_{\min}$  implies  $X\mu_B(\lambda_E) < 1$ , thus contradicting  $X\mu_B^R(\lambda_E) > 1$ .
2. If (13) holds with equality but (14) is strict, then  $1 > R(G) > 0$  and  $R(B) = 0$ . This implies that the entrant public reputation satisfies

$$\lambda_{FB}^R = \frac{\lambda_E \frac{1}{2}}{\lambda_E \frac{1}{2} + (1 - \lambda_E) \frac{1}{2} (\frac{1}{2} + \frac{1}{2} (1 - R(G)))} < \lambda_E^+ = \lambda_{SG}^R$$

Where the inequality follows from  $X\mu_B^R(\lambda_E) > 1$ . However the entrant's private belief of being accurate is the same in events  $(\omega = S^G, s = G)$  and  $(\omega = F^B, s = B)$  as in both events the entrant's private signal is confirmed by the project outcome. Hence we can apply Property iv) implying that if  $V(F^B, B) > 0$ , then  $V(S^G, G) > V(F^B, B)$ . Note however that from Property iii) we have  $V(F^B, G) \leq V(F^B, B)$  and hence equality in (13) would be in contradiction with  $V(S^G, G) > V(F^B, B)$ . Hence it must be  $V(F^B, B) = 0$  that, together with property i), iii) and the incentive compatibility constraints, implies  $V(\omega, s) = 0$  for all signals  $s$  and  $\omega \in \{F^B, S^G\}$ .

3. If both (13) and (14) hold with equality, then by summing (13) and (14) we obtain

$$(1 + \lambda_E)(V(S^G, G) + V(F^B, B)) = (1 - \lambda_E)(V(F^B, G) + V(S^G, B)) \quad (15)$$

Suppose that continuation payoffs in (15) are strictly positive, then Property iii) implies that the r.h.s. of (15) is not larger than  $(1 - \lambda_E)(V(F^B, B) + V(S^G, G))$ , which in turn is strictly smaller than the l.h.s. of (15). Thus a contradiction of equality (15). Hence equality (15) can only be satisfied when both sides are nil.  $\square$

This ends the proof of Lemma 2.  $\square$

### Proof of Proposition 3

Consider the competition between the original incumbent and an entrant in period  $t$ . Note that condition RIR implies that

$$\mu_G^{\bar{R}}(\lambda_I) - \mu_B^{\bar{R}}(\lambda_I) \geq \mu_G^{R_E}(\lambda_E) - \mu_B^{R_E}(\lambda_E)$$

independently of the entrant's rating policy  $R_E$ . Hence time  $t$  entrant can attract time  $t$  issuers only by charging a negative fee that compensates the issuer for the entrant's lower expected rating accuracy. The maximum the entrant is willing to pay to attract the issuer is  $\delta E[V^R(\tilde{\omega}, \tilde{s}_{Et})]$ , that is nil because of Lemma 2. As the entrant cannot attract the issuer, it cannot build up reputation and hence will leave the market at the end of period  $t$ .  $\blacksquare$

### Proof of Proposition 4

Note first that  $\lambda_{I,t} \geq \lambda_E$  implies that period  $t$  entrant cannot gain positive profit in  $t$  and the same reputational concern studied in Proposition 3 leads to the impossibility of entry. The upper bound  $V^M(\lambda_{I,t})$  immediately follows from Proposition 2. Let us consider

$\widehat{V}(\lambda_{I,t})$ . The incumbent's lowest stage payoff from competition with the entrant is when the public believe that the entrant will adopt a truthful strategy.<sup>30</sup> In this case, each entrant's fee is equal to  $c$  and the incumbent will set its fee at a level that makes the issuer indifferent between the entrant and the incumbent. This gives the incumbent a period  $t$  payoff of  $\frac{1}{2}(\mu_G(\lambda_{I,t}) - \mu_G(\lambda_E))X = (\lambda_{I,t} - \lambda_E)\frac{X}{4}$ . Truthful rating policy implies that the incumbent's reputation will move to  $\lambda_t^+$ ,  $\lambda_t$  and 0 in events  $S^G$ ,  $N$  and  $F^G$  respectively. These events occur with probability  $\Pr(S^G) = \frac{\lambda_t+1}{4}$ ,  $\Pr(N) = 1/2$  and  $\Pr(F^G) = \frac{1-\lambda_t}{4}$ , respectively. Hence the incumbent equilibrium payoff  $\widehat{V}(\lambda_{I,t})$  must satisfy the following functional equation

$$\widehat{V}(\lambda_{I,t}) = (1 - \delta)(\lambda_t - \lambda_E)\frac{X}{4} + \delta \left( \frac{\lambda_t + 1}{4}\widehat{V}(\lambda_{I,t}^+) + \frac{1}{2}\widehat{V}(\lambda_{I,t}) \right)$$

that is identical to equation (6) but for  $\lambda_E$  instead of  $\lambda_{\min}$ . Solving it gives  $\widehat{V}(\lambda_{I,t})$  in the Lemma. The proof of the result that truthful rating is incentive compatible for the incumbent is analogous to the one in Proposition 2, and is omitted.  $\square$

### Proof of Proposition 5:

The case  $n \leq T$  being trivial we focus on the case  $n > T$  and  $T = 1$ , that is, if implemented, a project generates its outcome after one period. This is the set-up allowing the entrant to build up its reputation the fastest. We first have the following lemma, which extends Lemma 3(ii) to any  $n \geq 2$ .

**Lemma 6** *Let  $\tau \in \{t, \dots, t + n - 1\}$  be the first period when a project rated by entrant  $t$  is implemented with positive probability. Then, consider the subgame that starts after the entrant receives  $s_\tau$ . Then, under  $A4(ii)$ , we have either " $V^R(\omega_\tau, G) > 0$  and  $V^R(\omega_\tau, B) > 0$ " or " $V^R(\omega_\tau, G) = V^R(\omega_\tau, B) = 0$ " for any  $\tau \in \{t, \dots, t + n - 1\}$ .*

**Proof:** The result is obvious for  $\tau = t + n - 1$  and for  $\tau = t + n - 2$  it follows from Lemma 3(ii). Hence, consider  $\tau < t + n - 2$ . Until  $\tau$  the entrant's public reputation and its private belief of being accurate coincide and are equal to  $\lambda_E$ . This implies that the entrant cannot have generated any positive profit before  $\tau + 1$ . If the project is not implemented in  $\tau$ , then the entrant's public reputation and its private belief of being accurate coincide and are equal to  $\lambda_E$  and hence the result holds trivially. Hence, suppose that the project is implemented in  $\tau$ . At the end of period  $\tau$ , after observing the project outcome of  $\tau$ ,

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<sup>30</sup>Beside, this is credible only if  $\lambda_{I,t} \geq \lambda_E^+$  as the entrant will never overtake the incumbent reputation in one step, and hence has a continuation payoff of 0 and can credibly commit to a truthfully rating policy.

the entrant's private belief for being accurate is  $\lambda_E^+$  or 0 depending on whether or not its private signal  $s_\tau$  correctly predicted project  $\tau$  outcome. That is, starting from this point the entrant has private information that we denote  $\theta \in \{\lambda_E^+, 0\}$ . We below study the game of incomplete information that starts at the beginning of period  $\tau + 1$  (or at the end of  $\tau$ ).

First, we consider a separating equilibrium in which the entrant signals its type  $\theta$  with its time  $\tau + 1$  rating fee and find that there is no separating equilibrium that leads to a positive continuation payoff to at least one type in  $\{\lambda_E^+, 0\}$ . To see this point, note that in a separating equilibrium the public perfectly learns  $\theta$  after observing the entrant fee  $f_{\tau+1}$ . Then 0 type's continuation payoff must be zero. Suppose that  $\lambda_E^+$  type's continuation payoff is strictly positive. Then, according to Proposition 4 and condition RIR, after the separation is done, the  $\lambda_E^+$  type always uses truth-telling strategy. However, for any  $\lambda_t \geq \lambda_E^+$ , the continuation payoff generated by the truth-telling strategy is such that the CRA is indifferent between reporting a high rating and a low rating when its signal is good whereas it strictly prefers giving a low rating when its signal is bad. This implies that if 0 type deviates and charges the same fee as  $\lambda_E^+$  type charges, it can get the same continuation payoff as the  $\lambda_E^+$  type by systematically giving a low rating, which contradicts the existence of such a separating equilibrium.

Second, consider a semi-separating equilibrium in which  $\lambda_E^+$  type uses a pure strategy while 0 type uses a mixed strategy in terms of fee charged in period  $\tau + 1$ . Then, we find that there is no such semi-separating equilibrium that leads to a positive continuation payoff to at least one type in  $\{\lambda_E^+, 0\}$ . If such an equilibrium exists, 0 type's expected payoff must be nil because it reveals its type with positive probability. Hence from A4(ii), 0 type exits immediately at the end of  $\tau$ . If  $\lambda_E^+$  type's continuation payoff is strictly positive, it will not exit, leading to a separating equilibrium. But we just showed that there is no separating equilibrium that leads to a positive continuation payoff to at least one type in  $\{\lambda_E^+, 0\}$ .

Last, consider now either a pooling equilibrium or a semi-separating equilibrium in which  $\lambda_E^+$  type uses a mixed strategy while 0 type uses a pure strategy in terms of fee charged in period  $\tau + 1$ . Then, for the reasons given previously, there is no equilibrium in which only one type realizes a positive continuation payoff. If such an equilibrium exists, then the other type exits at the end of  $\tau$  from A4(ii), which leads to a separating equilibrium. But we just showed that there is no separating equilibrium that leads to a positive continuation payoff to at least one type in  $\{\lambda_E^+, 0\}$ . ■

We now extend Lemma 4 to any  $n$ .

**Lemma 7** *Assume  $X\mu < 1$  and  $A4(ii)$ . Let  $\tau \in \{t, \dots, t+n-1\}$  be the first period when a project is rated by entrant  $t$ . Consider the subgame that starts after the entrant receives  $s_\tau$ . Then, it must be  $V^R(\omega_\tau, s_\tau) = 0$  for all  $(\omega_\tau, s_\tau)$  occurring with positive probability.*

**Proof:** The result is obvious for  $\tau = t+n-1$  and the result is proved for  $\tau = t+n-2$  in Lemma 4. Consider first  $\tau = t+n-3$ . When  $X\mu < 1$ , we need to consider two cases: in period  $\tau$ , the project is never implemented or is implemented only with a high rating. In the first case, the entrant's public reputation and its private belief of being accurate coincide and are equal to  $\lambda_E$ . Then, from Proposition 3, the entrant's continuation payoff is zero for any  $s_\tau$ . Hence, consider the second case in which the project is implemented in  $\tau$  only with a high rating. Then, a low rating gives zero continuation payoff for any  $s_\tau$ . Furthermore, from Lemma 6, the sign of the expected continuation payoff conditional on giving a high rating does not depend on  $s_\tau$ . If it is zero, then we obtain our result. If it is strictly positive, the entrant has an incentive to give a high rating regardless of  $s_\tau$ , which means babbling. Then, we obtain a contradiction since babbling leads to no implementation of project for any rating. This proves that  $V^R(\omega_\tau, s_\tau) = 0$  for all  $(\omega_\tau, s_\tau)$  occurring with positive probability for  $\tau = t+n-3$ .

Consider now  $\tau = t+n-4$ . Then, no implementation of project in  $\tau$  leads to zero continuation payoff from the result we proved for  $\tau = t+n-3$ . Hence, consider the case in which the project is implemented in  $\tau$  with only a high rating. Then, the argument written for  $\tau = t+n-3$  can be used to show that  $V^R(\omega_\tau, s_\tau) = 0$  for all  $(\omega_\tau, s_\tau)$  occurring with positive probability for  $\tau = t+n-4$ . Indeed, the same proof can be applied successively to any  $\tau < t+n-4$ . ■

Finally, Lemma 7 implies that time  $t$  entrant will exit immediately. ■

### Proof of Proposition 6

Note first that in all equilibria where the issuer hires only one of the two CRAs, the same analysis of Proposition 3 applies. Second, note that if the incumbent is hired alone, it can commit to the truthful rating policy. Consider therefore the subgame that starts after issuer  $t$  asks ratings from both the original incumbent and entrant  $t$ . If in this subgame, the CRAs' equilibrium rating policies do not affect the implementation decision (because irrespective of the ratings the project is either always implemented or never implemented), then the entrant's continuation payoff is zero (since the analysis of Lemma 4 and Lemma 5 applies) and the incumbent can charge a fee inducing the issuer to hire the incumbent alone instead of hiring both the entrant and the incumbent (or hiring the entrant alone).

Hence consider the subgame where both CRAs are hired and their ratings do affect investment decision. Then we have three cases:

1. A high rating from the incumbent is necessary to induce implementation of the project.
2. A high rating from the entrant is necessary to induce implementation and the incumbent rating has no effect on the decision to implement or not the project.
3. The project is implemented for all ratings except when both CRAs give the low ratings.

In this subgame the original incumbent is better off by minimizing the entrant's chances of building up its reputation. This implies that if the entrant's expected continuation payoff is positive, then the incumbent's optimal rating policy is to babble.

Consider case 1. In this case, the incumbent has an incentive to report a bad rating. This prevents implementation of the project and guarantees that the entrant cannot improve its reputation. Since the incumbent adopts the babbling strategy, its rating cannot affect investment decision implying that case 1 is impossible.

Consider case 2. Since the incumbent's rating is useless, the precision of the ratings obtained in this case is at maximum equal to the one obtained when only the entrant is hired and provides a truthful rating. This is less than the precision of a rating from the incumbent when hired alone. Thus in period  $t$  the entrant cannot make a positive profit. As a consequence, once hired the entrant has to build up reputation, otherwise in the following period it will not be able to obtain a positive profit because of the competition with the incumbent (or from a new entrant). This implies that the entrant faces the same conflict of interest as in the single rating and hence its continuation payoff is nil.

Consider case 3. If a low rating (respectively, a high rating) induces the entrant to have zero continuation payoff while a high rating (respectively, a low rating) induces the entrant to have a strictly positive continuation payoff, then the entrant will always give the high rating (respectively, the low rating). That is the entrant adopts the babbling rating policy. But then investors' decision cannot depend on the entrant's rating, which is a contradiction of 3. Suppose the entrant has strictly positive continuation payoffs with either rating. Fix the strategy of the entrant. Consider the deviation in which the original incumbent gives a low rating independently of its private signal. This does not affect the entrant's payoff when it gives a high rating since anyway the project will be implemented. However, it will reduce the entrant's payoff when it gives a low rating since then the

project will not be implemented and the entrant cannot build up its reputation. Thus the incumbent must adopt the babbling strategy and its rating is not informative, which again contradicts 3. Thus the only possibility for case 3 is that the entrant's continuation payoff is nil.

To summarize in all equilibria where the issuer hires both the entrant and the incumbent, the entrant's continuation payoff is nil and hence the entrant exits immediately, implying that experimentation is impossible. In all other equilibria the entrant is never hired.  $\square$

### Proof of Proposition 7

Consider an equilibrium where the public believes that the entrant's rating policy is truthful. Then investors will (not) finance a project that received a high (low) rating. In case the entrant issues a low rating, it obtains  $f_B$  but its reputation will not change. If  $f_B > 0$ , period  $t$  entrant can survive but in period  $t + 1$  it will be challenged by period  $t + 1$  entrant.<sup>31</sup> As these two CRAs have the same reputation, their expected continuation payoff from  $t + 1$  is nil by Bertrand competition. If event  $\omega_1 = F^G$  occurs, the entrant's reputation becomes zero and it will have to exit the market. Hence time 1 entrant's continuation payoff is positive only if it rates the project and the outcome  $\omega_1 = S^G$  is observed. In this case, the continuation payoff will be at least  $\widehat{V}(\lambda_E^+)$  from Proposition 4<sup>32</sup>. Under the truthful rating policy, we have  $\Pr(\omega_t = S^G) = \frac{\lambda_E + 1}{4}$ . Thus the minimum contingent fees  $(f_G, f_B)$  that the entrant is willing to charge to have the opportunity to rate period one project satisfy

$$(1 - \delta) \left( \frac{1}{2} (f_G + f_B) - c \right) + \delta \frac{\lambda_E + 1}{4} \widehat{V}(\lambda_E^+) = 0.$$

Let  $\overline{V}_I$  denote the original incumbent's continuation payoff in period 2 when it is not replaced. The value to the incumbent of rating period one project is  $-c(1 - \delta) + \delta \overline{V}_I$  while the value to the incumbent of letting the entrant rate period one project is  $\delta(1 - \frac{\lambda_E + 1}{4}) \overline{V}_I$ , where the original incumbent is assumed to remain the incumbent whenever the entrant does not manage to increase its reputation. Thus, the minimum fee that the original incumbent is willing to charge is

$$(1 - \delta) (f_I - c) + \delta \frac{\lambda_E + 1}{4} \overline{V}_I = 0.$$

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<sup>31</sup>In equilibrium in which issuer  $t + 1$  is expected to hire entrant  $t$  rather than the original incumbent, the original incumbent exits at the end of  $t$  since it did not realize any profit in  $t$  and expects zero profit from  $t + 1$ . This exit is followed by the entry of a new entrant.

<sup>32</sup>Actually, it will be  $\widehat{V}(\lambda_E^+)$  since all entrants can commit to truthful reporting with contingent fees.

In order to attract its first issuer the entrant has to compensate it for its lower accuracy and charge contingent fees  $(f_G, f_B)$  that satisfy

$$-f_I + \lambda_I \frac{X}{4} < -\frac{1}{2}(f_G + f_B) + \lambda_E \frac{X}{4}.$$

Therefore, the competition to rate period one project will be won by the incumbent whenever

$$-c + \frac{\delta}{1-\delta} \frac{\lambda_E + 1}{4} \bar{V}_I + \lambda_I \frac{X}{4} \geq -c + \frac{\delta}{1-\delta} \frac{\lambda_E + 1}{4} \widehat{V}(\lambda_E^+) + \lambda_E \frac{X}{4},$$

which is satisfied for  $\lambda_I \geq \lambda_I^{**}(\lambda_E)$  and all non-negative  $\bar{V}_I$ . In this instance the incumbent's winning fee is  $f_I = -\frac{\delta}{1-\delta} \frac{\lambda_E + 1}{4} \widehat{V}(\lambda_E^+) + (\lambda_I - \lambda_E) \frac{X}{4} + c$ . Since the same situation occurs in every period, it must be that  $\bar{V}_I = V_I$ . When  $\lambda_I < \lambda_I^{**}(\lambda_E)$ ,  $\bar{V}_I = 0$  and period 1 entrant rates the period one project. Then, the entrant's expected fees satisfy

$$\frac{1}{2}(f_G + f_B) = -(\lambda_I - \lambda_E) \frac{X}{4} + c, \quad (16)$$

and its overall expected payoff is  $V_E > 0$ .

We now verify that it is incentive compatible for the entrant to adopt the truthful strategy. In case the entrant receives a good signal and issues a high rating, then with probability  $\mu_G(\lambda_E)$ , the project is successful and the entrant's reputation jumps to  $\lambda_E^+$  leading to a continuation payoff of at least  $\widehat{V}(\lambda_E^+)$ . If instead it issues a bad rating, its continuation payoff will be nil. Now, suppose it receives a bad signal but issues a high rating. In this case, if the project is successful, then the entrant's public reputation jumps to  $\lambda_E^+$  whereas the entrant becomes certain of being of the inaccurate type since its signal differs from the outcome of the project. In this instance let  $V^{\bar{R}}(S^G, B)$  be the off-equilibrium continuation payoff. Note that  $V^{\bar{R}}(S^G, B) \leq V^{\bar{R}}(S^G, G)$ , because of property iii) in the proof of Lemma 2. To summarize, in order to commit to a truthful reporting, the entrant's fee scheme must satisfy the following incentive compatibility constraints.

$$f_G + \frac{\delta}{1-\delta} \mu_B(\lambda_E) V^{\bar{R}}(S^G, B) \leq f_B \leq f_G + \frac{\delta}{1-\delta} \mu_G(\lambda_E) \widehat{V}(\lambda_E^+). \quad (17)$$

The first (second) inequality guarantees that the entrant prefers to give a low (high) rating after receiving a bad (good) signal. It is straightforward to verify that there are  $(f_G, f_B)$  satisfying (16) and (17). ■

### Proof of Proposition 8

Given that the rating policies are truthful, an issuer prefers an entrant to the incumbent as long as  $-\frac{1}{2}(f_G + f_B) > -f_I + (\lambda_I - \lambda_E) \frac{X}{4}$ . When the entrant wins, the incumbent's fee is  $f_I = c$ . Now equation (9) imposes  $\frac{1}{2}(f_G + f_B) \leq (\lambda_I^*(\lambda_E) - \lambda_E) \frac{X}{4} + c$ , implying that the entrant will win when  $\lambda_I < \lambda_I^*(\lambda_E)$ , but cannot win when  $\lambda_I \geq \lambda_I^*(\lambda_E)$ . This restores the social optimum. ■

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