Reputation as an Entry Barrier in the Credit Rating Industry[1]

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Abstract

We study competition between an 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 when they enter the market. We show that free entry competition fails to select 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. Second, CRAs cannot charge higher fees for low rating than for high rating. Then, a rather incompetent CRA can dominate the market without concerns about entry. We derive policy implications.

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

JEL Codes: G24, L13, L5, D82

1 Introduction

Credit Rating Agencies (CRAs) are often considered a central culprit in the financial turmoil of 2008–2009.[1] Today, the 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. For 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 as long as issuers and investors trust the incumbent's ratings and CRAs charge fees that do not depend on their ratings (as is required by the Cuomo plan)[2], there exists a natural barrier to entry that hinders potentially more accurate CRAs from entering the credit rating business and replacing the less efficient incumbent.[3] 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 scarcity 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 (2008), p.284).

Even though one acknowledges 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 the paucity of NRSROs to a natural barrier to entry.[4] Dearth of applications to the status of NRSRO is also at odds with the

[1]See for instance "Today, they [the credit rating agencies] are a central culprit in the mortgage bust, in which the total loss has been projected at $250 billion and possibly much more. ... congress is exploring why the industry failed and whether it should be revamped" in "Triple-A-Failure," by Roger Lowenstein, New York Times Magazine, April 27, 2008.

For a formal analysis of the role of CRAs in the financial crisis, see Benmelech and Dlugosz (2009).

[2]The Cuomo plan, is an agreement between New York State Attorney General Andrew Cuomo and the three main CRAs; see "For Cuomo, Financial Crisis Is His Political Moment" by Michael Powell, Danny Hakim and Louise Story in New York Times (March 21, 2009). The plan aims at reducing the conflict of interest resulting from the CRAs' widespread practice of charging higher fees for more favorable ratings.

[3]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).

[4]In a hearing held on April 2, 2003 on rating agencies before the Capital Markets Subcommittee of the

high profitability of the credit rating business.[5] 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 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, to assess 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 to demonstrate its expertise.

Each period a short-lived firm wants to issue debt to finance a risky project. The issuer can hire a CRA to assess the quality of the project and publicizes a rating regarding the debt default risk. The issuer's expected profit increases with the reliability of the rater: a reliable rating reduces both the risk of implementing a negative NPV project, and the cost of capital for a positive NPV project. Each period an incumbent CRA and an entrant CRA compete in fees to attract the issuer. 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 first retrieves a private signal regarding the quality of the project and then publicizes a rating that may or not reflect this private signal. The accuracy of an entrant CRA's signal depends on its type that is either accurate or inaccurate. Its type is unknown to everybody (including to the entrant itself). The expected accuracy of an entrant CRA's signal is what we call the entrant's reputation. This reputation evolves as the public (i.e. issuers and investors) compares the entrant CRA's ratings with the actual performances of the rated projects. The first period incumbent is called the original incumbent. The precision of its signal, i.e. the reputation of the original incumbent, is imperfect, constant and known to everybody.[6] We assume that it is larger than an entrant's ex-ante accuracy but lower than the accuracy of an accurate type entrant.

A CRA's survival in the credit rating business is determined by a credit constraint meaning that a CRA should exit the market if it does not generate a positive profit within

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

[5]On average, between 1995 and 2000, Moody's annual net income amounted to 41.1% of its total assets (White, 2002).

[6]See Section 7.1 for the extension to the case in which the original incumbent's accuracy is unknown.

a finite time period.[7] In equilibria where the public trusts the incumbent to provide a sincere rating, an entrant CRA can make profits only after building up a reputation for providing a more accurate rating than the incumbent's. Thus, in such equilibria, an entrant can survive only if it can improve its reputation for being of accurate type.

We first present a simple model of finite horizon to illustrate the main conflict of interest faced by an entrant CRA.[8] We assume that, in order to survive, the entrant needs to build up a reputation for receiving more accurate signals than the incumbent. Suppose the entrant managed to attract the first issuer, retrieved a private signal about the issuer's project quality and now has to choose a rating to publicize: high or low rating. Note that the public's belief about the entrant's type can be updated only if some information is available about both the entrant's signal and the project quality. This is possible only if: first, the public can infer from the rating some information about the CRA's signal; second, the project is implemented so that the ex-post project quality is observed. The first condition requires the entrant's rating to be correlated with its private signal. The stronger this correlation, the stronger the impact of the rating on investors' behavior and the gain (loss) in reputation when the rating is validated (invalidated) by the project outcome. However, when the correlation between signal and rating is strong enough, a low rating is indicative of a negative NPV project and thus, only a project that received a high rating will be financed and implemented. As a consequence, a policy of strongly correlating the rating with the CRA's private signal is not credible for the entrant. This is because if the public expects such a rating policy, a low rating, leading to no implementation, would leave the entrant's reputation unchanged. Conversely, a high rating leading to implementation would increase the entrant's reputation with a strictly positive probability. Thus, the entrant will prefer giving a high rating no matter its private signal. But this implies that the entrant's rating and signal are not correlated. Similarly, a rating policy cannot be credible for the entrant if different ratings lead to substantially different expected reputations. Therefore, the only credible rating policies for an entrant are those whose information content is so little that the gain in reputation is not strong enough to overtake the original incumbent's reputation.

The same intuition can be applied to entry in other markets of experts certifying the quality of goods. A few elements are crucial for the same conflict of interest to emerge.

[7] This constraint is much weaker than a standard credit constraint since we allow a CRA to use any expected future profit to subsidize its current rating activity. Hence our result is different from the one in Terviö (2009) showing that too little experimentation of unknown talents occurs when a credit constraint prevents a worker from pledging future gain from experimentation.

[8] The result in the model of finite horizon holds regardless of whether or not the CRA privately knows its accuracy.

First the entrant expert aims at improving its reputation for using a reliable certifying technology. Second, a reliable certifying technology would shrink the demand for a good that is certified of low quality. Third, a shrink in the demand for the good implies that little can be known ex-post about the good's true quality and makes it difficult to verify whether the expert's technology was accurate. When these three conditions are met, an entrant expert can hardly commit to be truthful and hence cannot improve its reputation.

Second, we consider an infinite horizon model. In the case where CRAs' signals are public, we characterize the set of parameters for which it is socially optimal to experiment with entrant CRAs instead of keep hiring the original incumbent. In the case where CRAs' signals are private, there are multiple equilibria since the rating policy adopted by a CRA depends on the public's self-fulfilling expectations.[9] We study the market outcome induced by free competition under the constraint that CRAs' fees cannot be contingent on the rating, as was proposed in the Cuomo plan. To reflect the fact that incumbents' ratings impact investors more than ratings from newcomers, we focus on equilibria where the incumbent adopts the truthful rating policy. For this class of equilibria, we show that for any discount factor, the entrant faces the conflict of interest as outlined above and competition never leads to 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. However, we show that a monopolist CRA or an incumbent CRA can commit to a truthful rating policy if it is patient enough.

We study two different policy remedies. First, we consider the case where CRAs are allowed to charge fees that are contingent on ratings.[10] 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 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. For some level of parameters however, this equilibrium leads to an excessive experimentation of entrants as it produces the replacement of the original incumbent even if this would not be socially optimal. Second, under the Cuomo plan (i.e. when fees cannot be contingent on ratings), we show that it is possible to reach the social optimum by loosening the link between a CRA's reputation and its ability to attract issuers. This can be done when it is the social planner and not the issuer who determines which CRA should be hired.

[9]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.

[10]This is not allowed under the Cuomo plan.

Then, socially optimal experimentation of entrants can be achieved by granting a CRA a monopoly position as long as its reputation does not fall below a certain threshold.

The paper is organized as follows. Subsection 1.1 relates our work to the literature. Section 2 presents the basic framework on which we build our models. Section 3 presents the key insight in a simple finite horizon model of reputation building. Section 4 presents the main model of infinite horizon. Section 5 studies the social optimum. Section 6 studies the market equilibrium with non-contingent fees. In Section 7, we perform several extensions. First, we study the case of an original incumbent with unknown accuracy. Second, we consider the case of multiple ratings per issuer. Third, we briefly discuss further extensions. In Section 8, we first show that an entrant can commit to truthful rating either if it is a monopolist or if there are no credit constraints. And then the section provides two different policy remedies: contingent rating fees and regulated contingent monopoly. Section 9 contains policy implications and concludes. All proofs are in the Appendix.

1.1 Related literature

Some recent papers have offered explanations for the failure of the credit rating industry. Mathis, McAndrews and Rochet (2009) presented a model of reputation à la Benabou and Laroque (1992) and studied a monopolistic opportunistic CRA who can build reputation for being committed to truthfully revealing its private signal.[11] They showed 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 becomes optimal for an opportunistic CRA to be lax in its rating. Skreta and Veldkamp (2009) (and Sangiorgi, Sokobin and Spatt, 2009) considered a static model with naive investors where an issuer can engage in rating shopping (i.e., it can decide which ratings will be disclosed). They showed that for complex assets, the issuer will disclose only best ratings. This generates rating inflation even if CRAs are assumed to truthfully report their signals. Bolton, Freixas and Shapiro (2009) considered a static model with rating shopping where CRAs can manipulate their ratings but suffer an exogenous reputation cost for misreporting. They found that when there is a large enough fraction of naive investors, a duopoly rating industry is less efficient than a monopoly.[12] All the above papers explain how

[11] 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.

[12] Boot, Milbourn and Schmeits (2006) study the role of a rating agency as coordination device in the presence of multiple equilibria. Fulghieri, Strobl and Xia (2011) showed that a monopolist CRA can increase its profits by threatening of issuing unsolicited low rating.

rating inflation can originate from the fact that issuers can engage in rating shopping and/or have to pay higher fees when choosing to disclose a rating to investors. Our approach is complementary as we consider a dynamic framework of flat rating fees, no rating shopping and fully rational investors. We show a natural barrier to entry that can prevent accurate entrant CRAs to replace a less accurate incumbent.

Even though there have been many papers on strategic information transmission by experts,[13] much less has been written on industrial organization of the market of information intermediaries. Lizzeri (1999) considered certification intermediaries who can commit to a disclosure policy and found that a monopoly intermediary reveals only whether quality is above a minimal standard while competition leads to full revelation of quality.[14] Ottaviani and Sørensen (2006a) considered a setting without commitment to a disclosure policy and found that competition generates some bias in information revelation.[15] Faure-Grimaud, Peyrache and Quesada (2009) analyzed the conditions under which a rating intermediary finds it optimal to provide a buyer with the option to hide rating. They identified competition as a necessary condition. Similarly to Faure-Grimaud et al. (2010), Farhi, Lerner and Tirole (2010) studied competition among certifiers when each certifier can commit to a disclosure policy that includes whether or not to hide a given rating. In addition, they allow for the buyer of certification to have a second chance by going to a less demanding certifier. While, all these papers consider static models, none of them addressed entry issue, that is the focus of our paper. Our results are also related to Strausz (2005) who addressed a source of natural monopoly that is different from ours. He analyzed 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 showed that the certifier can resist bribes only if it is patient enough and the payoff from honest certification is sufficiently high. The latter condition is only satisfied when the certifier is a monopolist.

Farrell (1986) is close to our paper in terms of identifying an entrant's moral hazard as a source of entry barrier. He considers a two-period model in which an entrant makes a once-and-for-all choice between producing a high quality product and a low quality one and the quality becomes known to buyers only after period one. Entry barrier exists when an entrant has an incentive to choose low quality and hence "fly-by-night". This barrier

[13]For instance, our paper is related to the literature on cheap talk under career concerns (Holmström 1999, and Scharfstein and Stein, 1990) or reputational concerns (Ottaviani and Sørensen, 2006 a,b,c).

[14]Doherty, Kartasheva and Phillips (2009) extend the analysis to static competition among rating agencies.

[15]Similarly, Mariano (2010) find that, in a two-period model, competition between two symmetric credit rating agencies leads to rating inflation.

is generated because producing a low quality product is less costly and/or the incumbent commits to offer a certain level of surplus to buyers. The entry barrier exists in our model even if there is no cost saving from an entrant's misbehavior and the incumbent cannot commit in advance to any policy to discourage entry.

Our results are reminiscent of the findings in the bad reputation literature (Morris, 2001, and Ely and Välimäki, 2003). However the driving forces leading to their results are orthogonal to ours. They consider an expert whose payoff depends on his reputation for giving unbiased recommendations rather than being a biased expert who prefers advising always in the same direction. They show that an expert who cares about his future payoffs will try to build up reputation for not being the biased type. As a result, an expert with unbiased preference endogenously biases his recommendations against the one that an expert with biased preference would give. When future payoffs matter enough, this endogenous bias becomes strong enough to render the expert recommendations worthless to his clients, who hence will not hire him. For this "bad reputation" effect to have a bite, it is necessary that the expert is patient enough. Quite to the opposite, we show that a monopolist CRA (or an incumbent facing entry) whose accuracy is unknown can credibly build up reputation for being accurate provided it is sufficiently patient. Similarly, in the absence of credit constraint, an entrant can credibly build up its reputation if it is patient enough. What makes an entrant non-reliable in our model is the combination of the credit constraint and competition (i.e. it faces an incumbent with superior reputation), which creates the urge to build up reputation quickly. The main reason why the "bad reputation" logic does not apply to our model is that at the start a CRA cannot even try to differentiate itself from the biased type, first because it does not know its own type and second because there is no action that the biased type wold prefer a priori: A CRA type regards precision of signals and not preference over recommendations as in the bad reputation literature.[16]

Our paper is closely related to the papers studying pricing and experimentation in the multi-armed bandit literature (Bergemann and Välimäki (1996, 2000) and Felli and Harris (1996)). In particular, Bergemann and Välimäki (2000) consider competition between two long-run sellers selling to multiple long-run buyers when the quality of one seller's product is fixed and known while the quality of the other seller's product is uncertain and needs to be learned. They obtain an excessive experimentation result as we do when rating-contingent fees are allowed. In our model, the excessive experimentation is generated by

[16]See for instance Ely, Fudenberg and Levine (2008) for a characterization of a class of game for which the "Bad reputation" effect holds.

the credit constraint.[17][18] Nevertheless, all three papers consider complete information environment in which all players learn in a symmetric way. On the contrary, in our paper, each CRA receives a private signal and there is an endogenous exit and entry of CRAs due to the credit constraint. In this environment, we obtain a no experimentation result.

2 Basic Framework

In this section, we present the basic framework upon which we build the simple model (Section 3) and the model of infinite horizon (Section 4).

2.1 Issuers and investors

We model issuers and investors as in Mathis, McAndrews and Rochet (2009). In each period $t = 1, ...n, ...$ a short-lived cashless firm, named issuer t, wants to issue a security for financing an investment project. We normalize the project's cost to 1. If the project is financed, its return $\widetilde{X}_t$ is realized at the end of t . We assume $\widetilde{X}_t \in \{X, 0\}$, with $X > 1$ and $\Pr(\widetilde{X}_t = X) = \mu$. The project is of good quality and has positive net present value only if $\widetilde{X}_t = X$. For a bad quality project, $\widetilde{X}_t = 0$. The project's quality is unknown to everybody including the issuer.[19] The returns of issuers' projects are independently and identically distributed.

Investors are risk neutral and competitive. In the absence of any additional information about the project, the project will be financed and implemented only if $\mu X \geq 1$.

2.2 Credit Rating Agencies

2.2.1 Signals and Ratings

Issuer t can hire a CRA i to rate its security. 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

[17] Without the credit constraint, the collection of entrants realizes a positive profit if and only if they generate a higher surplus than the original incumbent. On the contrary, under the constraint, the original incumbent must leave the market within a finite number of periods if it does not generate any profit and from that period on any issuer's outside option is given by hiring a new entrant, whose signal is less accurate than that of the original incumbent, which explains over-experimentation.

[18] Bergemann and Välimäki (1996) and Felli and Harris (1996) find efficient experimentation when they consider a single long-run buyer who fully internalizes future impact of his experimentation. We find efficient experimentation in the absence of the credit constraint even if we consider a series of short-run issuers.

[19] If the project quality was privately known by the issuer, only issuers with positive NPV projects will seek financing and there would be no need of the additional public information provided by CRAs.

a cost $c > 0$ for the CRA and generate a signal $\widetilde{s}_{i,t} \in \{G, B\}$ regarding issuer t's project quality. This signal is private and is observed only by the CRA. We assume that there is no moral hazard on incurring c and that the CRA needs to be hired by issuer t in order to generate $\widetilde{s}_{i,t}$.[20]

After observing $\widetilde{s}_{i,t}$, CRA i will publicize a rating $r_{i,t}$ that will be either *high* $(r_{i,t} = G)$ or *low* $(r_{i,t} = B)$ and need not coincide with $\widetilde{s}_{i,t}$. A CRA i's *rating policy* $R_{i,t}(s)$ is the probability that CRA i gives a high rating to project t after observing $\widetilde{s}_{i,t} = s$. One particular rating policy is the truthful one, denoted $\overline{R}$, that consists in giving a rating that always coincides with the signal: $\overline{R}(G) = 1 - \overline{R}(B) = 1$. At the opposite, when the rating is completely independent from the signal, we have a babbling rating policy, denoted $\underline{R}$, satisfying $\underline{R}(G) = \underline{R}(B)$. While rating policies are endogenous, we assume that ratings are always publicly disclosed.[21]

2.2.2 Accuracy and Reputation

Let CRA E denote an *entrant.* Let θ denote an entrant's type which regards the accuracy of its signals. Formally,

$$\begin{aligned} \Pr\left(\text{CRA } E\text{' signal is correct}|\,\theta\right) &= \Pr\left(\widetilde{s}_{E,t} = G|\,\widetilde{X}_t = X, \theta\right) = \Pr\left(\widetilde{s}_{E,t} = B|\widetilde{X}_t = 0, \theta\right) \\ &= (1+\theta)/2. \end{aligned}$$

An entrant is either of *accurate type* $(\theta = \lambda_E^a)$ or of *inaccurate type* $(\theta = \lambda_E^{ia})$. An accurate type's signals are more precise than those of an inaccurate type: $0 \leq \lambda_E^{ia} < \lambda_E^a \leq 1$.

Let $\nu \in (0,1)$ denote the ex-ante probability of $\theta = \lambda_E^a$. Then, the *initial expected accuracy,* or, with some abuse of terminology, *the initial reputation* of the entrant is given by $\lambda_E := \nu\lambda_E^a + (1-\nu)\lambda_E^{ia}$, implying

$$\Pr\left(\text{CRA } E\text{' signal is correct}\right) = (1+\lambda_E)/2.$$

In the absence of CRAs, the social surplus in period t is $\max\{0, \mu X - 1\}$. Since the resource $c > 0$ would be spent to retrieve a signal, it is socially optimal to hire a CRA with reputation $\lambda \in [0,1]$ only if the revelation of its signal can affect investors' decision to finance or not the project. In this instance the project is implemented if and only if

[20] The issuer can check whether at least part of the cost has incurred. This assumption is common in Bolton, Freixas and Shapiro (2009), Mathis McAndrews and Rochet (2009), Skreta and Veldkamp (2009).

[21] This is equivalent to assuming no rating shopping since rating shopping means that it is the issuer who decides which rating(s) to be disclosed.

the CRA's signal is G, which leads to a period t social surplus equal to

$$SS(\lambda) := \mu\frac{1+\lambda}{2}(X-1) - (1-\mu)\frac{1-\lambda}{2} - c.$$

Let $\lambda_{\min}$ be such that $SS(\lambda_{\min}) = \max\{0, \mu X - 1\}$, that is the minimum CRA reputation that can justify its rating service from a social optimum perspective. Let $\mu_s(\lambda)$ denote the probability that period t project is of good quality given that a CRA with reputation λ received signal $s \in \{G, B\}$, that is $\mu_s(\lambda) := \Pr\left(\widetilde{X}_t = X | \widetilde{s}_t = s\right)$. Then, $\lambda > \lambda_{\min}$ implies

$$\mu_B(\lambda)X - 1 < 0 < \mu_G(\lambda)X - 1.$$

3 A simple model of reputation building

In this section, in order to deliver the key insight, we consider a simple model of reputation building. In this model, there is a single entrant CRA who needs to build its reputation above an exogenously given threshold reputation, denoted by λ_I, within a *finite* number of periods. Investors and issuers do not know whether the CRA is of accurate or of inaccurate type and the CRA's initial reputation is $\lambda_0 = \lambda_E$. We assume

A0: $\lambda_{\min} < \lambda_I < \lambda_E^a$ and $\lambda_E \leq \lambda_I$

λ_I is higher than $\lambda_{\min}$ and λ_E. However, the accurate type's accuracy is higher than λ_I.

While in this simple model we assume that the CRA knows its type θ from the beginning, the same result holds when the CRA does not know θ. The CRA rates one project per period for $n \geq 1$ periods to build up its reputation with respect to the public, i.e., the investors and the issuers. The timing within each period $t \in \{1, ..., n\}$ is as follows:

- The CRA receives a private signal $s_t \in \{G, B\}$ about issuer t's project.
- The CRA issues a rating $r_t \in \{G, B\}$.
- The investors observe r_t and decide whether or not to finance issuer t's project.
- Only if the project is financed, its outcome, i.e. success or failure, is realized.

Therefore, at the end of each period t, an event $\omega_t \in \Omega := \left\{S^G, S^B, F^G, F^B, N^G, N^B\right\}$ is publicly observed, where for instance S^G (respectively, F^B) means that the project was financed with a high rating (respectively, with a low rating) and it succeeded (respectively, it failed) and N^G means that the project was not financed after receiving a high rating. Thus, at the end of period t, the public history is $h_t = (\omega_1, ..., \omega_t)$. Let λ_t denote the public's updated belief about the accuracy of the CRA's signals *after* observing the public history h_t.[22] For the CRA, the information at time t after observing $\widetilde{s}_t$ but before issuing a rating is $\widehat{h}_t = (\theta, (s_1,\omega_1), ..., (s_{t-1},\omega_{t-1}), s_t)$.

In this simple model, we assume that the CRA's payoff is only determined by λ_n, its public reputation updated at the end of the n-th period. Namely, we assume that if, at the end of the n-th period, the CRA's reputation λ_n is strictly above the target level λ_I, then its payoff equals a strictly positive constant $V > 0$; otherwise the CRA's payoff is nil.

In the case of $\mu X \geq 1$, we make two additional assumptions. First, we assume that the CRA's signals are precise enough that $\mu_G(\lambda) > 1 - \mu_G(\lambda)$ holds for $\lambda \geq \lambda_E^{ia}$; that is, conditional on receiving a good signal, the probability of success $(\widetilde{X}_t = X)$ is higher than the probability of failure $(\widetilde{X}_t = 0)$, regardless of the entrant's type. This assumption is equivalent to $\lambda_E^{ia} > 1 - 2\mu$. Second, we assume that when $\lambda_t \leq \lambda_{\min}$, it cannot reach λ_I within a period. More precisely, suppose that the public expects the CRA with reputation λ_t to adopt a truthful rating policy in $t+1$ and let $\lambda_{\omega_{t+1}}^{\overline{R}}(\lambda_t)$ denote the entrant's updated reputation after an event $\omega_{t+1} \in \Omega$ has been observed:

$$\frac{1 + \lambda_{\omega_{t+1}}^{\overline{R}}(\lambda_t)}{2} := \Pr\left(\text{CRA } E\text{'s signal is correct } | \, \omega_{t+1}, \overline{R}\right).$$

We assume $max \left\{\lambda_{SG}^{\overline{R}}(\lambda_{\min}), \lambda_{FB}^{\overline{R}}(\lambda_{\min})\right\} := \lambda_{\min}^{+} \leq \lambda_I$. Note that this assumption does not exclude the possibility for a CRA with reputation $\lambda_t \leq \lambda_{\min}$ to reach reputation larger than λ_I within two or more periods.

In a SPE, in every period t the CRA gives the rating r_t which maximizes its expected continuation payoff given $\widehat{h}_t$. This induces a rating policy as a function of $\widehat{h}_t$. Issuers and investors correctly anticipate the mapping from $\widehat{h}_t$ into the rating policies adopted by the CRA and use h_t and r_t to update their belief about the quality of project t and the CRA's accuracy θ. Then we have the following result.

Proposition 1 *Assume A0; for the case of $X\mu \geq 1$, assume $\lambda_E^{ia} > 1 - 2\mu$ and $\lambda_{\min}^{+} \leq \lambda_I$. Then, the CRA's equilibrium payoff is always zero for any finite horizon n (i.e. the CRA can never build a reputation higher than λ_I).*

The proof is by induction. Clearly if $\lambda_n \leq \lambda_I$, the CRA's payoff is nil. Thus, it

[22] Formally, λ_t satisfies: $\Pr(\text{The CRA's signal is correct } | \, h_t) = \frac{1+\lambda_t}{2}$.

is sufficient to show that if $\lambda_t \leq \lambda_I$ implies a nil continuation payoff, then $\lambda_{t-1} \leq \lambda_I$ necessarily leads to a nil continuation payoff.

Take any given period t and suppose that at the beginning of the period the CRA's reputation is $\lambda_{t-1} \leq \lambda_I$. We distinguish two cases: $\mu X < 1$ and $\mu X \geq 1$. Below, we provide the proof for $\mu X < 1$ and sketch the proof for $\mu X \geq 1$, which is detailed in the Appendix. For $\mu X < 1$, in the absence of rating, the project is not implemented. Hence, in period t, two cases may arise: either the project is never financed regardless of the rating or it is financed only with one rating, say a high rating. If the project is never financed, then nothing can be learned about the project quality and $\omega_t \in \{N^G, N^B\}$. Since $\lambda_{t-1} \leq \lambda_I$, it cannot be that each of the two events leads to public posterior belief $\lambda_t > \lambda_I$. If $\lambda_t > \lambda_I$ for only one of the two events, say N^G, then no matter its private information $\widehat{h}_t$, the CRA would give the only rating leading to N^G (i.e. the rating G). This leads to a babbling rating policy, implying that the CRA's rating is non-informative and hence cannot affect the CRA's reputation, which is a contradiction. Therefore, $\lambda_t \leq \lambda_I$ for all $\omega_t \in \{N^G, N^B\}$ and the result is proven.

Consider now the case in which the project is financed only with a high rating. Then, we have $\omega_t \in \{N^B, S^G, F^G\}$. If $\lambda_t > \lambda_I$ for only one ω_t among the three possible events, then for all $\widehat{h}_t$, the CRA would give the only rating that can give a positive continuation payoff.[23] This leads to a babbling rating policy, implying that the CRA's rating cannot affect neither decision to finance the project nor the CRA's reputation, which is a contradiction. Suppose $\lambda_t > \lambda_I$ for two out of the three events. If these two events are $\{S^G, F^G\}$, the CRA will always give a high rating, meaning a babbling rating policy. Thus suppose $\lambda_t > \lambda_I$ for either $\omega_t \in \{N^B, S^G\}$ or $\omega_t \in \{N^B, F^G\}$. Note that in both cases $\omega_t = N^B$ can be guaranteed by giving a low rating whereas $\omega_t = S^G$ or $\omega_t = F^G$occurs only when the project is of good quality or bad quality, respectively. Therefore the CRA will always strictly prefer giving a low rating leading again to babbling.[24] Therefore, $\lambda_t < \lambda_I$ for all $\omega_t \in \{N^B, S^G, F^G\}$ and the result is proven.

We now briefly sketch the proof for the case $X\mu \geq 1$. For this case, in the absence of rating, the project is implemented. Thus, in period t, two cases may arise: either the project is financed only with one rating, say a high rating, or it is financed with either

[23] An exception would be the case in which $\lambda_E^a = 1$ and the CRA knows that the event leading to an increase in reputation is impossible. For instance, $s_t = B$ while only $\omega_t = S^G$ leads to $\lambda_t > \lambda_I$. In this instance the CRA is indifferent between giving a low rating leading to $\omega_t = N^B$ or a high rating leading to $\omega_t = F^G$.

[24] An exception would be the case in which $\lambda_E^a = 1$, $s_t = G$ and $\lambda_t > \lambda_I$ for $\omega_t \in \{N^B, S^G\}$. Then, only the CRA knowing that its type is perfectly accurate may give a high rating (and only when its signal is G). But then after $\omega_t = N^B$, one must have $\lambda_t < \lambda_{t-1}$, contradicting our premise that $\lambda_t > \lambda_I$ only if $\omega_t \in \{N^B, S^G\}$.

rating. The previous proof shows that if only a high rating leads investors to finance the project, the CRA cannot build its reputation. Hence, we only need to consider the case in which the project is implemented no matter the rating. Furthermore, for the case $\lambda_{t-1} \leq \lambda_{\min}$, the assumption $\lambda_{\min}^{+} \leq \lambda_I$ implies $\lambda_t \leq \lambda_I$ that lead to a nil continuation. Therefore, consider $\lambda_{\min} < \lambda_{t-1} \leq \lambda_I$. The assumption $\lambda_E^{ia} > 1-2\mu$ implies that a CRA's with signal $s_t = G$ believes that project t is more likely to succeed than to fail. As its reputation cannot increase after giving a rating that is opposite to the project outcome, such CRA strictly prefers giving a high rating. This implies that a low rating can only be associated with a signal $s_t = B$. Thus, after observing $r_t = B$, investors will deduce $s_t = B$. Because $\lambda_{t-1} > \lambda_{\min}$ implies $\mu_B(\lambda_{t-1})X - 1 < 0$, investors will not implement a project that received a low rating, which contradicts the premise that the project is implemented no matter the rating.

The above Proposition shows that the very need of a CRA to give ratings that increase its reputation generates a conflict of interest that makes its ratings not credible. Two assumptions are crucial to generate such a conflict of interest. First, to make profits, the CRA needs to improve its reputation above a given threshold. Second, the CRA needs to build a reputation higher than this threshold within a finite (no matter how long) period of time, i.e. by sequentially rating a finite number of issuers. In what follows, we show how these two features endogenously emerge in an infinite horizon model of competition between an original incumbent CRA and an infinite sequence of entrant CRAs.

4 The Model of Infinite Horizon

In this section, we build a model of infinite horizon on the basic framework introduced in Section 2. 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 $\lambda_I \in (0,1)$ denote *the accuracy of the original incumbent's private signal* (i.e. *the original incumbent's reputation*). Formally,

$$\Pr\left(\widetilde{s}_{I,t} = G |\, \widetilde{X}_t = X\right) = \Pr\left(\widetilde{s}_{I,t} = B |\, \widetilde{X}_t = 0\right) = (1+\lambda_I)/2.$$

As $0 < \lambda_I < 1$, the original incumbent's signal is informative but not perfect. The parameter λ_I is fixed and common knowledge.[25] Time t entrant can be of accurate type or of inaccurate type, and entrant types are independently and identically distributed. We assume that an entrant's type is unknown to everybody including the entrant itself.

[25] This assumption is not crucial as is shown in Section 7.1.

Furthermore, in order to provide closed form solutions of CRAs' value functions, we focus on the case $\mu = 1/2$ and set $\{\lambda_E^{ia}, \lambda_E^{a}\} = \{0, 1\}$.[26] The latter condition means that an inaccurate entrant's signal is pure noise, whereas an accurate entrant receives perfect signals. These parametric setting greatly simplifies the algebra without affecting the economic trade-offs leading to our main result. In what follows, we replace A0 (introduced in Section 3) with A1, which combines A0 with $\lambda_E \geq \lambda_{\min}$:

A1: $1 > \lambda_I \geq \lambda_E \geq \lambda_{\min}$.

No special assumption beyond A1 is required for the case $\mu X > 1$.

4.1 Entry and Exit under a Credit Constraint

In period one, the original incumbent (i.e. CRA I) and an entrant from the pool compete. In subsequent periods, any exiting CRA is replaced by an entrant from the pool. In other words, a new entrant enters only if there is an exiting CRA. We assume zero cost of entry. As a consequence, in any period t, two CRAs compete.

A CRA's exit is determined by a credit constraint, meaning that no CRA can stay in the business for too long without generating strictly positive profits.[27] Assumptions A2 and A3 provide simple exit rules that capture this idea.

A2: 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.

A3: If a CRA active in period t expects to generate no profits in the future, it will exit the market at the end of period t.

After a CRA exits, the surviving CRA, if any, becomes the next period incumbent CRA.

4.2 Rating Policies and Projects Implementation

Because CRA's signals are not public, the information content of a CRA rating depends both on the CRA's reputation and rating policy. Consider a CRA with reputation λ.

[26] As is discussed in Section 7.3 assuming $\mu \neq 1/2$ would introduce a conformity bias in CRAs' rating that would reinforce our central result.

[27] For instance, suppose that an entrant has a limited amount of capital but that staying in the market requires it to spend some cost per period in order to maintain its office, staff etc. Then, it can stay only a finite number of periods in the market without generating any profit.

Given $\mu = 1/2$, we have $\mu_G(\lambda) = \frac{(1+\lambda)}{2}$ and $\mu_B(\lambda) = \frac{(1-\lambda)}{2}$. If a CRA with reputation λ adopts rating policy R and gives a project a rating of r, then investors' posterior belief that the project is of good quality is denoted $\mu_r^R(\lambda) := \Pr\left(\widetilde{X}_t = X \middle| r, R\right)$.[28] The project will be financed and implemented only if $\mu_r^R(\lambda)X \geq 1$.

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 for the project 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 information content of the rating is $\mu_G^R(\lambda) - \mu_B^R(\lambda) = \lambda\left(R(G) - R(B)\right)$ and increases with the CRA reputation λ and the correlation between the private signal and the rating measured by $R(G) - R(B)$. For example, for the truthful (babbling) rating policy $R(G) - R(B)$ is maximum (resp. minimum) and equals 1 (resp. 0).

4.3 Evolution of reputation

The original incumbent's reputation λ_I is fixed and known. Consider any other CRA with initial reputation λ_i and suppose the public expects the CRA to adopt a rating policy R to rate period t project. Let $\lambda_{\omega_t}^R(\lambda_i)$ denote its updated reputation after an event $\omega_t \in \Omega$ has been observed:

$$\frac{1 + \lambda_{\omega_t}^R(\lambda_i)}{2} := \Pr\left(\text{CRA's signal is correct } | \, \omega_t, R\right)$$

For example, if the entrant uses the truthful rating policy $\overline{R}$ then $\lambda_{SG}^{\overline{R}} = \lambda_{FB}^{\overline{R}} = \frac{2\lambda_i}{\lambda_i + 1} > \lambda_i$ and $\lambda_{SB}^{\overline{R}} = \lambda_{FG}^{\overline{R}} = 0$. We shall denote $\lambda_i^+ := \frac{2\lambda_i}{\lambda_i+1}$ and $\lambda_E^+ := \frac{2\lambda_E}{\lambda_E+1}$ and assume:

A4: $\lambda_E^+ > \lambda_I$.

A4 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.[29]

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

[28] Formally, $\mu_G^R(\lambda) = \frac{1}{2} + \frac{R(G)-R(B)}{2(R(G)+R(B))}\lambda$, and $\mu_B^R(\lambda) = \frac{1}{2} - \frac{R(G)-R(B)}{2(2-R(G)-R(B))}\lambda$.

[29] Since $\lambda_E^+ > \lambda_E$, A4 is equivalent to $\lambda_E > \lambda_I/(2-\lambda_I)$ and A1 and A4 are satisfied if and only if $max\left\{\lambda_{\min}, \lambda_I/(2-\lambda_I)\right\} < \lambda_E \leq \lambda_I$.

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 cannot learn anything about the CRA's type.[30]

5 Socially optimal experimentation

In this section, we study the socially optimal CRA hiring strategy under the assumption that, once hired, a CRA's private signal becomes public information. Consider the problem of a social planner who can decide which CRA to hire (in each period) to maximize social welfare . The alternative is between having all projects rated by the original incumbent and 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^B can happen. Thus the optimal way of experimenting with entrants consists of: (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 λ_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 that results from having the original incumbent I with known accuracy λ_I rate the infinite sequence of projects. These payoffs are normalized by $1/(1-\delta)$ where δ is the discount factor. Experimenting with entrants is socially preferable to consistently hiring the original incumbent if and only if $W_E(\lambda_E) > W_I$. We have:

Proposition 2 *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, under A1, experimenting with the entrants is socially optimal if and only if*

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

6 Competition

In this section we focus on market competition in the entry game under the assumptions that CRAs' signals are private information and that the rating fees a CRA can charge

[30]Note that after observing outcome ω_t, a CRA's private belief about its accuracy need not coincide with its public reputation $\lambda^R_{\omega_t}$. More precisely, if the outcome of the project is (is not) predicted by its private signal, then the CRA's private belief of being accurate is λ_i^+ (resp. 0).

cannot be contingent on the rating assigned to the issuer. This case of non-contingent fee corresponds to the fee scheme under the Cuomo plan.[31] In addition, it allows us to isolate the effect of reputational concern on truth-telling since in a static model, a truth-telling equilibrium always exists under the Cuomo plan. We first describe the payoff resulting from static competition between two CRAs, then we analyze the dynamic game.

6.1 CRAs' Stage Competition

CRA's payoff in a given period is (endogenously) determined from competition. In each period t, two CRAs (for instance, CRA i and CRA j) simultaneously offer 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. A project is financed only if its expected payoff, conditional on rating, exceeds 1. Thus, period t issuer's expected payoff from hiring CRA i is

$$\begin{aligned} u(f_{i,t}, R_{i,t}, \lambda_{i,t}) &= -f_{i,t} + \Pr(r_{i,t} = G) \max\left\{\mu_G^{R_{i,t}}(\lambda_{i,t})X - 1, 0\right\} \\ &\quad + \Pr(r_{i,t} = B) \max\left\{\mu_B^{R_{i,t}}(\lambda_{i,t})X - 1, 0\right\}, \end{aligned} \tag{2}$$

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 CRA that provides the most informative rating, the issuer first, maximizes the chances of implementing a good project while reducing its financing cost, and second, it minimizes the chances of implementing a bad project. Thus, if two CRAs charge the same fee, then the issuer will prefer the CRA which 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 informative than its competitor's and sufficiently informative 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:

$$u(c, R_{i,t}, \lambda_{i,t}) - \max\{u(c, R_{j,t}, \lambda_{j,t}), \underline{u}\} \leq (\lambda_{i,t} - \lambda_{\min})\frac{X}{4}. \tag{3}$$

(ii) CRA j's payoff is nil.

[31] 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 common practice before the Cuomo plan. See footnote 40 for the common practice.

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.

6.2 CRAs' Dynamic Competition

We move now to the equilibrium of the entry game. Note first that there are trivial equilibria where any arbitrarily given CRA cannot survive in the credit rating business because issuers and investors expect the CRA to adopt a 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 cannot affect investors' behavior. 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 λ_t, rating r_t, and signal s_t. Thus, it is optimal for the CRA to adopt a babbling rating policy. Hence, 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 the original incumbent or an entrant if $\delta > 1 - \lambda_{\min}$) enjoys a monopoly position. The latter case is illustrated in Section 8.1.

In what follows we restrict our attention to equilibria satisfying two plausible properties. First, since all entrants are ex-ante identical, we will focus on equilibria where, at the time they first arrive in the market all entrants are expected to adopt the same rating policy, denoted as R_E. Second, as it happens in the real world, an incumbent rating should affect investors' behavior 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 rating policy as long as its reputation λ_t is not smaller than the entrant's reputation, λ_E. At the time of entry all CRAs adopt the same rating policy R_E.

Consider the competition between the original incumbent and a new entrant CRA in period t. Observe that, in period t, the entrant cannot generate any strictly positive profit. To understand this point, note first that condition RIR and $\lambda_E \leq \lambda_I$ implies that the public expects the incumbent's 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 it could increase its reputation and gain a positive profit in $t+1$. In 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.

We first study the subgame that starts after entrant t wins the competition and receives a private signal s_t. Let $V^R(\omega_t, s_t)$ denote the entrant's continuation payoff at $t+1$ given that: first, in period t, it received signal $s_t \in \{G, B\}$, second, the public expected it to adopt the rating policy R, and third, the event ω_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 ω_t and s_t. Formally,

Lemma 2 *Consider the subgame that starts after period t entrant wins the competition to rate issuer t and receives a private signal s_t. Under assumptions A1-A4, in all equilibria satisfying condition RIR, we have $V^R(\omega_t, s_t) = 0$ for all $s_t \in \{G, B\}$ and all $\omega_t \in \Omega$ 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 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 allowing it to overtake the incumbent's reputation. If no such rating exists, then the CRA cannot make positive profits and has to exit the market. If such a rating exists, then a conflict of interest of the same nature illustrated for the finite horizon model emerges. While the intuition for the result is as in Section 3, the proof is more involved because a CRA's continuation payoff needs not be constant for $\lambda_t > \lambda_I$. Details are in the Appendix.

Lemma 2 has a direct consequence on an entrant's ability to attract its first issuer from the original incumbent. When the period-t entrant sets its fees to compete with the original incumbent, it cannot pledge any future profits. Hence, the minimum fee it can charge is c. The original incumbent then can set fees larger than c and still 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-A4 and the Cuomo plan, in all equilibria satisfying condition RIR, no experimentation of any entrant occurs and the original incumbent dominates the market forever.*

7 Extensions

7.1 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 that satisfy condition RIR exist, and have the property that no experimentation is possible. We also provide an upper and a lower bound for the incumbent's equilibrium payoff. Within this framework, the most favorable situation for the new incumbent is when the public believes that all new entrants are always babbling. In this case the incumbent enjoys a monopolistic position. The worst situation is when the public believes that the new entrants will adopt the truthful rating policy.[32] Let

$$\widehat{V}(\lambda_t, \lambda) := \frac{X}{4-3\delta}\left(\frac{4-3\delta-\delta\lambda}{4}\lambda_t - (1-\delta)\lambda\right)$$

Then we have

Proposition 4 *If the incumbent's true accuracy is unknown and its (public and private) reputation in period t is $\lambda_{It} > \lambda_E$ and $\delta \geq 1 - \lambda_{\min}$, then under assumptions A1-A4 and the Cuomo plan, equilibria satisfying condition RIR exist and are such that in period t the incumbent is hired and adopts the truthful rating policy. Its equilibrium payoff $V(\lambda_{It})$ satisfies*

$$\widehat{V}(\lambda_{It}, \lambda_E) \leq V(\lambda_{It}) \leq \widehat{V}(\lambda_{It}, \lambda_{\min}),$$

The equilibrium payoff of period t entrant is 0.

7.2 Multiple ratings

We now consider the case in which 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 makes the hiring decision. Third, hired CRAs give their ratings. If both CRAs are hired, they give simultaneous ratings. Hence, a CRA's rating policy might change depending on whether the issuer is also rated by its competitor but it is not contingent upon the rating publicized 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.

[32]The entrant can commit to use the truthful rating policy only if $\lambda_{It} \geq \lambda_E^+$ and therefore in a SPE the lower bound cannot be reached when $\lambda_E \leq \lambda_{It} < \lambda_E^+$.

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). Take 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 own ratings. The intuition is simple. Suppose that when the issuer hires both CRAs, the original incumbent reduces the informativeness of its rating by inflating its rating such that a high rating from the entrant becomes pivotal to the implementation of the project.[33] Then the entrant will face the same conflict of interests that it faces when it is the only hired CRA. On the contrary, if the issuer only hires the original incumbent, then this can safely provide a truthful rating. We have:

Proposition 5 *Consider the case in which c is low enough that an issuer can obtain a rating from each CRA and focus on the equilibria where condition RIR applies whenever the entrant is hired alone. Under assumptions A1- A4 and the Cuomo plan, either entrant t is never hired, or the issuer t hires both entrant t and the original incumbent. In the latter case the entrant's continuation payoff is nil and hence the entrant exits immediately.*

7.3 Discussion

We briefly discuss few additional extensions. First, note that we assumed that a project's outcome is a deterministic function of its quality. Stochastic outcomes would reinforce our results. When projects' outcomes are stochastic, it becomes impossible to perfectly tell a good project from a bad one even after observing the project's outcome. This weakens the inference about the entrant's type that can be made when comparing the CRA's ratings with project outcomes. This further hinders the entrant's ability to build up its reputation.

Second, while for simplicity our formal analysis is based on the case $\mu = 1/2$, our result would be reinforced for $\mu \neq 1/2$. The qualitative result holds by continuity for μ close to 1/2. For the case of strong public belief about a project quality (i.e. μ close to 0 or 1), it has been shown that an expert with reputational concern tends to conform its rating to this belief.[34] Thus, a prior belief would further hamper an entrant CRA's ability to commit to the truthful rating policy and hence its capacity to build up its reputation and survive in the business.

[33] This is reminiscent of the empirical findings in Becker and Milbourn (2011) that incumbents inflated their rating in the presence of competition

[34] See for instance Mariano (2010).

Third, consider relaxing the CRA's credit constraint implied by assumption A2. Namely suppose that a CRA must exit the market if it does not generate positive profits for n consecutive periods, with $n \geq 2$ and finite. This would give an entrant CRA more chances to build up its reputation before it is forced to exit. This case is more complex than the base model as the entrant CRA might end up being more informed than the public about the actual accuracy of its signal. However as long as reputation can only be built on the basis of the hard public evidence given by the history of ratings and projects' outcomes, the natural barrier to entry we identified would remain. The intuition is simple and goes along the same logic described in Section 3.

Fourth, we focused on equilibria where it is optimal for the incumbent to adopt the truthful rating policy. However, for the incumbent to maintain its dominant position it is sufficient to provide a rating whose expected accuracy is, first, not worse than the ex-ante expected accuracy of an entrant rating and second, large enough to justify being hired by issuers. This would guarantee that the entrant cannot make strictly positive profit at entry and hence cannot credibly commit to a reliable rating policy upon being hired. A similar result would obtain if the precision of a CRA's signal resulted not only from the exogenous quality of its rating technology but also from some endogenous effort of the CRA. Let assume that for the same level of effort in time t, the precision of the original incumbent's signal in t is not smaller than the expected precision of an entrant's signal. Then, in all equilibria where the incumbent's rating is expected to be more accurate than the rating from a new CRA, the latter cannot build reputation for having a superior rating technology.

Fifth, consider the case of a general distribution of the entrant's signal precision. Then, it is easy to see that as long as the entrant's continuation payoff is non-decreasing in the expected precision of its signal, 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.

8 When can a varying reputation CRA be reliable?

In this section we show that truth-telling rating policy is possible even when the CRA has varying reputation. First, we show that under the Cuomo plan a CRA with varying reputation can commit to the truthful rating policy if it is in a monopoly position or if there is no credit constraint. However, for these results to hold it is necessary that the CRA is patient enough. Differently from the findings in Morris (2001) and Ely and Välimäki (2003) and Ely, Fudenberg and Levine (2008), what makes an entrant rating non-reliable is not the excessive weight given to future reputation but rather the urge of building up reputation relatively quickly. Second, we consider two mechanisms that allow entry independently of the CRA discount rate. This can be achieved by allowing entrant CRA to charge contingent fees or by letting the regulator, rather than the market, match issuers and CRAs.

8.1 Monopoly

In this subsection we show that quite contrary to the competition case, if the entrant is in a monopoly position, (i.e. it never faces competing CRA), then there are equilibria where investors expect the monopolist CRA to adopt the truthful rating policy and that policy is indeed optimal for the CRA as long as the discount factor δ is large enough.

In every period t, by credibly adopting the truthful rating policy, a monopolist can secure a non-negative payoff of $\max\{0, (\lambda_t - \lambda_{\min}) X/4\}$. Thus as long as $\lambda_t > \lambda_{\min}$ the credit constraint is not binding. Note however that even a monopolist faces the temptation of giving a high rating after receiving a bad signal in the hope of quickly improving its reputation and continuation payoff. The following proposition shows that this temptation can be resisted only if the CRA is patient enough to wait for the first positive signal to try to improve its reputation.

Proposition 6 *Consider an entrant in monopoly position, if $\delta \geq 1 - \lambda_{\min}$, then, there exists an equilibrium in which in each period t the monopolist truthfully reveals its private signals and as long as $\lambda_t \geq \lambda_{\min}$ the monopolist's continuation payoff is*

$$V^M(\lambda_t) = \widehat{V}(\lambda_t, \lambda_{\min}).$$

Proposition 6 is similar to Proposition 4. Both basically suggest that regardless of facing or not facing competition, a sufficiently patient incumbent can commit to the truthful rating policy.

8.2 Absence of credit constraints

We consider now the effect of eliminating the credit constraint in the presence of competition and assume that any CRA whose reputation is above $\lambda_{\min}$ can stay in business even without generating profits. At time 1 only the original incumbent and time 1 entrant are present. In subsequent periods, any CRA whose reputation drops below $\lambda_{\min}$ exits and is replaced by an entrant from the pool. The purpose here is to show that under RIR the entrant CRA can gain reputation above λ_I and make positive profit only if it is patient enough.

Proposition 7 *In the absence of credit constraint to the CRAs, if $\delta > 1-\lambda_I$ there exists an equilibrium satisfying RIR leading to to the social optimal experimentation.*

Without the credit constraint, in any equilibrium with entry, the outside option of every issuer is to hire the original incumbent. Therefore, the collection of entrants realizes a positive profit if and only if they generate a higher surplus than the original incumbent, which generates efficient experimentation.

8.3 Contingent Fees

From now on, we assume again credit constraint. In this section, we study the equilibrium of the entry game when CRAs are allowed to charge rating fees that are contingent on the rating note. Let f_r denote the fee charged for rating $r \in \{G, B\}$. We show that in this scenario, 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. Note that period t entrant can propose an incentive compatible fee scheme by charging higher fees for a low rating than 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. This makes its commitment to the truthful rating credible. The fee for a high rating is lower but if a high rating is followed by a good outcome $\widetilde{X}_t = X$, 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.[35] Starting from this point, continuation strategies and payoffs are those described in Proposition 4 for the case of a varying reputation incumbent. 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 original incumbent's reputation is not too large in comparison to that of the entrant. Formally, define $\lambda_I^{**}(\lambda_E)(> \lambda_E)$ as the λ_I solving the following equation

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

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

Proposition 8 *Assume A1- A4 and that each CRA can condition its fee to its rating. Then, there exists an equilibrium such that;*

[35] 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.

(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

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

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

$$V_E = -V_I > 0.$$

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 for higher rating is the opposite to what could open the credit rating market to the competition of entrants. Only by charging fees that are higher for a low rating compared to the fees charged for a 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 as is described in the following Corollary .

Corollary 1 *In the equilibrium described in Proposition 8, competition generates socially excessive experimentation for $\lambda_I \in (\lambda_I^*(\lambda_E), \lambda_I^{**}(\lambda_E))$.*

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. Our result is reminiscent of the excessive experimentation result obtained by Bergemann and Välimäki (2000) who consider competition between two long-run sellers selling to multiple long-run buyers when the quality of one of the seller's product is fixed and known while the quality of the other seller's product is uncertain and needs to be learned. Their result is due to the fact that each individual buyer does not fully internalize future consequences of his experimentation on other buyers. In our model, over-experimentation is generated by the credit constraint. Thanks to the credit constraint, in equilibria where the first entrant attracts the issuer, the original incumbent is forced out of business. Then in the following periods, time 1 entrant will face competition from new entrants whose reputation is lower than the original incumbent's. Hence the amount the entrant is willing to pay to attract its first issuer is larger in the presence of credit constraints. Because in the absence of credit constraint optimal experimentation is obtained, credit constraint lead to over-experimentation. It can be shown that the social optimum can be obtained by imposing a legal lower bound to the entrant's average fee.[36]

Third, this "pay if you are bad" contingent fee scheme can be difficult to implement ex-post. An issuer who received a low rating from an entrant CRA will have to pay f_B but it will not be able to raise the money necessary to finance the project because of the low rating resulted from a truthful rating policy. Furthermore the fee f_B must be large enough to compensate the entrant for the expected continuation payoff obtained when giving a high rating. Thus, "pay if you are bad" contingent fee is not an equilibrium if the issuer's internal funds are bounded compared to an entrant CRA's potential future profits.

8.4 Regulated contingent monopoly

In Section 6, we showed that an entrant CRA's desire to increase its reputation above the incumbent's leads to a conflict of interest that makes entry impossible. A solution to this problem would consist in breaking the link between a CRA's reputation and its ability to attract issuers. For this purpose, consider the following situation: in every period t, first, the social planner decides whether issuer t will be rated by the incumbent or by the entrant, second the selected CRA will propose a non-regulated *flat* fee to the issuer, third if the issuer accepts, the CRA gives its rating and investors decide whether to finance the issuer's project. For this institutional framework, if $\delta > 1 - \lambda_{\min}$ there is an equilibrium where the social optimum described in Section 5 is restored and any hired CRA adopts the truthful rating policy. Namely, if $\lambda_I > \lambda^*(\lambda_E)$, the social planner lets the original incumbent rate all issuers. In this case the incumbent will be in a monopolistic position and, as illustrated in Section 8.1, it can commit to the truthful rating policy. If $\lambda_I \leq \lambda^*(\lambda_E)$, the social planner lets the first entrant rate the project until an event F^G is realized. As soon as an F^G event is realized, the CRA is replaced with a new entrant with fresh reputation λ_E who should rate projects until an event F^G happens. This process continues until an entrant of accurate type is identified. As in Section 8.1 the hired CRA enjoys a monopoly position until an event F^G is observed. Hence there is an equilibrium where a varying reputation monopolist adopts the truthful strategy provided $\delta > 1 - \lambda_{\min}$.

[36]Social optimum can be obtained by imposing $\frac{1}{2}(f_G + f_B) \geq (\lambda_E - \lambda_I^*(\lambda_E))\,\frac{X}{4} + c$.

9 Conclusion and policy implications

Reputational concern is often argued as the key force that guarantees the well-functioning of the credit rating market by reducing conflicts 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."[37]

Our analysis provides a theoretical ground to this argument. By maintaining the public's confidence in their commitment to truthful ratings, today's incumbent CRAs 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.

However, the presence of the natural barrier to entry would put incumbents in such a comfortable situation that they might have little incentive to improve their rating technology, which could explain their failures during the last financial crisis. This failure, coupled with the recent rumors and scandals about the incumbent CRAs' rating practices, is casting doubts on the sincerity and reliability of their ratings.[38] According to our model the fading of public' confidence in the incumbent rating is a necessary condition to generate a credible threat from potential entrants. Not surprisingly, after many years of paucity of applications, new CRAs are recently entering the market and plan to apply to the NRSRO status.[39] Still, according to our model, nothing guarantees that these new entrants will gain the public's trust that is necessary to survive in the business. Below we provide some directions for policies that might help the settling of more effective CRAs.

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. Our first policy implication is that NRSRO accreditation should be maintained. This would prevent entry of CRAs

[37]http://www.sec.gov/news/extra/credrate/standardpoors.htm

[38]See, for instance, "Triple-A-Failure," by Roger Lowenstein, in New York Times Magazine (April 27, 2008) and "The Big Short: Inside the Doomsday Machine" by Michael Lewis (2010).

[39]In 2006 only five rating agenecies had the NRSRO accreditation. As to 2011 this numbr is doubled.

whose technology to assess default risk is completely non-reliable. As a result, by obtaining the NRSRO accreditation an entrant could increase the public's trust in its rating technology. However NRSRO accreditation does not guarantee that the entrants will be sincere in their ratings and/or that the public will believe them. Hence, the entrant CRAs should be allowed to use incentive schemes leading to truthful rating policies. Namely an entrant 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.[40] This however has two drawbacks. First, the pay-if-you-are-bad fee schedule cannot be implemented with financially constrained issuers. A way to avoid this issue is to have investors rather than issuer paying for the ratings. Second, this policy is in contrast to the Cuomo plan (i.e. no contingent fee) that has its own virtues. The Cuomo plan combined with no rating shopping, has been proposed to eliminate incumbent CRAs' conflict of interest by Bolton, Freixas and Shapiro (2009). The same policy would also eliminate rating inflation in Mathis, McAndrews and Rochet (2009) and in Skreta and Veldkamp (2009). These papers also found that moving to the investor-pays pricing could solve both the (incumbents') conflicts of interest and the rating inflation although the investor-pays pricing can create its own problem of free-riding among investors.

We show that it is possible to maintain the benefits of the Cuomo plan while making experimentation with entrant CRAs possible. To this purpose one should break the link between a CRA reputation and its ability to attract issuers. This can be achieved by letting the social planner decide which CRA should rate which issuer. The socially optimal policy for experimentation would consist in giving monopoly power to an entrant CRA as long as its rating does not reveal to be wrong. However, this policy is effective only in equilibria where the public expects the current monopolist to use the truthful rating policy.

Previous papers have also 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 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

[40] 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."

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.

10 Appendix

Proof of Proposition 1

Suppose $\mu X \geq 1$. Consider period $t-1 < n$ and suppose that $\lambda_t \leq \lambda_I$ leads to a nil continuation payoff. Note that, $\lambda_{t-1} \leq \lambda_{\min}$ necessarily leads to a nil continuation payoff because the assumption $\lambda_{\min}^{+} \leq \lambda_I$ implies $\lambda_t \leq \lambda_I$. Therefore, consider $\lambda_{\min} < \lambda_t \leq \lambda_I$. If the project is financed only with a high rating, we can apply the previous argument to obtain our result. Hence suppose that the project is financed irrespective of the rating. Then $\omega_t \in \{S^G, F^G, S^B, F^B\}$. Clearly if $\lambda_t > \lambda_I$ for some ω_t, there must be certain ω_t for which $\lambda_t < \lambda_{t-1}$. As for the case $\mu X < 1$, it cannot be that $\lambda_t > \lambda_I$ for only one ω_t as this would lead to a babbling rating policy. If $\lambda_t > \lambda_I$, for three out of the four possible events, then there is a rating that guarantees $\lambda_t > \lambda_I$ irrespective of the project outcome. The CRA will strictly prefer giving this rating, leading to a babbling rating. For the same reason, if $\lambda_t > \lambda_I$, for two out of the four events, then these two events cannot be associated with the same rating (say $\omega_t \in \{S^G, F^G\}$). Neither the two events can be associated with the same project outcome (say $\omega_t \in \{S^G, S^B\}$), because the probability of having $\omega_t \in \{S^G, S^B\}$ is μ and does not depend on the type of the CRA. Therefore, it cannot be that $\lambda_t > \lambda_I$ for $\omega_t \in \{S^G, S^B\}$ and $\lambda_t \leq \lambda_I$ for $\omega_t \notin \{S^G, S^B\}$. Hence, suppose $\lambda_t > \lambda_I$ for say $\omega_t \in \{S^G, F^B\}$. Then after receiving a signal G, any CRA considers that the project is more likely to be of good quality than of bad quality and thus strictly prefers giving a high rating (recall that in this case $\lambda_t > \lambda_E^{ia}$ implies $1-\mu_G(\lambda_t) < \mu_G(\lambda_t)$). Therefore, a low rating is necessarily associated with signal B no matter the CRA type and hence must lead to no implementation because $\lambda_{t-1} \geq \lambda_{\min}$. This contradicts the hypothesis that the project is implemented irrespective of the rating. A symmetric argument can be used if $\lambda_t > \lambda_I$ for $\omega_t \in \{F^G, S^B\}$. ■

Proof of Proposition 2

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,

$$W_I = \frac{1}{2}\left(\frac{1+\lambda_I}{2}X - 1\right) - c. \tag{4}$$

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

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

Solving this equation gives

$$W_E(\lambda) = \frac{1}{2}\left(\frac{2(1-\delta)(1+\lambda) + \delta\lambda_E}{4(1-\delta) + \delta\lambda_E}X - 1\right) - c, \tag{5}$$

which is strictly increasing in λ. The comparison of W_I and $W_E(\lambda_E)$ 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. ■

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. The issuer's profit maximization leads to select the CRA that solves

$$\max\left\{u(f_{i,t}, R_{i,t}, \lambda_{i,t}), u(f_{j,t}, R_{j,t}, \lambda_{j,t}), \underline{u}\right\}. \tag{6}$$

When the solution of (6) 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 $\max\left\{u(c, R_{j,t}, \lambda_{j,t}), \underline{u}\right\} = u(f_{i,t}, R_{i,t}, \lambda_{i,t})$. 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 (3) 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 (3) that corresponds to the case $R_{i,t} = \overline{R}$ and $R_{j,t} = \underline{R}$. □

Proof of Lemma 2

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

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

where $\pi^R_{t+1}(\omega_t, s_t)$ is the entrant's expected profit in $t+1$ and $V^R_2(\omega_t, s_t)$ is the expected continuation payoff starting from $t+2$. Let λ^R_ω be the entrant's public reputation at the beginning of time $t+1$, given $\omega_t = \omega$ and let $\widehat{\lambda}_{\omega,s}$ 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 $\lambda^R_\omega \leq \lambda_I$.

Property (i) holds because the entrant can always exit the market at no cost. Property (ii) holds because $\lambda^R_\omega \leq \lambda_I$ and RIR implies that in $t+1$ the original incumbent is expected to give a more accurate rating than time t entrant. Hence, from Lemma 1, $\pi^R_{t+1}(\omega, s) \leq 0$. For the same reasons, $\lambda_E \leq \lambda_I$ implies that entrant t cannot generate profit in period t. Thus, from A2 the entrant must exit at the end of in $t+1$ yielding $V^R_2(\omega_t, s_t) = 0$ and $V^R(\omega_t, s_t) \leq 0$. The equality follows from Property (i).

We have the following Lemma regarding π^R_{t+1}.

Lemma 2.1

Under A3, for any given $\omega_t \in \Omega$

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

(ii) It is impossible to have "$\pi^R_{t+1}(\omega_t, s_t) > 0$ and $\pi^R_{t+1}(\omega_t, s'_t) \leq 0$ " 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) Consider for instance $\pi^R_{t+1}(\omega_t, G) > 0$ and $\pi^R_{t+1}(\omega_t, B) = 0$. The latter and (i) imply $V^R(\omega_t, B) = 0$. 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 $\pi^R_{t+1}(\omega, B) > 0$, which is a contradiction. The same logic applies to the case of $\pi^R_{t+1}(\omega_t, G) = 0$ and $\pi^R_{t+1}(\omega_t, B) > 0$. □

Lemma 2.1 (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 2.2 *If $X\mu < 1$, then in any equilibrium satisfying Properties (i)-(ii) , it must be $V^R(\omega_t, s_t) = 0$ for all (ω_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 $\omega_t = N^B$, $\lambda^R_N = \lambda_E \leq \lambda_I$ and a nil continuation payoff because of Property (ii). If a high rating also leads to no implementation of the project (i.e. $X\mu_G^R(\lambda_E) < 1$), then the entrant's continuation payoff is nil for any rating and therefore our result is proven.

Now, suppose $X\mu_G^R(\lambda_E) \geq 1$. Then a high rating leads to implementation of the project with positive probability $p > 0$. Thus, 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 $\omega_t \in \{F^G, N^B\}$, it results $\lambda_{\omega_t}^R \leq \lambda_E \leq \lambda_I$, hence $V^R(\omega_t, s) = 0$ from Property (ii). From Lemma 2.1 (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 now 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 because $X\mu < 1$. This contradicts the hypothesis $X\mu_G^R(\lambda_E) \geq 1$.□

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 $\widehat{\lambda}_{\omega,s} = \widehat{\lambda}_{\omega',s'}$, $\lambda_\omega^R < \lambda_{\omega'}^R$ 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 $\widehat{\lambda}_{\omega_t,s_t} = \lambda_E^+$ (resp. $\widehat{\lambda}_{\omega_t,s_t} = 0$). For instance, if $(\omega_t, s_t) = (S^G, G)$, the entrant attaches probability λ_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 increases 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 $h(T) = \{\omega_{t+1}, \omega_{t+2}, \cdots, \omega_{t+T}\}$ and let $\lambda_{t+T}(\omega_t)$ be the CRA's public reputation at the end of this history. Then $\lambda_\omega^R < \lambda_{\omega'}^R$ implies

$\lambda_{t+T}(\omega) < \lambda_{t+T}(\omega')$. At time $t+T+1$, if the CRA is out of business, its stage payoff is 0; otherwise, it is $u(c, \overline{R}, \lambda_{t+T}(\omega_t)) - \max\{u(f_E, R_E, \lambda_E), \underline{u}\}$, which increases in $\lambda_{t+T}(\omega_t)$. Taking the expectation across all continuation histories, and considering that at time t the CRA private belief of being accurate is the same as $\widehat{\lambda}_{\omega,s} = \widehat{\lambda}_{\omega',s'}$, we can conclude that $V^R(\omega', s') > V^R(\omega, s)$.

Then we have

Lemma 2.3

If $X\mu > 1$, then in any equilibrium satisfying Properties (i)-(iv), it must be $V^R(\omega_t, s_t) = 0$ for all (ω_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: $X\mu_B^R(\lambda_E) < 1$ and $X\mu_B^R(\lambda_E) > 1$. In the first case, the proof of Lemma 2.2 can be applied to obtain a contradiction: babbling rating policy and $X\mu > 1$ imply that the project is always implemented, which contradicts $X\mu_B^R(\lambda_E) < 1$.

Therefore, we consider $X\mu_B^R(\lambda_E) > 1$; hence, the project is implemented regardless of rating. For $\omega_t \in \left\{S^B, F^G\right\}$, it results in $\lambda_{\omega_t}^R \leq \lambda_E < \lambda_I$, consequently $V^R(\omega_t, s) = 0$ 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:

$$\begin{aligned} \mu_G(\lambda_E)V^R(S^G, G) &\geq (1-\mu_G(\lambda_E))V^R(F^B, G) && (7) \\ (1-\mu_B(\lambda_E))V^R(F^B, B) &\geq \mu_B(\lambda_E)V^R(S^G, B) && (8) \end{aligned}$$

Recall that $\mu_G(\lambda_E) > \mu_B(\lambda_E)$ and hence $(1-\mu_B(\lambda_E)) > (1-\mu_G(\lambda_E))$.

1. It cannot be that (7) is strict. If so, 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 (7) holds with equality but (8) is strict, then $1 > R(G) > 0$ and $R(B) = 0$. This implies that the entrant's public reputation satisfies

$$\lambda_{F^B}^R = \frac{\lambda_E(1-\mu)}{\lambda_E(1-\mu) + (1-\lambda_E)(1-\mu)(\frac{1}{2} + \frac{1}{2}(1-R(G)))} < \lambda_E^+ = \lambda_{S^G}^R,$$

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 $(\omega = F^B, s = B)$

because the entrant's private signal is confirmed by the project outcome in both events. 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 (7) would contradict $V(S^G, G) > V(F^B, B)$. Thus, it must be $V(F^B, B) = 0$, which, together with properties (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 (7) and (8) hold with equality, then by summing up (7) and (8) we obtain

$$\mu_G(\lambda_E)V(S^G, G)+(1-\mu_B(\lambda_E))V(F^B, B) = (1-\mu_G(\lambda_E))V(F^B, G)+\mu_B(\lambda_E)V(S^G, B) \tag{9}$$

   Suppose that continuation payoffs in (9) are strictly positive, then Property (iii) implies that the r.h.s. of (9) is not larger than $(1-\mu_G(\lambda_E))V(F^B, B)+\mu_B(\lambda_E)V(S^G, G)$, which in turn is strictly smaller than the l.h.s. of (9) because $\mu_G(\lambda_E) > \mu_B(\lambda_E)$. Therefore a contradiction of equality (9). Hence equality (9) can only be satisfied when both sides are nil. □

This ends the proof of Lemma 2. □

Proof of Proposition 3

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

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

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

Proof of Proposition 4

Note first that $\lambda_I > \lambda_E$ 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. It remains to be shown that in equilibrium the varying reputation incumbent can commit to the truthful rating policy. In period t, the maximum (minimum) profit the incumbent with reputation λ_t can make are $(\lambda_t - \lambda_{\min})\frac{X}{4}$ (resp. $(\lambda_t - \lambda_E)\frac{X}{4}$) and is achieved when the entrant is expected to adopt the babbling (resp. truthful) rating policy. In an equilibrium where the incumbent rating policy is truthful, only projects which received a high rating will be financed, implying $\omega_t \in \left\{N^B, S^G, F^B\right\}$. At the end of period t, the incumbent reputation will move to λ_t, λ_t^+ and 0 in event N^B, S^B and F^G, respectively. When $\lambda_{t+1} = 0$, the incumbent is known to be inaccurate and hence can no longer generate profits. Considering that the ex ante probabilities of these events are $\Pr(N^B) = 1/2$, $\Pr(S^G) = \frac{\lambda_t+1}{4}$ and $\Pr(F^G) = \frac{1-\lambda_t}{4}$, the incumbent's maximum and minimum possible equilibrium payoff consistent with a truthful rating policy must satisfy the following functional equation

$$V(\lambda_t, \lambda^*) = (1-\delta)\left(\lambda_t - \lambda^*\right)\frac{X}{4} + \delta\left(\frac{\lambda_t + 1}{4}V(\lambda_t^+, \lambda^*) + \frac{1}{2}V(\lambda_t, \lambda^*)\right), \tag{10}$$

where λ^* equals $\lambda_{\min}$ or λ_E depending we consider the maximum or minimum incumbent equilibrium payoff, respectively. The solution of functional equation (10) equals $\widehat{V}(\lambda_t, \lambda^*)$.

We now show that a patient enough incumbent has an incentive to truthfully report its signal. A low rating leads to no implementation of the project, an unchanged reputation and a continuation payoff of $\widehat{V}(\lambda_{I,t}, \lambda^*)$. If the incumbent received a good signal and truthfully reports it, then, its expected continuation payoff is $\frac{1+\lambda_t}{2}\widehat{V}(\lambda_t^+, \lambda^*)$. If it received a bad signal but reports a high rating, then, its expected continuation payoff is at most $\frac{1-\lambda_t}{2}\widehat{V}(\lambda_t^+, \lambda^*)$. Therefore, truthful rating is an equilibrium if the following incentive constraints hold:

$$\frac{1-\lambda_t}{2}\widehat{V}(\lambda_t^+, \lambda^*) \leq \widehat{V}(\lambda_t, \lambda^*) \leq \frac{1+\lambda_t}{2}\widehat{V}(\lambda_t^+, \lambda^*), \tag{11}$$

which are satisfied for any $\delta \in [1-\lambda^*, 1]$ and for any $\lambda_t \geq \lambda_{\min}$. Because $\lambda_{\min} < \lambda_E$, inequalities (11) are satisfied for $\lambda^* \in \{\lambda_{\min}, \lambda_E\}$ as long as $\delta > 1 - \lambda_{\min}$. ■

Proof of Proposition 6

The proof goes along the same lines of the proof of Proposition **4** with $\lambda^* = \lambda_{\min}$.■

Proof of Proposition 7:

Consider the case where the entrant reputation is $\lambda_t = \lambda_E$ and let denote V_E and V_I the entrant's and the original incumbent's expected equilibrium payoffs. This is the case whenever a new entrant arrives hence without loss of generality we can focus on time 1. Let f_E and f_I denote the rating fees charged at time 1 by the entrant and the original incumbent respectively. There are two possible situations: (a) the issuer hires the incumbent, then the entrant cannot build up reputation and will set $f_E = c$. As a result, $V_E = 0$ whereas $V_I = (\lambda_I - \lambda_E)\frac{X}{4}$ and the discounted sum of issuers' and the incumbent's payoffs is equal to the social welfare and equal to W_I. (b) The entrant can set f_E at sufficiently low level to attract time 1 issuer despite the incumbent's stronger reputation. Then $f_I = c$, $V_I = 0$. Because both the CRAs are expected to adopt the truthful rating policy, the functional equation representing the entrant continuation payoff is given by (10) with λ_I instead of λ^* and the resulting expected continuation payoff is $V_E = \widehat{V}(\lambda_E, \lambda_I)$. Note, from the Proof of Proposition 4, that at this stage the truthful strategy is incentive compatible only if $\delta > 1 - \lambda_I$. Note also that because the entrant will charge the minimum fee allowing to attract the issuer away from the incumbent, every issuer's net payoff is $\frac{1}{2}(\frac{1+\lambda_I}{2}X - 1) - c$. In other words, the discounted sum of payoffs of all issuers' and the original incumbent's payoff equals W_I. Similarly to the case of socially optimal experimentation with entrants, an entrant will be replaced by a new entrant as soon as an event F^G occurs. So the total social welfare obtained in case (b) equals $W_E(\lambda_E)$. Let p_t represent the probability for entrant t to become a fresh new entrant: for instance, $p_1 = 1$, $p_2 = \frac{1-\lambda_E}{4}$. Then we have

$$\sum_{t=1}^{\infty} p_t \delta^t V_E = W_E(\lambda_E) - W_I.$$

This equality shows that $V_E > 0$ if and only if $W_E(\lambda_E) > W_I$.

Proof of Proposition 8

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.[41] As these two CRAs have the same reputation, their expected

[41] 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.

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 $\widehat{V}(\lambda_E^+, \lambda_E)$ from Proposition 4[42]. 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 in order to have the opportunity to rate period one project satisfy

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

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 $-c(1-\delta) + \delta\overline{V}_I$. 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 satisfies

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

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

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

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

$$\frac{1}{2}(f_G + f_B) = -(\lambda_I - \lambda_E)\frac{X}{4} + c, \tag{12}$$

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

[42] Actually, it will be $\widehat{V}(\lambda_E^+, \lambda_E)$ since all entrants can commit to truthful reporting with contingent fees.

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 λ_E^+ leading to a continuation payoff of at least $\widehat{V}(\lambda_E^+, \lambda_E)$. 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 λ_E^+ whereas the entrant becomes certain of being the inaccurate type since its signal differs from the outcome of the project. In this instance let $V^{\overline{R}}(S^G, B)$ be the off-equilibrium continuation payoff. Note that $V^{\overline{R}}(S^G, B) \leq V^{\overline{R}}(S^G, G) = \widehat{V}(\lambda_E^+, \lambda_E)$, 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.

$$f_G + \frac{\delta}{1-\delta}\mu_B(\lambda_E) V^{\overline{R}}(S^G, B) \leq f_B \leq f_G + \frac{\delta}{1-\delta}\mu_G(\lambda_E)\widehat{V}(\lambda_E^+, \lambda_E). \tag{13}$$

The first (second) inequality guarantees that the entrant prefers to give a low (high) rating after receiving a bad (good) signal. It is a straightforward verification that there are (f_G, f_B) satisfying (12) and (13).■

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Proof of Proposition 5

Consider the subgame in period $t+1$ where time t entrant is still active, its reputation is below λ_I, and has not made positive profit yet. We show that the entrant's continuation payoff is nil. First note that if the incumbent is hired alone, it can commit to the truthful rating policy. Hence the entrant cannot make positive profit when hired alone as it cannot provide a rating that is more accurate than the one of the incumbent. Thus, consider the subgame that starts after issuer $t+1$ 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, for the same fee the issuer would prefer hiring only the original incumbent alone. Hence the entrant's profit cannot be positive. Thus, consider the subgame where both CRAs are hired and their ratings do affect investment decisions. 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.

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.

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 the entrant is hired alone and provides a truthful rating. This is less than the precision of a rating from the incumbent when hired alone. Since a necessary condition for the entrant to have a positive continuation payoff is to charge a fee larger than c, it implies that issuer $t+1$ prefers hiring the incumbent alone rather than hiring both CRAs if it expects case 2 to arise. Therefore, the entrant cannot make a positive profit in case 2.

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 and 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 in any case the project will be implemented. However, it will reduce the entrant's payoff when it gives a low rating as two low ratings lead to no implementation of the project and hence 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.

Consider now time t. The same argument used for period $t+1$ applies to period t. Namely, in all equilibria where the issuer hires only one of the two CRAs, the same analysis of Proposition 3 applies. Thus, consider 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 or never implemented), then the entrant's continuation payoff is zero (since the analysis of Lemma 2.2 and Lemma 2.3 applies) and the incumbent can charge a fee inducing the issuer to hire the incumbent alone instead of hiring the two CRAs or the entrant alone. Hence consider the subgame where both CRAs are hired and their ratings do affect investment decisions, that are Cases 1, 2 and 3. Cases 1 and 3 can be eliminated with the same arguments used for period $t+1$. Consider Case 2. The argument used for $t+1$ still applies and hence the entrant cannot make a positive profit in Case 2. As a consequence, once hired the entrant has to build up reputation in t; otherwise in $t+1$, it will be unable to realize a positive profit as is previously proved when we considered $t+1$. This implies that the entrant faces the same conflict of interest as in the single rating and hence its 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. ■