Market Power and Reputational Concerns in the Ratings Industry

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Abstract

This paper studies the incentives of rating agencies to reveal the information that they obtain about their client firms. In the model, rating agencies seek to maximize their reputation and protect their market power. They observe public information and obtain either precise or noisy private information about a firm. Reputational concerns dictate that a rating reflects private information when it is precise. However, when private information is noisy, two situations arise. In a monopoly, the rating agency may ignore private information and issue a rating that conforms to public information. Under some conditions, it may even become cautious and issue bad ratings ignoring both types of information. With competition, however, it has incentives to contradict public information as a way to pretend that it holds precise private information. Moreover, it may become more likely to issue good ratings in an attempt to protect market power.

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1. Introduction

Rating agencies have received much attention in the debate on the 2007-2009 financial crisis. The fact that rating agencies are paid by the firms they rate generates conflicts of interest that can lead to inaccurate ratings. A standard argument is that if rating agencies were not exposed to these conflicts of interest, incentives to safeguard their reputation would make them worry enough about providing reliable information to investors, and hence would ensure accurate ratings. However, this paper shows that a rating agency that worries about reputation might not have incentives to provide accurate ratings *even in the absence of conflicts of interest.* This suggests that solving the problem of conflicts of interest, while certainly very important, might not be sufficient to secure the best possible ratings.

The reason why reputation should be very important for rating agencies is because it confers credibility to their announcements, and consequently, makes firms hire their services. This should be a strong motive for rating agencies to want to provide accurate ratings. To achieve this objective rating agencies should consider all available information when assigning a rating. However, they can make mistakes, either because their credit models and rating methodologies might contain errors, the information they have is incomplete or inaccurate, or they do not fully understand the securities for which they are providing a rating.[1] In order not to damage their reputation and ultimately their profits, rating agencies do not want to be *seen* to make mistakes and worry about giving the *appearance* of competence. This paper shows that, as a result, they can simply ignore or contradict some available information when assigning a rating. Conse-

[1]Both S&P and Moody's disclosed that they detected errors in their computer models. In the case of Moody's, this led them to assign top-notch triple A ratings to products whose ratings, in some cases, should have been up to four notches lower. See for example, "Moody's error gave top ratings to debt products", Financial Times, May 20 2008, "Moody's launches review in wake of errors", Financial Times, May 21 2008, and "S&P discloses errors in rating models", Financial Times, June 13 2008.

quently, reputational concerns can lead to ratings that are not as accurate and reliable as possible.[2] These results hold even though the model abstracts from bribes, conflicts of interest and repeated relationships between rating agencies and their client firms. They are particularly relevant for regulators, who are always looking for different ways to assess the work of rating agencies.

The aim of this paper is twofold. First, it is to examine the incentives of rating agencies to reveal the information that they obtain while assessing their client firms. These incentives depend on the effect that revealing this information has on the reputation of rating agencies, in particular if they can make mistakes in their assessments. Second, it is to explore in what way competition and market power in the ratings industry affects the incentives of rating agencies to reveal their information. To develop an intuition about the effect of competition, I first discuss the case of a monopolistic rating agency which I use as a benchmark model. In reality, there is some degree of competition in the ratings industry but the results derived for the monopolistic case allow me to highlight how competition affects which information is incorporated in ratings as well as overall rating levels. For example, I can use those results to identify and explain the circumstances in which good ratings become more likely with competition - a situation often associated with ratings inflation.

In this paper, I take into account that a rating determines to a large extent the success of the firm (or project) that receives it. In this sense, a bad rating has far more consequences than a good one. First, a bad rating increases financing costs which can

[2]The following quote illustrates this point: "Another rating agency reported to the Staff that one of its foreign ratings surveillance committees had knowledge that the rating agency had issued ratings on almost a dozen securities using a model that contained an error. (...) Nonetheless, the committee agreed to continue to maintain the ratings for several months, until the securities were downgraded for other reasons. Members of the committee (...) considered the rating agency's reputational interest in not making its error public, according to the rating agency." Source: United Stated Securities and Exchange Commission, 2008, "Summary Report of Issues Identified in the Commission Staff's Examinations of Select Credit Rating Agencies".

damage the firm.[3] Second, a bad rating might deter prospective investors from investing in the firm, which may restrict its sources of funds available to spend in value-creating projects. This can be because the regulatory regime requires or encourages broker-dealers, banks, insurance companies, pension funds, and other institutional investors, which are among the major participants in fixed income security markets, to buy securities that are rated investment grade (i.e., receive a good rating in the terminology of the paper).[4] The model captures this situation and shows how this asymmetry between good and bad ratings affects rating agencies decisions.

Suppose there is a project which requires a rating. Both project and rating can be good or bad. A rating agency issues the rating based on two sources of information: public information, that expresses prior expectations about the project, and private information that is assembled by the rating agency's analysts or provided by the firm. Private information is either precise or noisy which means that a rating agency can be of two types: it perfectly identifies the project's type or it can make mistakes. The economy is unsure about the rating agency's type but attaches a subjective probability to a rating agency not making mistakes. I refer to this probability as the rating agency's reputation. The rating agency knows its own type and wants to maximize reputation.

Consider the situation in which public information is strongly in favor of either a good or bad rating. A rating agency with noisy private information that finds itself in a situation in which public and private information diverge, might just *conform* to public information issuing the rating that everyone expects because of fears of being seen to make mistakes. However, the asymmetry between a good and bad rating dis-

[3] Hand, Holthausen, and Leftwich (1992) and Kliger and Sarig (2000) provide empirical evidence of the link between ratings and the cost of capital of borrowing firms. The former document a significant negative effect in stock and bond returns for downgrades, and a weaker effect for upgrades. The latter find that bond prices react positively (negatively) to better (worse) than expected ratings using a Moody's refinement of its rating system. Firms take this link seriously to the extent that it influences capital structure decisions as shown by Kisgen (2006, 2007).

[4] White (2002), BIS (2000), Cantor and Packer (1995) and Partnoy (1999) list some of these regulatory requirements.

cussed above generates a bias towards bad ratings, which is most evident when public information is weakly in favor of a good rating. In this case, the rating agency might simply ignore all information and issue a bad rating. The argument is as follows. A good project succeeds if the rating is good but might fail if the rating is bad, whereas a bad project always fails. Only failures and successes are observable. Hence, the rating agency might want to be *cautious* and issue a bad rating, which is more likely to generate a failure, and therefore less likely to lead to a mistake that is easy to ascertain. This happens because a monopolistic rating agency does not feel compelled to show how good its private information really is.

In a situation in which an incumbent rating agency faces a pool of potential competitors ready to enter the industry it needs to show (or to pretend) that it is of the type that does not make mistakes, to avoid being replaced by a competitor. In this case, a rating agency with noisy private information becomes *aggressive* and chooses to contradict public information more often than in a monopoly. If the rating agency contradicts public information and the rating turns out to be correct, the market is more likely to assume that it is because private information is precise and the rating agency's reputation increases. The consequence is that ratings become less accurate.

For the reasons mentioned above, it is important that the project receives a good rating. Therefore, a new rating agency may be asked to enter the industry and issue a second rating if the incumbent rating agency issues a bad first rating. This gives the new rating agency the chance to build up reputation if the rating it issues turns out to be correct and, as a result, it can threaten the *status quo* of the incumbent. An incumbent with noisy private information can avert this by issuing a good rating. This means that reputational concerns can induce ratings inflation in a competitive setting. Finally, herding on the first rating by the new rating agency depends on the reputation level of the incumbent rating agency and on the strength of public information.

Rating agencies can be conformist, cautious, or aggressive even when they worry about reputation. For example, in the years preceding the 2007-2009 financial crisis rating agencies assigned the highest rating grades to many new and hard-to-value securities such as mortgage backed securities and collateralized debt obligations. Even though nobody fully understood how these securities worked, there was generally little concern about their quality and many investors even regarded them as conservative and low-risk investments.[5] Hence, rating agencies had strong reputational incentives to simply issue high ratings. Investors would see their expectations fulfilled and be able and prepared to buy these securities; rating agencies would appear competent and capable of understanding the securities they had been hired to rate.[6]

Related Literature

This paper contributes to the literature on information revelation and competition for financial intermediaries by addressing the importance of reputation for rating agencies. This is relevant because of the unique features of rating agencies relative to other financial intermediaries that have been examined in the literature, such as investment banks or financial analysts. While the first papers in this literature consider intermediaries that cannot establish a reputation (e.g. Biglaiser, 1993, and Lizzeri, 1999), more recent ones handle this topic in different ways. Bolton, Freixas and Shapiro (2007, 2010) address the conflicts of interest faced by financial intermediaries that provide advice to investors (rating agencies in Bolton, Freixas and Shapiro, 2010) when they incur a fixed reputational cost every time their advice is misleading or confusing. Damiano, Li and Suen (2008) also consider an exogenous reputational cost and how it affects the credibility of ratings. This paper does not tackle conflicts of interest issues and deals with reputation endogenously using Bayesian updating. In this way it is easier to derive the

[5] Manson and Rosner (2007) discuss the difficulties in assessing the risk of such securities.

[6] This story echoes what happened with the Enron case in which rating agencies also had to deal with complex energy derivatives and which lead to equally inflated ratings.

value of reputation in different scenarios and to link it to the information structure of the model.

A closely related paper with endogenous reputation is Mathis, McAndrews and Rochet (2009) which assesses how it can act as disciplining device for rating agencies in an infinite period model based on the cheap talk literature (e.g., Crawford and Sobel, 1982, Sobel, 1985, Benabou and Laroque, 1992, Morris, 2001). The authors characterize the sufficient conditions in a truthtelling equilibrium but tie the results to the existence of conflicts of interest. Bar-Isaac and Shapiro (2010) build up on this paper to model the problem of a rating agency that chooses in each period how much to invest in reputation for accurate ratings by hiring better analysts. They conclude, as in the model below, that reputation is not enough to ensure accurate ratings and link changes in its importance to the business cycle: a rating agency builds up reputation in booms to milk it in recessions. Bouvard and Levy (2010) develop a model in which (endogenous) reputation is used by a rating agency to attract both firms and potential investors. While this dampens the importance of conflicts of interest, ratings manipulation still occurs in such model. In their case, it results from low effort choices in information production activities when a rating agency with a good reputation vis-à-vis investors wants to dissipate its reputation in order to attract business from firms. Manipulation of information also arises in Durbin and Iyer (2009) due to an advisor's concerns for appearing incorruptible. They discuss how to use bribes to restore truthful information transmission.[7]

Sangiorgi, Sokobin and Spatt (2009) and Skreta and Veldkamp (2009) present another mechanism to generate biased (or inflated) ratings. They use ratings shopping in models in which rating agencies always reveal information truthfully. In Skreta and Veldkamp (2009) the problem is worse for ratings of complex assets, i.e. assets whose

[7]On a related topic, Stolper (2009) focuses on the role of regulation to induce rating agencies to assign correct ratings.

payoffs are more uncertain.[8] Even though I do not directly model uncertainty in the model below, one can think of a situation in which public information is less informative about the rating, i.e. if it is weakly in favor of either a good or bad rating, as one in which "uncertainty" is greater. In such situation, ratings are less biased towards public information and are more likely to reflect the private signal. Interestingly, this contrasts to Skreta and Veldkamp (2009) intuition.

This paper also borrows from Ottaviani and Sorensen (2006a, 2006b, 2006c). They study the impact of career and reputational concerns on the reports of analysts and derive that they tend to conform to the prior belief, except in competition, when their reports are excessively differentiated due to private information. While these papers share some important features with mine, there are some crucial differences. In the model below, a rating agency always knows the quality of its private signal and, in order to resemble rating scales and emphasize the difference between investment and non-investment grade securities, the private signal and the rating are assumed to be binary rather then continuously distributed. Moreover, allowing for an asymmetry between a good and bad rating makes it possible to explore effects which are not in Ottaviani and Sorensen's papers. The possibility of conformism is also present in Prat (2005). In a career concerns model, increased disclosure about an agent's actions leads to conformism by which the agent ignores the private signal and mimics the behavior of an "able" agent. This produces worse outcomes in terms of information revelation and makes it harder to evaluate the agent's ability. This also happens in the model presented below precisely when there is less "uncertainty" about the rating, i.e. when the public prior becomes more informative (either in favor of a good or bad rating). In a related paper, Bar-Isaac (2011) endogenizes the quality of the private signal. He considers a situation in which an agent can exert effort to improve the quality of a signal about the

[8] In Sangiorgi, Sokobin and Spatt (2009) this happens when the heterogeneity among the valuations of different rating agencies is greatest.

outcome of a project. An agent has stronger incentives to generate information when there is more uncertainty about the outcome and this information can help him decide on the best course of action. This kind of mechanism could exacerbate incentives to conform as present in my model: The rating agency's incentives to exert effort would be dampened precisely when the public prior is more informative about the rating and therefore, when better private information is less useful ex-ante.

This paper is also related to the broader literature on herding on the actions or forecasts of others (e.g., Scharfstein and Stein, 1990, Trueman, 1994, Avery and Chevalier, 1999, Graham, 1999, Effinger and Polborn, 2001, for applied theory work; Welch, 2000, or Hong, Kubik and Solomon, 2000, for empirical work), and on the literature on the importance of reputation for underwriters (e.g., Chemmanur and Fulghieri, 1994).

On the empirical side, there is an increasing number of papers that look at rating agencies (e.g., Benmelech and Dlugosz, 2009a, 2009b, Ashcraft, Goldsmith and Vickery, 2009, Rajan, Seru and Vig, 2010). Many investigate the extent of rating agencies' contribution to the subprime crisis, but fail to identify *a single* reason behind ratings agencies' mistakes. This suggests that ratings-shopping, conflicts of interest and reputational concerns might all have played an important part in the decisions of rating agencies in the years preceding the crisis. Finally, there is also empirical evidence on how competition affects the informational content and accuracy of ratings. Doherty, Kartasheva, and Phillips (2009) analyze the optimal disclosure policy of rating agencies for different industry structures focusing on what differences in rating scales mean in terms of credit risk of firms. Cantor and Packer (1997) also look at the issue of differences in rating scales. Becker and Milbourn (2010) use Fitch's market share as a measure of competition faced by other rating agencies and find that competition leads to more issuer-friendly ratings.

The rest of the paper is organized as follows. Sections 2 describes the basic characteristics of the monopolistic model and section 3 contains the equilibrium analysis and comparative statics. Section 4 develops a more realistic scenario in which there is competition in the ratings industry and section 5 concludes.

2. The Benchmark Model: A Monopoly

In this economy there is a risk-neutral rating agency and time is divided in two dates: date 0 and date 1.[9]

2.1. The Project and Public Information

At date 0 there is an idea for a project which yields an operational cash-flow at date 1 that is positive if the project is good (G) or negative if the project is bad (B). The type of project is not known *ex-ante* but general conditions of the economy determine a common prior belief over it. Specifically, a project is good with probability θ and bad with probability $1-\theta$, with $\theta \in (0,1)$. This probability summarizes public information about the type of project. The institutional and legal regime establishes that a rating agency uses its technology to evaluate the project and generate a rating which is always made public.[10] The rating determines the cost of financing the project.

2.2. The Objective of the Rating Agency and Private Information

The rating agency chooses which rating to issue at date 0 so as to maximize reputation at date 1.[11] During this process, it obtains private information about the project which

[9]Rating agencies operate for longer periods but assuming two dates makes the analysis more tractable while still capturing the importance of reputation. Bolton, Freixas and Shapiro (2010) follow a similar simplifying assumption.

[10]In Mählmann (2008) a firm has discretion over the disclosure of credit ratings.

[11]In the version of the paper that circulated under the title "Do Reputational Concerns Lead to Reliable Ratings?" I solve for the problem of a rating agency that wants to maximize fees. I show that these fees increase with reputation. Because the algebra is quite complicated I present here a

takes the form of a private signal that can be of two types: s_G indicates that the project is good and s_B indicates that the project is bad. The quality of the private signal depends on the rating agency's ability, represented by a, which can be high (H) or low (L). An H rating agency obtains a precise private signal that reveals the type of project, while an L rating agency obtains a noisy private signal. The rating agency knows its own type but everyone else attaches a probability to the type of rating agency. The probability α_0 represents the subjective belief that a rating agency is of type H at date 0, with $\alpha_0 \in \left(\frac{1}{2}, 1\right)$, and α_1 is the updated belief at date 1. I refer to these probabilities as the rating agency's reputation.[12] An H rating agency always identifies the type of project which means that:

$$\Pr\left(s_G \mid G, H\right) = \Pr\left(s_B \mid B, H\right) = 1,$$

and

$$\Pr\left(s_G \mid B, H\right) = \Pr\left(s_B \mid G, H\right) = 0. \tag{1}$$

An L rating agency makes mistakes half of the times which means that:[13]

$$\Pr\left(s_G \mid G, L\right) = \Pr\left(s_B \mid B, L\right) = \frac{1}{2}$$

and

$$\Pr\left(s_G \mid B, L\right) = \Pr\left(s_B \mid G, L\right) = \frac{1}{2}. \tag{2}$$

simplified version whose qualitative results remain the same. Details are available on request.

[12]The fact that $\alpha_0 \in \left(\frac{1}{2}, 1\right)$ does not affect the results which can be generalized for any value of $\alpha_0 \in (0, 1)$. This assumption is only used to allow for an easier comparison with the results derived in Section 4.

[13]In Appendix A.1.2. I argue that the qualitative results of the model hold for a more general information structure.

There are two types of ratings: a good rating r_G and a bad rating r_B. A bad rating can be interpreted as a non-investment grade rating and a good rating can be interpreted as an investment grade rating. When deciding on the rating, the rating agency considers both the prior belief θ and the private signal, which it can choose to follow or contradict with the rating that it ultimately issues. In equilibrium, a rating agency with ability a issues a rating that contradicts the private signal with probabilities $\Pr(r_G \mid s_B, \theta, a)$ and $\Pr(r_B \mid s_G, \theta, a)$, respectively.

2.3. *Success of a Project and Ratings*

A rating is required to raise financing for the project. The operational cash-flow of the project, which is independent of the rating, is used to pay for the financing costs. A good rating decreases financing costs, while a bad rating increases them. As a result, when the rating is bad, even the operational cash-flow generated by a good project might be insufficient to cover for the financing costs and, as a consequence, the project is perceived as a failure.[14] This happens with probability β, i.e. β is the probability that a good project fails following a bad rating. The operational cash-flow generated by the bad project is negative which means that financing costs are never covered for and the project is equally perceived as a failure. The fact that a project succeeds (S) or fails (F) is observable, however, a good project that fails is indistinguishable from a bad project. Therefore, β gives the extent at which the type of project is verifiable following a bad rating. It is never verifiable if $\beta = 1$, and it is always verifiable if $\beta = 0$.[15]

I use this formulation to capture the importance of a good rating to a firm and the

[14] Manso (2011) presents a model in which ratings have a similar effect which he denotes as “feedback effect”: a rating is “self-fulfilling” as it determines the interest rate which affects the probability of survival of the borrower which, in turn, influences its credit quality. In an earlier paper, Boot, Milbourn and Schmeits (2006) also consider a model in which ratings have a real impact on firms’ choices and on outcomes.

[15] In Appendix C I also discuss what happens when a bad project succeeds following a good rating with probability β.

fact that, in reality, what matters to investors is whether they get their money back rather than the intrinsic quality of a project. It also captures an important feature of financial regulation. The manager of a firm whose debt has received a bad rating (non-investment grade) has a much harder time persuading investors to participate in the project and some investors might even be unable to do so due to regulatory constraints. In this sense, if $\beta = 1$ a good project always fails following a bad rating because either financing costs are too high or financing funds are unavailable and the project is not even undertaken. In the analysis that follows I explore two cases: $\beta > 0$ (for which there is an asymmetry between a good and bad rating) and $\beta = 0$ (for which there is symmetry between a good and bad rating). I highlight which results hold in each case.

2.4. Posterior Beliefs

The outcome of the project is publicly observable at date 1. At this point, the belief about the type of rating agency is updated by comparing this outcome to the rating. This posterior belief, which is generally represented by α_1, is equal to one of the following probabilities: $\alpha_1(r_G, S)$, $\alpha_1(r_B, F)$, $\alpha_1(r_G, F)$ or $\alpha_1(r_B, S)$. In particular, $\alpha_1(r_G, S)$ ($\alpha_1(r_G, F)$) represents the posterior belief that the rating agency is of type H given that it assigns a good rating to a project that succeeds (fails); and $\alpha_1(r_B, F)$ ($\alpha_1(r_B, S)$) represents the posterior belief that the rating agency is of type H given that it assigns a bad rating to a project that fails (succeeds). For a combination *(rating, outcome)* equal to (r_G, S) it is obvious that the rating agency correctly identified a good project, and for (r_G, F) and (r_B, S) that it incorrectly identified a bad and good project, respectively. However, in the case of (r_B, F) and $\beta \epsilon (0, 1]$ it is not possible to know if the rating agency correctly identified a bad project or incorrectly identified a good project which failed due to the rating.

Table 1 summarizes the notation. Some of these notation is introduced in the next

Table 1.: Summary of notation

θ	Prior probability of a G project, $\theta \in (0, 1)$
$s_G,\ s_B$	Good and bad private signal
r_G, r_B	Good and bad rating
a	Rating agency's ability, a=$\{H, L\}$
α_0, α_1	Probability of an H rating agency at dates 0 and 1 (represents reputation)
β	Probability that a G project fails following r_B
$\alpha_1(r_G, S)$ $(\alpha_1(r_G, F))$	Probability of an H rating agency when r_G is assigned to a project that succeeds (fails)
$\alpha_1(r_B, S)$ $(\alpha_1(r_B, F))$	Probability of an H rating agency when r_B is assigned to a project that succeeds (fails)
$\overline{\gamma}$	Probability of an L rating agency contradicting a bad private signal
$\underline{\gamma}$	Probability of an L rating agency contradicting a good private signal

section.

3. Equilibrium Analysis for the Monopoly Benchmark

This section characterizes the equilibrium in which a rating agency is rewarded for correct ratings and punished otherwise. In this sense, it consists of the optimal choices by the rating agency of contradicting the private signal at date 0 so as to maximize reputation at date 1.

At date 0, the rating agency obtains the private signal and chooses which rating to issue. If a rating agency with ability a and a good private signal issues the private signal as a rating it achieves $\alpha_1(r_G, S)$ at date 1 if the project succeeds, and $\alpha_1(r_G, F)$ otherwise. Its expected reputation is equal to:

$$\Pr(S \mid s_G, a)\, \alpha_1(r_G, S) + \Pr(F \mid s_G, a)\, \alpha_1(r_G, F)$$

where $\Pr(S \mid s_G, a) = \Pr(G \mid s_G, a)$ and $\Pr(F \mid s_G, a) = \Pr(B \mid s_G, a)$.[16] If the rating

[16]These probabilities also depend on the prior belief θ. This is ignored for simplicity, as far as

agency does not issue the private signal as a rating its expected reputation is equal to:

$$\Pr\left(S \mid s_G, a\right) \alpha_1 \left(r_B, S\right) + \Pr\left(F \mid s_G, a\right) \alpha_1 \left(r_B, F\right)$$

where $\Pr\left(S \mid s_G, a\right) = (1-\beta) . \Pr\left(G \mid s_G, a\right)$ and $\Pr\left(F \mid s_G, a\right) = \beta . \Pr\left(G \mid s_G, a\right) + \Pr\left(B \mid s_G, a\right)$. The rating agency issues the rating that generates the highest expected reputation. That is to say that in equilibrium, the sign of:

$$\begin{aligned} &\Pr\left(S \mid s_G, a\right) \alpha_1 \left(r_G, S\right) + \Pr\left(F \mid s_G, a\right) \alpha_1 \left(r_G, F\right) - \\ &\qquad \left(\Pr\left(S \mid s_G, a\right) \alpha_1 \left(r_B, S\right) + \Pr\left(F \mid s_G, a\right) \alpha_1 \left(r_B, F\right)\right), \end{aligned} \quad (3)$$

is positive (negative) when the rating agency follows (contradicts) the private signal and it is equal to zero when the rating agency is indifferent. In this case the equilibrium is in mixed strategies.

Likewise for the case of a bad private signal. In equilibrium, the sign of:

$$\begin{aligned} &\Pr\left(S \mid s_B, a\right) \alpha_1 \left(r_G, S\right) + \Pr\left(F \mid s_B, a\right) \alpha_1 \left(r_G, F\right) - \\ &\qquad \left(\Pr\left(S \mid s_B, a\right) \alpha_1 \left(r_B, S\right) + \Pr\left(F \mid s_B, a\right) \alpha_1 \left(r_B, F\right)\right), \end{aligned} \quad (4)$$

is negative (positive) when the rating agency follows (contradicts) the private signal and it is equal to zero when the rating agency is indifferent. The equilibrium probabilities that an L rating agency contradicts the private signal, i.e. $\Pr(r_G \mid s_B, \theta, L)$ and $\Pr(r_B \mid s_G, \theta, L)$, are denoted by $\overline{\gamma}$ and $\underline{\gamma}$ respectively. The results are summarized in Proposition 1 whose complete proof is relegated to Appendix A. Figure 1 represents some of the results graphically.

Proposition 1. *An H rating agency always issues the private signal as a rating. For*

notation is concerned.

the L rating agency there are $\underline{\theta}$ and $\overline{\theta}$, with $\underline{\theta} < \overline{\theta}$, such that: when $\theta \in \left[\overline{\theta}, 1\right)$ it always issues a good rating and when $\theta \in (0, \underline{\theta}]$ it always issues a bad rating. When $\theta \in \left(\underline{\theta}, \overline{\theta}\right)$, the rating agency behaves as follows: when the private signal is bad it issues a good rating with probability $0 < \overline{\gamma} < 1$ and a bad rating otherwise; and when the private signal is good it issues a bad rating with probability $0 < \underline{\gamma} < 1$ and a good rating otherwise. The difference between the equilibrium values of $\underline{\gamma}$ and $\overline{\gamma}$ is given by $\bar{\gamma} - \underline{\gamma} = 2\theta - 1 - \frac{\alpha_0}{1-\alpha_0} \frac{2(1-\theta)(1-2\theta+\theta\beta)}{1-\theta+\theta\beta}$. If $\alpha_0 > \frac{1+\beta}{1+2\beta}$, the threshold $\underline{\theta}$ exceeds $\frac{1}{2}$.

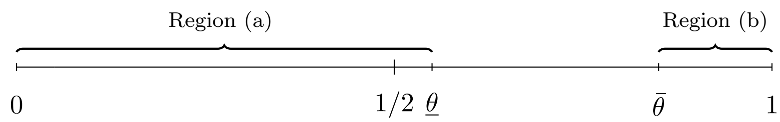

Figure 1.: Equilibrium behavior of the L rating agency as a function of θ when $\alpha_0 > \frac{1+\beta}{1+2\beta}$.

Region (a): The rating agency always issues r_B. Between $\underline{\theta}$ and $\bar{\theta}$: When the private signal is s_G it issues r_B with probability $\underline{\gamma}$ and r_G otherwise; when the private signal is s_B it issues r_G with probability $\overline{\gamma}$ and r_B otherwise. Region (b): The rating agency always issues r_G.

The starting point to prove Proposition 1 is to show that there cannot be an equilibrium in which an H rating agency contradicts the private signal. In addition, since a rating agency wants to maximize reputation, an L rating agency has incentives to mimic the behavior of an H rating agency. The rest of the proof follows easily from here.

The proposition states that when public information is strongly in favor of a good (bad) rating and the L rating agency's private information indicates that the project is bad (good), there are situations in which it chooses to issue a good (bad) rating. In this case, the rating agency *conforms* to the prior belief and ignores private information. This is because the L rating agency wants to pretend to have received a good (bad) private signal as this would have been very likely ex-ante, had it been of type H. This result is independent of the value of β. However, when $\frac{1}{2} < \theta < \underline{\theta}$ public information is weakly in favor of a good rating but there are situations in which an L rating agency chooses to ignore this even when its private information indicates that the project is good, and issues a bad rating. In this case, the rating agency is *cautious* and ignores all information. This happens when $\alpha_0 > \frac{1+\beta}{1+2\beta}$ and $\beta > 0$. If an L rating agency chooses to issue a good rating and this rating is correct, the rating agency manages to boost reputation. But if such rating is incorrect and the project fails, the rating agency's type is revealed. So the rating agency tries to hide its true type behind a bad rating which can also be shown to be incorrect (if the project succeeds) but which is more likely to generate a project that indeed fails because $\beta > 0$. In this way, the rating agency reputation is more likely to remain reasonably unscathed. This is particularly important first, when the reputation level at date 0, α_0, is high because this is when the opportunity cost of a mistake is higher; and second, when the probability β that a good project fails following a bad rating is high because this is when hiding the type behind a bad rating is more effective.

Comparative statics results are summarized in Proposition 2. The proof is in Appendix A.1.4.

Proposition 2. *In equilibrium,* $\overline{\gamma} - \underline{\gamma}$ *is: 1) increasing in the value of the prior belief* θ*; 2) decreasing in the probability that a good project fails following a bad rating,* β*; 3) decreasing in the reputation level at date 0,* α_0*, if* $\theta < \frac{1}{2-\beta}$ *and increasing otherwise.*

Point 1 states that more positive public information results in a higher (lower) probability of contradicting a bad (good) private signal. Point 2 specifies that as the outcome of the project becomes less likely to be verifiable following a bad rating, an L rating agency becomes less (more) likely to contradict a bad (good) private signal. Finally, point 3 indicates that as the reputation level at date 0, α_0, increases, an L rating agency becomes less (more) likely to contradict a bad (good) private signal when $\theta < \frac{1}{2-\beta}$, i.e. when public information is in favor of a bad rating.[17] An increase in the reputation

[17] And even in favor of a good rating if $\beta > 0$ because $\frac{1}{2-\beta} > \frac{1}{2}$ when $\beta \neq 0$.

level at date 0, α_0, increases the reputation level at date 1, α_1, regardless of the rating provided that it is correct.[18] If the rating is incorrect, reputation becomes zero because the rating agency is revealed as an L type. Hence, an increase in the reputation level at date 0, α_0, increases the reputational cost that a rating agency faces from issuing an incorrect rating and, as a consequence, the rating agency has more incentives to gamble on the rating that is ex-ante more likely to be correct. When the prior belief θ is low enough and/or the probability that a good project fails following a bad rating, β, is high enough, it is indeed the case that a bad rating is ex-ante more likely to be correct than a good rating, or at least less likely to be inconsistent with the outcome of the project. The opposite happens when $\theta > \frac{1}{2-\beta}$.

4. Competition

To make the model more realistic, and to highlight further effects, I introduce some degree of competition in the ratings industry. At present, competition is limited to the existence of a relatively small number of rating agencies and the advantages of increasing competition in the sector remain unclear. For this reason, it is important to explore how it affects information revelation when rating agencies worry about reputation.

Competition is modeled as follows. Consider the framework presented in section 2 and assume that the monopolistic rating agency, which is the incumbent rating agency and is henceforth denoted by i, faces competition from a group of identical rating agencies. Each rating agency that belongs to this group aims to enter the industry and is denoted by j. The private signal of a rating agency j is as described in Section 2.2. but its reputation level at date 0 is given by $\alpha_{0j} = \frac{1}{2}$; this is a new rating agency for which there is no information, hence the prior about its true type is uninformative. The

[18]This is straightforward from expressions (12)-(13).

subscripts j and j' are used to denote two rating agencies of this group whenever it is required to distinguish between them. Table 2 revises the notation.

The objective of rating agency i is to maximize reputation relative to the competitors. The idea is that being the most reputable in a pool of rating agencies confers *market power* to a rating agency, which increases with the reputation gap relative to the others in the pool. The objective of each rating agency j is to enter the industry and build up reputation to differentiate itself from the other rating agencies in the group.

Two distinct cases are considered. In the first case, denoted as *single rating case*, rating agency i is very well established in the industry which makes a rating issued by j worthless. In this case, rating agency i acts to maintain its market power and rating agencies j wait for an opportunity to enter the industry. This happens when rating agency i makes a mistake or its reputation level falls below that of the j-types. In the second case, denoted as *sequential ratings case*, one randomly selected rating agency j is given the opportunity to issue a second rating if rating agency i issues a bad first rating. It is reasonable to assume that the second rating has no effect on the probability of success of the project. This is because rating agency j is a newcomer which still needs to build up reputation, and therefore, whose rating should have little or no impact on financing costs. However, a good (even if second) rating might be valuable to attract a wider group of investors who would be unable to participate otherwise due to the regulatory constraints explained in Section 2.3. Empirical evidence by Bongaerts, Cremers and Goetzmann (2010) supports this story. They test three reasons for why already rated firms ask for an additional rating: information production, rating shopping and certification with respect to regulatory and rules-based constraints. Their evidence supports certification only. The additional rating matters for regulatory purposes and does not seem to provide significant information related to credit spreads.[19]

[19] The probability of success of a project remains as in Section 2.3 but the results derived below hold even if the second rating affects this probability moderately. For more details see footnote (32).

Table 2.: Revised notation for rating agency i

$s_{iG},\ s_{iB}$	Good and bad private signal
$r_{iG},\ r_{iB}$	Good and bad rating
$\alpha_{1i}(r_{iG}, S)$ $(\alpha_{1i}(r_{iG}, F))$	Probability of an H rating agency when it assigns r_G to a project that succeeds (fails)
$\alpha_{1i}(r_{iB}, S)$ $(\alpha_{1i}(r_{iB}, F))$	Probability of an H rating agency when it assigns r_B to a project that succeeds (fails)
$\overline{\gamma_i}$	Probability of an L rating agency contradicting a bad private signal
$\underline{\gamma_i}$	Probability of an L rating agency contradicting a good private signal
$\overline{\gamma_i^s}$	Probability of an L rating agency contradicting a bad private signal with sequential ratings
$\underline{\gamma_i^s}$	Probability of an L rating agency contradicting a good private signal with sequential ratings

4.1. Equilibrium Analysis: Single Rating Case

Rating agency i chooses which rating to issue at date 0 so as to maximize its market power defined as the difference between its reputation level at date 1 and that of competitors, $\alpha_{1i}(.,.) - \alpha_{0j}$. If $\alpha_{0j} = 0$ there is a monopoly and if $\alpha_{0j} = \alpha_{1i}(.,.)$ the rating agencies are identical and competition is maximized, in the sense that profits are minimized. If $\alpha_{1i}(.,.) < \alpha_{0j} = \frac{1}{2}$, rating agency i is the "worst" in the industry and is replaced by a rating agency j randomly selected out of the pool.[20] Intuitively, this formulation captures how the reputation of a rating agency increases the value of its ratings. One could think that, in a model in which rating agencies compete in fees (Bertrand competition), higher reputation relative to a competitor allows the rating agency to charge higher fees.[21]

The idea now is to examine how the results in Proposition 1 change with competition. It is shown in Appendix B.1. that the behavior of an H rating agency remains the same meaning that it always follows the private signal. Consequently, if rating agency i makes a mistake it is revealed as an L type and $\alpha_{1i}(r_{iB}, S) = \alpha_{1i}(r_{iG}, F) = 0$. This

[20] Note that this is a model in which rating agencies want to maximize reputation and there are no conflicts of interest or ratings shopping. The most reputable rating agency is also the industry "leader".

[21] In a working paper (and considerably longer) version of the paper that circulated under the title "Do Reputational Concerns Lead to Reliable Ratings?" I consider a duopoly with different reputation levels. The fees are derived endogenously and shown to increase with the reputation gap between the two rating agencies. The qualitative results are therefore as derived here.

is when it is replaced by a competitor j. Hence, for an L rating agency with a good private signal expression (3) becomes

$$\Pr\left(S \mid s_{iG}, L\right)\left(\alpha_{1i}\left(r_{iG}, S\right) - \alpha_{0j}\right) - \Xi \Pr\left(F \mid s_{iG}, L\right)\left(\alpha_{1i}\left(r_{iB}, F\right) - \alpha_{0j}\right) \tag{5}$$

and for an L rating agency with a bad private signal expression (4) becomes

$$\Pr\left(S \mid s_{iB}, L\right)\left(\alpha_{1i}\left(r_{iG}, S\right) - \alpha_{0j}\right) - \Xi \Pr\left(F \mid s_{iB}, L\right)\left(\alpha_{1i}\left(r_{iB}, F\right) - \alpha_{0j}\right), \tag{6}$$

where $\Xi = 1$ if $\alpha_{1i}\left(r_{iB}, F\right) > \alpha_{0j}$ and $\Xi = 0$ otherwise.[22] The choices of the rating agency are summarized in Proposition 3 which is proven in Appendix B.1.

Proposition 3. *An H rating agency i always issues the private signal as a rating. An L rating agency i issues good ratings more often than in a monopoly when $\theta < \frac{1}{2-\beta}$ and less often when $\theta > \frac{1}{2-\beta}$.*

Note that the penalty for a mistake is as in a monopoly (reputation becomes zero) whereas the reward for being correct is smaller. Hence, an L rating agency becomes *aggressive* and contradicts the prior belief more often than in an monopoly regardless of the private signal. In doing so, a correct rating prompts larger increases in reputation given that it is more likely to result from a perfect private signal. This happens even when $\beta = 0$. The comparative statics results for $\underline{\gamma_{i1}}$ and $\overline{\gamma_{i1}}$ yield similar results to the monopoly case.

It is interesting to compare this to the behavior of a rating agency that chooses to issue the most accurate ratings. An H rating agency issues the private signal as a rating.

[22] There is no indicator function in the first term because, in this case, there is no doubt that the rating agency correctly identified the project and $\alpha_{1i}\left(r_{iG}, S\right) > \alpha_{0j}$. This is straightforward from the expressions and applies also to a rating agency j.

An L rating agency with a good private signal issues a good rating if $Pr\left(G|\, s_G\right) > Pr\left(B|\, s_G\right)$, i.e. when $\theta > \frac{1}{2}$, and a bad rating otherwise. An L rating agency with a bad private signal issues a good rating if $Pr\left(G|\, s_B\right) > Pr\left(B|\, s_B\right)$, i.e. when $\theta > \frac{1}{2}$, and a bad rating otherwise. This is already quite different from what an L monopolist does according to Proposition 1 and Figure 1. With competition, the accuracy of ratings deteriorates even further as the L rating agency actually contradicts public information regardless of the private signal.

When $\beta = 1$ an L rating agency always issues good ratings more often than in monopoly. In this case, a bad rating always causes a failure and it is impossible to distinguish if the project was indeed bad or if it failed due to the rating. Hence, to be able to come across as an H rating agency and to increase its reputation relative to the competitors, an L rating agency gambles on being correct by issuing good ratings.

In the *single rating case* a rating agency i always competes with a rating agency j with reputation equal to $\frac{1}{2}$. This is because rating agency j never gets a chance to issue a rating unless rating agency i makes a mistake and is driven out of the industry. If rating agency j also issues a rating at date 0, rating agency i needs to consider how j's reputation evolves between dates 0 and 1. This is the *sequential ratings case* discussed in the next section.

4.2. Equilibrium Analysis: Sequential Ratings Case

4.2.1. The Problem of Rating Agency j

One randomly selected rating agency j issues a second rating at date 0 following a bad first rating from rating agency i. The market power of this rating agency j is defined as the difference between its reputation level at date 1 and that of any rating agency j' which remains in the pool, $\alpha_{1j}\left(.,.\right) - \alpha_{0j'}$. An H rating agency ($i$ or j) always follows the private signal (shown in Appendix B.2.1.). Consequently, a bad rating to a project that succeeds means, as in a monopoly and in the *single rating case*, that j is an L rating agency and $\alpha_{1j}(r_{jB}, S) = 0$ but a good rating to a project that fails no longer means that $\alpha_{1j}(r_{jG}, F) = 0$. This is because a bad first rating could have caused a good project to fail. Given this, expressions (4) and (3) for an L rating agency become:

$$Pr(S \mid s_{jB}, r_{iB,}L)(\alpha_{1j}(r_{jG}, S) - \alpha_{j'0}) + \Pi_G Pr(F \mid s_{jB}, r_{iB}, L)(\alpha_{1j}(r_{jG}, F) - \alpha_{j'0}) - \Pi_B Pr(F \mid s_{jB}, r_{iB}, L)(\alpha_{1j}(r_{jB}, F) - \alpha_{j'0}) \quad (7)$$

$$Pr(S \mid s_{jG}, r_{iB}, L)(\alpha_{1j}(r_{jG}, S) - \alpha_{j'0}) + \Pi_G Pr(F \mid s_{jG}, r_{iB}, L)(\alpha_{1j}(r_{jG}, F) - \alpha_{j'0}) - \Pi_B Pr(F \mid s_{jG}, r_{iB}, L)(\alpha_{1j}(r_{jB}, F) - \alpha_{j'0}). \quad (8)$$

where $\Pi_G = 1$ if $\alpha_{1j}(r_{jG}, F) > \alpha_{j'0}$ and $\Pi_G = 0$ otherwise. Likewise for Π_B.

4.2.2. The Problem of Rating Agency i

The market power of rating agency i differs as follows in relation to the *single rating case*. Following a bad first rating, rating agency j can either contradict it (and issue r_{jG}) or agree with it (and issue r_{jB}). When it correctly contradicts the first rating, rating agency i is revealed as an L type and is out of the industry. When it incorrectly contradicts the first rating, rating agency i competes with j if $\alpha_{1j}(r_{jG}, F) > \alpha_{j'0}$ or with *j'* otherwise. Its market power becomes $\alpha_{1i}(r_{iB}, F) - max\{\alpha_{1j}(r_{jG}, F), \alpha_{j'0}\}$. Likewise for when rating agency j correctly agrees with the first rating. The market power of rating agency i becomes $\alpha_{1i}(r_{iB}, F) - max\{\alpha_{1j}(r_{jB}, F), \alpha_{j'0}\}$. Then, expressions (5) and (6) become:

$$\Pr\left(S\mid s_{iG},a\right)\left(\alpha_{1i}\left(r_{iG},S\right)-\alpha_{0j}\right)-\Pr\left(F\mid s_{iG},a\right)\left[Pr\left(r_{jB}\right)\Upsilon_{B}\left(\alpha_{1i}\left(r_{iB},F\right)-\right.\right.$$
$$\left.\left.max\left\{\alpha_{1j}\left(r_{jB},F\right),\alpha_{j'0}\right\}\right)+Pr\left(r_{jG}\right)\Upsilon_{G}\left(\alpha_{1i}\left(r_{iB},F\right)-max\left\{\alpha_{1j}\left(r_{jG},F\right),\alpha_{j'0}\right\}\right)\right] \quad (9)$$

$$\Pr\left(S\mid s_{iB},a\right)\left(\alpha_{1i}\left(r_{iG},S\right)-\alpha_{0j}\right)-\Pr\left(F\mid s_{iB},a\right)\left[Pr\left(r_{jB}\right)\Upsilon_{B}\left(\alpha_{1i}\left(r_{iB},F\right)-\right.\right.$$
$$\left.\left.max\left\{\alpha_{1j}\left(r_{jB},F\right),\alpha_{j'0}\right\}\right)+Pr\left(r_{jG}\right)\Upsilon_{G}\left(\alpha_{1i}\left(r_{iB},F\right)-max\left\{\alpha_{1j}\left(r_{jG},F\right),\alpha_{j'0}\right\}\right)\right], \quad (10)$$

where $\Upsilon_B = 1$ if $\alpha_{1i}\left(r_{iB},F\right) > max\left\{\alpha_{1j}\left(r_{jB},F\right),\alpha_{j'0}\right\}$ and $\Upsilon_B = 0$ otherwise. Likewise for Υ_G. Note that $\alpha_{0j} = \alpha_{j'0}$. From looking at the previous expressions, it is clear that the reward for a correct good rating does not change relative to the *single rating case*, whereas the reward for a correct (or unverifiable) bad rating is likely to decrease. This anticipates the equilibrium results which are presented in the next section.

4.2.3. Equilibrium Results

Appendix B.2. derives the results established in Proposition 4.

Proposition 4. *(1) An H rating agency i (j) always issues the private signal as a rating. (2) An L rating agency i issues good ratings more often than in the single rating case. This means that* $\overline{\gamma_i^s} - \underline{\gamma_i^s} > \overline{\gamma_i} - \underline{\gamma_i}$. *(3) An L rating agency j behaves as follows: when the private signal is bad, it issues a good rating with probability* $0 \leq \overline{\gamma_j} < 1$ *and a bad rating otherwise; and when the private signal is good, it issues a bad rating with probability* $0 < \underline{\gamma_j} \leq 1$ *and a good rating otherwise.*

For rating agency i, this is an extension of the *single rating case* in which a bad rating has an extra disadvantage: it gives rating agency j an opportunity to issue a rating and start building up reputation if the rating is correct. This can threaten the s*tatus quo* of an L rating agency i. Hence, its incentives to issue a good rating in order to deny the competitor this opportunity increase. This happens even if $\beta = 0$.

When given the opportunity to issue a rating, an L rating agency j considers two effects. On the one hand, contradicting the first rating and issuing a good rating increases reputation if this rating is correct. Even if incorrect, there is no way to check whether the project was in fact good but failed due to the bad first rating when $\beta > 0$. On the other hand, a bad first rating provides an additional signal to the rating agency and increases the probability of failure of a good project when $\beta > 0$. Rating agency j balances these effects and ends up following a mixed strategy in most cases. It can herd on the first rating and issue a bad rating when the prior belief θ is sufficiently low (public information is strongly in favor of a bad rating) and/or the reputation level of rating agency i at date 0, α_0, is sufficiently high (the first rating is likely to be correct).[23]

Corollary 1. *Rating agency j can herd on the first rating when the prior belief θ is sufficiently low and/or the reputation level of rating agency i at date 0, α_0, is sufficiently high.*

As far as accuracy of ratings is concerned, it worsens with respect to the monopolistic case as rating agency i issues good ratings more often, regardless of public *and* private information. This is in line with the empirical results by Becker and Milbourn (2010), which show how an incumbent rating agency reacts to increased competition: ratings levels go up, the correlation between ratings and yields fall, and the ability of ratings to predict default deteriorates. This result also suggests that ratings inflation can occur despite of reputational concerns whenever a rating agency wants to prevent a competitor

[23] Hyytinen and Pajarinen (2008) study how disagreements in ratings are stronger in situations of higher informational opacity in particular, for young firms. This results are in line with the theoretical predictions of the corollary. It makes sense to think of the prior belief θ of a young firm as uninformative and therefore somewhere around $\frac{1}{2}$. In this case herding is less likely to occur.

from building up reputation.

Finally, it would be interesting to see how the equilibrium value of $\overline{\gamma_i^s} - \underline{\gamma_i^s}$ affects $\overline{\gamma_j} - \underline{\gamma_j}$ when the equilibrium is in mixed strategies. The relationship is shown to be negative and is stated in Corollary 2.

Corollary 2. *For a given $\overline{\gamma_i^s} - \underline{\gamma_i^s}$, rating agency j is less (more) likely to contradict a bad (good) private signal when rating agency i is more likely to contradict a bad private signal. A rating agency j is more (less) likely to contradict a bad (good) private signal when rating agency i is more likely to contradict a good private signal.*

Take the situation in which an L rating agency i is very likely to contradict a bad private signal and consequently, it is ex-ante very likely to issue a good rating. Then, when a bad rating is issued it is more likely that rating agency i is of type H. Contradicting this rating is risky hence, an L rating agency j is less (more) likely to contradict a bad (good) signal and issues a bad rating more often. Take the situation in which an L rating agency i is very likely to contradict a good private signal and consequently, it is ex-ante very likely to issue a bad rating. Then, when a bad rating is indeed issued it is very likely that rating agency i is of type L. Contradicting this rating is relatively safe hence, an L rating agency j is more (less) likely to contradict a bad (good) signal and issues a good rating more often.

5. Conclusions

This paper looks at the incentives of rating agencies to reveal information about their client firms, in a framework in which they use public and private information about these firms, and aim to maximize reputation. It shows how the quality of the private information and the structure of the ratings industry shapes the behavior of rating agencies. Precise private information is always incorporated in ratings which improves their accuracy. Noisy private information is mostly ignored by a monopolistic rating agency which tends to conform to public information. However, in a competitive ratings industry in which an incumbent rating agency wants to protect its market power, public and private information are used to gamble on being correct and increasing reputation. In such setup, reputational concerns do not guarantee the most accurate ratings possible. Rating agencies start contradicting public information regardless of private information because if they are lucky and issue the correct ratings, the market associates this to precise private information. Competition also forces an incumbent rating agency to issue good ratings more often than in a monopoly to deny competitors the possibility to issue a second rating and the chance to build up reputation.

The model clearly illustrates how reputation and a competitive ratings industry do not ensure accurate ratings if the quality of a rating agency's private information is low (noisy) even in the absence of conflicts of interest. However, accurate ratings are always obtained if the quality of private information is high (precise) regardless of how the ratings industry is organized. An implication that arises from comparing the behavior of the two types of rating agency is that an important way to generate more accurate ratings may be to promote better mechanisms for gathering and processing information. Related to this topic, the papers by Bar-Isaac and Shapiro (2010) and Bar-Isaac (2011) discussed above show that new problems emerge when the quality of the private information of an agent becomes a decision variable, which indicates that this topic provides an interesting avenue for future research.

A. Appendix

A.1. *Proof of Propositions 1 and 2*

This Appendix characterizes the unique equilibrium in which a rating agency is rewarded for correct ratings and punished otherwise.[24] In such equilibrium, the following happens: $\alpha_1(r_G, S) > \alpha_1(r_G, F)$ and $\alpha_1(r_B, F) > \alpha_1(r_B, S)$. Define $\tau \in \{H_G, H_B, L_G, L_B\}$ as the set of possible types, where H and L indicate the rating agency's type, and G and B indicate the private signal, e.g. H_G is an H rating agency with a good private signal. The set of possible actions is binary: issue a good rating (r_G) or issue a bad rating (r_B). The proof is divided in two main steps: first, to show that in equilibrium an H rating agency must issue the private signal as a rating and second, to derive the equilibrium behavior of an L rating agency.[25]

A.1.1. *Rating Agency's Posterior Beliefs about the Type of Project*

The rating agency forms the posterior belief about the type of project using the prior belief θ and expressions (1) or (2). Hence:

$$\Pr(G \mid s_G, H) = 1,\ \Pr(G \mid s_B, H) = 0 \textit{ and } \Pr(G \mid s_G, L) = \Pr(G \mid s_B, L) = \theta. \quad (11)$$

A.1.2. *Auxiliary Lemmas*

[24] Other equilibria may exist but are difficult to interpret in the context of the paper.
[25] This is as in Boot, Milbourn and Thakor (2005).

Lemma 1. *An H rating agency has less incentives to contradict the private signal than an L rating agency.*

This is the intuition. From expression (11), the H rating agency is always certain about the type of project, whereas the L rating agency is always unsure. Hence, contradicting the private signal means a mistake for sure to H and a mistake with a positive probability to L. As a consequence, H has less incentives to contradict the private signal than L. Mathematically, one can write expressions (3) and (4) for both types of rating agency, and use (11) and the fact that $\alpha_1(r_G, S) > \alpha_1(r_B, S)$ and $\alpha_1(r_B, F) > \alpha_1(r_G, F)$. For example, if H_G is indifferent between issuing r_G and r_B expression (3) becomes $\alpha_1(r_G, S) = (1-\beta)\,\alpha_1(r_B, S) + \beta\alpha(r_B, F)$. In this case, L_G has less incentives to issue r_G because $\theta\alpha_1(r_G, S) + (1-\theta)\,\alpha_1(r_G, F) < \alpha_1(r_G, S)$, and more incentives to issue r_B because $(1-\beta)\,\theta\alpha_1(r_B, S) + (\beta\theta + 1 - \theta)\,\alpha_1(r_B, F) > (1-\beta)\,\alpha_1(r_B, S) + \beta\alpha_1(r_B, F)$. This means that it prefers to issue r_B. The same reasoning applies to the case of H_B and L_B.

Lemma 2. *Whenever an L_G (L_B) rating agency contradicts the private signal, an L_B (L_G) rating agency follows the private signal. Likewise for an H rating agency. Moreover, whenever an L_G (L_B) rating agency is indifferent between contradicting and following the private signal, so is an L_B (L_G) rating agency.*

This essentially means that the L rating agencies make similar rating choices. Depending on the private signal, an L rating agency uses expressions (3) or (4) to decide on the rating. Using expression (11), $\Pr(S \mid s_G, L) = \Pr(S \mid s_B, L) = \theta$ and $\Pr(F \mid s_G, L) = \Pr(F \mid s_B, L) = 1 - \theta$ if the rating is good, and $\Pr(S \mid s_G, L) = \Pr(S \mid s_B, L) = (1-\beta)\,\theta$ and $\Pr(F \mid s_G, a) = \Pr(F \mid s_B, a) = \beta\theta + 1 - \theta$ if the rating is bad. Therefore, expressions (3) and (4) are equal. For the H rating agencies it is also straightforward to show that if expression (3) is negative (or equal to zero), then (4) is negative (and if (4) is positive (or equal to zero), then (3) is positive).

Lemma 3. *There cannot be an equilibrium in which an H rating agency contradicts the private signal.*

This is shown by contradiction. Assume that in equilibrium an H_G rating agency issues r_B with positive probability. In this case, an L and H_B rating agencies issue r_B (for sure) by Lemmas 1 and 2. But then an H_G rating agency prefers to issue r_G to reveal its type and maximize reputation. The same reasoning applies if an H_B rating agency issues r_G with positive probability. The only equilibrium that arises is derived below. Note that these Lemmas are likely to hold for a more general information structure: Lemma 1 only requires that the H rating agency is more certain about the type of project than the L rating agency; Lemma 2 holds as long as an L rating agency makes mistakes at most half of the times; Lemma 3 just follows.[26] Hence, the main qualitative results of the model are robust to some changes in the model setup.

A.1.3. Posterior Beliefs about the Rating Agency's Type

Reputation evolves between dates 0 and 1 according to how the rating compares to the outcome of the project. By Lemma 2, an L_G rating agency contradicts a good private signal with probability $\underline{\gamma}$ and an L_B rating agency contradicts a bad private signal with probability $\overline{\gamma}$. By Lemma 3, an H rating agency follows the private signal. Hence, if the rating agency issues r_B its reputation at date 1 equals one of the following expressions:

$$\alpha_1 \left(r_B, F\right) = \frac{\alpha_0 \left(1-\theta\right)}{\alpha_0 \left(1-\theta\right) + \left(1-\alpha_0\right) \frac{1}{2} \left(1-\theta+\theta\beta\right) \left(1-\overline{\gamma}+\underline{\gamma}\right)} \quad or \quad \alpha_1 \left(r_B, S\right) = 0. \tag{12}$$

Several situations explain (r_B, F): with probability $\alpha_0 \left(1-\theta\right)$ the H rating agency correctly identifies the project (which is bad with probability 1-θ if it fails), with probability

[26] In this case Lemma 2 should read: "Whenever an L_G (L_B) rating agency contradicts the private signal or is indifferent between contradicting and following the private signal, an L_B (L_G) rating agency follows the private signal. Likewise for an H rating agency."

$(1-\alpha_0)\frac{1}{2}(1-\theta+\theta\beta)(1-\overline{\gamma})$ the L_B rating agency follows the private signal and is either correct or incorrect and a good project fails due to the rating, and with probability $(1-\alpha_0)\frac{1}{2}(1-\theta+\theta\beta)\underline{\gamma}$ the L_G rating agency contradicts the private signal and is either incorrect or correct and a good project fails due to the rating. And if the rating agency issues r_G its reputation at date 1 equals one of the following expressions:

$$\alpha_1(r_G, S) = \frac{\alpha_0}{\alpha_0 + (1-\alpha_0)\frac{1}{2}\left(1-\underline{\gamma}+\overline{\gamma}\right)} \quad or \quad \alpha_1(r_G, F) = 0. \tag{13}$$

Several situations explain (r_G, S): with probability α_0 the H rating agency correctly identifies the project (which is good for sure if it succeeds), with probability $(1-\alpha_0)\frac{1}{2}\overline{\gamma}$ the L_B rating agency incorrectly contradicts the private signal, and with probability $(1-\alpha_0)\frac{1}{2}\left(1-\underline{\gamma}\right)$ the L_G rating agency correctly follows the private signal.

A.1.4. The Equilibrium Behavior of an L Rating Agency

An L rating agency uses expression (4) (or (3)) to choose the rating, which using (11), (12) and (13) looks as follows:

$$\theta\frac{\alpha_0}{\alpha_0 + (1-\alpha_0)\frac{1}{2}\left(1-\underline{\gamma}+\overline{\gamma}\right)} - (\theta\beta+1-\theta)\frac{\alpha_0(1-\theta)}{\alpha_0(1-\theta)+(1-\alpha_0)\frac{1}{2}(1-\theta+\theta\beta)\left(1-\overline{\gamma}+\underline{\gamma}\right)} \tag{14}$$

It is straightforward to show that (14) is strictly decreasing in $\overline{\gamma}-\underline{\gamma}$ and strictly increasing in θ. When $\theta \to 1$, the expression is positive which means that issuing r_G is preferable and $\overline{\gamma}=1$ and $\underline{\gamma}=0$. This is the equilibrium when $\theta > \frac{1}{1-\beta+\alpha_0}$. When $\theta \to 0$, the expression is negative which means that issuing r_B is preferable and $\overline{\gamma}=0$ and $\underline{\gamma}=1$. When $\theta=\frac{1}{2}$, it can be shown that $\overline{\gamma}=1$ and $\underline{\gamma}=0$ is not an equilibrium because the expression is negative. But $\overline{\gamma}=0$ and $\underline{\gamma}=1$ can be the equilibrium if $\alpha_0 > \frac{1+\beta}{1+2\beta}$. Otherwise, there are two thresholds, $\underline{\theta}$ and $\overline{\theta}$ such that when $\theta \in \left(\underline{\theta}, \overline{\theta}\right)$ the equilibrium is in mixed strategies. The difference between the equilibrium values of $\overline{\gamma}$ and $\underline{\gamma}$ is given by:

$$\overline{\gamma} - \underline{\gamma} = 2\theta - 1 - \frac{\alpha_0}{1-\alpha_0} \frac{2(1-\theta)(1-2\theta+\theta\beta)}{1-\theta+\theta\beta}.$$

It is straightforward to show that $\frac{d(\overline{\gamma}-\underline{\gamma})}{d\theta} > 0$[27] and $\frac{d(\overline{\gamma}-\underline{\gamma})}{d\beta} < 0$, but $\frac{d(\overline{\gamma}-\underline{\gamma})}{d\alpha_0} = -\frac{2(1-\theta)(1-2\theta+\theta\beta)}{(1-\alpha_0)^2(1-\theta+\theta\beta)}$ which is positive if $\theta > \frac{1}{2-\beta}$ and negative otherwise.

A.1.5. The Region Between $\underline{\theta}$ and $\overline{\theta}$

Take $\theta = \overline{\theta}$ defined above as the equilibrium value of θ for which $\overline{\gamma} = 1$ and $\underline{\gamma} = 0$ and expression (14) is positive. And take $\theta = \underline{\theta}$ defined above as the equilibrium value of θ for which $\overline{\gamma} = 0$ and $\underline{\gamma} = 1$ and expression (14) is negative. When substituting the $\overline{\gamma}$'s and $\underline{\gamma}$'s in the expression, the latter exceeds the former if $\underline{\theta} = \overline{\theta}$ which is impossible. Given that the expression is increasing in θ this requires that $\underline{\theta} < \overline{\theta}$. Hence, there is a region $\theta \in \left(\underline{\theta}, \overline{\theta}\right)$ for which the equilibrium is in mixed strategies.

B. Appendix

B.1. Proof of Proposition 3

The posterior beliefs about the type of project remain the same, hence Lemmas 1-3 still hold and the posterior beliefs in section A.1.3 remain unchanged with $\alpha_{1i}(r_{iG}, F) = \alpha_{1i}(r_{iB}, S) = 0 < \frac{1}{2}$. Consequently, when $\Xi = 1$, an L rating agency chooses the rating

[27] This can also be shown by implicit differentiation of expression (14): $\frac{d(\overline{\gamma}-\underline{\gamma})}{d\theta} = -\frac{\frac{\partial(14)}{\partial\theta}}{\frac{\partial(14)}{\partial(\overline{\gamma}-\underline{\gamma})}}$.

looking at (6) (or (5)) which becomes:

$$\theta\left(\frac{\alpha_0}{\alpha_0+(1-\alpha_0)\frac{1}{2}\left(1-\underline{\gamma_i}+\overline{\gamma_i}\right)}-\frac{1}{2}\right)-(\theta\beta+1-\theta)\times$$
$$\left(\frac{\alpha_0(1-\theta)}{\alpha_0(1-\theta)+(1-\alpha_0)\frac{1}{2}(\theta\beta+(1-\theta))\left(1-\overline{\gamma_i}+\underline{\gamma_i}\right)}-\frac{1}{2}\right). \quad (15)$$

The expression varies with $\overline{\gamma_i}-\underline{\gamma_i}$ and θ as its counterpart in (14). However, expression (15) differs from (14) by the term $\frac{1}{2}(\theta\beta+1-2\theta)$. If this term is positive the incentives to issue r_G for a given θ increase, and in equilibrium $\overline{\gamma_i}-\underline{\gamma_i}>\overline{\gamma}-\underline{\gamma}$. This happens when $\theta<\frac{1}{2-\beta}$. The opposite happens when $\theta>\frac{1}{2-\beta}$. When $\beta=1$, $\frac{1}{2}(\theta\beta+1-2\theta)>0$ and in equilibrium $\overline{\gamma_i}-\underline{\gamma_i}>\overline{\gamma}-\underline{\gamma}$. It can also be shown by implicit differentiation that the signs of the derivatives of $\overline{\gamma_i}-\underline{\gamma_i}$ with respect to θ and α_0 remain unchanged.

Also note that, in equilibrium, $\alpha_{1i}(r_{iG},S)>\frac{1}{2}$ (this happens because $\alpha_0>\frac{1}{2}$) and $\alpha_{1i}(r_{iB},F)>\frac{1}{2}$, which means that $\Xi=0$ never occurs. If $\alpha_{1i}(r_{iB},F)<\frac{1}{2}$, rating agency i is replaced by a rating agency j every time it issues r_{iB} and the expression simplifies to $\theta\left(\frac{\alpha_0}{\alpha_0+(1-\alpha_0)\frac{1}{2}\left(1-\underline{\gamma_i}+\overline{\gamma_i}\right)}-\frac{1}{2}\right)$. In this case, $\overline{\gamma_i}=0$ and $\underline{\gamma_i}=1$ cannot be an equilibrium because the expression is positive which means that issuing r_G is always preferable. But $\overline{\gamma_i}=1$ and $\underline{\gamma_i}=0$ cannot be an equilibrium either because when substituting these values in $\alpha_{1i}(r_{iB},F)$, it turns out that it always exceeds $\frac{1}{2}$, which is a contradiction.[28]

[28]Intuitively, it means that every time r_{iB} is issued it is clear that the rating agency is of type H.

B.2. Proof of Proposition 4

B.2.1. Rating Agency j*: Posterior Beliefs about the Type of Project and the Rating Agency's Type*

This is the problem of rating agency j taking the values of $\underline{\gamma_i^s}$ and $\overline{\gamma_i^s}$ as given. Rating agency j knows that rating agency i behaves according to Lemmas 1-3 because i's posterior beliefs about the type of project remain as in (11). The posterior beliefs about the type of project for rating agency j are different from those derived in Appendix A.1.1. and can be written as follows:

$$
\begin{aligned}
Pr\left(G \mid s_{jB}, r_{iB}, H\right) = Pr\left(B \mid s_{jG}, r_{iB}, H\right) &= 0, \\
Pr\left(B \mid s_{jB}, r_{iB}, H\right) = Pr\left(G \mid s_{jG}, r_{iB}, H\right) &= 1, \\
Pr\left(G \mid s_{jB}, r_{iB}, L\right) = Pr\left(G \mid s_{jG}, r_{iB}, L\right) &= \frac{\Psi_{nc}\theta}{\Psi_{nc}\theta + \Psi_c\left(1-\theta\right)}, \\
Pr\left(B \mid s_{jB}, r_{iB}, L\right) = Pr\left(B \mid s_{jG}, r_{iB}, L\right) &= \frac{\Psi_c\left(1-\theta\right)}{\Psi_{nc}\theta + \Psi_c\left(1-\theta\right)}.
\end{aligned}
$$

where Ψ_{nc} is the probability of rating r_{iB} given that the project is good, and Ψ_c is the probability of rating r_{iB} given that the project is bad, both from the point of view of an L rating agency j. These probabilities are $\Psi_{nc} = \left(1-\alpha_0\right)\frac{1}{2}\left(1-\overline{\gamma_i^s}+\underline{\gamma_i^s}\right)$ and $\Psi_c = \alpha_0 + \left(1-\alpha_0\right)\frac{1}{2}\left(1-\overline{\gamma_i^s}+\underline{\gamma_i^s}\right)$. Define $\Phi\left(r_{iB}\right) = 1-\overline{\gamma_i^s}+\underline{\gamma_i^s}$. Given this, it is trivial to show that Lemmas 1-3 also apply to rating agency j. Lemma 1 still holds because the signal of an H rating agency remains a better predictor of the project outcome than the signal of an L rating agency. Lemma 2 still holds because L_B and L_G choose the rating to issue based on (7) and (8) which are shown to be equal as in Appendix A.1.2. Given this, Lemma 3 follows.

The posterior belief about the rating agency type $\alpha_{1j}(r_{jG},S)$ is as derived in Appendix A.1.3. evaluated for $\alpha_0=\frac{1}{2}$, $\alpha_{1j}(r_{jB},F)=\frac{(1-\theta)}{(1-\theta)+\frac{1}{2}(1-\theta+\theta\beta\Psi_{nc})\left(1-\overline{\gamma_j}+\underline{\gamma_j}\right)}$ and $\alpha_{1j}(r_{jB},S)=0$.[29] Finally, $\alpha_{1j}(r_{jG},F)=\frac{\Psi_{nc}\theta\beta}{\Psi_{nc}\theta\beta+\frac{1}{2}(1-\theta+\Psi_{nc}\theta\beta)\left(1-\underline{\gamma_j}+\overline{\gamma_j}\right)}$ which is not equal to zero as rating agency j can be of type H if a failure is caused by the (first) rating r_{iB} issued to a good project by an L rating agency i.

B.2.2. The Equilibrium Behavior of Rating Agency j

An L rating agency chooses the rating by looking at (7) (or (8)), which for $\Pi_G=0$, $\Pi_B=1$, $Pr(S\mid s_{jB},r_{iB,}a)=(1-\beta)Pr(G\mid s_{jB},r_{iB,}a)$ and $Pr(F\mid s_{jB},r_{iB,}a)=\beta Pr(G\mid s_{jB},r_{iB,}a)+Pr(B\mid s_{jB},r_{iB,}a)$ become:[30]

$$
\begin{aligned}
&(1-\beta)\Psi_{nc}\theta\left(\frac{1}{1+\frac{1}{2}\left(1-\underline{\gamma_j}+\overline{\gamma_j}\right)}-\frac{1}{2}\right)-\\
&(\beta\Psi_{nc}\theta+\Psi_c(1-\theta))\left(\frac{(1-\theta)}{(1-\theta)+\frac{1}{2}\left(1-\theta+\theta\beta(1-\alpha_0)\frac{1}{2}\Phi(r_{iB})\right)\left(1-\overline{\gamma_j}+\underline{\gamma_j}\right)}-\frac{1}{2}\right)
\end{aligned}
\tag{16}
$$

The expression is decreasing in $\overline{\gamma_j}-\underline{\gamma_j}$ and increasing in θ. When $\theta\to 0$, it is negative which means that issuing r_B is preferable and $\overline{\gamma}=0$ and $\underline{\gamma}=1$. When $\theta\to 1$, it is positive but $\overline{\gamma_j}=1$ and $\underline{\gamma_j}=0$ cannot be an equilibrium because the expression is negative for these values of γ_j. For high levels of θ the possible equilibria are in mixed strategies. Moreover, there is no equilibrium for which $\Pi_B=0$ because $\alpha_{1j}(r_{jB},F)>\frac{1}{2}$. If $\alpha_{1j}(r_{jB},F)<\frac{1}{2}$, the expression is positive which means that issuing r_G is always preferable. However, not only $\overline{\gamma_j}=1$ and $\underline{\gamma_j}=0$ has already been ruled out as an equilibrium, but also $\alpha_{1j}(r_{jB},F)$ would exceed $\frac{1}{2}$ in this case, which is a contradiction.

[29] Bear in mind that a bad rating r_{iB} issued by rating agency i (the most reputable agency) is enough to generate a failure with probability β.

[30] The denominators of the probabilities of success and failure cancel out and are therefore ignored.

In addition, note that $\frac{\partial\left(\overline{\gamma_j}-\underline{\gamma_j}\right)}{\partial\left(\overline{\gamma_i^s}-\underline{\gamma_i^s}\right)}<0$. Since $\frac{d\Psi_{nc}}{d\left(\overline{\gamma_i^s}-\underline{\gamma_i^s}\right)}=\frac{d\Psi_{c}}{d\left(\overline{\gamma_i^s}-\underline{\gamma_i^s}\right)}=-\frac{1}{2}\left(1-\alpha_0\right)<0$ and $\frac{d\alpha_{1j}\left(r_{jB},F\right)}{d\left(\overline{\gamma_i^s}-\underline{\gamma_i^s}\right)}=\frac{\theta\beta(1-\alpha_0)\frac{1}{4}\left(1-\overline{\gamma_j}+\underline{\gamma_j}\right)}{\left(1-\theta+\frac{1}{2}\left((1-\theta)+\theta\beta(1-\alpha_0)\frac{1}{2}\Phi(r_{iB})\right)\left(1-\overline{\gamma_j}+\underline{\gamma_j}\right)\right)^2}>0$, the derivative of expression (16) with respect to $\overline{\gamma_i^s}-\underline{\gamma_i^s}$ is equal to:

$$-(1-\beta)\frac{1}{2}\left(1-\alpha_0\right)\theta\left(\alpha_{1j}\left(r_{jG},S\right)-\frac{1}{2}\right)-\left(\left(1-\beta\right)\Psi_{nc}\theta+\Psi_c\left(1-\theta\right)\right)\left(\frac{d\alpha_{1j}\left(r_{jB},F\right)}{d\left(\overline{\gamma_i^s}-\underline{\gamma_i^s}\right)}\right)$$
$$+\frac{1}{2}\left(1-\alpha_0\right)\left(1-\theta+\theta\beta\right)\left(\alpha_{1j}\left(r_{jB},F\right)-\frac{1}{2}\right)<0.$$

This is negative because for a mixed strategies equilibrium, expression (16) is equal to zero which implies that:

$$(1-\beta)\frac{1}{2}\left(1-\alpha_0\right)\theta\left(\alpha_{1j}\left(r_{jG},S\right)-\frac{1}{2}\right)>\frac{1}{2}\left(1-\alpha_0\right)\left(1-\theta+\theta\beta\right)\left(\alpha_{1j}\left(r_{jB},F\right)-\frac{1}{2}\right).$$

To sum up, the derivatives of expression (16) with respect to $\overline{\gamma_i^s}-\underline{\gamma_i^s}$ and $\overline{\gamma_j}-\underline{\gamma_j}$ are negative and by implicit differentiation $\frac{\partial\left(\overline{\gamma_j}-\underline{\gamma_j}\right)}{\partial\left(\overline{\gamma_i^s}-\underline{\gamma_i^s}\right)}<0$.

B.2.3. The Equilibrium Behavior of Rating Agency i

An L rating agency i chooses the rating by looking at (10) (or (9)). From the comparison with expression (15), it is clear that the incentives to issue r_{iG} are now higher than in the *single rating case* even if $\Upsilon_G=1$ and $\Upsilon_B=1$. From the problem of rating agency j, $Pr\left(r_{jB}\right)>0$[31] and $max\left\{\alpha_{1j}\left(r_{jB},F\right),\frac{1}{2}\right\}>1/2$ in equilibrium. Hence, the reward for a correct (or unverifiable) bad rating issued by i decreases for sure in equilibrium even if $max\left\{\alpha_{1j}\left(r_{jG},F\right),\frac{1}{2}\right\}=1/2$. This means that in equilibrium $\overline{\gamma_i^s}-\underline{\gamma_i^s}>\overline{\gamma_i}-\underline{\gamma_i}$.[32]

[31] An L rating agency either issues a bad rating or plays a mixed strategy.

[32] If the second rating affects the probability of success of a project, β increases if the second rating is bad and decreases if the second rating is good. In this case, $\alpha_{1i}\left(r_{iB},F\right)$ depends on the second rating that is issued but provided that the changes in β are moderate in both directions there is no reason for the "average" value of $\alpha_{1i}\left(r_{iB},F\right)$ to deviate much from the value used above. Since the second

B.2.4. When $\Pi_G = 1$

There is an extra term in expression (16) equal to $(\beta\Psi_{nc}\theta + \Psi_c(1-\theta))\left(\alpha_{1j}(r_{jG}, F) - \frac{1}{2}\right)$. Everything else constant, this increases the incentives of rating agency j to issue a good rating, but it can be easily shown that an equilibrium in which $\overline{\gamma_j} = 1$ and $\underline{\gamma_j} = 0$ is still ruled out because, as when $\Pi_G = 0$, the expression is negative for these values of γ_j. Note that $\frac{\partial\left(\overline{\gamma_j} - \underline{\gamma_j}\right)}{\partial\left(\overline{\gamma_i^s} - \underline{\gamma_i^s}\right)} < 0$ as when $\Pi_G = 0$ because $\frac{d\alpha_{1j}\left(r_{jG}, F\right)}{d\left(\overline{\gamma_i^s} - \underline{\gamma_i^s}\right)} < 0$.

C. Symmetry between a Good and Bad Rating

If a bad project succeeds following a good rating with probability β, $\Pr(S \mid ., a) = \Pr(G \mid ., a) + \beta \Pr(B \mid ., a)$ and $\Pr(F \mid ., a) = (1-\beta)\Pr(B \mid ., a)$ regardless of the private signal if the rating is good and expression (13) becomes:

$$\alpha_1(r_G, S) = \frac{\alpha_0\theta}{\alpha_0\theta + (1-\alpha_0)\frac{1}{2}(\theta + (1-\theta)\beta)\left(1 - \underline{\gamma} + \overline{\gamma}\right)} \quad or \quad \alpha_1(r_G, F) = 0.$$

Everything else remains the same. In a monopoly it can be easily shown that the results only differ relative to Appendix A.1.4. because $\overline{\gamma} = 0$ and $\underline{\gamma} = 1$ can no longer be an equilibrium when $\theta = \frac{1}{2}$. Instead, the equilibrium is in mixed strategies. In the *single rating case*, the new expression (15) differs from the new (14) (both calculated with the new probabilities, $\alpha_1(r_G, S)$ and $\alpha_1(r_G, F)$ as derived in this Appendix) by the term $\frac{1}{2}(1-\beta)(1-2\theta)$. In equilibrium $\overline{\gamma_i} - \underline{\gamma_i} > (<)\, \overline{\gamma} - \underline{\gamma}$ only if $\theta < (>)\, \frac{1}{2}$ and the rating agency still chooses to contradict the prior belief more often than in a monopoly. In the *sequential ratings case*, the new expression (10) can be compared to the new (15) and the incentives to issue r_{iG} in order to deny the competitor the possibility to build up

rating agency needs to build up reputation it is reasonable to assume that this is the case.

reputation remain higher than in the *single rating case*, as explained in Section 4.2.3.

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