Credit Rating Catering

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September 12, 2016

Abstract

I show that competition can be harmful between credit rating agencies even when investors are rational and issuers disclose all their ratings. In my model, agencies cannot commit to ratings which truthfully reveal their independent private signals, but face penalties if a project with a good rating defaults. A monopolist agency can manipulate its ratings only by disregarding its own signals. In a duopoly, agencies can selectively manipulate the ratings of projects which obtain better preliminary assessments from the other agency. As the penalty for selective manipulation is smaller in expectation, there is often more manipulation in a duopoly. Thus, competition may lead to reduced welfare despite the additional information brought by the second agency. My model also sheds light on why competition is especially harmful in the structured debt segment.

"...a Chase investment banker complained that a transaction would receive a significantly lower rating than the same product was slated to receive from another rating agency: "There's going to be a three notch difference when we print the deal if it goes out as is. I'm already having agita about the investor calls I'm going to get." Upon conferring with a colleague, the Moody's manager informed the banker that Moody's was able to make some changes after all: "I spoke to Osmin earlier and confirmed that Jason is looking into some adjustments to his [Moody's] methodology that should be a benefit to you folks."" Wall Street and the Financial Crisis: Anatomy of a Financial Collapse. U.S. Senate (2011)

1 Introduction

The rise and fall of structured finance products shook the credit ratings industry. Rating innovative structured products was a lucrative business: just within a decade it became the principal source of profit for the big rating agencies.[1] However, the collapse of housing and the widespread downgrades of structured products cast a suspicion on the ratings that agencies assigned in the first place. Thus, the performance of credit rating agencies (CRAs) and the role of the ratings industry became a widely debated topic among academics, regulators and the general investing public, leading to U.S. Senate hearings and investigations by the

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[1] Since Moody's is a listed company it is the most transparent. While its revenues from the structured segment were similar to revenues from rating corporates in 2000, by 2005 the structured segment was twice the size of corporates, even though corporate ratings revenue increased by almost 50% during the period. Also, a former S&P employee stated that "revenues grew tenfold between 1995 and 2005 and rating volumes grew five or six fold" in the residential mortgage segment (Raiter, 2010).

Department of Justice.[2] Much of the discussion is organized around a puzzle: how come the oligopolistic market structure of rating agencies failed to correctly assess risks in the structured segment, but seems to operate without systemic flaws in the corporate segment?

I analyze a model in which credit rating agencies cannot commit to truthfully reveal their information, but it is costly for them if a project carrying their high rating defaults. The model is derived for a monopolist agency and also for a duopoly of agencies, which allows the comparison of equilibrium outcomes across market structures. Agencies in a duopoly may learn about each other's information during the rating process, which leads to strategic interactions. While a monopolist can only manipulate ratings by disregarding its own information, agencies in a duopoly may selectively manipulate those ratings that the other agency is more optimistic about. As a result, there is generally more manipulation in a duopoly, which implies that competition may lead to reduced welfare despite the additional information brought by the second agency. My model also sheds light on why competition is especially harmful in the structured debt segment.

The paper presents an analytically tractable static game, which describes how monopolist and duopolist rating agencies assign ratings to issuers seeking favorable ratings for their respective projects. The rating process consists of two stages. It begins with agencies assigning preliminary ratings to issuers based on their own information technology, that generates a noisy signal for each project. Importantly, agencies learn the preliminary ratings assigned by the other agency. Then, in the second stage of the rating process, agencies assign offered ratings to issuers, which may be better than the respective preliminary rating initially assigned. In turn, issuers decide whether to pay a rating fee for the agencies to disclose their offered ratings. This two stage process provides agencies with two opportunities to manipulate ratings. First, they can manipulate preliminary ratings by misreporting their signals to issuers. This can be done by randomly assigning better than justified preliminary ratings. I label this kind of manipulation as rating *inflation.* Second, as agencies learn about issuers' preliminary ratings assigned by the other agency they can also selectively assign better offered ratings. Following Griffin et al. (2013) I refer to this method of manipulation as rating *catering.* The quote above illustrates the mechanism of rating catering. Naturally, a monopolist agency is only able to inflate ratings, as it cannot condition manipulation on another agency's preliminary ratings, while agencies in a duopoly may both inflate and cater ratings.

The first insight is that generally there will be more manipulation in a duopoly than in a monopoly because the expected cost for catering is lower than the expected cost of inflation. Agencies have an incentive to manipulate ratings because issuers only pay the rating fee if they acquire a high rating. However, agencies incur an exogenously set default cost whenever a project carrying their respective good rating defaults. Agencies find it optimal to manipulate the ratings of those projects first that are less likely to default in order to minimize the expected default cost. Since catering conditions manipulation on a second signal that suggests a high rating, catered projects are less likely to default than inflated ones. Hence, the more sophisticated method of manipulation decreases the expected default cost and makes it more difficult for agencies in a duopoly to commit to ratings which truthfully reveal their signals.

Inflating and catering ratings always reduces welfare. Ex ante a randomly chosen project

[2] In 2015 S&P reached a settlement agreement of $1.4 billion with the U.S. Justice Department, several states and a pension fund over dispute of inflating its subprime-mortgage ratings. Also, its executives admitted that business relationships affected modeling updates. As of early 2016, Moody's is still under investigation by the Justice Department.

has negative net present value (NPV) due to adverse selection, implying that it should not be financed. In turn, if an agency's signal suggests that a project should not be financed then that project has to be worse than a randomly chosen one in expectation and inflating its rating would reduce the total NPV of financed projects. Also, if agencies in a duopoly have contradicting signals about a project's type then that project's expected default probability will be identical to the prior default probability. This follows from the assumption that signals are unbiased. The precision of a signal suggesting that a project will default or succeed is identical, therefore, contradicting signals will imply that the posterior probability of default is equal to the prior probability. Since catering enables the financing of projects with contradicting signals, catering has the same negative effect on welfare as financing a randomly chosen project.

As the main contribution, I show that competition may lead to reduced welfare despite the additional information brought by the second agency. A monopoly will lead to higher welfare than a duopoly if the monopolist can commit to convey more information than can agencies in a duopoly, combined. This will be the case if the agency's expected cost of inflation is significantly larger than the expected cost for catering. The expected cost is always proportional to the conditional default probability of the project who's rating is manipulated. Hence, when a monopolist is confident that its pessimistic assessment will lead to a default it will be reluctant to disregard it. To the contrary, catering only requires agencies in a duopoly to disregard contradicting signals. In turn, if the ex ante default probability is low, agencies in a duopoly will have a strong incentive to cater, which may lead to lower welfare than could be achieved by a monopolist.

My model sheds light on why competition may have been especially harmful in the structured segment.[3] The goal of issuers in the structured segment was to design assets that receive AAA ratings from agencies, which certifies that their default risk is sufficiently low.[4] The model suggests that when the rated asset's ex ante default probability is low, there is likely to be much more catering in a duopoly than inflation in a monopoly. Hence, competition is more harmful when it comes to low risk assets and since in the structured segment issuers' goal was to design and market low risk assets, competition could have contributed significantly to loose rating standards in the structured segment due to catering.

Additionally, I show that the merger of two agencies is socially undesirable if the total information available to agencies is the same before and after the merger. Holding information constant makes it possible to isolate the effect of market structure. After the merger the agency is able to charge a higher rating fee. Since issuers only pay the rating fee in equilibrium if the rating is high, the higher fee makes it more attractive to the agency to manipulate ratings. This will lead to an equilibrium with higher rates of catering and inflation after the merger.

The equilibrium derived for a duopoly of agencies matches stylized facts documented by the empirical literature. First, issuers find it optimal to purchase ratings from both agencies in equilibrium. This holds for the corporate segment, where both S&P and Moody's cover virtually the whole sector. Also, in the structured segment Griffin et al. (2013) reports that about 85% of AAA rated capital was rated by the two largest agencies. Second, the model predicts that as commitment problems worsen, agencies in a duopoly will first cater ratings.

[3] There is also evidence that competition reduces rating standards in the corporate segment as well (Becker and Milbourn, 2011), however, the widespread downgrades that took place in the structured segment during the subprime crisis was unprecedented (Griffin and Tang, 2012).

[4] Coval et al. (2009) report that about 60 percent of all structured products were AAA-rated globally. To the contrary, in the corporate segment only 1 percent of the issues had AAA-ratings.

This is in line with the evidence provided by Griffin et al. (2013), who analyze the structured segment and find that agencies will cater for selected issuers by improving their model implied ratings when issuers obtained better model implied ratings from the competing agency. Also, catered projects default with higher probability ex post in the model, which is consistent with catered ratings experiencing larger subsequent downgrades (Griffin and Tang, 2012). Third, as agencies increase manipulation with competition, rating standards may deteriorate. This is in line with the evidence presented by Becker and Milbourn (2011), who show that the entrance of Fitch in the corporate segment led to less informative ratings.

1.1 Related literature

To the best of my knowledge, this is the first paper to model information flows between credit rating agencies during the rating process. I show that as incentive problems arise, agencies first cater ratings by selectively improving the ratings of issuers who managed to obtain better assessments from the other agency. As incentive problems turn from bad to worse agencies start to inflate preliminary assessments. As a main contribution I show that adding another agency with conditionally independent information may lead to lower efficiency.

A group of papers argue that competition might lead to inflated ratings and reduced efficiency through rating shopping. The presence of naive investors (Bolton et al. 2012; Skreta and Veldkamp 2009), asset complexity (Skreta and Veldkamp, 2009) and the inability of investors to observe undisclosed contacts between issuers and agencies (Sangiorgi and Spatt, 2015) all allow issuers to hide bad ratings from investors, which reduces welfare. Compared to these papers I show that even if both ratings are disclosed to rational investors, a duopoly may still lead to lower efficiency due to catering.[5]

In this paper the only purpose of ratings is to convey information between issuers and investors in order to overcome adverse selection. However, the use of ratings may be justified by other reasons. If ratings are widespread referred to in regulations, ratings may be used by investors for regulatory arbitrage (Opp et al., 2013) or result in institutions behaving like naive/trusting investors (Bolton et al., 2012). It has also been pointed out by the recent theoretical literature that credit ratings may provide a coordination mechanism. Multiple equilibria may exist if issuers can choose the riskiness of their projects (Boot et al., 2006) or when to default (Manso, 2013) and ratings may help in equilibrium selection.

The predictions of the model relates to predictions derived from models of reputational concerns. Strausz (2005) explores the conditions under which reputational concerns are powerful enough to prevent certifiers from "capture". Capture happens when certifiers accept bribes in exchange for certifying product quality. However, capture in his model is an out-of-equilibrium event, more suited to explain large scandals, while in the model presented below, catering and rating inflation occur in equilibrium and can be better reconciled with the deterioration of general rating standards. Bar-Isaac and Shapiro (2013) focus on reputational concerns along the business cycle and find that ratings quality is countercyclical. Mathis et al. (2009) find that agencies maintain a good reputation as long as their income is sufficiently diversified. While my model is static, I also find that manipulation is more likely

[5] Models of reputational concerns provide mixed results on the welfare implications of competition. Competition between agencies may be welfare reducing due to the decreased value of reputation (Bouvard and Levy 2013; Camanho et al. 2012). On the other hand, competition may have a disciplining effect on agencies, either because they hope to capture future monopolistic rents (Bar-Isaac and Shapiro, 2013) or because of the threat of entry (Frenkel, 2015). However, if markets trust the incumbent agency, competent potential entrants may fail to enter in the first place (Jeon and Lovo, 2011).

to occur when fundamentals (e.g. average default probability) are favorable and when low default costs prevent the agencies from committing to truthful disclosure.

Taking a broader perspective, the model belongs to the literature analyzing certification intermediaries. The seminal model introduced by Lizzeri (1999) allows certifiers to choose and commit among general disclosure rules. While he shows that competition leads to honest disclosure I explore how two agencies, absent of commitment, free ride on each other's information in order to minimize the costs associated with rating manipulation.

For a more extensive review of the recent theoretical literature see Jeon and Lovo (2013). The remainder of the paper is organized as follows. The next section will present the model and the equilibrium in a monopoly and a duopoly. Section 3 compares the efficiency of a monopoly with a duopoly. Section 4 discusses empirical implications and compares them to empirical findings. The final section concludes.

2 The Model

There are a unit mass of issuers indexed by j who have access to risky projects. Projects can be either of good type ($\theta_j = g$) or of bad type ($\theta_j = b$). Good projects never default, while bad projects always default. The net present value (NPV) of a good (bad) project is $V_g = R - 1$ ($V_b = -1$), where projects return $R > 1$ in case of no default and each project requires an initial investment of 1 unit of capital. The share of issuers with good projects is denoted by π_g, implying that the average project has value of $\bar{V} = \pi_g V_g + (1 - \pi_g) V_b = \pi_g R - 1$.

Assumption 1 (Average project has negative NPV)

$$\bar{V} < 0 \iff \pi_g < 1/R$$

It is assumed that the average NPV of projects is negative, implying that without rating agencies the market would break down due to adverse selection.

Issuers do not know their projects' type and have an outside option of 0. Though issuers may learn about their project during the rating process, they cannot credibly convey what they learn to investors. Hence, learning during the rating process does not affect their outside option.[6]

Rating agencies indexed by $i \in \{1, 2\}$ have access to rating technologies that produce signals about projects, $s_{ij} \in \{a, b\}$ with properties

$$Pr(s_{ij} = a|\theta_j = g) = Pr(s_{ij} = b|\theta_j = b) = 1 - \alpha, \quad \alpha \in \left[0, \frac{1}{2}\right]$$

where $\alpha = 0$ implies a perfectly informative technology and $\alpha = 1/2$ means that the signal is uninformative. The errors produced by the rating technologies are assumed to be independent across technologies.[7]

[6] Alternatively, one can assume that issuers know their projects' type. This would imply that issuers can condition their strategies on their type. However, while this complicates derivations it does not result in significant insights, which follows from the fact that bad issuers have a strong incentive to mimic the behavior of good issuers. Having 0 outside option greatly simplifies derivations. However, it is somewhat restrictive, as it reduces the bargaining power of those issuers who learn that their project is good.

[7] I.e. $Pr(s_{1j} = b, s_{2j} = b|\theta_j = g) = \alpha^2$

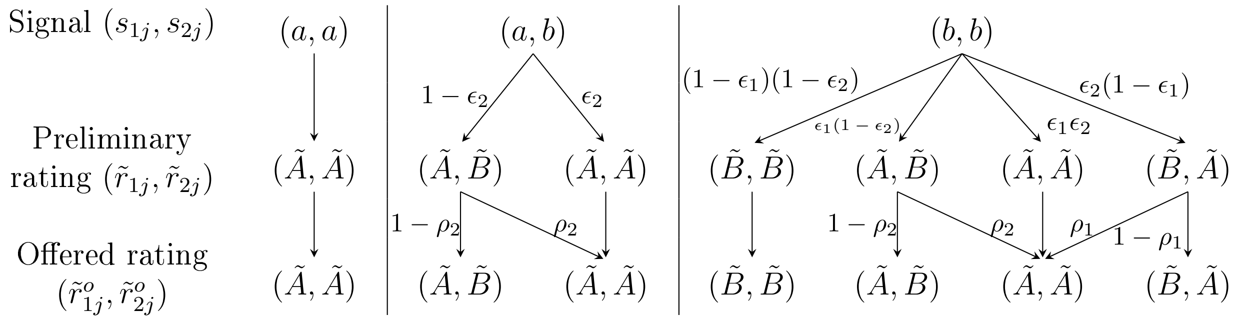


Figure 1: The rating process given signals. The figure illustrates how signals are transformed into offered ratings during the rating process when agencies inflate preliminary ratings with ϵ_i and cater offered ratings with ρ_i. Note that receiving (b, a) signals is not shown as it is symmetric to the (a, b) case.

Agencies set fees, f_i, which only have to be paid by issuers if they choose to disclose their respective offered ratings and are set privately and contracted at the beginning of the rating process.[8]

Once fees are set, as a first step of the rating process, rating agencies transform the signals produced by the rating technology into preliminary ratings, $\tilde{r}_{ij} \in \{\tilde{A}, \tilde{B}\}$. Agencies are allowed to *inflate* preliminary ratings with inflation probability ϵ_i, which is a standard assumption in the literature, but they always convey a good signal honestly, by assigning an $\tilde{A}$ preliminary rating to the respective issuers:[9]

$$\epsilon_i = Pr(\tilde{r}_{ij} = \tilde{A} | s_{ij} = b), \quad Pr(\tilde{r}_{ij} = \tilde{A} | s_{ij} = a) = 1$$

After preliminary ratings are assigned, agencies learn the preliminary ratings assigned by the other agency. If the other agency assigned an $\tilde{A}$ preliminary rating then an agency may *cater* for these issuers by improving their *offered* ratings, $r^o_{ij} \in \{\tilde{A}, \tilde{B}\}$. As before, agencies cannot assign a worse offered rating than their assigned preliminary rating:

$$\rho_i = Pr(r^o_{ij} = \tilde{A} | \tilde{r}_{ij} = \tilde{B}, \tilde{r}_{-ij} = \tilde{A}), \quad Pr(r^o_{ij} = \tilde{A} | \tilde{r}_{ij} = \tilde{A}) = 1.$$

otherwise $r^o_{ij} = \tilde{r}_{ij}$.

Figure 1 summarizes the rating process. Note that once projects receive an a signal or an $\tilde{A}$ preliminary rating they will always be assigned an $\tilde{A}$ offered rating from the respective agency. This follows from the fact that agencies cannot deflate ratings during the rating process.[10] Second, a project with two bad signals can only be offered an $\tilde{A}$ rating if at least one agency chooses to inflate its preliminary rating. Hence, without inflation, catering only affects projects with mixed signals.

Given offered ratings and fees, issuers choose the ones (if any) they want to purchase and disclose to the public. Issuers have four pure strategies (over which they may implement mixed strategies), namely, purchase agency 1's rating, purchase agency 2's rating, purchase

[8]This is in line with industry standards and the theoretical literature. Also, Bizzotto (2015) analyzes the fee structure decision of a rating agency and finds that in equilibrium an agency only asks for a fee if the rated project is sold and does not ask for an upfront fee.

[9]See Bolton et al. (2012) or Opp et al. (2013).

[10]In the current setup this is not restrictive as agencies have all the bargaining power (they set the rating fee by making a take it or leave it offer). Hence, by deflating ratings, agencies could not corner issuers any further.

both and purchase none. Formally, the strategy of issuers is represented with a function $D(r_1^o, r_2^o, f_1, f_2) \to [0,1]^4$, where the 4 outputs are the probabilities assigned to the respective pure strategies.[11]

Observed ratings are $r_{ij} \in \{A, B, \emptyset\}$, where $\emptyset$ stands for undisclosed, implying that the given agency-issuer offered rating was not disclosed. Investors observe ratings and bid for the projects, given its rating(s). Investors only condition their bids on project ratings, implying that they cannot make inference from the distribution of ratings.[12]

Finally, defaults are costly for rating agencies. Whenever a sold project with an A rating defaults, agents learn that the respective project was bad (as only bad projects default) and the respective agency made a potentially intentional error. Hence, the respective agency endures a *default cost* of c. One can think of many interpretations of the default cost. I will assume for simplicity that it is a direct monetary cost imposed by a regulator (see footnote 2 for such an example).

The default cost has a key role in the model. It helps agencies overcome their basic commitment problem. As investors cannot verify the amount of rating manipulation, agencies cannot commit to disclosure rules. Instead, the default cost will help commitment, as investors understand that agencies will have to pay the default cost if they assign A ratings to bad projects.

All players (issuers, rating agencies and investors) are assumed to be risk neutral. Here is a summary of the game:

1. Agencies $i = 1, 2$ and issuers sign contracts, setting fees, f_i.
2. Agencies receive the signals s_{ij} about issuers and produce preliminary ratings $\tilde{r}_{ij}$ with inflation ϵ_i.
3. Agencies produce offered ratings r_{ij}^o with catering ρ_i.
4. Issuers decide whether to pay the fees to the agencies for disclosing their offered ratings to the public.
5. Investors bid for the projects, given their respective ratings.
6. Project cash flows become realized, default costs are paid by agencies.

Below I state the Perfect Bayesian Equilibrium of the game.

Definition 1 (Equilibrium) *1. Issuers optimally choose which offered ratings to purchase (if any), given fees (f_i) and beliefs of investors.*

2. Rating agencies optimally set fees and manipulation levels (ϵ_i, ρ_i), given issuers' ratings purchase strategies, investors' beliefs and fees and manipulation levels set by the other rating agency.

3. Investors' beliefs about success probabilities are correct for all rating combinations. Hence, by bidding competitively for projects, they break even in expectation.

[11] E.g. $D() = \{0, 0, 1, 0\}$ corresponds to "purchase both", while $D() = \{0.5, 0.5, 0, 0\}$ means "with 50% purchase agency 1's rating and with 50% purchase agency 2's rating"

[12] In the current setup there is no aggregate uncertainty, as all players know the share of good projects. If investors could learn from the distribution of ratings then they could perfectly infer the amount of rating manipulation, which is unrealistic. Learning from the distribution would be a reasonable assumption if combined with aggregate uncertainty. However, these would unnecessarily complicate the model. While they would affect the amount of manipulation they are orthogonal to the methods of manipulation, which is my main focus here.

I will look for a symmetric equilibrium, where players with the same information act the same way.

2.1 Monopoly

Let $\mu_{s_{1j}s_{2j}}$ denote the mass of projects that received signals s_{1j} and s_{2j}, respectively.[13] Since there is a unit mass of issuers and the two signals partition projects into four groups,

$$\mu_{aa} + \mu_{ab} + \mu_{ba} + \mu_{bb} = 1$$

will hold. This implies for example that μ_{aa} can be interpreted as the unconditional probability of obtaining a signals from both rating technologies. The monopolist only observes the first signals, s_{1j}, hence, it cannot distinguish projects based on s_{2j}.[14]

Define $p_A(\epsilon)$ (p_B) as the conditional probability that a project is good, given that it received an A (B) rating from the monopolist agency, who is inflating ratings with ϵ:

$$p_A(\epsilon) = Pr(\theta_j = g | r_{1j} = A, \epsilon) = \frac{\pi_g(1-\alpha+\alpha\epsilon)}{\mu_{aa}+\mu_{ab}+\epsilon(\mu_{ba}+\mu_{bb})}, \; p_B = Pr(\theta_j = g | r_{1j} = B) = \frac{\pi_g \alpha}{\mu_{ba}+\mu_{bb}}$$

Observe, that inflating ratings does not affect p_B, as the composition of projects with B offered ratings is unchanged by randomly inflating them.

Investors cannot verify the amount of rating inflation, which prevents the rating agency from committing to any given level of inflation. Let $\hat{p}_{r_{1j}}$ be investors' belief about the conditional success probability of project j with an $r_{1j} \in \{A, B, \emptyset\}$ rating. Then, investors' willingness to pay for a project with an A rating is $\hat{p}_A R - 1$, implying that issuers are only going to purchase an A rating if

$$f_1 \leq \hat{p}_A R - 1, \tag{1}$$

otherwise issuers could not recover the rating fee, f_1, from selling the project for $\hat{p}_A R - 1$ to investors.

Since the monopolist is proposing a take-it-or-leave-it fee, it will always set $f_1 = \hat{p}_A R - 1$, hence, equation (1) will hold with equality in equilibrium.

In order to formulate the rating agency's problem, one needs to find the optimal rating purchase strategy of issuers. This is straightforward. Issuers never want to purchase a B rating, since it reveals the worst possible information at a cost. Also, they always want to purchase an A rating, whenever (1) holds, which implies that they will be able to recover the rating fee from selling the project.

The problem of the rating agency is to find the inflation level, ϵ^*, which maximizes its profit, given that only A-rated issuers pay the fee:

$$\epsilon^* = \arg\max_{\epsilon} [\mu_{aa} + \mu_{ab} + \epsilon(\mu_{ba} + \mu_{bb})][\hat{p}_A R - 1 - c(1 - p_A(\epsilon))], \tag{2}$$

where the first bracket is the mass of issuers offered an A rating, $\hat{p}_A R - 1$ is the equilibrium fee and $c(1 - p_A(\epsilon))$ is the expected default cost per A-rated project. Note that investors'

[13] I.e. $\mu_{aa} = \pi_g(1-\alpha)^2 + (1-\pi_g)\alpha^2$, $\mu_{ab} = \mu_{ba} = \alpha(1-\alpha)$, $\mu_{bb} = \pi_g \alpha^2 + (1-\pi_g)(1-\alpha)^2$.

[14] In the Welfare section I will consider the case when a monopolist has access to both signals in order to keep the amount of information constant across market structures.

beliefs ($\hat{p}_A$) enter the profit function and the agency cannot influence these beliefs. This is a result of its commitment problem.

Inflating ratings has two effects. First, it increases the mass of issuers who will purchase the respective A rating. This clearly increases revenues. However, higher inflation also increases the likelihood that the default cost will be incurred (the success probability, $p_A(\epsilon)$, is strictly decreasing in inflation, ϵ). This decreases expected profits.

It follows from (2) that the default cost helps the agency overcome its commitment problem. Intuitively, there will be a range of default costs when the agency's lack of commitment will result in rating inflation. If the default cost is sufficiently high then investors will know that the agency has no interest in inflating ratings. Finally, if the default cost was *too* high, then the agency would be better off without providing ratings. This latter case is ruled out by the following assumption.

Assumption 2

$$p_A(0)R - 1 \geq (1 - p_A(0))c.$$

Assumption 2 says that if the agency does not inflate ratings ($\epsilon = 0$) then an A-rated project's expected NPV ($p_A(0)R - 1$) must be at least as large as its expected default cost $(1 - p_A(0))c$. This is likely to hold when the rating technology is sufficiently precise ($p_A(0)$ is close to 1) and the default cost (c) is sufficiently low. In principal, with a better rating technology the agency can afford to operate with a higher default cost, as its signal will commit fewer errors.

It is clear that if Assumption 2 is violated, then agency profits in (2) will always be negative for any rational beliefs about the conditional success probability of financed projects. Observe, that rationality requires $\hat{p}_A \leq p_A(0)$, that is, when investors are most optimistic about A-rated projects, their belief has to be consistent with zero inflation.

It is instructive to decompose the profit function into issuers with different signals:

$$\epsilon^* = \arg\max_{\epsilon}(\mu_{aa} + \mu_{ab})[\hat{p}_A R - 1 - c(1 - p_A(0))] + \epsilon(\mu_{ba} + \mu_{bb})][\hat{p}_A R - 1 - c(1 - p_B)], \quad (3)$$

where the first term is the profit from providing A ratings to issuers with good ($s_{1j} = a$) signals and it is clear that this does not depend on inflation. The second term captures the profit from offering A ratings to issuers with bad ($s_{1j} = b$) signals.

The first order condition of the agency follows immediately from (3),

$$\hat{p}_A R - 1 - c(1 - p_B) \leq 0, \quad (4)$$

which is the difference between the marginal benefit and marginal cost of inflation. The marginal benefit of inflation is the rating fee ($\hat{p}_A R - 1$) while the marginal cost of inflation is the expected default cost of a project that would be assigned a B rating without inflation.

The first order condition (4) will lead to a corner solution with no inflation ($\epsilon^* = 0$) if the marginal cost of inflation exceeds the rating fee. If the marginal cost and benefit are equal, it will imply that the agency is indifferent regarding the amount of inflation ($\epsilon^* \in [0, 1]$). The inequality in (4) follows from Assumption 1, which states that the average project has a negative expected NPV. This rules out the corner solution $\epsilon = 1$ to be part of any equilibrium.

Finally, investor beliefs must be consistent in equilibrium,

$$\hat{p}_A = p_A(\epsilon^*). \tag{5}$$

This equilibrium condition closes the model. All else equal, $\hat{p}_A > p_A(\epsilon^*)$ would imply that investors are too optimistic about A-rated projects, and would realize negative payoffs, on average (and issuers would realize positive profits, as investors' valuation exceeds equilibrium rating fees). Also, if $\hat{p}_A < p_A(\epsilon^*)$ then by bidding more aggressively for A-rated projects, investors could secure a positive profit.

The following lemma characterizes the equilibrium.[15]

Lemma 1 (Equilibrium with a monopolist agency) *Under Assumptions 1 and 2*

(i) Issuers always purchase $\tilde{A}$ offered ratings, never purchase $\tilde{B}$ offered ratings.

(ii)

$$\epsilon^* = \begin{cases} 0, & \text{if } c(1-p_B) \geq p_A(0)R - 1 \\ \dfrac{(\mu_{aa}+\mu_{ab})[p_A(0)R - 1 - c(1-p_B)]}{(\mu_{bb}+\mu_{ba})[c(1-p_B) - (p_B R - 1)]}, & \text{if } c(1-p_B) < p_A(0)R - 1 \end{cases} \tag{6}$$

(iii) Investor beliefs satisfy $\hat{p}_A = p_A(\epsilon^*)$, $\hat{p}_B < p_A(\epsilon^*)$, $\hat{p}_\emptyset < 1/R$.

The proof is straightforward and provided in the Appendix. Given that the agency is not inflating ratings, its marginal benefit from manipulation is the expected NPV of an A-rated project ($p_A(0)R - 1$). Similarly, its marginal cost of inflation is the expected default cost of the inflated project ($c(1-p_B)$). When the marginal cost exceeds the marginal benefit, the only equilibrium is zero inflation.

However, when the marginal cost is lower than the marginal benefit without inflation, the agency cannot commit to zero inflation. Therefore, investors will decrease their valuations to the point, where the agency is indifferent regarding the amount of inflation (so the first order condition (4) is satisfied with an equality). Thus, $\hat{p}_A$ will be implied by

$$\hat{p}_A R - 1 = c(1-p_B), \tag{7}$$

which means that in an equilibrium with positive inflation the marginal cost equals the marginal benefit of inflation. Combining (5) and (7), one finds the equilibrium success rate of financed projects,

$$p_A(\epsilon^*) = \frac{1 + c(1-p_B)}{R} \quad for \quad \epsilon^* > 0. \tag{8}$$

Finally, solving (8) for equilibrium inflation, ϵ^*, gives (6). Observe, that the equilibrium success probability, $p_A(\epsilon^*)$, is increasing in the default cost, as a higher default cost alleviates the commitment problem. Also, a more precise rating technology implies that the success probability of a B-rated project, p_B, will be closer to 0, implying that the net effect of a better technology (taking into account the agency's behavioral response) is higher conditional success rate. This directly follows from the fact that the more precise technology increases the expected default cost of B-rated projects.

[15] Besides the equilibrium described here, there always exists a trivial Perfect Bayesian Equilibrium, where investors believe projects are bad, regardless of ratings, and agencies do not provide ratings. Therefore, strictly speaking, the equilibrium described in Lemma 1 is not unique. However, it is the unique equilibrium in which transactions occur.

As the default cost approaches zero, it is clear from (7) that the expected NPV of financed projects also goes to zero. In the special case, when the default cost is equal to zero ($c = 0$), there is no cost of inflation. However, equilibrium condition (5) still needs to be satisfied, implying that the agency will pick an inflation level that will result in A-rated projects carrying zero expected NPV, $p_A(\epsilon^*) = 1/R$.

Looking at (6) it is clear that inflation increases with the value of a honest rating $(p_A(0)R - 1)$ and decreases with the marginal default cost $(c(1 - p_B))$. The cutoff condition for no inflation is more likely to be satisfied when default cost is high and when the rating technology is noisy (high α). This captures the basic incentive conflict of a rating agency: the better (i.e. more valuable) its information the less he can resist the temptation to inflate.

Both fee revenue and default costs linearly increase with the mass of financed bad projects. This implies that when there is inflation in equilibrium the marginal cost and revenue of inflation is equal for all levels of inflation, leading to the profit neutrality of inflation. Hence, if investors mistakenly choose an off equilibrium $\hat{p}_A$ that is marginally higher than the respective equilibrium belief (and the agency and investors knows this) then the rating agency would find it optimal to respond by inflating *all* ratings. Observe that the profit neutrality of inflation does not mean that the rating agency is earning zero profit, as it is always profitable to sell A ratings to projects that received a signals due to the fact that the marginal default cost of these projects is lower than the rating fee.

In equilibrium only A-rated projects will be financed. This implies that off equilibrium beliefs on B-rated and unrated projects have to be sufficiently pessimistic in order to sustain the equilibrium. In particular, investors need to be at least marginally more pessimistic about B-rated projects, than A-rated projects, otherwise issuers would find it optimal to purchase B-ratings. This is not restrictive, as investors understand that B ratings are a result of b signals, implying negative expected NPV. Also, investors need to believe that purchasing a project without a rating would lead to a loss, on average. This is, in fact, guaranteed by adverse selection (see Assumption 1) and provides the sufficient incentive for issuers to purchase A ratings.

Finally, note that if the monopolist rating agency could credibly commit to an inflation level then it would always choose zero inflation as this results in the highest profit for him, even if its costless to inflate ratings.[16] To see this, one has to substitute out $\hat{p}_A$ with $p_A(\epsilon)$ in (2) to find that agency profit is strictly decreasing in rating inflation, ϵ. This follows from the simple intuition, that in the current setup the monopolist extracts all gains from trade and gains from trade is the highest if signals are revealed honestly.

2.2 Duopoly of agencies

Introducing a second agency in the game leads to a richer strategy space. First, CRAs are now able to both inflate and cater ratings. Catering becomes possible, because agencies are assumed to be able to verify each other's assigned preliminary ratings. Second, issuers can condition their rating purchase decisions on offered ratings and fees from two agencies. Finally, investors have to form beliefs about the conditional default probabilities of projects with various rating combinations.

In particular, let $\hat{p}_{r_{1j}r_{2j}}$ be investor beliefs about the conditional success probability of project j with $r_{1j}, r_{2j} \in \{A, B, \emptyset\}$ ratings. Since purchasing a B rating is never optimal

[16] This is what happens for example in Opp et al. (2013), where the monopolist agency can commit to fees, signal precision and disclosure rules.

for issuers, as it reveals the worst possible information at a cost[17], the relevant beliefs are $\hat{p}_{AA}, \hat{p}_{A\emptyset}, \hat{p}_{\emptyset A}$, as projects could potentially be financed with these rating combinations.

Similarly to the notation introduced above, define $p_{r_{1j}r_{2j}}(\epsilon_1, \epsilon_2, \rho_1, \rho_2)$ as the conditional probability that a project is good, given that it received $r_{1j}, r_{2j} \in \{A, B, \emptyset\}$ ratings, when agencies are inflating and manipulating ratings with $\{\epsilon_1, \epsilon_2, \rho_1, \rho_2\}$. E.g.

$$p_{AA}(\epsilon_1, \epsilon_2, \rho_1, \rho_2) = Pr(\theta_j = g | r_{1j} = A, r_{2j} = A, \epsilon_1, \epsilon_2, \rho_1, \rho_2)$$

In order to solve the model, one has to make a guess about the equilibrium rating purchase strategy of issuers (and later verify) in order to formulate the profit function of agencies. Suppose issuers who are offered A ratings from both agencies find it optimal to purchase both and no other issuer finds it optimal to purchase ratings.

If issuers have to purchase both ratings in order to sell their projects, the sum of the rating fees proposed by the two agencies cannot exceed the price investors are willing to pay for a project with two A ratings:

$$f_1 + f_2 \leq \hat{p}_{AA}R - 1,$$

which implies that agencies will always set the highest possible fee, otherwise they would be leaving money on the table[18]:

$$f_i = \hat{p}_{AA}R - 1 - f_{-i}.$$

Given the guess on issuer behavior and the optimal fee the problem of agency 1 may be formulated as

$$\begin{aligned}\epsilon_1^*, \rho_1^* = \arg\max_{\epsilon_1, \rho_1} \mu_{aa}[f_1 - c(1 - p_{AA}(\mathbf{0}))] + \\ + [\mu_{ba}(\epsilon_1 + (1-\epsilon_1)\rho_1) + \mu_{ab}(\epsilon_2 + (1-\epsilon_2)\rho_2)][f_1 - c(1 - \pi_g)] + \\ + \mu_{bb}[\epsilon_1\epsilon_2 + \epsilon_1(1-\epsilon_2)\rho_2 + \epsilon_2(1-\epsilon_1)\rho_1][f_1 - c(1 - p_{BB})], \quad (9)\end{aligned}$$

where the first line captures the profit from issuers with two good signals. The second line is the profit from providing A ratings to issuers with mixed signals, where the first bracket is the mass of issuers with mixed signals that are either inflated or catered and the difference between the fee and their expected default cost is in the second bracket. The third line is the profit from providing A ratings to issuers that received b signals from both rating technologies. The first term in brackets gives the probability of these issuers being offered A ratings from both agencies. In particular, such an issuer's rating may be inflated by both agencies ($\epsilon_1\epsilon_2$) or may be inflated by one agency and catered by the other ($\epsilon_i(1-\epsilon_{-i})\rho_{-i}$). The final bracket is the difference between the rating fee and the expected default cost of these issuers.

The marginal benefit from a financed project is always the rating fee, however, the marginal cost depends on the signals. The marginal cost will be the highest for issuers with two bad signals, $c(1 - p_{BB})$, since these projects are very likely to default. Hence, agencies will be reluctant to inflate ratings. Instead, they will be more likely to cater ratings first, as the default cost of issuers with mixed signals equals the unconditional default cost,

[17]This follows from restricting agencies' strategy space by only allowing them to manipulate B (preliminary) ratings into A (preliminary) ratings, and not the other way.

[18]Since issuers only purchase ratings if they are offered an A rating from both agencies, reducing fees does not generate additional demand for ratings.

$c(1-\pi_g)$. This follows from the fact that signals are unbiased, so if a project receives contradicting signals, then the posterior success probability will be equal to the prior:

$$p_{AB}(\mathbf{0}) = \frac{\pi_g \alpha(1-\alpha)}{\mu_{ab}} = \pi_g.$$

Since I will only focus on symmetric equilibria, equilibrium fees proposed by the agencies will coincide, $f_1 = f_2 = (\hat{p}_{AA}R - 1)/2$. The equilibrium fee also has to be at least as high, as the marginal expected default cost without manipulation, which is stated in the following assumption.

Assumption 3

$$\frac{p_{AA}(\mathbf{0})R - 1}{2} \geq (1 - p_{AA}(\mathbf{0}))c$$

The interpretation of Assumption 3 is the same as the interpretation of Assumption 2. Assumption 3 guarantees that when agencies are not manipulating ratings, the rating fee has to be larger than the expected default cost, otherwise, agencies would not want to participate in the market.

Finally, investor beliefs have to be consistent in equilibrium. This will be satisfied if

$$\hat{p}_{AA} = p_{AA}(\epsilon_1^*, \epsilon_2^*, \rho_1^*, \rho_2^*).$$

Since only those issuers will purchase ratings who are offered A ratings from both agencies, the equilibrium can be pinned down by this condition together with the first order conditions of (9), while other beliefs will only appear on the off-equilibrium path.

The following lemma states the symmetric Perfect Bayesian Equilibrium for the game with two agencies.[19]

Lemma 2 (Equilibrium with two agencies) *Under Assumptions 1 and 3*

(i) Issuers with $\{\tilde{A}, \tilde{A}\}$ offered ratings will purchase both, otherwise they will purchase none.

(ii) Equilibrium inflation and catering satisfy

$$\begin{cases} \epsilon^* = \rho^* = 0 & \text{if } \frac{p_{AA}(\mathbf{0})R-1}{2(1-\pi_g)} \leq c \\ \epsilon^* = 0, 0 < \rho^* \leq 1 & \text{if } \frac{p_{AA}(0,0,1,1)R-1}{2(1-p_{BB})} \leq c < \frac{p_{AA}(\mathbf{0})R-1}{2(1-\pi_g)} \\ 0 < \epsilon^* < 1, \rho^* = 1 & \text{if } c < \frac{p_{AA}(0,0,1,1)R-1}{2(1-p_{BB})} \end{cases}$$

(iv) Equilibrium beliefs satisfy: $\hat{p}_{AA} = p_{AA}(\epsilon^*, \rho^*)$, $\hat{p}_{A\emptyset}, \hat{p}_{\emptyset A} \leq \frac{\hat{p}_{AA}R+1}{2R}$, $\hat{p}_{\emptyset\emptyset} \leq 1/R$

The proof of Lemma 2 can be found in the Appendix, together with formulae for equilibrium inflation and catering.

The first result is that only those projects are going to be financed, which are offered A ratings from both agencies. The reason they purchase both is that they want to prevent pooling with issuers who are only offered an A rating from a single agency. The intuition is as follows. If issuers offered A ratings from both agencies would randomly purchase a

[19] Note that by introducing strategy refinements (trembling hand errors), the same equilibrium is found to satisfy sequential rationality together with pinned down equilibrium beliefs. However, as it would only complicate notation, I only focus on the Perfect Bayesian Equilibrium. Similarly to Lemma 1, the equilibrium described here is unique in the sense that it is the only pure strategy equilibrium in which transactions occur.

single rating then this would lead to agencies competing in fees in order to attract business. However, if fees are sufficiently low, issuers offered A ratings from both agencies will find it optimal to purchase the second rating so they could distinguish themselves from issuers who are only offered an A rating from a single agency. This mechanism rules out pure strategy equilibrium candidates in which projects with a single public rating obtain financing.[20]

Given that issuers purchase both A ratings when offered, issuers with contradicting offered ratings would not want to purchase the single A rating because investors will correctly infer that the undisclosed rating of these issuers has to be B. This implies that they will value such projects accordingly: their valuation will not exceed the value of an average project, which is negative by Assumption 1.[21]

The second finding is the "pecking order" nature of rating manipulation methods. When the default cost is sufficiently high, agencies will not manipulate ratings. However, when the default cost is too low to prevent manipulation, agencies will first start to cater ratings and once they have catered all ratings, they will also start inflating ratings. The reason they start with catering is simple: catered projects default with lower probability than inflated projects, which makes them cheaper to manipulate as the associated expected default cost will be lower. As a result, if an issuer obtains two b signals, but one agency inflates its preliminary rating to $\tilde{A}$, then the issuer will secure financing, because even if its preliminary rating is not inflated by the other agency, it will be catered.

Figure 2 illustrates the pecking order nature of manipulation methods. If the default cost (c) is high, then agencies in a duopoly do not cater (solid line) nor inflate (dotted line) ratings, as shown in region A. In regions B+C+D they cater but do not inflate. Finally, they cater for everyone and also inflate in region E.

As agencies propose take-it-or leave it fees and issuers with two A offered ratings purchase both, agencies are able to increase fees up to the point where issuers are indifferent between their outside option and purchasing both ratings, hence $f = (\hat{p}_{AA}R - 1)/2$.[22] Clearly, given the other agency's strategy, agencies do not have an incentive to deviate from these fees. If one agency were to increase its fee, his revenue (together with other agency's) would drop to zero as issuers would not find it optimal to purchase any ratings. Also, decreasing fees always decreases profits. If the agency would find it optimal to sell an A rating to a project that was only offered a B rating, then the agency could easily cater/inflate the project's rating and charge the original fee. Hence, attracting business by reducing rating fees is suboptimal.

Since only projects with two A ratings will be financed, investor beliefs about the default probabilities of these projects must be correct in equilibrium. Following the structure of the equilibrium, beliefs about issuers with different rating combinations will be on the off-equilibrium path. For projects with one disclosed A rating, investors believe that these are worth at most the rating fee, otherwise all issuers who can, would only want to purchase one rating. Also, issuers without any disclosed ratings are believed to be at most average, which

[20]The structure of the equilibrium is different with equilibria reached in models of rating shopping, where issuers often find it optimal to only disclose a single rating in equilibrium (Bolton, Freixas, and Shapiro, 2012; Skreta and Veldkamp, 2009; Sangiorgi and Spatt, 2015). Also, it is likely to break if there are significant variable costs associated with rating production. However, as discussed in Section 4, empirical evidence does suggest that issuers purchase multiple ratings in the corporate and structured segments.

[21]This follows from the fact, that in the best case scenario these issuers obtained contradicting signals and conditional on obtaining contradicting signals, a project has average NPV, which is negative.

[22]One could easily find a mechanism, like Nash bargaining to make this part of the model more realistic. Note that while Nash bargaining clearly affects allocation it would also affect efficiency, as if issuers are able to bargain lower fees then this would decrease the optimal manipulation levels for given default costs.

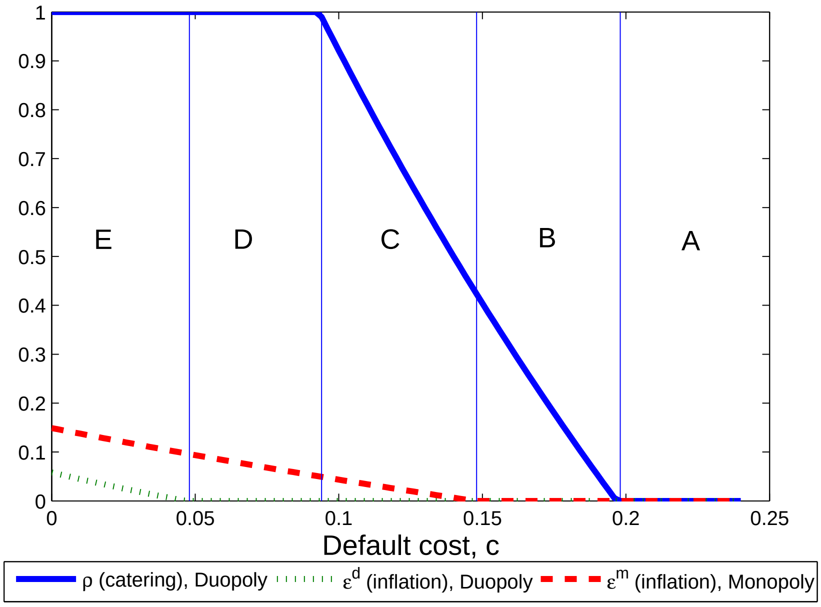


Figure 2: Equilibrium manipulation levels as a function of c. Vertical lines indicate the ranges of the default cost that correspond to the parameter regions in Lemma 1 and 2. In regions A+B a monopolist does not inflate ratings, while in regions C+D+E it does. Agencies in a duopoly do not cater nor inflate ratings in region A, they cater in regions B+C+D and they also inflate in region E. Parameters are: $R = 1.2$, $\alpha = 0.05$, $\pi_g = 0.5$

prevents their financing.

2.3 Comparing manipulation and rating standards of a monopoly and a duopoly.

How do the parameter regions of Lemma 1 and 2 relate? Figure 2 shows an example, highlighting the amount of inflation and catering in a monopoly and duopoly. Vertical lines divide the default cost (c) into four regions. A monopoly does not inflate (dashed line) in regions A+B, while it does in regions C+D+E. Agencies in a duopoly do not manipulate in region A, cater (solid line) but do not inflate (dotted line) in regions B+C+D and both cater and inflate in region E.

In region B of Figure 2 agencies in a duopoly cater ratings while a monopolist reports honestly, which implies that agencies in a duopoly may start manipulating ratings at higher cost levels. Below I state a sufficient condition for this result.

Corollary 1

$$p_A(0)R - 1 < (p_{AA}(\mathbf{0}) - p_A(0))R \text{ is sufficient for } \frac{p_A(0)R - 1}{1 - p_B} < \frac{p_{AA}(\mathbf{0})R - 1}{2(1 - \pi_g)}$$

See the proof in the Appendix. Corollary 1 says that when the marginal value of the second honest rating exceeds the marginal value of the first honest rating then there will be a range of default costs, such that issuers in a duopoly will cater and a monopolist does not inflate ratings in equilibrium (region B in Figure 2). Intuitively, when a second honest opinion is highly valuable, agencies in a duopoly will start catering ratings at higher default cost levels. Also, catering is less harmful than inflating ratings in a monopoly since catered projects default with lower probability. The condition in Corollary 1 is likely to be satisfied when signal noise α is neither too low and neither too high, as the too extremes $\alpha = 0$ ($\alpha = 0.5$) imply $p_{AA}(\mathbf{0}) = p_A(0) = 1$ ($p_{AA}(\mathbf{0}) = p_A(0) = \pi_g$). With moderate signal noise investors are willing to pay a significant premium for a second a signal as the probability that a bad project receives a single a signal is α, but receiving two a signals is only α^2.

The next corollary relates inflation levels across market structures.

Corollary 2 *Let ϵ^{mon} (ϵ^{duo}) denote equilibrium inflation levels in a monopoly (duopoly). Then $\epsilon^{duo} \leq \epsilon^{mon}$.*

Corollary 2 implies that there will always be a nonempty set of parameter values where a monopolist inflates ratings but agencies in a duopoly do not inflate. In terms of Figure 2, this implies that regions D+C have positive measure. As agencies in a duopoly only start inflating ratings once they cater for everyone, it is easy to show that inflation levels in a duopoly will always be lower than in a monopoly. Catering for everyone implies that all issuers who are inflated by at least one agency will automatically obtain a second A rating through catering. This makes inflation expensive for agencies as projects with two bad signals are likely to default.

Equilibrium rating standards are the result of the precision of the rating technology and equilibrium manipulation levels. I define rating standard as the difference between the NPV of a financed project and a randomly chosen project:

$$RS^{mon} = (p_A(\epsilon^*) - \pi_g)R \quad \text{and} \quad RS^{duo} = (p_{AA}(\epsilon^*, \rho^*) - \pi_g)R, \tag{10}$$

where RS^{mon} and RS^{duo} stand for rating standard in a monopoly and a duopoly, respectively. It is important to emphasize that rating standards in (10) capture the quality of financed projects, not the total value of financed projects. This implies that efficiency may be decreasing in rating standards, if higher rating standards prevent the financing of not only many bad projects, but also many good projects.[23]

Corollary 3 *Rating standards RS^{mon} and RS^{duo} are at least weakly*

(i) increasing in the default cost, c.

(ii) increasing in rating precision, $1 - \alpha$.

(iii) decreasing in good projects' return (R) if there is manipulation in equilibrium, otherwise it is strictly increasing.

(iv) decreasing in the share of good projects (π_g) if there is manipulation in equilibrium.

When agencies find it optimal to manipulate ratings, rating standards are increasing in the default cost, as a higher default cost helps overcome the commitment problem of agencies. Of course, when agencies find it optimal to report ratings truthfully, increasing the default cost does not affect agency behavior.

Rating standards are directly related to the precision of the rating technology, $(1 - \alpha)$. When agencies report truthfully, a more precise signal leads to ratings that are more strongly correlated with project types, leading to increased standards. Interestingly, when agencies

[23] For example, a technology that only assigns an A rating to good issuers with a total mass of zero will constitute the highest rating standard, but will also result in zero efficiency as only issuers with zero mass secure financing.

find it optimal to manipulate ratings, a more precise technology still leads to higher rating standards, even though agencies react to higher precision by increasing manipulation levels, as A ratings become more valuable. The intuition is clear from (8). The expected default cost associated with manipulated projects increases because agencies are more confident that projects obtaining bad signals will default. The only exception to this is when agencies in a duopoly find it optimal to cater but not inflate ratings. In this case, the marginal project being financed is the one with contradictory signals, which implies that their expected NPV does not depend on signal precision. Hence, in this case the effect of increased precision is exactly offset by the behavioral response of increased catering.

Increasing the payoff of good projects (R) has two effects. First, it mechanically increases rating standards as higher potential returns lead to higher stakes: information is more valuable. Second, agencies are more tempted to manipulate ratings due to the increased value of information. When agencies find it optimal not to manipulate, the former effect will dominate and rating standards will increase. However, when they are manipulating in equilibrium, the behavioral response outweighs the mechanical effect and rating standards will decrease. This latter result is somewhat surprising, as it suggests that when agencies face commitment problems, increasing the payoff of good projects decreases the value added of an A rating. From (8) it is clear that the expected return $p_A(\epsilon^*)R$ is held constant by the agency if R increases. However, the average project's payoff also increases leading to the depreciation of an A rating's value added.

Rating standards strongly depreciate when the share of good projects increases and agencies are already manipulating ratings. First, the benchmark increases as now a randomly chosen project will succeed with a higher probability. This leads to smaller rating standards. Second, agencies respond by increasing manipulation because if the share of good projects is higher the probability that a manipulated project will succeed is also higher, reducing the expected default cost. When agencies do not manipulate in equilibrium, higher share of good projects may increase or decrease rating standards depending on the level of the share of good projects and also on the precision of ratings. Intuitively, when the share of good projects is high, the potential increase in the success probability ($p_A(0)-\pi_g$ and $p_{AA}(\mathbf{0})-\pi_g$) will be lower, which will result in decreasing standards whenever the share of good projects increases. However, when the share of good projects is low, increasing their share significantly decreases issuers who are bad but obtain good signals, leading to higher standards. Also, when signals are highly precise, there is only little room to improve $p_A(0)$ and $p_{AA}(\mathbf{0})$, while if signals are noisy, rating standards may improve as a result of an increase in the share of good projects.

The following corollary relates rating standards across market structures.

Corollary 4 *If*

$$2\pi_g - p_B - 1 > 0, \tag{11}$$

there always exists an interval for the default cost, c, such that $RS^{mon} > RS^{duo}$.

When agencies are not manipulating ratings, having an additional good signal always increases the probability that the given project is good. Hence, rating standards of the duopoly will always be higher in this case. However, when agencies manipulate ratings in equilibrium, surprisingly, the reverse could hold. For example, suppose that the monopoly inflates ratings while agencies in the duopoly cater (but do not inflate) ratings. Then

$$RS^{mon} - RS^{duo} = 1 + c(1 - p_B) - [1 + 2c(1 - \pi_g)] \propto 2\pi_g - p_B - 1,$$

implying that if the share of good projects (π_g) is sufficiently high, rating standards in a monopoly will be higher than rating standards in a duopoly. The condition (11) has a straightforward interpretation: if the success probability of a catered project in a duopoly (π_g) is large relative to the success probability of an inflated project in a monopoly (p_B) then agencies in a duopoly will be more aggressive in catering ratings than a monopoly will be in inflating ratings. Note that a necessary condition for (11) to hold is that the majority of the projects must be good ($\pi_g > 1/2$). Otherwise, agencies in a duopoly always produce higher rating standards.

Rating standards are often in the focus of empirical work, as they capture the quality of ratings. However, it must be emphasized, that they do not tell us everything about efficiency, since they stay silent about the quantity of financed projects.

3 Welfare

This section provides the welfare analysis. Below I will set some boundaries for the analysis by only focusing on the region of parameters that is of interest. Second, I introduce the welfare measure and show how it relates to rating standards. Third, I show how the welfare ranking of market structures depends on parameters. Finally, I provide some intuition about the main mechanisms that drive the welfare ranking result.

In order to keep the discussion on welfare simple, I will assume that the distribution of projects is such that it is never optimal to cater for all issuers.

Assumption 4

$$\mu_{aa}(p_{AA}(\mathbf{0})R - 1) + 2\mu_{ab}\bar{V} < 0,$$

which implies that if agencies were to cater for all issuers (but not inflate) then the expected NPV of a project with two A ratings would be negative. Hence, agencies in a duopoly would never find it optimal to inflate ratings, but they may find it optimal to cater with some $\rho < 1$.

Assumption 4 implies that equilibrium behavior will always fall into regions A+B+C in Figure 2. I focus on these regions, because they highlight the different methods of rating manipulation across market structures (inflating in monopoly and catering in duopoly). Also, it simplifies the comparison of welfare across market structures, as the number of possible monopoly-duopoly regime pairs is reduced to four, since the monopoly will either inflate ratings or report truthfully, and agencies in a duopoly will either cater ratings or report truthfully.

Assumption 4 limits our attention to cases where there is meaningful disagreement among CRAs. This makes catering harmful, in the sense that it can diminish all gains from trade. Assumption 4 is likely to be violated in the following cases. First, if information is highly precise and/or strongly correlated across agencies then the mass of issuers who have contradicting signals will be small ($\mu_{ab} \approx 0$). Second, in settings where the average project has a payoff close to zero ($\bar{V} \approx 0$), catering would not be very harmful for efficiency.

3.1 Welfare measure

Does the additional information available in a duopoly lead to improved welfare? To measure welfare I use the total NPV of financed projects, normalized by the total NPV of successful projects ($\pi_g V_g$). I assume that the default cost paid by agencies is not considered waste,

$s_1 \backslash s_2$	a	b
a	$\mu_{aa}(p_{AA}(\mathbf{0})R-1)$	$\mu_{ab}\bar{V}$
b	$\mu_{ba}\bar{V}$	$\mu_{bb}(p_{BB}R-1)$

Table 1: Total NPV of projects with given signal combinations.

but it is collected by a regulator that distributes it among risk neutral consumers, who have constant, unit, marginal utility for money.[24] In case of a monopoly,

$$W^{mon}(\epsilon^*) = \frac{(\mu_{aa}+\mu_{ab})(p_A(0)R-1)+\epsilon^*(\mu_{bb}+\mu_{ba})(p_BR-1)}{\pi_g V_g}$$

and W^{duo} is analogous,

$$W^{duo}(\rho^*) = \frac{\mu_{aa}(p_{AA}(\mathbf{0})R-1)+\rho^* 2\mu_{ab}\bar{V}}{\pi_g V_g}.$$

The welfare measures above clearly show that inflating and catering ratings adds projects with negative expected NPVs to the financed pool. Thus, both catering and inflation reduces welfare, as expected:

$$\frac{\partial W^{mon}(\epsilon)}{\partial \epsilon} \propto p_BR-1<0$$
$$\frac{\partial W^{mon}(\rho)}{\partial \rho} \propto \bar{V}<0$$

where the second inequality hold by Assumption 1 and the expected NPV of a project with one bad rating is always worse than average, $p_BR-1<\bar{V}<0$.

Observe, that the welfare measures are directly related to rating standards.

$$W^{mon}(\epsilon^*) = \frac{[\mu_{aa}+\mu_{ab}+\epsilon^*(\mu_{bb}+\mu_{ba})](p_A(\epsilon^*)R-1)}{\pi_g V_g} = = \frac{[\mu_{aa}+\mu_{ab}+\epsilon^*(\mu_{bb}+\mu_{ba})](RS^{mon}+\bar{V})}{\pi_g V_g} \quad (12)$$

$$W^{duo}(\rho^*) = \frac{[\mu_{aa}+\rho^* 2\mu_{ab}](p_{AA}(\rho^*)R-1)}{\pi_g V_g} = \frac{[\mu_{aa}+\rho^* 2\mu_{ab}](RS^{duo}+\bar{V})}{\pi_g V_g}. \quad (13)$$

It is clear from equations (12)-(13) that welfare is the product of the quantity of financed projects (the terms in brackets) times the quality of financed projects (the terms in parenthesis). While catering and inflating ratings always increases the quantity of financed projects, they also decrease rating standards, and the latter effect always dominates.[25] The NPV of

[24] At the other extreme, one may assume that the default cost is complete waste. In that case welfare equals to the agency's profit, since other players earn zero profit in expectation. Furthermore, if the default cost paid by agencies would reduce welfare, that would only strengthen the result that a monopoly may lead to higher welfare. To illustrate this, consider a case when the same projects are financed irrespective of market structure. Then agencies in a duopoly would have to pay a total default cost individually that is equal to the default cost paid by the monopolist. Hence, if paying the default cost is welfare decreasing, then a monopoly would produce higher welfare, even if the same projects are financed.

[25] This implies that in the current setup welfare will be monotone increasing in equilibrium rating standards within market structures.

the average project ($\bar{V}$) enters the welfare measures because rating standards are defined as the difference between the value of a highly rated project and that of an average project. Hence, the welfare measures will be equal to zero, when rating standards decrease to the point where a highly rated project has zero NPV.[26]

3.2 Comparing monopoly and duopoly welfare

In order to build some intuition for relating welfare across market structures, consider the total NPV of projects with given signals, as shown in Table 1. If agencies choose not to manipulate ratings then total NPV in a monopoly would be equal to the sum of the first row of Table 1, which includes those issuers that obtained an a signal from the first agency's rating technology. Introducing a second agency further differentiates these issuers and prevents the financing for a group of issuers with average expected NPV projects ($\mu_{ab}\bar{V}$). Clearly, as average NPV ($\bar{V}$) is negative by Assumption 1, duopoly leads to higher welfare if there is no manipulation.

Furthermore, by Assumption 4 catering only affects projects with mixed signals. Hence, catering always adds projects with average expected NPV. It follows that when agencies cater to every second project with mixed signals ($\rho = 1/2$) and a monopolist does not inflate ratings, welfare (and rating standards) will be equal across market structures. These observations are formally stated in the following lemma.

Lemma 3

$$(i) \quad W^{duo}(0) > W^{mon}(0)$$
$$(ii) \quad W^{duo}(1/2) = W^{mon}(0)$$

While it is easy to prove the statements in Lemma 3, part (i) is not a trivial result. Recall, that under a duopoly issuers need to obtain A ratings from both agencies, which reduces the mass of issuers who are able to market their assets in equilibrium.[27] However, this is outweighed by the higher expected NPV of sold projects in a duopoly.[28]

Below I state the main welfare result of the paper.

Proposition 1 (Comparing monopoly and duopoly welfare) *If Assumption 4 holds and agencies provide ratings in equilibrium under both market structures then*

(i) $W^{mon}(\epsilon^*) > W^{duo}(\rho^*)$ *if* $\pi_g > \bar{\pi}_g(\alpha, V_g, c)$ *and* $c < \bar{c}(\alpha, \pi_g, V_g)$.

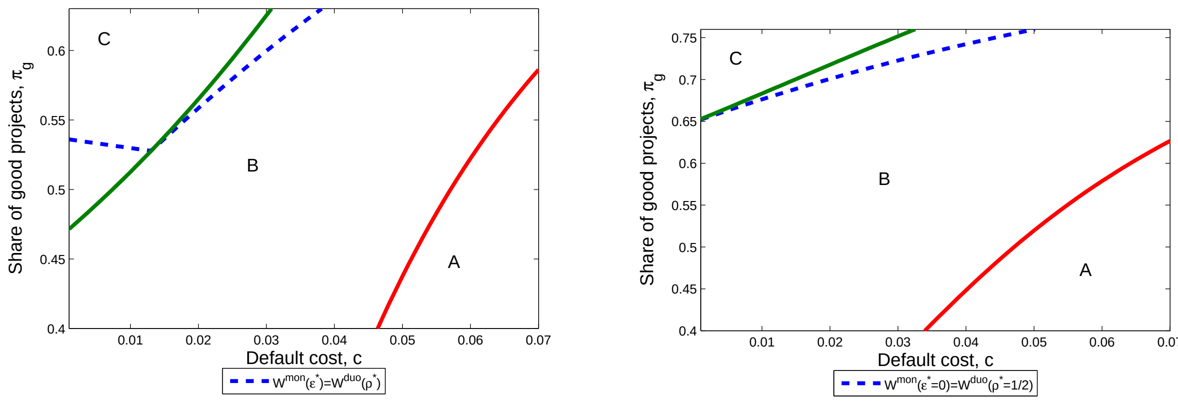
(ii) Otherwise $W^{duo}(\rho^*) \geq W^{mon}(\epsilon^*)$,

where $\bar{\pi}_g(\alpha, V_g, c)$ *and* $\bar{c}(\alpha, \pi_g, V_g)$ *are functions given in the Appendix.*

[26]Note that in order to ease notation, $p_{AA}()$ only has equilibrium catering, ρ^*, as its argument, since from Assumption 4 it follows that $\epsilon^* = 0$ in a duopoly and also the amount of catering is symmetric.

[27]E.g. assuming that with three agencies only projects with three A ratings get financed, efficiency would decrease by moving from a single agency to three agencies if signal noise α is sufficiently low and the share of good projects π_g is sufficiently high.

[28]One can think of this problem in terms of hypothesis testing. Suppose the rating technology works as follows. The null hypothesis is the project being good while the alternative is that the project is bad. Agencies can commit type I errors by giving "B" ratings for a good project and type II errors by giving "A" ratings for a bad project. In this framework moving from a monopoly to a duopoly implies that type I errors will *increase* from $\pi_g\alpha$ to $\pi_g\alpha(2-\alpha)$ (recall that good projects with mixed signals will not be financed) while type II errors will decrease from $(1-\pi_g)\alpha$ to $(1-\pi_g)\alpha^2$. Also note that I am implicitly assuming that signal errors are symmetric, e.g. agencies in reality might prefer signals which commit relatively less type I errors and more type II errors. If so, moving to a duopoly would imply greater welfare gains.



(a) Low signal noise, $\alpha = 0.05$

(b) High signal noise, $\alpha = 0.1$

Figure 3: Welfare ranking. The solid lines divide the parameter space into regions A,B and C, which correspond to the regions of Figure 2. In regions A+B the monopolist does not inflate ratings ($\epsilon^* = 0$), while in region C it does ($\epsilon^* > 0$), as stated in Lemma 1. In region A agencies in a duopoly do not cater ratings ($\rho^* = 0$), while in regions B+C they do cater ($\rho^* > 0$), as stated in Lemma 2. Along the dashed line welfare is equal in a monopoly and duopoly, above the dashed line a monopoly leads to higher welfare, while below the dashed line duopoly leads to higher welfare. In region B the dashed line corresponds to the inverse of function $\bar{c}(\cdot)$ and in region C it corressponds to the function $\bar{\pi}_g(\cdot)$, both introduced in Proposition 1. The share of good projects (π_g) is bounded by above by Assumption 4. Other parameters are: $R = 1.06$.

Proposition 1 provides the conditions for the welfare ranking of a monopoly and a duopoly. A monopoly produces higher welfare if the share of good projects is sufficiently high and the cost of default is sufficiently low, otherwise a duopoly always leads to higher welfare.

What are the important mechanisms behind Proposition 1? First, in a duopoly there is more information available, since signal errors are independent across agencies. This increases the maximum potential welfare. Financing only those issuers who obtain good signals from both agencies limits the mass of financed projects, however, it leads to higher welfare through increased rating standards, as the projects that are sorted out by the second signal carry negative expected NPV.

Second, increasing the number of agencies has a clear positive effect, as it decreases fees relative to the default cost, which helps overcome the commitment problem agencies face. Intuitively, lower rating fees decrease the temptation to manipulate ratings. In order to illustrate this result, consider the no noise limit, when $\alpha \to 0$. This is an interesting limit, because it keeps the available information constant across market structures (perfect information) and also holds constant the method of manipulation, as manipulated projects will certainly be bad projects. In this limit a monopolist would not inflate ratings if $c > V_g$, as its rating fee converges to the NPV of a good project (V_g) and inflated projects default with probability $(1 - p_B) \to 1$, implying that the default cost (c) will be paid with certainty. On the other hand, agencies in a duopoly divide the fee revenue, which leads to a rating fee of $V_g/2$. Hence, they will only manipulate if $c < V_g/2$. Thus, a monopolist will always start inflating at higher default costs and will lead to (weakly) lower welfare in the no noise limit.[29]

[29] Alternatively, one can also isolate the effect of market structure by analyzing the welfare implications of the merger of two agencies. This also keeps both the available information and manipulation methods constant as the merged agency can condition its manipulation strategy on both signals. See the subsection on a merger below.

Third, moving to a duopoly also changes the optimal method of rating manipulation. Since agencies in a duopoly can selectively manipulate ratings by cherry picking the relatively better ones through catering, they are more aggressive in manipulating ratings. This effect may be so strong that it outweighs the positive effects of added information and market structure. This will be likely to happen, when incentive problems arise due to low default costs and the share of good projects is high, as these conditions make catering very attractive to agencies.

Figure 3 illustrates the results of Proposition 1. The solid lines divide the parameter space into regions A,B and C, which correspond to the respective regions of Figure 2. In each panel, welfare in a monopoly and duopoly coincide along the dashed line. Welfare in a monopoly is higher if parameters fall above the dashed line and higher in a duopoly if parameters fall below the dashed line. In region A (when the default cost is high and the share of good projects is low) agencies do not manipulate ratings, regardless of market structure. In region B agencies in a duopoly find it optimal to cater ratings but a monopolist does not inflate ratings. This implies that the dashed line in region B corresponds to the set of parameters, which induced agencies in a duopoly to cater every second project ($\rho^* = 1/2$), as this will lead to equal welfare if a monopolist does not inflate, as stated in Lemma 3.

In region C, when incentive problems are the worst due to low default cost and the high share of good projects, agencies in a duopoly cater ratings and a monopolist inflates ratings. On the left panel of Figure 3 the dashed line in region C highlights the parameter values, where welfare measures of the monopoly and duopoly coincide when a monopolist inflates with $\epsilon^* > 0$ and agencies in a duopoly cater with $\rho^* > 1/2$.

The dashed lines in Figure 3 correspond to the functions $\bar{\pi}_g(\alpha, V_g, c)$ and $\bar{c}(\alpha, \pi_g, V_g)$ introduced in Proposition 1. The function $\bar{c}(\alpha, \pi_g, V_g)$ is the dashed line in region B (inverted) while $\bar{\pi}_g(\alpha, V_g, c)$ is the dashed line in region C, holding signal noise and the payoff of good projects fixed. Observe, that in the right panel, when signal noise is relatively high, welfare measures only cross once along the default cost, c, when agencies in a duopoly cater with $\rho^* = 1/2$. This follows from the fact, that catering is more harmful, since high signal noise leads to frequent disagreements among agencies, which provides ample opportunity to cater ratings.

3.2.1 Comparative statics on the ex-ante share of good projects

The ex-ante share of good projects (π_g) has a decisive role in the welfare result. In order to build some intuition for this, observe that welfare measures are directly related to equilibrium agency fees. Assume that parameters fall in region C of Figure 2, where agencies always manipulate ratings in equilibrium ($\epsilon^* > 0$ in a monopoly and $\rho^* > 0$ in duopoly). This implies that the value of financed projects will satisfy

$$p_A(\epsilon^*)R - 1 = f^{mon} = c(1 - p_B) = cPr[\theta_j = b|s_{1j} = b] \tag{14}$$

$$p_{AA}(\rho^*)R - 1 = 2f^{duo} = 2c(1 - \pi_g) = c2Pr[\theta_j = b|s_{1j} = a, s_{2j} = b], \tag{15}$$

where f^{mon} (f^{duo}) is the equilibrium rating fee in a monopoly (duopoly) and comparing with (12)-(13) it is clear that welfare is proportional to these measures. Intuitively, the rating fee is a good proxy for welfare because the total rating fees paid by an issuer is equal to the expected NPV of a financed project in equilibrium. This is shown by the first equalities in (14) and (15). Second, if agencies manipulate ratings in equilibrium rating fees must be equal to the expected default cost of a manipulated project, because this makes the agencies indifferent regarding the amount of manipulation. This is shown by the second equalities in

(14) and (15).

Equations (14) and (15) imply that fees will be the product of the default cost parameter c and the conditional probabilities of the manipulated projects being bad. If the given conditional probability is high then manipulation will be low (implying larger fees and welfare), as agencies want to avoid paying the expected cost associated with the increased likelihood of defaults.

Figure 4 shows the conditional default probabilities in (14)-(15) as a function of the share of good projects, π_g, for two levels of signal noise. The solid line shows twice the probability of a catered project defaulting, which is the relevant measure for expected default cost as agencies in a duopoly split the fee revenue equally. As π_g increases, the probability that a catered issuer is bad is linearly decreasing, inducing agencies in a duopoly to gradually increase catering. The dotted line shows the conditional default probability of a project that has one b signal. If the share of good projects (π_g) is low, then the curve is almost flat, as it is likely that projects receiving b signals will, in fact, default. However, for high levels of π_g the probability will decrease at a faster pace, as it becomes likely that the signal is wrong, since most projects are ex ante good. For a precise signal, like on the left panel of Figure 4 this will only happen when there are very few bad projects.

This asymmetry will lead to an interval where the relative default probability of an inflated project will be large compared to the default probability of a catered project (this can be seen on the left panel in Figure 4 when $\pi_g >\approx 0.5$). The two panels highlight that this can happen when signal noise (α) is low and the share of good projects (π_g) is high.[30]

The reason this asymmetry emerges follows from the assumption that signal errors are independent of the true type of the project. In principal, agencies could calibrate their rating technologies so that the probability of committing false positive errors (classifying good projects as bad) is different from committing false negative errors (classifying bad projects as good). Intuitively, when there are only very few good projects, agencies might prefer a technology that only commits false positive errors, as this way the financed pool, though small, has better quality. I relax this assumption in a companion paper, Farkas (2016).

Figure 5 provides numerical examples. Vertical lines divide parameters to regions A,B and C, which correspond to the regions introduced in Figure 2. In panel (a) the share of good projects is relatively low and, as discussed above, this will imply that duopoly welfare (solid line) will always be higher than monopoly welfare (dashed line). Panel (b) shows an example when the share of good projects is high and the return on good projects is low, similarly to low risk assets. In this case, agencies in a duopoly start to cater at very high default cost levels, implying that when catering exceeds 1/2,[31] a monopoly will always produce higher welfare.

Finally, observe, that for high default costs a duopoly may substantially dominate a monopoly, even if there is significant amount of catering. This suggests that the presence of catering by itself is not a sufficient condition to support a monopolistic market structure.

[30] It is easy to show that when $\alpha > 1/3$ then $2Pr[\theta_j = b|s_{1j} = a, s_{2j} = b] > Pr[\theta_j = b|s_{1j} = b]$ always, implying that signal noise has to be sufficiently small for a monopoly to produce higher welfare.

[31] As stated in Lemma 3, when $\rho = 1/2$ and a monopolist does not inflate ratings, welfare will be equal across market structures.

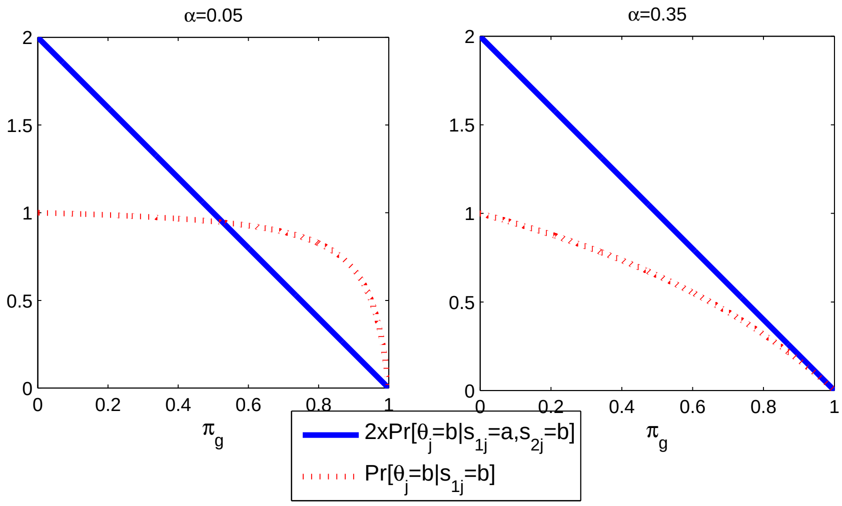


Figure 4: Conditional probabilities of default given signals as a function of the share of good projects, π_g. The left panel shows the case when signal noise is relatively low ($\alpha = 5\%$), while the right panel shows the case when signal noise is relatively high ($\alpha = 35\%$).

3.2.2 Isolating the effect of market structure and information

In order to isolate the effect of market structure and information, I analyze the welfare implications of a merger of two rating agencies. Analyzing a merger isolates the effect of market structure when comparing the merged agency with a duopoly (since information is held constant), but also isolates the effect of an additional signal when comparing the merged agency with the monopolist (since both operate as monopolists).

The merged agency will observe both signals, keeping the amount of information constant before and after the merger. Similarly, a merged agency may condition its manipulation method on both signals, which implies that manipulation methods are also held constant. In particular, if faced by commitment problems, a merged agency will find it optimal to first assign A ratings to issuers with mixed signals, just like agencies in a duopoly start by catering ratings.

Formally, the merged agency's objective is

$$\tilde{\rho}^* = \arg\max_{\tilde{\rho}} \mu_{aa}[\tilde{f} - c(1 - p_{AA}(\mathbf{0}))] + \tilde{\rho}(\mu_{ba} + \mu_{ab})[\tilde{f} - c(1 - \pi_g)],$$

where $\tilde{\rho}$ is the probability of assigning an A rating to an issuer with mixed signals, $\tilde{f}$ is the rating fee of the merged agency and by Assumption 4 the merged agency will never want to inflate ratings.

Observe, that assigning a good rating to issuers with mixed signals ($\tilde{\rho}$) has the same impact on welfare as catering (ρ), since both methods guarantee financing of issuers with mixed signals. Hence, welfare in a merger may be defined using the welfare measure of the duopoly, as

$$W^{merger}(\tilde{\rho}^*) = W^{duo}(\tilde{\rho}^*) = \frac{\mu_{aa}(p_{AA}(\mathbf{0})R - 1) + \tilde{\rho}^* 2\mu_{ab}\bar{V}}{\pi_g V_g}.$$

The merged agency will find it optimal not to manipulate, if

$$c > \frac{p_{AA}(\mathbf{0})R - 1}{1 - \pi_g},$$

which, together with the condition for no catering in a duopoly stated in Lemma 2 implies that the merged agency will require a default cost twice as large than agencies in a duopoly for truthful reporting. This directly follows from the fact that if there is no manipulation, the sum of the two rating fees in a duopoly will be the same as the rating fee after the merger.

The following proposition states the results.

Proposition 2 (Welfare implications of a merger/added signal) *(i) If the default cost is sufficiently high, then a merger does not affect welfare:*

$$W^{duo}(0) = W^{merger}(0) \quad \textit{if} \quad c \geq \frac{p_{AA}(\mathbf{0})R - 1}{1 - \pi_g}$$

(ii) If the default cost is sufficiently low, then a merger is welfare decreasing:

$$W^{duo}(\rho^*) > W^{merger}(\tilde{\rho}^*) \quad \textit{if} \quad c < \frac{p_{AA}(\mathbf{0})R - 1}{1 - \pi_g}$$

(iii) If $c \in [\underline{c}, \frac{p_A(0)R-1}{1-\pi_g})$ *then*

$$W^{merger}(\tilde{\rho}^*) < W^{mon}(\epsilon^*), \quad \textit{where} \quad \underline{c} < \frac{p_A(0)R - 1}{1 - \pi_g}$$

Otherwise $W^{merger}(\tilde{\rho}^*) \geq W^{mon}(\epsilon^*)$.

The proofs are straightforward. When the default cost is sufficiently high to deter the merged agency from manipulation then a merger does not affect welfare as only those projects obtain financing in both cases who have two a signals. However, if the merged agency finds it optimal to assign A ratings to some issuers with mixed signals then the merger is welfare decreasing, because either agencies in a duopoly do not cater ratings at all if

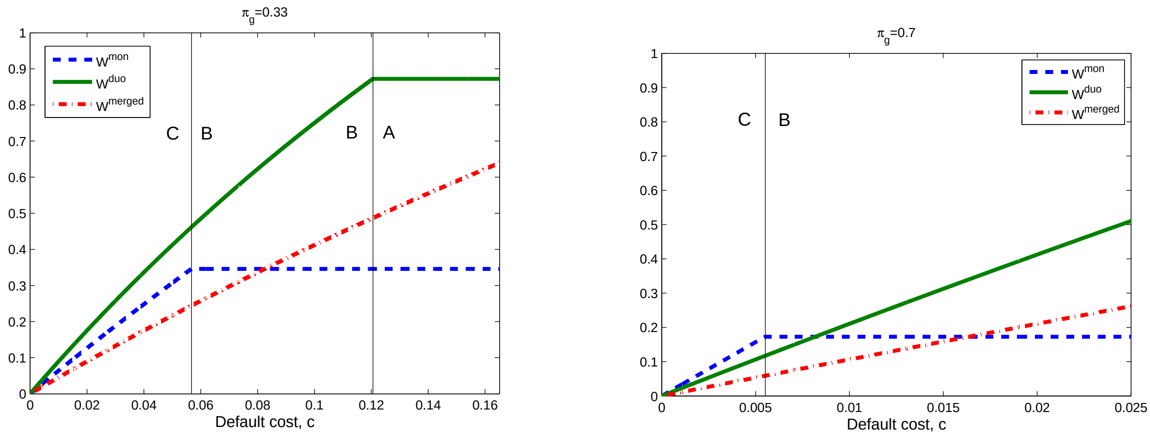
$$\frac{p_{AA}(\mathbf{0})R - 1}{2(1 - \pi_g)} \leq c < \frac{p_{AA}(\mathbf{0})R - 1}{1 - \pi_g} \tag{16}$$

or cater less, as rating standards are always higher if agencies in a duopoly cater ratings

$$p_{AA}(\rho^*) = \frac{2c(1 - \pi_g) + 1}{R} > \frac{c(1 - \pi_g) + 1}{R} = p_{AA}(\tilde{\rho}^*) \tag{17}$$

The somewhat surprising result in Proposition 2 is that moving from a (merged) monopoly to a duopoly may leave welfare unchanged if agencies do not have commitment problems in either market structures. Thus, the standard intuition, that a duopoly always leads to lower deadweight loss compared to a monopoly breaks down in the current setup. The fundamental source of inefficiency here is signal noise, which results in the financing of some bad projects and also prevents the financing of some good projects. Hence, welfare is only increasing with the quantity of financed good projects, while in the standard model welfare is generally increasing with quantity. If information is held fixed welfare cannot change beyond an upper bound by changing market structure, as both market structures use the information in the most efficient way (i.e. only allowing the financing of projects with two a signals).

Proposition 2 also implies that a merger does not increase information rents. This is because agencies in a duopoly do not compete in fees, but extract all the gains from trade. However, if there were more than two agencies, there could be incentives to merge as more



(a) Low share of good projects

(b) High share of good projects

Figure 5: Welfare and market structure. Vertical lines indicate parameter regions, corresponding to the regions introduced in Figure 2. Parameters are: $\alpha = 0.05$ and V_g is set such that $\mu_{aa}p_{aa} + 2\mu_{ab}\bar{V} = -0.1$. In panel (a) $V_g = 0.17$, in panel (b) $V_g = 0.03$.

agencies could lead to equilibria where agencies are forced to compete in rating fees.[32] On the other hand, merging does have the benefit that default costs only have to paid by one agency after the merger.

The additional signal of the merged agency is only welfare improving compared to a monopoly if the default cost is sufficiently high. However, the additional signal also undermines commitment through two channels. First, it increases the value of its honest rating, which enables the agency to increase its fee. This makes rating manipulation more tempting. Second, the merged agency can now cater the ratings for issuers with mixed signals, that are better, on average, than issuers who's ratings may be considered for inflation in a monopoly. This decreases the expected default cost, due to the more sophisticated selection of manipulated projects.

Figure 5 illustrates how welfare changes with the default cost in a monopoly (dashed line), a duopoly (solid line) and a merged agency (dash-dot line). As stated in Proposition 2, welfare after a merger is never greater than welfare in a duopoly. The point where a merged agency caters for every second issuer with mixed signals ($\tilde{\rho}^* = 1/2$) corresponds to the intersection of W^{merger} (dash-dot line) and W^{mon} (dashed line). Since at this default cost level the monopolist always finds it optimal not to inflate ratings ($\epsilon^* = 0$), the welfare measures will always coincide at the corresponding default cost level. The value of $\underline{c}$ used in Proposition 2 is zero on both panels of Figure 5.[33]

4 Empirical Implications

Issuers always find it optimal to purchase both offered A ratings in equilibrium. Since investors are rational and the average issuer has a negative NPV project, issuers cannot shop

[32] This prediction is in line with the history of mergers in the ratings industry. Becker and Milbourn (2011) illustrates the multiple mergers that led to the appearance of Fitch. Also, S&P is a result of the 1941 merger between Standard Statistics and Poor's Publishing. On the other hand, the two dominant agencies led to a stable market structure in recent decades.

[33] However, in some extreme cases, when the share of good projects (π_g) is very low, the welfare measures could intersect again for some default cost level close to (but still above) zero.

ratings by only disclosing the most favorable one.

The two largest agencies, S&P and Moody's both cover virtually all corporate bonds in the US, which is consistent with the predictions of the model. However, Bongaerts et al. (2012) reject the hypothesis that this behavior is due to the informativeness of the second and third rating, while in the model the only motive to purchase a rating is to convey information as I abstract from regulatory advantages. Also, my model stays silent on the role of unsolicited ratings as in equilibrium revealing unsolicited ratings does not increase the bargaining power of agencies.[34] Hence, in this respect the model better fits evidence from the structured segment. Griffin et al. (2013) report that about 85% of AAA rated capital in the CDO market was rated by both Moody's and S&P. Furthermore, they also find that having an additional AAA rating paid off to issuers on average, as it increased the funds they could raise by more than the cost of the additional rating, which suggests that investors valued the second rating.

I show that agencies in a duopoly always choose to first cater ratings and only if they have catered to everyone will they consider assigning inflated preliminary ratings. By using the other agency's information agencies minimize their liability. This supports the empirical findings of Griffin et al. (2013) who manage to reconstruct agency model implied ratings and conclude that an agency was more likely to make upward adjustments to model implied ratings when the other agency's model was more optimistic. Taking a broader perspective, a group of papers find that agencies selectively manipulate the ratings of those who they anticipate future business from. Alp (2013) reports that rating standards deteriorated in the junk bond segment from 1985 to 2002, as agencies anticipated expansion in that segment. Hau et al. (2013) and Efing and Hau (2015) provide further evidence that banks who bought lucrative business to agencies received favorable treatment. They show that ratings are more inflated for issuers who bring more business and adjustments are larger for complex deals.[35]

Models of rating shopping usually generate an inverse relationship between rating precision and manipulation (Bolton, Freixas, and Shapiro, 2012; Skreta and Veldkamp, 2009). The intuition is as follows. Naive investors fail to account for the strategic behavior of issuers, who may selectively disclose their ratings. Thus, if the rating technology is more precise, issuers will not have that many opportunities to shop ratings. In contrast, if the rating technology becomes more precise[36] in the model presented here, it will usually lead to increased levels of rating catering and inflation, since information is now more valuable, which increases the temptation to manipulate ratings.

There is a consensus in the literature that incentive conflicts were more widespread in the structured segment than in the corporate segment. Proponents of rating shopping argue that rating structured products is more difficult due to their complexity, which, in turn, leads to less precise signals and more shopping. In contrast, my model suggests that the structured segment's problems were magnified by the perception, that a very precise rating technology was available to agencies. While addressing this question is beyond the scope of this paper, it does seem to be the case that initial rating of corporations (i.e. for their first bond issuance) is more costly than the rating of a structured product. Langohr and Langohr

[34]Fulghieri et al. (2014) build a model to analyze the role of unsolicited ratings while Bannier et al. (2010) investigate empirically why unsolicited ratings are lower on average.

[35]As noted in Michalek (2010) the profit margins for rating new complex products was the highest in the structured segment and being among the first to rate these yielded future business: "Since these novel structures and deals were by definition high value added, they attracted a generous ratings fee. Thus, the new structure and new instrument represented a future cash flow to the rating agency that successfully rates that structure/instrument. The managers in the [Moody's Structured Derivative Products] Group were understandably eager to land that future cash flow [...]."

[36]I.e. the fixed cost of obtaining a rating technology decreases.

(2010) report that rating corporations takes 6 to 12 weeks, and involves "thorough review of business fundamentals, including judgments about the company's competitive position and evaluation of management and its strategies."[37] In contrast, rating a structured product is fundamentally a quantitative exercise, which does not require the evaluation of qualitative information, like the business strategy of a corporation. As a former Moody's employee testified (Michalek, 2010), the rating "process would have taken anywhere from 4-8 weeks for CBOs and CLOs, and in some cases, longer. As more and more issuances took the form of "series" deals [...], the timeline compressed enormously." Furthermore, deals usually required at most two analysts.[38] Another way to quantify overall rating precisions across different segments is to compare rating transition probabilities. This is addressed by Standard & Poors (2008). Interestingly, they report that the long term (up to the end of 2007) average of one-year downgrade probabilities from AAA and AA notches[39] is higher for corporates than for CDOs. Similarly, Cornaggia et al. (2015) find that the 5 year downgrade probability from Moody's Aaa notch is higher for corporates than for structured products, though they do find higher long run default rates for Aaa rated structured products. Finally, one can directly evaluate the ex post performance of structured products. Park (2011) examines the performance of subprime mortgage backed securities. She reports that until 2011 only 0.17% of AAA rated MBS deals issued between 2004 and 2007 suffered principal losses. Consistent with the model of this paper, the above suggest that rating precision (even if it was only perceived) might have played a crucial role in the behavior of rating agencies.[40]

As emphasized already, the model provides a strong intuition why the ex ante payoff characteristics of rated projects may play an important role in determining the socially optimal market structure and they can also shed light on why correctly assessing the risk of structured debt was so challenging for agencies. As Benmelech and Dlugosz (2009) point out, in the structured segment originators could easily design their products to get the optimal rating-cost combination with software provided by rating agencies. Additionally, originators' primary goal was to obtain AAA ratings for the senior tranches, which then could be marketed as safe assets. However, as I have shown above, in an environment where projects have low risk (provide low return with high probability) agencies in a duopoly may have a strong incentives to cater ratings. On the other hand, corporations face greater uncertainty regarding the outcome of the rating process as it is less transparent to them. Baghai et al. (2014) provide both indirect and direct evidence that corporations take into account offered ratings in their issuance decisions, which suggests that a non trivial fraction of corporations opt-out from issuing debt at the end of the rating process. In turn, the corporate segment might be less vulnerable to catering.

5 Concluding remarks

This paper analyzes how market structure affects the opportunities to manipulate credit ratings during the rating process. To this end, the rating process is modeled in detail, allowing agencies to learn about each other's assessments during the rating process. The analytically tractable framework makes it possible to analyze the efficiency implications of market structure, recognizing that the optimal method of rating manipulation varies with market

[37] p. 162.

[38] "Note that the [Moody's] Derivatives Group in NY was, at the time I left, the only group that I knew to retain - in general - the "two analysts per deal" staffing structure, and during the last two years of my tenure an increasing number of deals were being rated in NY by only one analyst." (Michalek, 2010)

[39] As Griffin et al. (2013) report, 75-80% of CDO capital issued had AAA ratings from at least one of the agencies.

[40] Coval et al. (2009) make a similar point when they emphasize that agencies neglected how sensitive their ratings were to modeling assumptions.

structure.

I show that a monopoly may lead to higher efficiency, even if the combined information of agencies in a duopoly is superior. This is surprising given that investors fully understand the incentive structure. When issuers seeking finance offer low return assets with a high probability of success (similarly to safe assets) agencies in a duopoly will have a strong incentive to cater ratings whenever the other agency has a more optimistic assessment.

The model presented here makes many assumptions in order to keep it tractable, some of which deserve further investigation. First, it is likely that agencies have an influence on the rating technology that they use. In particular, given signal(s), the rating technology described here holds constant the composition of projects, whereas in reality there is a trade-off between the probabilities of misclassifying good projects as bad and bad projects as good. This is investigated in a companion paper (Farkas, 2016). Second, the welfare analysis abstracts from the cost of information production. In a duopoly if both agencies invest into information acquisition it will lead to an efficiency loss, since most of the time they will agree. However, the incentives to maintain the overall precision of the rating technology may be much lower in a duopoly due to learning, which mitigates the redundancies in information acquisition. Third, I only compare a monopoly with a duopoly, while the prevailing market structure consists of three larger agencies and a competitive fringe. Finally, allowing investors to learn from the cross section of ratings could serve as an important discipling device for agencies. These are left for future work.

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6 Appendix

Proof of Lemma 1. In an equilibrium (3) will be maximized subject to (4) and (5). There are two cases. If (4) holds with a strict inequality, it is optimal for the agency not to inflate ratings, implying $\epsilon^* = 0$. It follows that equilibrium beliefs satisfy $\hat{p}_A = p_A(0)$. This gives the condition $c(1 - p_B) \geq p_A(0)R - 1$ for $\epsilon^* = 0$. Now consider the case when $c(1 - p_B) < p_A(0)R - 1$. It is clear that $\epsilon^* = 0$ can no longer be part of an equilibrium, as if investors were to believe that $\hat{p}_A = p_A(0)$, the agency would always want to inflate all ratings. Also, $\epsilon^* = 1$ cannot be part of any equilibrium, because of Assumption 1. Thus, $0 < \epsilon^* < 1$ has to hold. Since the profit function is linear in ϵ, the agency must be indifferent about inflation in equilibrium. This will be satisfied if (4) holds with an equality. Finally, combining (4) with (3) gives an equation, that exactly has one solution in ϵ^*, as $p_A(\epsilon)$ is strictly decreasing in ϵ. The result is shown in the main text.

Proof of Lemma 2. First, consider the symmetric equilibrium strategy of issuers who are offered $\tilde{A}$ ratings from both agencies. In a symmetric equilibrium, where agencies can only use pure strategies ($f_1 = f_2$), the following must hold:

$$D(\tilde{A}, \tilde{A}, f_1, f_2) = [q, q, p, 1 - p - 2q],$$

where function outputs correspond to action probabilities 'purchase agency 1's rating', 'purchase agency 2's rating', 'purchase both' and 'purchase none', respectively. Now consider the case when $p > 0$ and $q > 0$. This would imply that issuers with $\{\tilde{A}, \tilde{A}\}$ offered ratings are indifferent between purchasing both or purchasing only one A rating from one of the agencies. In turn, issuers with mixed offered ratings always want to purchase their A rating in order to pool with $\{\tilde{A}, \tilde{A}\}$ issuers who only purchase a single rating. Hence, $D(\tilde{A}, \tilde{B}, f_1, f_2) = [1, 0, 0, 0]$ and $D(\tilde{B}, \tilde{A}, f_1, f_2) = [0, 1, 0, 0]$. Also, the marginal value of a second A rating $((\hat{p}_{AA} - \hat{p}_{A,\emptyset})R)$ has to be equal to the equilibrium rating fee. With such strategies it is easy to show that agencies always have an incentive to marginally decrease their fees. If agency 1 decreases its fee marginally, there will be two effects. First, there will be a jump in agency 1's fee revenue, as issuers with $\{\tilde{A}, \tilde{A}\}$ offered ratings now find it optimal to always purchase agency 1's rating. Second, since agency 1 is selling ratings in a higher proportion to issuers with $\{\tilde{A}, \tilde{A}\}$ offered ratings, its expected default cost per issuer will decrease. Both effects increase agency profits. However, fees cannot be arbitrarily low, as this will prevent agencies from providing ratings. Thus, there is no symmetric equilibrium with $p > 0$ and $q > 0$, since agencies either want to decrease fees or they do not want to provide ratings at all. Second, consider the case when $p = 0$ and $q > 0$. In this case agencies have an incentive to compete in fees and the same argument holds as above. Third, consider the case when $0 < p < 1$ and $q = 0$. In this case agencies would want to marginally decrease fees so issuers respond by $p = 1$. Hence, the only candidate left is $p = 1$ and $q = 0$. This implies that issuers with contradictory offered ratings cannot pool with $\{\tilde{A}, \tilde{A}\}$ issuers, leading to $D() = [0, 0, 0, 1]$ for all issuers who are not offered $\tilde{A}$ by both agencies. The equilibrium strategy of issuers gives the profit function (9). Consider its partial derivatives of the profit (denoted by π), with respect to ρ_1 and ϵ_1: $\frac{\partial \pi}{\partial \rho_1}\frac{\partial \pi}{\partial \epsilon_1}$. Assume that in equilibrium $0 < \epsilon_1^* < 1$ and $0 < \rho_1^* < 1$. This implies that both partial derivatives must equal zero. However, it is easy to show that this leads to a contradiction. Similarly, the candidates in which (i) $\epsilon_1^* = 1$ and $0 < \rho_1^* < 1$ and (ii) $0 < \epsilon_1^* < 1$ and $\rho_1^* = 0$ also lead to contradictions. Hence, the only candidates left are those in which

$$\frac{\partial \pi}{\partial \epsilon_1} < 0, \frac{\partial \pi}{\partial \rho_1} < 0,$$

implying $\rho_1^* = \epsilon^* = 0$ (region A in Figure2),

$$\frac{\partial \pi}{\partial \epsilon_1} < 0, \frac{\partial \pi}{\partial \rho_1} = 0,$$

implying $0 < \rho_1^* < 1$ and $\epsilon^* = 0$ (region B+C in Figure2),

$$\frac{\partial \pi}{\partial \epsilon_1} < 0, \frac{\partial \pi}{\partial \rho_1} > 0,$$

implying $\rho_1^* = 1$ and $\epsilon^* = 0$ (region D in Figure2), and

$$\frac{\partial \pi}{\partial \epsilon_1} = 0, \frac{\partial \pi}{\partial \rho_1} > 0,$$

implying $\rho_1^* = 1$ and $0 < \epsilon^* < 1$ (region E in Figure2). It is easy to show, that given agency 2's strategy and a parameters, exactly one of the above condition pairs will hold. Hence, what is left to show is that given that one condition holds, there is only a unique symmetric equilibrium. The marginal cost of catering is $c(1-\pi_g)$ if there is no inflation and $c(1-p_{BB})(> c(1-\pi_g))$ if there is inflation, while the marginal cost of inflation is always $c(1-p_{BB})$. Since the cost of catering is smaller, $(p_{AA}(\mathbf{0})R-1)/2 \leq c(1-\pi_g)$ has to be satisfied for the no catering/no inflation equilibrium. If $(p_{AA}(\mathbf{0})R-1)/2 > c(1-\pi_g) > (p_{AA}(0,0,1,1)R-1)/2$ then the symmetric equilibrium catering level will be implied by

$$c(1-\pi_g) = (p_{AA}(0,0,\rho^*,\rho^*)R-1)/2$$

which has exactly one solution as $p_{AA}(\dot{)}$ is strictly decreasing in ρ_1 and ρ_2. The solution gives equilibrium ρ^* to be

$$\rho^* = \frac{\mu_{aa}[p_{AA}(\mathbf{0})R - 1 - 2c(1-\pi_g)]}{2\mu_{ab}[2c(1-\pi_g) - \bar{V}]}$$

If $\frac{p_{AA}(0,0,1,1)R-1}{2(1-\pi_g)} > c > \frac{p_{AA}(0,0,1,1)R-1}{2(1-p_{BB})}$ will imply that catering all ratings ($\rho^* = 1$) is optimal, and no inflation is also optimal as the marginal cost of inflation $c(1-p_{BB})$ is larger than the equilibrium rating fee $\frac{p_{AA}(0,0,1,1)R-1}{2}$. Finally, if $c < \frac{p_{AA}(0,0,1,1)R-1}{2(1-p_{BB})}$ the agency will find it optimal to inflate ratings. The symmetric equilibrium level of inflation is implied by

$$c = \frac{p_{AA}(\epsilon^*,\epsilon^*,1,1)R-1}{2(1-p_{BB})},$$

which has a unique solution as the success probability is strictly decreasing in inflation. The solution for ϵ^* is implied by

$$2\epsilon^* - \epsilon^{*2} = \frac{(\mu_{aa} + 2\mu_{ab})[p_{AA}(0,0,1,1)R - 1 - 2c(1-p_{BB})]}{\mu_{bb}[2c(1-p_{BB}) - (p_{BB}R-1)]}$$

Proof of Corollary 1.

$$\frac{p_{AA}(\mathbf{0})R-1}{2(1-\pi_g)} - \frac{p_A(0)R-1}{(1-p_B)} > \frac{p_A(0)R-1}{2(1-\pi_g)} - \frac{p_A(0)R-1}{(1-p_B)} \underbrace{>}_{2(1-\pi_g)<1-p_B} 0$$

Proof of Corollary 2. It is easy to show that

$$\frac{p_A(0)R-1}{(1-p_B)} > \frac{p_{AA}(0,0,1,1)R-1}{2(1-p_{BB})}$$

$$\epsilon^{mon} > \epsilon^{duo} \text{ for } c = 0$$

The first inequality implies that the monopolist will start to inflate at a higher default cost level. The second inequality says that at $c = 0$ inflation in a monopoly will always be larger. Given these, the only way $\epsilon^{mon} < \epsilon^{duo}$ can occur, is if $\epsilon^{mon} = \epsilon^{duo}$ has two (or more) roots in c on the interval where $\epsilon^{duo} > 0$ and $c \geq 0$. However, this can easily be ruled out as the equation $\epsilon^{mon} = \epsilon^{duo}$ has exactly two roots and one of them is always negative.

Proof of Corollary 3. Proof of (i): when agencies do not manipulate in equilibrium, rating standards are unaffected by marginal changes in c. However, when they do manipulate, rating standards will be increasing in c, because[41]

$$\frac{\partial p_A(\epsilon^*)}{\partial c} = \frac{1-p_B}{R} > 0$$

$$\frac{\partial p_{AA}(0,\rho^*)}{\partial c} = \frac{2(1-\pi_g)}{R} > 0$$

$$\frac{\partial p_{AA}(\epsilon^*,\rho^*)}{\partial c} = \frac{2(1-p_{BB})}{R} > 0$$

Proof of (ii): when agencies do not manipulate ratings, it is clear that $p_A(0)$ and $p_A(\mathbf{0})$ are strictly increasing in $1-\alpha$, which gives the result. When agencies do manipulate in equilibrium,

$$\frac{\partial p_A(\epsilon^*)}{\partial \alpha} = -\frac{c}{R}\frac{\partial p_B}{\partial \alpha} < 0,$$

$$\frac{\partial p_{AA}(0,\rho^*)}{\partial \alpha} = 0$$

$$\frac{\partial p_{AA}(\epsilon^*,\rho^*)}{\partial c} = -\frac{2c}{R}\frac{\partial p_{BB}}{\partial \alpha} < 0,$$

which lead to the result. Proof of (iii): if there is manipulation in equilibrium,

$$RS^{mon} = 1 + c(1-p_B) - \pi_g R$$

and

$$RS^{duo} = 1 + 2c(1-\pi_g) - \pi_g R \quad \text{or} \quad RS^{duo} = 1 + 2c(1-p_{BB}) - \pi_g R,$$

which are all clearly decreasing in R. Otherwise $RS^{mon} = R(p_A(0) - \pi_g)$ and $RS^{duo} = R(p_{AA}(\mathbf{0}) - \pi_g)$, which are clearly increasing in R if the signals are informative, $\alpha < 1/2$. Proof of (iv): p_B and p_{BB} are increasing in π_g, which imply that $p_A(\epsilon^*)$ and $p_{AA}(\epsilon^*,\rho^*)$ are decreasing in π_g, which is sufficient for the result.

Proof of Corollary 4. First, observe that rating standards in a monopoly and duopoly will be equal if $\rho^* = 1/2$ in a duopoly and $\epsilon^{*mon} = 0$. The c that implements $\rho^* = 1/2$ is $c = \frac{p_A(0)R-1}{2(1-\pi_g)}$. From Corollary 1 it is clear that if $2(1-\pi) < 1-p_B$ then a monopoly will find $\epsilon^{*mon} = 0$ to be optimal at this point. Now if c marginally decreases then a monopolist will still not inflate, while agencies in a duopoly will choose $\rho^* > 1/2$, which imply that rating standards in the monopoly will be higher.

Proof of Lemma 3. Proof of part (i):

$$W^{duo}(0) - W^{mon}(0) = \frac{-\mu_{ab}\bar{V}}{\pi_g V_g}$$

Proof of part (ii):

$$W^{duo}(1/2) = \frac{(\mu_{aa} + \mu_{ab}/2 + \mu_{ba}/2)(p_{AA}(0,1/2)R-1)}{\pi_g V_g} = \frac{(\mu_{aa}+\mu_{ab})(p_A(0)R-1)}{\pi_g V_g} = W^{mon}(0),$$

since $\mu_{ab} = \mu_{ba}$ and $p_{AA}(0,1/2) = p_A(0)$.

[41] With a slight abuse of notation, let $p_{AA}(\epsilon^*,\rho^*) = p_{AA}(\epsilon^*,\epsilon^*,\rho^*,\rho^*)$.

Proof of Proposition 1. In order to rank welfare, one needs to solve for the paramaters, where $W^{mon}(\epsilon^*) = W^{duo}(\rho^*)$. There are two regions to consider. First, in region B it is clear that one needs to find a solution to $W^{mon}(0) = W^{duo}(1/2)$. The solution to this is

$$\bar{c}(\alpha, \pi_g, V_g) = \frac{\pi_g V_g(1-\alpha) - \alpha(1-\pi_g)}{2(1-\pi_g)(\mu_{aa}+\mu_{ab})}$$

Second, there may be a second solution in region C, where the monopoly inflates ratings in equilibrium, $W^{mon}(\epsilon^* > 0) = W^{duo}(\rho^* > 1/2)$. The solution to this is

$$\underline{c}(\alpha, \pi_g, V_g) = \frac{(1-2\alpha)[1+\alpha(2\pi_g-1)(1-\pi_g+\pi_g V_g) + \pi_g(2\pi_g+V_g-3)]}{2(1-\alpha)(1-\pi_g)(\mu_{aa}+\mu_{ab})}$$

Finally, at $c = 0$: $W^{mon}(\epsilon^*) = W^{duo}(\rho^*) = 0$. It is easy to show that if $\bar{c}(\alpha, \pi_g, V_g)$ does not exist, then $\underline{c}(\alpha, \pi_g, V_g)$ also does not exist and $W^{duo}(\rho^*) > W^{mon}(\epsilon^*)$ always. If $\bar{c}(\alpha, \pi_g, V_g)$ does exist then there are two cases. Either the solution to $\underline{c}(\alpha, \pi_g, V_g)$ does not exist (as on the right panel of Figure 3) and $W^{duo}(\rho^*) > W^{mon}(\epsilon^*)$ for all $c < \bar{c}(\alpha, \pi_g, V_g)$ or the solution to $\underline{c}(\alpha, \pi_g, V_g)$ does exist, in which case $W^{duo}(\rho^*) < W^{mon}(\epsilon^*)$ for all $\underline{c}(\alpha, \pi_g, V_g) < c < \bar{c}(\alpha, \pi_g, V_g)$ and $W^{duo}(\rho^*) > W^{mon}(\epsilon^*)$ for $c < \underline{c}(\alpha, \pi_g, V_g)$ (this happens on the left panel of Figure 3). The function $\bar{\pi}_g(\alpha, V_g, c)$ is the inverse of $\underline{c}(\alpha, \pi_g, V_g)$ with respect to π_g, which is well defined as $\underline{c}(\alpha, \pi_g, V_g)$ is strictly decreasing in π_g.

Proof of Poposition 2, part (iii).[42] It is clear that when $\tilde{\rho}^* < 1/2$, the merger of two agencies always produces higher welfare than a monopoly. Also, $\tilde{\rho}^* = 1/2$ is optimal when $\frac{p_A(0)R-1}{1-\pi_g} = c$. At this default cost level, the monopolist always finds it optimal not to inflate ratings ($\epsilon^* = 0$). It follow that at this point the welfare measures will cross, and if c is marginally smaller than $\frac{p_A(0)R-1}{1-\pi_g}$ then welfare in a merger will always be smaller, as in this case $\tilde{\rho}^* > 1/2$ and $\epsilon^* = 0$.

[42]Note that statements in (i) and (ii) directly follow from the inequalities (16) and (17).