

# The Credit Ratings Game

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## Abstract

The collapse of AAA-rated structured finance products in 2007-2008 has brought renewed attention to conflicts of interest in Credit Ratings Agencies (CRAs). We model competition among CRAs with three sources of conflicts: 1) the CRA conflict of understating risk to attract business; 2) the issuers' ability to purchase only the most favorable ratings; and 3) the trusting nature of some investor clienteles. These create two distortions. First, competition can reduce efficiency, as it facilitates ratings shopping. Second, ratings are more likely to be inflated in booms and when investors are more trusting. We also discuss efficiency enhancing regulatory interventions.

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“*[The investment] could be structured by cows and we would rate it*”

- Analyst at one of the main credit rating agencies in an e-mail referring to structured finance products, April 5, 2007<sup>1</sup>

The analyst in the above statement refers to a key dilemma for credit rating agencies: how should they act when their principal source of revenue comes from the firms whose products they are rating? This potential source of conflict has repeatedly been brought to the public’s [and regulators’] attention, in particular following the East Asian Financial Crisis (1997), and in the aftermath of the failures of Enron (2001) and Worldcom (2002), but it has never been so salient as in the recent financial crisis. Indeed, while credit rating agency (CRA) profits exploded with the growth of structured finance products (Moody’s profits, for example, tripled between 2002 and 2006<sup>2</sup>), the large number of downgrades of these securities from 2007 onwards fostered suspicion that ratings standards had been relaxed during the boom years. Along with these allegations of possible conflicts of interest for CRAs, many commentators have also reproved (institutional) bond investors for their excessive reliance on ratings, and for not doing their homework in independently assessing default risk. The combination of CRA reliance on fees from issuers, investors who were too trusting, and issuers looking to benefit from the mispricing of their issues could have led to substantial ratings inflation with important systemic consequences.

In this paper, we combine these elements in a model of credit ratings and CRA competition to analyze the equilibrium outcome of ratings and the efficiency consequences of possible equilibrium ratings inflation. The model gives rise to two fundamental equilibrium distortions. First, competition among CRAs may reduce market efficiency since it facilitates ratings shopping by issuers and results in excessively high *reported* ratings. We show in particular that, as a result of issuer shopping, efficiency may be higher under a monopoly CRA than under a duopoly despite the potential for the increased informativeness of two ratings. Second, CRAs are more prone to inflate ratings in boom times, when there is a

larger clientele of investors in the market who take ratings at face value, and when the risks of failure which could damage CRA reputation are lower.

Thus, the key building blocks of our model are:

- *Issuer payments for ratings:* In practice, CRA fees involve both a fee at the time of issuance and an annual fee for as long as the issue is outstanding. Importantly, while CRAs have list price schedules, they may renegotiate fees with regular customers (White (2002)).<sup>3</sup> In addition, CRAs offered related consulting services, such as pre-rating assessments.
- *Issuer shopping for ratings:* In practice, as in our model, an issuer pays a CRA only if it asks the CRA to make the rating public.<sup>4</sup> Also, if an issuer is unhappy with a rating, it may solicit another one.<sup>5</sup>
- *CRA credit models may vary in precision:* We consider CRA credit-risk models that provide imperfect assessments of default risk. As Deven Sharma, president of S&P, declared: “Events have demonstrated that the historical data we used and the assumptions we made significantly underestimated the severity of what has actually occurred”.<sup>6</sup>
- *CRAs can make ‘adjustments’ to their credit-risk model outputs:* As Griffin and Tang (2010) show in their study of credit ratings of structured products, CRAs used *noisy* credit-risk models, to which they made frequent adjustments before determining the final rating. Importantly for our analysis, they show that these adjustments tended to shift the rating upwards relative to the model-predicted rating.
- *Reputation concerns for CRAs:* As rating agencies executives often argue, CRAs are concerned with maintaining their reputation for providing timely and accurate assessments of (changes in) default risk. Accordingly, we introduce in our model a reputation cost CRAs incur in the event that an issue they rated highly ends up in default. Short

term gains from inflating an issue's quality can thus be smaller in our model than long term reputation losses from jaded investors.

- *Barriers to entry in the credit rating industry:* We confine our analysis to competition between two CRAs. However, it is possible but somewhat tedious to extend our analysis to the case of three CRAs, which is broadly the current market structure in the credit rating industry. This high concentration of CRAs is a reflection of large barriers to entry into this industry. One 'artificial' barrier has been established by the SEC, which created the *Nationally Recognized Statistical Rating Organization* (NRSRO) category in 1975, to designate CRAs whose ratings were recognized as being valuable for investment decisions. Although seven firms initially had this designation, mergers brought this down to three (Standard & Poor, Moody's, and Fitch) and the SEC did not admit new firms until recently.<sup>7</sup> Since Congress, local governments, and regulatory agencies adopted this designation, this has according to White (2002) resulted in an "absolute barrier to entry". The extremely high profit margins of CRAs are also emblematic of a highly concentrated industry.
- *Sophisticated and 'trusting' investor clienteles:* Some of the potential investors in rated issues are sophisticated and understand a CRA's potential conflicts of interest; they are thus able to see through ratings inflation. On the other hand, a significant fraction (which may vary) of investors are trusting, in that they take the CRAs' ratings at face value. This coexistence of trusting and sophisticated investors may be due to different types of incentives to perform due diligence. Trusting investors, for example, may be pension fund managers, whose compensation only marginally depends on the ex-post return of the assets they manage. Moreover, the more complex the investments, the more costly it may be to uncover their value. Sophisticated investors, on the other hand, could be hedge funds, whose returns depend more directly on the profitability of the investment. Regulation that forces managers to only purchase investments with good ratings could also provide incentives to be trusting.<sup>8</sup> Boot, Milbourn, and Schmeits

(2005), in a study of the CRA credit watch mechanism, also model investors who take ratings at face value, calling them institutional investors. Similarly, Hirshleifer and Teoh (2003) model investors with “limited attention and processing power”. More generally, this allows for a rich and subtle interaction between two different investor clienteles (which seems of the essence for CRAs) and contributes to the literature on differences of opinion.<sup>9</sup>

Incorporating these key features into our model, we demonstrate under what situations ratings inflation is more likely to occur, what its impact is on market efficiency, and what the impact of regulatory proposals is likely to be. Furthermore, we examine empirical implications of the model and evidence from current studies on CRAs and structured finance products. We now summarize these points.

Our most important result is that, in general a duopoly ratings industry is less efficient than a monopoly. The reason is that, although in a duopoly investors could obtain more information, the issuer has more opportunities to shop for a good rating and to take advantage of trusting investors by only purchasing the best ratings. By extending the model to two periods to allow for endogenous reputation, we further show that the greater efficiency of a monopoly CRA holds for any parameter constellation. This result is consistent with the findings of Becker and Milbourn (2009), who show that the greater competitive threat posed by Fitch in the corporate bond market coincides with a deterioration in ratings quality.

CRAs may inflate the quality of the issuer’s investment when there are more trusting investors in the market and/or when CRA expected reputation costs are lower. As these features are common to entire classes of issues of similar characteristics, ratings inflation is not just about idiosyncratic attributes of a single issuer but has systemic effects. In particular, in boom times, when more investors are trusting and the probability of getting caught is smaller, more ratings inflation is likely to occur. This result is consistent with the findings of Ashcraft, Goldsmith-Pinkham and Vickrey (2009), who show that ratings of mortgage-backed securities were least accurate at the peak of the real-estate boom. We also

show that more precise CRA credit-risk models both enhance CRA payoffs from inflating their ratings and increase their probability of getting caught ex-post, so that their overall effect is ambiguous.

We also show that when an issuer is more important to a CRA, either because it is a repeat issuer or because it has larger issues, the CRA is more prone to inflate that issuer's ratings. This result is in line with the findings of He, Qian and Strahan (2010), who show that CRAs rated large structured product issuers more favorably, and Faltin-Traeger (2009), who finds that repeat issuers are more likely to stick with the same CRA if they received a more favorable early rating.

Lastly, we analyze reforms to the industry in the context of our model. The Cuomo plan, which is an agreement between New York State Attorney General Andrew Cuomo and the three main CRAs, requires that the issuers pay CRAs upfront for their rating, not contingent on the report. In our model, this plan eliminates the incentives for CRAs to inflate ratings, but does not eliminate shopping. Therefore mandating automatic disclosure of any ratings solicited is necessary to get rid of the shopping distortion.<sup>10</sup> The upfront fees may, however, undermine CRA incentives to invest in model accuracy and due diligence, making oversight on methodology potentially important.

While we dedicate section 7 to empirical evidence, we offer a summary of the related theoretical literature below.

### **Related Theoretical Literature**

There is by now a substantial literature on information intermediaries in both microeconomics and finance. The paper closest to ours is Mathis, McAndrews and Rochet (2009), who examine the incentives of a monopoly CRA to inflate ratings in a model of endogenous reputation.<sup>11</sup> They find that reputation cycles may exist where a CRA builds up its reputation by relaying information accurately only to exploit this reputation later by collecting fees for inflated ratings. They also demonstrate that truth-telling incentives are weaker when the CRA has more business from rating complex products. While their model endogenizes reputation, it restricts them to analyzing only a monopolist and to define a complex product

simply as one where the CRA's reputation is at stake. By making the large assumption that reputation is exogenous, we are able to examine the effects of competition and include a wealth of parameters on which we can perform comparative statics. Nevertheless, we endogenize reputation in a simple repeated game in section 5 to show that our results are indeed robust.

In the microeconomics literature, information intermediaries are modeled as engaging in acquiring and certifying information by committing to disclosure rules, as for example in Biglaiser (1993) and Lizzeri (1999). In contrast, credit rating agencies don't commit to information disclosure rules and their incentives come from the possible reputation costs they incur when they provide inaccurate information. This is akin to the issues financial analysts face when they recommend stocks, as analyzed by Benabou and Laroque (1992) and by Morgan and Stocken (2003). The model of Morgan and Stocken (2003) also addresses the issue of unverifiable information provision, when the certifier can lie but thereby incurs a lying cost (this problem is examined further in Kartik, 2009, Kartik, Ottaviani, and Squintani, 2007, and Ottaviani and Sorensen, 2006).

Although our signaling game is simpler in some respects, we extend the analysis relative to this literature by examine how strategic contracting between the informed party (the CRA) and an interested party (the issuer in our case) can affect information revelation. Our problem is also related in this respect to the economics literature on strategic contracting when the information revealed affects a third party, which covers a wide number of microeconomic issues (see Inderst and Ottaviani, 2008, Durbin and Iyer, 2009, and Mariano, 2008). In Pagano and Volpin (2010), CRAs have no conflicts of interest, but can choose to be more or less opaque depending on what the issuer asks for. They show that because of the existence of a winner's curse, opacity can enhance liquidity in the primary market but may cause a market freeze in the secondary market.

In Bolton, Freixas, and Shapiro (2007), we analyze a situation of strategic contracting where the informed parties (banks) set prices for their products at the same time as providing recommendations about them to uninformed investors. We show that competition

unambiguously reduces banks' incentives to oversell their products. Interestingly, this turns out not to be the case in our model of conflicts for CRAs. The reason is that CRA ratings are as likely to be complements as substitutes and issuers may choose to purchase ratings from both CRAs in equilibrium. Also, the presence of trusting investors distorts CRA incentives to inflate ratings in the same way, whether in a duopoly or a monopoly. In contrast, in Bolton, Freixas, and Shapiro (2007), information revelation came from the banks' need to differentiate their products.

Several related papers have studied other implications of shopping for good ratings. Faure-Grimaud, Peyrache and Quesada (2009) look at corporate governance ratings in a market with truthful CRAs and rational investors. They show that issuers may prefer to suppress their ratings if they are too noisy. They also find that competition between rating agencies can result in less information disclosure. Skreta and Veldkamp (2009) and Sangiorgi, Sokobin and Spatt (2009) also assume that CRAs truthfully relay their information and demonstrate how noisier information creates more opportunity for shopping by issuers to take advantage of a naive clientele.

Farhi, Lerner, and Tirole (2010) are concerned with how certifiers such as rating agencies or academic journals position themselves with respect to the transparency and coarseness of their certifications. While they allow for heterogeneity among certifiers, they set aside reputation effects and the incentives to produce generous ratings or certifications. They examine the strategy of sellers (our issuers) when they face certifiers that differ in their standards. When a fail for the high level certification is not disclosed, then sellers may opt first for an ambitious certification strategy (approaching certifiers with higher standards first) provided the non-disclosure of the fail is not transparent. This strategy is related to ratings shopping, as the result in both cases is that market does not observe negative information.

The paper is organized as follows: In Section 1, we write down the model and solve the case for a single CRA. In Section 2, we analyze the case of competition between two CRAs. Section 3 compares efficiency in the two market structures. Section 4 takes the conclusion from Section 3 that competition decreases efficiency and examines its robustness. Section 5

investigates different plans to regulate the credit rating industry. Section 6 lays out empirical implications of the model and surveys the evidence. Finally, Section 7 concludes.

## 1 The Model

We consider three types of *risk neutral* agents: issuers, credit ratings agencies (CRA), and a mass 1 of investors. Funds from investors are sought by issuers for independent investments in multiple periods, although we will focus primarily on the analysis of a single issue in the first period.

An investment is characterized by its probability of default: a *bad* investment defaults with probability  $p > 0$ , and a *good* investment defaults with probability zero. Either type of investment yields the same return  $R$  when not in default, and 0 in default<sup>12</sup>. The investment has constant returns to scale, so that each unit issued has the same return profile.

All agents believe ex-ante that the investment is good with probability  $\frac{1}{2}$ . This creates a role for the CRA, which can use its technology to find out whether the investment is good or bad. A signal  $\theta \in \{g, b\}$  which is private information of the CRA has the following informational content about the true type  $\omega$  of the investment:

$$\Pr(\theta = g \mid \omega = g) = \Pr(\theta = b \mid \omega = b) = e,$$

The variable  $e$  measures the quality of the signal received, which we will refer to as the *precision* of the signal. At  $e = \frac{1}{2}$  the signal has revealed no information and agents retain their ex-ante beliefs. For  $e > \frac{1}{2}$ , the signal becomes informative. We assume that the level of precision is known and lies in the interval  $(\frac{1}{2}, 1)$ .

The CRAs post their fee  $\phi$  at which a rating can be purchased before they receive the signal. When they are approached by an issuer CRAs proceed to retrieve the signal  $\theta$  and produce a credit report. After observing the report, the issuer has the choice whether to pay  $\phi$  to have the CRA's proposed rating distributed, or to refuse to purchase it. In other words,

we allow the issuer to “shop” for ratings. This timing is meant to capture in a simple way the back and forth negotiations that often go on when CRAs make their ratings reports.<sup>13</sup> If the issuer shops and refuses to buy the CRA’s report, that in itself is a signal, which conveys information to investors.

The published rating is a message or report of  $m = G$  (“Good”) or  $m = B$  (“Bad”) that is observable to investors. Once the rating is announced, or if it is not announced due to the issuer’s refusal to purchase it, the issuer sets a uniform price  $T$  for the investment. Since the cost of production of the investment is normalized to zero, we can interpret the price  $T$  as a *spread*. Investors, after observing the rating and the price  $T$ , finally decide how much of the investment to purchase.

There are two types of investors, *sophisticated* and *trusting*. A fraction  $1 - \alpha$  of investors is sophisticated. These investors observe the payoffs of the game for both the CRA and the issuer, and therefore understand the CRA’s and issuer’s potential conflict of interest. They do not know, however, whether the investment is good or bad, as they do not observe the signal of the CRA and they only have access to the CRA’s report. Trusting investors assume that CRAs always truthfully rate the investment and therefore take CRAs’ ratings at face value. Also, when they don’t observe a rating these investors simply retain their ex-ante beliefs. Sophisticated investors, on the other hand, rationally update their beliefs.

One way to motivate the coexistence of trusting and sophisticated investors is to observe that different types of investors have different incentives to perform due diligence. Trusting investors may be managing third party investments and their pay may only depend marginally upon the realized return of the assets they manage<sup>14</sup>. Sophisticated investors’ incentives on the other hand may be investing their personal funds or their pay may be more closely tied to realized returns.

If investors find out that a CRA inflated its rating, they *punish* the CRA in future periods by ignoring its reports. At the time the rating is issued, however, investors cannot determine whether the rating is truthful or not. More formally, they cannot determine whether the rating  $m \in \{B, G\}$  is equal to the signal received by the CRA  $\theta \in \{b, g\}$ . But they are able

to find out ex-post whether the CRA lied in the event of a default. In practice it is difficult to determine whether a CRA misled investors even ex-post. Still, it is generally easier to make that determination ex-post rather than ex-ante. To simplify the analysis we make the somewhat extreme assumption that investors can perfectly identify whether the CRA lied in the event of a default.<sup>15</sup>

Hence, if the CRA receives a signal  $\theta = g$  and reports  $m = G$ , then if the investment fails the CRA will not be punished, as investors can see that it acted in *good faith*. However, a CRA who receives a signal  $\theta = b$  and reports  $m = G$  will be punished if the project fails. Reputation costs create an incentive for CRAs to tell the truth, since investors can eventually learn and punish the CRA. We denote the reputation cost by  $\rho$ . This is the discounted sum of future CRA profits, which are available when the CRA is not caught lying.<sup>16</sup> To simplify the analysis we follow Morgan and Stocken (2003), Ottaviani and Sorensen (2008), and Bolton, Freixas, and Shapiro (2007) by assuming that reputation costs are exogenously given. This allows us, in particular, to explore policy implications in a tractable manner.

For tractability, we also assume that the reputation  $\rho$  at stake is slightly noisy:

**Assumption A0:** There is a tiny amount of uncertainty on the part of the CRA about the actual value of  $\rho$ , i.e.  $\rho \in [\tilde{\rho} - \varepsilon, \tilde{\rho} + \varepsilon]$  such that  $\varepsilon \rightarrow 0$ . This uncertainty is resolved when the CRA receives its signal.

This assumption restricts the CRA's strategy space since for any small amount of uncertainty, however small, it will be unable to set fees exactly at levels to make itself indifferent between reports. Thus, this small uncertainty limits the CRA to pure strategies.

Investors can either purchase 1 unit or 2 units of the investment. We assume that they have a reservation utility that is increasing in the size of their investment, specifically they need a return of  $u$  on the first unit of their investment and a return of  $U$  on the second unit, where  $U > u$ .<sup>17</sup> One may think of this in several ways: it could be an investor holding her money in cash and needing a larger return to invest all of it, a need for a higher return in order to commit to only one investment vehicle and not diversify, or a form of risk aversion.

We make the following assumptions on the returns on investment:

$$(1 - p)R > u \tag{A1}$$

$$(1 - (1 - e)p)R > U \tag{A2}$$

$$(1 - \frac{p}{2})R < U \tag{A3}$$

Assumption A1 says that an investor who knows the investment is bad is willing to purchase 1 unit. Assumption A2 says that an investor with reliable information that the investment is good is willing to purchase 2 units. The information problem is explicit in assumption A3: not knowing whether an investment is good or bad (and evaluating the investment with the ex-ante beliefs), an investor is not willing to purchase 2 units. This implies that if the CRA did not exist, the issuer would not be able to sell 2 units to any investor since the probability that the issue is bad is too large. The CRA can therefore potentially improve market efficiency by providing information. These assumptions are standard<sup>18</sup> and are necessary to create a value enhancing role for CRAs through information provision.

To simplify our expressions for payoffs, we introduce the following notation:

$$\begin{aligned} V^G &= (1 - (1 - e)p)R - U \\ V^B &= (1 - ep)R - u \\ V^0 &= (1 - \frac{p}{2})R - u \end{aligned}$$

The terms  $V^G$  and  $V^B$  represent the marginal value<sup>19</sup> to sophisticated investors when the CRA truthfully reports  $m = G$  and  $m = B$ , respectively. They also represent the marginal value to trusting investors when the CRA reports  $m = G$  and  $m = B$ , whether truthfully or not. The term  $V^0$  is the marginal value to investors who maintain their ex-ante beliefs about the value of the investment.

## The Ratings Game with a single CRA

We begin by examining the game with a monopoly CRA. The timing of moves in this game is as follows:

1. The CRA posts its fee  $\phi$ .
2. The CRA receives the signal and then makes a report of  $m = G$  or  $m = B$ .
3. The issuer observes the report and decides whether to buy and distribute it or not. The issuer then sets a price  $T$  for a unit of the investment.
4. Investors observe the price  $T$  and the CRA rating, if there is any, and decide how much of the investment to purchase.
5. The investment return is realized.

When the monopoly CRA receives a signal it must decide what to report. The issuer must decide whether to purchase the report, and subsequently how much to charge investors. Sophisticated investors must infer how good the investment is and formulate their willingness to pay<sup>20</sup>. We solve the game backwards, beginning with the CRA decision of what report to issue after observing the signal.

**Lemma 1** *Given the fee  $\phi$ , the CRA's reporting strategy is:*

1. *For  $\phi > e\rho\rho$ , the CRA inflates ratings (always reports  $G$ )*
2. *For  $0 < \phi < e\rho\rho$ , the CRA reports the truth, relaying its signal perfectly.*

The proof is in the internet appendix.

When the CRA offers a  $B$  rating, the issuer responds by not purchasing this rating, as it only decreases investor valuations. The CRA therefore only obtains the fee  $\phi$  when it offers the  $G$  rating. There are thus two possible reporting regimes, one where the CRA inflates the investment quality (when the fee is larger than the expected reputation cost) and one where the CRA truthfully reveals the investment quality (when the fee is smaller than the expected reputation cost).

We proceed next to derive the equilibrium fees the CRA sets under each informational regime.

**Proposition 1** *The equilibrium of the fee setting game is:*

1. *If  $\alpha 2V^G - V^0 > e\rho$ , the CRA inflates ratings, sets  $\phi = \alpha 2V^G - V^0$  and has profits*

$$\alpha 2V^G - V^0 + \left(1 - \frac{ep}{2}\right)\rho,$$

2. *If  $\alpha 2V^G - V^0 < e\rho$ , the CRA reports truthfully, sets  $\phi = \min[2V^G - \max[\alpha V^0, V^B], e\rho]$ , and has profits*

$$\frac{1}{2} \min[2V^G - \max[\alpha V^0, V^B], e\rho] + \rho.$$

The proof is in the internet appendix.

The proposition establishes that the CRA maximizes its profits by choosing ratings inflation over truthtelling whenever the profits from ratings inflation ( $\alpha 2V^G - V^0$ ) are larger than the expected reputation cost  $e\rho$ .<sup>21</sup> Overstating the quality of the investment is an equilibrium outcome, despite the presence of reputation costs. This is also a point that Mathis, McAndrews, and Rochet (2009) make.

The cutoff  $\alpha 2V^G - V^0 - e\rho$  determines whether the CRA inflates the quality of the investment. Thus, when reputation costs are smaller and the size of the trusting audience larger, the CRA is more likely to take advantage of trusting investors by inflating ratings. Conversely, when reputation costs are larger and the size of the sophisticated audience larger, the CRA is more likely to tell the truth and create information for all investors. This suggests that ratings inflation is more likely in boom times when investors have lower incentives to perform due diligence, as the ex-ante quality of investments is then higher. Note also that an increase in the precision of the signal  $e$  has competing effects. It raises the expected valuation of trusting investors, giving higher short term returns to the CRA. On the other hand, it also increases the likelihood that the CRA gets caught if it misled investors, decreasing future returns.

## 2 Competition among Ratings Agencies

We next examine the game where two ratings agencies compete in selling ratings to issuers. The CRAs can be thought of as having differentiated products since they are receiving imperfect ( $e < 1$ ) signals about the quality of the investment. In addition, two ratings provide *more* information than just one rating, so the issuer may want to purchase both. The timing of the game with competition is similar to the game with one CRA:

1. Each CRA posts a fee  $\phi_k$ , where  $k = 1, 2$  represents the firm.
2. The CRAs receive their signals and produce reports of  $m = G$  or  $m = B$ ,
3. The issuer observes the reports and decides whether to purchase and distribute one, both, or neither report. It then sets a price  $T$  per unit of the investment,
4. Investors observe the report(s) purchased by the issuer and decide how much of the investment to purchase,
5. The return is realized.

Again to simplify our expressions for payoffs, we adopt the following notation:

$$V^{GG} = \left(1 - \frac{(1-e)^2}{(1-e)^2 + e^2 p}\right)R - U,$$

$$V^{BB} = \left(1 - \frac{e^2}{(1-e)^2 + e^2 p}\right)R - u$$

The terms  $V^{GG}$  and  $V^{BB}$  represent the marginal value to sophisticated investors when both CRAs truthfully report  $m = G$  and  $m = B$ , respectively. They also represent the marginal value to trusting investors when both CRAs report  $m = G$  and  $m = B$ , respectively, whether truthfully or not. The marginal value to trusting investors when one CRA reports  $m = G$  and the other reports  $m = B$  is  $V^0$ , the ex-ante marginal value before any information is obtained about the investment.

To simplify the analysis, we make the following assumption about the marginal value of an additional positive report:<sup>22</sup>

$$\alpha 2V^G - V^0 > 2(V^{GG} - V^G) \quad (\text{A4})$$

This means that the value of the first  $G$  report for trusting investors is larger than the value of a second  $G$  report for all investors. This assumption is a way of expressing decreasing returns to  $G$  reports. It is slightly stronger than standard decreasing returns. This assumption is always satisfied if the precision  $e$  is sufficiently high (close to one) or sufficiently low (close to one-half) as in those cases,  $V^{GG} = V^G$ .

We also make the following assumption:

$$\alpha 2V^G - V^0 - \min[2(V^{GG} - V^G), e\rho\rho^D] < e\rho\rho^D \quad (\text{A5})$$

This condition guarantees existence of the truthtelling equilibrium by preventing one CRA from unilaterally deviating to inflating its ratings and catering only to trusting customers. If this condition did not hold, there would be less truthtelling in duopoly, which would only strengthen our results on the efficiency of monopoly in sections 3 and 4. Lastly, we assume that

$$\frac{V^0}{2V^G} < \frac{V^{BB}}{V^0}. \quad (\text{A6})$$

This is not critical to the results at all, but simplifies the exposition<sup>23</sup>.

We denote the discounted sum of future profits in a duopoly for each CRA if it is not caught lying by  $\rho^D$ . Again this is an exogenous variable as in the case of monopoly.<sup>24</sup> As before, we solve the game backwards, beginning with the decision of what report to issue after observing the signal.

**Lemma 2** *For a given set of fees for both CRAs, CRA  $k$ 's reporting strategy is:*

1. *If  $\phi_k > e\rho\rho^D$ , the CRA inflates ratings (always reports  $G$ ).*

2. If  $\phi_k < e\rho^D$ , the CRA reports the truth, relaying its signal perfectly.

The proof is the same as that of Lemma 1. We next solve for the equilibrium of the fee setting game.

**Proposition 2** *The equilibrium of the fee setting subgame (assuming A4-A6 hold) is:*

1. If  $\alpha 2(V^{GG} - V^G) > e\rho^D$ , both CRAs always report  $G$ ,  $\phi_k = \alpha 2(V^{GG} - V^G)$  for  $k = 1, 2$  with CRA profits given by

$$\alpha 2(V^{GG} - V^G) + (1 - \frac{ep}{2})\rho^D.$$

2. If  $\alpha 2(V^{GG} - V^G) < e\rho^D$ , both CRAs report truthfully,  $\phi_k = \min[2(V^{GG} - V^G), e\rho^D]$  for  $k = 1, 2$  with CRA profits given by

$$\min[2(V^{GG} - V^G), e\rho^D] + \rho^D.$$

The proof is in the internet appendix.

There are thus two possible equilibria: one where both CRAs always inflate the quality of the investment, and one where both CRAs reveal truthfully their information about the investment. The cutoff determining which equilibrium prevails is whether the current payoff from inflating ratings  $\alpha 2(V^{GG} - V^G)$  is larger or smaller than the expected cost of getting caught  $e\rho^D$ .

In general, with a larger fraction of sophisticated investors and a larger reputation cost there will be more truthtelling. An increase in the precision of the signal, however, creates a trade-off. The probability of getting caught is rising in the precision, making truthtelling more likely. But, the current payoff from manipulating ( $\alpha 2(V^{GG} - V^G)$ ) is increasing for low precision levels, meaning that truthtelling is less likely. However, in contrast to the case of monopoly, for high precision levels the current payoff is decreasing in the precision, meaning that current and future incentives are aligned in making truthtelling more likely.

Comparing the outcome under competition to the case of a monopoly CRA – where the cutoff for truth-telling is whether  $\alpha 2V^G - V^0 - e p \rho$  is larger than zero or not – we find that, as the marginal value of a CRA positive report is decreasing, the payoff to inflating ratings is larger in a monopoly. Still, it is likely that  $\rho > \rho^D$ , since the expected loss of business should be larger in monopoly, which may mitigate the increase in fees available to the monopolist. Note, however, that if trusting investors were to overestimate the precision of the CRAs’ reports, the incentive to inflate would be very strong irrespective of market structure (current payoffs increase, future costs don’t change). Ashcraft and Schuermann (2008) support the idea of overestimation, “Credit ratings were assigned to subprime MBS with significant error. Even though the rating agencies publicly disclosed their rating criteria for subprime, investors lacked the ability to evaluate the efficacy of these models.” Lastly, if we define shopping as taking place when there are less than two  $G$  signals ( $\Pr(\text{Shopping}) = 1 - \Pr(\text{two } G \text{ signals})$ ), we find that shopping increases in duopoly when precision decreases<sup>25</sup>. Skreta and Veldkamp (2009) also point out that less precise signals imply more ratings shopping by issuers.

### 3 Market Efficiency

We now turn to the evaluation of the efficiency of equilibrium outcomes. Note that in our model it is not completely obvious what the relevant efficiency benchmark is, as we have a fraction of investors who are trusting. We consider total ex-ante surplus,<sup>26</sup> evaluating expected surplus for all agents from the point of view of a sophisticated agent, thus adopting a paternalistic point of view. In other words we take the view that one role of financial regulation is to protect trusting investors from mistakes they may make based on faulty information. The main motivation for this view is that trusting investors would support such regulations with the benefit of hindsight once their naivete is exposed.

We begin by establishing two benchmarks for total surplus, the first best and the market

solution when there are no CRAs. The first best (subscript FB) is given by:

$$\begin{aligned} W_{FB} &= \frac{1}{2}(2R - u - U) + \frac{1}{2}((1 - p)R - u) \\ &= V^0 + \frac{1}{2}(R - U) \end{aligned}$$

The top expression is given by the probability that the investment is good multiplied by the surplus created when investors purchase two units plus the probability the investment is bad multiplied by the surplus when only one unit is purchased.

The market solution when there are no CRAs (subscript 0) is just given by

$$W_0 = V^0,$$

since both trusting and sophisticated investors would then only purchase one unit. Therefore the maximum surplus that can be gained through the provision of credit ratings is given by  $\frac{1}{2}(R - U)$ , the extra unit purchased when the investment is good.

We now analyze the total surplus in each regime for both monopoly and duopoly. In the total surplus calculations we add the surplus of investors, credit rating agencies and issuers. The fees of credit rating agencies and the prices charged by issuers net out. Note also that we exclude future surplus from our welfare calculations and look only at efficiency in the short run, as our reputation parameters  $\rho$  and  $\rho^D$  are exogenous. Finally, note that assumption A4 implies that  $\alpha 2V^G - V^0 > 0$ , or  $\alpha > \frac{V^0}{2V^G}$ . We therefore examine total surplus (and investor surplus) only for the interval  $\alpha \in [\frac{V^0}{2V^G}, 1]$ .

1. Monopoly CRA, ratings inflation regime ( $\alpha 2V^G - V^0 > epp$ ):

Only trusting investors purchase at the high prices, as the rating reveals no positive information to sophisticated investors. Since trusting investors believe the investment is good, they invest 2 units. Total surplus is then:

$$W_M^G = \alpha[V^0 + (V^0 + u - U)]. \tag{1}$$

(where the subscript  $M$  refers to the monopoly and superscript  $G$  refers to the fact that the CRA always reports  $G$ ).

This expression is positive, although it may be quite small. The first term in the expression in square brackets is our market solution when there are no CRAs and is positive, while the second term is negative by A3. Hence, as intuition suggests, the presence of a credit rating agency reduces surplus in this scenario.

2. Monopoly CRA, truthtelling regime ( $\alpha 2V^G - V^0 < e\rho\rho$ ):

There are two subcases here, depending on how the issuer prices the investment when there is no report (interpreted correctly by sophisticated investors as a  $B$  report that was not purchased). First, when  $\alpha V^0 < V^B$  the issuer optimally sets its price low enough so as to sell the issue to both types of investors. Total surplus then equals:

$$W_{MT1} = V^0 + \frac{1}{2}V^G \quad (2)$$

As expected, the surplus is higher than when there is no CRA as  $V^G > 0$  by assumption A2. As the precision approaches  $e = 1$ , the surplus approaches the first best.

When  $\alpha V^0 > V^B$ , there is an additional distortion, because the issuer then sets its price high (when there is no report) to cater only to trusting investors. In this subcase, total surplus is obviously smaller:

$$W_{MT2} = V^0 + \frac{1}{2}V^G - \frac{1-\alpha}{2}V^B \quad (3)$$

3. Duopoly, ratings inflation regime ( $\alpha 2(V^{GG} - V^G) > e\rho\rho^D$ ):

Total surplus here is exactly the same as when there is a monopoly CRA who always reports  $G$ . Trusting investors purchase 2 units and sophisticated investors purchase nothing. The split of rents between CRAs and the issuer, however, is different here, as the issuer can earn more than  $V^0$  per investor due to competition. If there is a fixed

operating cost for CRAs, this would be less efficient than the case of a monopoly CRA. Both an inflating monopoly and an inflating duopoly are less efficient than a market without CRAs.

4. Duopoly, truthtelling regime ( $\alpha 2(V^{GG} - V^G) < e p \rho^D$ ):

When  $\alpha \in [\frac{V^0}{2V^G}, \frac{V^{BB}}{V^0}]$ , the issuer sets the price so as to cater to both types of investor when there is no report. Total surplus then equals:

$$W_{DT1} = (e^2 + 2e(1-e)\alpha + (1-e)^2)V^0 + \frac{1}{2}(e^2 - (1-e)^2)(R-U) \quad (4)$$

$$+ (2e(1-e)\alpha + (1-e)^2)(V^0 + u - U)$$

In contrast, when the fraction of trusting investors is large ( $\alpha \in [\frac{V^{BB}}{V^0}, 1]$ ) and when there are no  $G$  reports the issuer sets a high price at which only trusting investors purchase. Trusting investors are also the only ones to purchase when there is only one  $G$  report. Thus, the total surplus is the same as in equation (4), minus the surplus lost from the fact that the issuer targets only trusting investors:

$$W_{DT2} = (e^2 + 2e(1-e)\alpha + (1-e)^2)V^0 + \frac{1}{2}(e^2 - (1-e)^2)(R-U) \quad (5)$$

$$+ (2e(1-e)\alpha + (1-e)^2)(V^0 + u - U)$$

$$- \frac{1-\alpha}{2}[(1-e)^2(R-u) + e^2((1-p)R-u)]$$

Comparing these expressions for total surplus we find a surprising result: truthtelling in duopoly yields a lower surplus than truthtelling in monopoly. We establish this in the following proposition:

**Proposition 3** *Given Assumptions A0-A6, a truthtelling monopoly strictly dominates a truthtelling duopoly.*

The proof is in the internet appendix.

A duopoly is less efficient because there are more opportunities for the issuer to take advantage of trusting investors. This can occur when one CRA reports  $G$  and one reports  $B$ , or when both report  $B$ . In contrast, under a monopoly CRA there is only the opportunity to shop when the monopoly CRA reports  $B$ . As a result, issuers set high prices that exclude sophisticated investors from the market when, from an efficiency perspective, they should be participating. Also, the additional information of the second report is wasted. This is predicated on the fact that assumption A4 places a lower bound on the number of trusting investors, since clearly shopping doesn't occur when all investors are sophisticated.

When this result is coupled with the fact that a duopoly is as efficient as a monopoly when both are inflating the quality of the investment (and less efficient if we consider operating costs), this suggests that competition among information intermediaries may be detrimental when shopping is allowed. More formally, conditional on being in the same informational regime, monopoly increases total surplus. Therefore, policy proposals encouraging entry may not be the best methods to increase efficiency. This is in line with the evidence presented in Becker and Milbourn (2009), who document less accurate ratings in the corporate bond market due to more competition from Fitch.

### **Are there any benefits to competition?**

Our result that competition among CRAs reduces market efficiency is obtained by comparing outcomes under a monopoly and duopoly for the same informational regime. A natural question then is whether there can be any benefits to competition when the informational regime differs across market structures. Consider first the comparison of monopoly and duopoly under different information regimes. It is easy to see that a truthtelling monopoly not only dominates a truthtelling duopoly but also a duopoly in which CRAs inflate ratings. But does a monopoly CRA that inflates ratings dominate a truthtelling duopoly? The next lemma establishes that this is *not* the case.

**Lemma 3** *Total surplus for a truthtelling duopoly is larger than that of a monopoly CRA who inflates ratings.*

The proof is in the internet appendix.

This lemma underscores the harmful effects of CRA ratings inflation relative to issuer shopping. The parameters for which both scenarios can occur simultaneously depend on the intersection of the following two inequalities:

1.  $\alpha 2(V^{GG} - V^G) < e\rho\rho^D$ , which guarantees that CRAs in a duopoly prefer to rate truthfully, and
2.  $\alpha 2V^G - V^0 > e\rho\rho$ , which ensures that a monopoly CRA prefers to inflate ratings to attract more issuers.

Note first that these inequalities can only hold in both market structures if the measure  $\alpha$  of trusting investors is small. Otherwise, the financial rewards for CRAs from inflating their ratings and overselling the issue to trusting investors are just too high. Note, moreover, that truth-telling in the duopoly is more likely when the informational value of a second rating is low ( $V^{GG}$  close to  $V^G$ ). Thus, somewhat paradoxically, a CRA duopoly dominates a monopoly only in situations when the marginal value of a second CRA is small. Moreover, in the following section we demonstrate that when reputation is endogenized, the CRAs will be in the same information regime for all parameters, which implies that monopoly is always more efficient.

Finally, note that even when a duopoly dominates a monopoly, this does not imply that competition is efficient, as the negative effects from issuer shopping remain. It is straightforward to show that reducing competition to create a *regulated duopoly*, in which issuers are required to purchase a rating from both CRAs, would be welfare superior to an unregulated duopoly.<sup>27</sup> Indeed, under such a regulation: *i*) CRAs would always strictly prefer to rate truthfully, as the purchase of their rating is then no longer contingent on its content; *ii*) issuer shopping would be eliminated; and, *iii*) issues would be rated based on the maximum available information. In fact, without the CRA conflict of interest and issuer shopping, total surplus would be equal to the first-best (constrained, of course, by the precision of the CRAs' information).<sup>28</sup>

## 4 Endogenous Reputation

We now explore the effect of endogenizing reputation costs in a fully specified dynamic model. The endogenous reputation cost from being caught inflating ratings is the cost in foregone future ratings sales. The simplest way of extending our model to allow for such an endogenous reputation cost is to consider a two-period version, in which the payoff weight attached to the second period is given by a parameter  $\beta$  (as, for example, in Laffont and Tirole, 1993), where  $\beta$  may be larger than 1. The size of the parameter  $\beta$  then represents the importance of future relative to current profits for the CRAs. Thus, for example, at the onset of an issuance boom, future capitalized CRA profits are likely to be large, so that  $\beta$  is large. In contrast, at the end of an issuance boom and at the onset of a recession  $\beta$  is small.

Consider first the situation of a monopoly CRA. The simplification obtained from the two-period formulation is that we can solve the game backwards starting from the second period (taking as given that the CRA has not been caught inflating ratings in the first period). As the second period is the last period, there are no more reputation concerns that discipline the CRA, so that the CRA always inflates its ratings. From A4, we know  $\alpha 2V^G - V^0 > 0$ , so that the CRA's optimal policy in the second period is to sell the overrated issue only to trusting investors and thus realize a positive profit of  $\alpha 2V^G - V^0$ . In period 1, *endogenous reputation costs* from foregone future profits are then given by  $\rho = \beta(\alpha 2V^G - V^0)$ . With such an endogenous reputation cost the CRA then inflates ratings in period 1 if and only if

$$(\alpha 2V^G - V^0) > ep\beta(\alpha 2V^G - V^0),$$

or

$$\beta < \frac{1}{ep}.$$

This simple analysis of the dynamic CRA monopoly thus reveals that with endogenous reputation costs a CRA is more likely to engage in ratings inflation when future profits matter less, as towards the end of an issuance boom. This is consistent with both the

theoretical results of Mathis, McAndrews, and Rochet (2009) and the empirical findings of Ashcraft, Goldsmith-Pinkham and Vickery (2010).

Consider next the situation of a duopoly CRA. Once again, the two CRAs inflate ratings in period 2, as there are no costs in being caught inflating ratings. Each CRA's best response in the second period is to sell the overrated issue only to trusting investors and thus realize a positive profit of  $\alpha 2(V^{GG} - V^G)$ . In period 1 then, *endogenous reputation costs* from foregone future profits are given by  $\rho^D = \beta \alpha 2(V^{GG} - V^G)$ . In period 1 a CRA duopoly that inflates ratings, in which each CRA earns  $\alpha 2(V^{GG} - V^G)$ , is then an equilibrium if and only if

$$\alpha 2(V^{GG} - V^G) > ep\beta \alpha 2(V^{GG} - V^G),$$

or again

$$\beta < \frac{1}{ep}.$$

This implies:

**Proposition 4** *In the model with endogenous reputation costs, in the first period*

- i) The CRA(s) report truthfully in both monopoly and duopoly iff  $\beta \geq \frac{1}{ep}$*
- ii) The CRA(s) inflate ratings in both monopoly and duopoly iff  $\beta < \frac{1}{ep}$*

Thus, with endogenous reputation costs, it is the same condition which determines whether a monopoly CRA or a duopoly CRA will rate truthfully in period 1 or not. In other words, in our simple dynamic extension with endogenous reputation costs, the equilibrium information regime is the same across market structures, so that a monopoly always dominates a duopoly in this situation. This simple analysis thus suggests that making reputation endogenous may well strengthen our efficiency results rather than weaken them. It would be of interest (but beyond the scope of this paper) to explore these issues more systematically in a fully general dynamic game, possibly with an infinite horizon. There is currently no model of oligopolistic competition over an infinite horizon in the CRA literature; indeed there are very few such models in the industrial organization literature for obvious reasons

of tractability.<sup>29</sup>

## 5 Regulating the Credit Ratings Industry

The subprime crisis has brought to light the poor performance of CRAs in rating structured financial products and reminded investors of CRAs' past poor performance in predicting the East Asian crisis, the excesses of the dotcom bubble, and the collapse of Enron. Governmental bodies have been debating how to regulate CRAs and some initial rules have been issued.

In this section we discuss the most prominent proposals in the context of our model. In our view, the key issues which the proposals seek to address are:

1. eliminating the CRA conflicts of interest by preventing issuers from influencing ratings
2. preventing issuers from shopping for ratings and disclosing only ratings they prefer, and
3. monitoring the quality of the ratings methodology.

New York State Attorney General Andrew Cuomo reached an agreement<sup>30</sup> with credit ratings firms to change some features of the rating process in the summer of 2008. The agreement between Cuomo and Standard & Poor's, Moody's, and Fitch essentially addresses the first point, preventing issuers from paying for specific ratings and forcing issuers to pay the CRA upfront before it does its initial analysis.<sup>31</sup> This restriction can eliminate ratings inflation by CRAs in our model by eliminating the issuer's ability to provide incentives for good ratings<sup>32</sup>. Importantly, however, it does not eliminate shopping by an issuer; an issuer may still reach an agreement with a CRA to not publish a bad rating. In our model, issuer shopping can create distortions even with unbiased CRA ratings due to the trusting nature of some investors. There have been several moves to decrease CRA conflicts of interest. The SEC recently enacted a rule which prohibits consulting activity related to ratings by CRAs.

The Dodd-Frank financial reform bill states that ratings must be explicitly separated from sales and marketing.<sup>33</sup>

Prohibiting shopping by enforcing that CRAs must automatically disclose any rating that was paid for by an issuer would achieve the first best surplus<sup>34</sup> in our model when combined with the Cuomo plan. The SEC currently has a proposed rule that would formalize this prohibition. Nevertheless, shopping may be difficult to eliminate because of informal discussions between issuers and CRAs that may still take place. This points to a possible need for auditing by a regulator.

Even by eliminating shopping from the Cuomo plan, there is a risk for an efficiency loss due to moral hazard. Suppose the precision of the signal  $e$  were a choice variable of the CRA and larger precision is more costly. If the CRA can choose this precision after being paid upfront<sup>35</sup> and it is non-contractible then the CRAs would choose the minimum precision of  $\frac{1}{2}$  and knowing this, the issuer would not hire the CRA in the first place. Therefore there would be a breakdown in the market for certification.

Interestingly, our main model with no regulation shows that adding the observable choice of precision in monopoly will lead to positive investment by the CRA since the issuer pays contingent fees. Still, our total surplus calculations show that breakdown of the CRA market could still be a better outcome than a CRA who inflates quality, but worse than an a CRA who tells the truth. Consequently, it is crucial that the new regulatory structure for CRAs is accompanied by oversight of minimum analytical standards for the CRAs (and these standards are set appropriately and could be enforced), so as to regain the beneficial aspects summarized above. The Dodd-Frank bill discusses analytical standards and mandates the SEC to issue rules regarding training, experience and competence for CRA analysts and procedures and methodologies for ratings themselves.

One last approach to improving ratings quality lies in enhancing the market's ability to punish CRAs. In our model, this would increase the reputation cost, making truth-telling more likely. The SEC has issued some rules forcing CRAs to disclose their track record, making their performance more transparent. More importantly, the Dodd-Frank bill lowers

the bar for liability claims against CRAs. CRAs had been "immune from misstatements under Section 11 of the Securities Act of 1933" and have won most cases against them based on the arguments that credit ratings are free speech and are "extensively disclaimed" (Partnoy (2002)). Therefore eliminating this immunity could impose serious costs on CRAs for ratings inflation.

## 6 Empirical Implications

This paper demonstrates that competition among CRAs can reduce market efficiency due to the shopping effect and provides a framework for understanding the trade-offs in recent policy proposals regarding the credit rating industry. In this section we examine evidence surrounding testable implications of the model. We conclude by discussing systematic evidence related to our assumption that investors are trusting.

The model offers several hypotheses for testing:

1. The model shows that poor quality ratings are increasing in the fraction of trusting investors, current payoffs, and decreasing in the expected probability of getting caught (the reputation cost). While it is difficult to measure these variables, all three of these factors are more likely to occur in boom times and less likely to occur in recessions: when times are good, the probability of defaults are lower, which may decrease due diligence on the part of investors and also decrease evidence of ratings bias. Moreover, as a follow-on effect this can increase demand and issuance, generating larger fees for CRAs. Hence the implication of the model is to examine whether poor ratings quality is more likely during boom times.
2. As opposed to other theoretical papers, ratings inflation can arise in our model purely due to conflicts of interest and not shopping. Empirically, we can attempt to exploit the lack of shopping possibilities in the corporate bond markets to see if conflicts of interest (the trade-off between higher current profits and expected future profits) have

some explanatory power. Variables which affect current and future profits, such as the degree of competition can be related to ratings quality.

3. We show in the section on competition that shopping is more likely when the CRAs' models are less precise.
4. Shopping is used by issuers to exploit trusting investors. Hence if shopping is occurring, investors are not taking into account the selection effect. This means that shopping type behavior causes (i) yields to be more dependent on ratings and (ii) fewer ratings to imply worse ex-post performance.

We make use of a set of very recent empirical papers focused on CRAs and ratings quality to examine our hypotheses. In order to do so, we interpret the investment in our model broadly as applying to both the corporate bond markets and structured finance products (indeed, in the internet appendix we explicitly model the restructuring process). We attempt to point out where institutional details either benefit or detract from the model.

The implication that ratings inflation is more likely to happen in boom times has been documented in several recent papers. Ashcraft, Goldsmith-Pinkham, and Vickery (2010) find that as mortgage backed security issuance volume shoots up in 2005 to mid-2007, ratings quality declines. Specifically, subordination levels<sup>36</sup> for subprime and Alt-A MBS deals decrease over this time period when conditioning on the overall risk of the deal. Moreover, subsequent ratings downgrades for the 2005 to mid-2007 cohorts are dramatically larger than for previous cohorts. Griffin and Tang (2010) find that CRA adjustments to their models' predictions of credit risk in the CDO market were positively related to future downgrades. These adjustments were overwhelmingly positive and the amount adjusted (the width of the AAA tranche) increases sharply from 2003 to 2007 (from 6% to 18.2%). The adjustments are not well explained by natural covariates (such as past deals by collateral manager, credit enhancements, other modeling techniques). Furthermore, 98.6% of the AAA tranches of CDOs in their sample failed to meet the CRAs' reported AAA standard (for their sample

from 1997 to 2007). They also find that adjustments increase CDO value on average by \$12.58 million per CDO.

On the relationship between current payoffs and ratings inflation, He, Qian, and Strahan (2010) find that MBS tranches sold by larger issuers<sup>37</sup> performed significantly worse (market prices decreased) than those sold by small issuers during the boom period of 2004-2006. Faltin-Traeger (2009) shows that when one CRA rates more deals for an issuer in a half-year period than another CRA, the first CRA is less likely to be the first to downgrade that issuer's securities in the next half-year. He also finds that if a CRA rates a deal higher, that CRA is more likely to be chosen by the issuer on the issuer's next deal. This effect is strongest for Fitch.

Our model isolates two basic causes of poor ratings quality: conflicts of interest (ratings inflation) and shopping. While it is difficult to isolate these in reality, an interesting comparison arises between the corporate bond market and the structured finance market. First, in the corporate bond market, S&P and Moody's rate virtually every rated issue. This implies there is little scope for shopping there. Nevertheless, our model suggests the trade-off between current profits and future payoff may still influence ratings quality. Becker and Milbourn (2009) find supporting evidence: they show that increases in market share by Fitch (a proxy for more competition) lead to higher ratings. Moreover, this evidence suggests that more competition may not be better, even when shopping is not as much of an issue.

Second, the methodology for rating corporate bonds is more standardized and the bonds themselves are much less complicated than structured finance products. Our paper suggests shopping is more likely when the CRAs' models are less precise, which is certainly the case comparing corporate bonds to structured finance. Within the structured finance arena, Ashcraft, Goldsmith-Pinkham, and Vickery (2010) find that the MBS deals that were most likely to underperform were ones with more interest-only loans (because of limited performance history) and lower documentation, i.e. more opaque or difficult to evaluate loans.

Our paper posits that shopping is used by issuers to exploit trusting investors. Regarding

the dependency of yields on ratings, Adelino (2009) shows that AAA tranche yields of MBS do not have extra predictive power about defaults or subsequent rating downgrades outside of the rating itself. However, it is not obvious from his results that this got worse during the boom (table 12, Adelino (2009)). With respect to less ratings leading to poorer performance, there is mixed evidence. Griffin and Tang (2009) find no evidence that CDOs rated by multiple rating agencies experience less default. Both Benmelech and Dlugosz (2009) (for ABS) and Ashcraft, Goldsmith-Pinkham, and Vickery (2010) (for RMBS), however, find that ex-post downgrades of structured finance products are both more likely and larger in deals rated by a single CRA<sup>38</sup>. Ashcraft, Goldsmith-Pinkham, and Vickery (2009), in preliminary work, find that the more issuers switch among CRAs, the lower subordination is for Alt-A RMBS, indicating benefits to shopping around<sup>39</sup>.

While not a prediction, a key part of the paper is our assumption that a fraction of investors are trusting. While there is substantial anecdotal evidence for this, we take this opportunity to describe systematic evidence. There are two views of trusting investors that explain why they did not perform proper due diligence and analysis. The first explains this using incentive problems, while the second claims the analysis was too complex for them. While the second is difficult to measure, there are two papers in the literature on corporate bond ratings which demonstrate that ratings were important to some investors solely for regulatory purposes. Kisgen and Strahan (2009) demonstrate that the acquisition of NRSRO status for Dominion Bond Rating Service in 2003 changed the impact of its ratings on bond yields only in situations where this status was important<sup>40</sup>. Bongaerts, Cremers, and Goetzmann (2009) find that Fitch's rating were often used to break ties between S&P and Moody's.

Focusing on the structured finance market, Adelino (2009) finds intriguing evidence of naivete. He finds that while initial yields on tranches below AAA predict future credit performance (probability of default and future ratings downgrades), the initial yields on AAA tranches had no predictive power. This is consistent with the hypothesis that investors in AAA tranches had no other information beyond the credit ratings themselves.

## 7 Conclusion

Our paper contains an analysis of Credit Rating Agencies (CRAs) and their conflicts of interest. The model includes the critical elements of the industry: issuer's payments may influence ratings, issuers may shop for ratings, CRA models may vary in precision, barriers to entry create market power for CRAs, reputation considerations affect decisionmaking, and different clienteles for investments exist. This allow us to provide a simple general framework for the analysis of the rating industry and its efficiency that brings a surprising result on the adverse effects of competition.

We find that the presence of more trusting investors or lower reputation costs give CRAs incentives to inflate the quality of investments, while the precision of the CRAs analysis has dual effects: more precision raises current payoffs but also increases the probability of paying a reputation cost. Our analysis of market efficiency makes it clear that, in general, a monopoly is more efficient than a duopoly. This is because a duopoly provides more opportunities for the issuer to shop and mislead trusting investors. In terms of regulation, we suggest that upfront fees (as in the Cuomo plan) accompanied by enforcing automatic disclosure of ratings and oversight of analytical standards will minimize distortions from conflicts of interest and shopping.

To present a closed form model of CRA competition, we have abstracted away from several aspects of the industry that would be worth analyzing further. We simplified the ratings process to allow for only two levels of ratings rather than a finer partition and did not allow for subsequent upgrades and downgrades that CRAs make while monitoring an investment. In terms of the investment being issued, we did not model conduits with multiple assets or make a clear distinction between idiosyncratic and systematic risk. Lastly, while we did extend the model in section 4 to two periods to endogenize reputation, a model of CRA competition over a longer time horizon could yield interesting results.

# Notes

<sup>1</sup>United States Securities and Exchange Commission (2008), p.12.

<sup>2</sup>"Triple-A-Failure," by Roger Lowenstein, *New York Times Magazine*, April 27, 2008. Moody's profits are the easiest of the CRAs to measure since they are a public stand-alone company. "Moody's operating margins exceeded 50 percent for the past six years, three to four times those of Exxon Mobil Corp., the world's biggest oil company". "Bringing Down Wall Street as Ratings Let Loose Subprime Scourge," by Elliot Blair Smith, [www.bloomberg.com](http://www.bloomberg.com), Sept 24, 2008.

<sup>3</sup>The SEC found that in a sample of subprime RMBS deals, 12 arrangers represented 80% of the business in both number and dollar volume, while for CDOs of subprime deals, 11 arrangers accounted for 92% of the deals and 80% of the dollar volume. (SEC (2008) p.32).

<sup>4</sup>"Typically the rating agency is paid only if the credit rating is issued". SEC (2008), p.9.

<sup>5</sup>"Brian Clarkson, then president and chief operating officer of Moody's Investor's Service acknowledged that, 'There is a lot of rating shopping that goes on...What the market doesn't know is who's seen certain transactions but wasn't hired to rate those deals.'" [*Bond-Rating Shifts Loom in Settlement; N.Y.'s Cuomo Plans Overhaul of How Firms Get Paid*, Aaron Lucchetti, Wall Street Journal, June 4, 2008.]

<sup>6</sup>"Testimony before the Committee on Oversight and Government Reform, United States House of Representatives", Deven Sharma, October 22, 2008.

<sup>7</sup>Until 2003, when the SEC gave Dominion the NRSRO designation. In 2005, A.M. Best received the designation, and in 2006, 3 more designations were given out (White (2010)).

<sup>8</sup>One might argue that investors were all sophisticated because they both originated and held these securities. However, this is not true empirically. From Lehman Brothers (2008) calculations in April 2008, we know that U.S. commercial and savings banks represented only 23% of the holders of non-agency AAA securities. If we were generous, we might add broker dealers (who held 6.1%) to the list of possible originators.

The main other holders were GSES and the FHLB system (18.8%), money managers (13.8%), insurance companies (7.6%), and overseas investors (25.2%).

<sup>9</sup>We provide a somewhat different (more institution-based) explanation for why differences of opinion arise (see, Harrison and Kreps, 1978, and Scheinkman and Xiong, 2003).

<sup>10</sup>This regulation can only address explicit shopping. The implicit shopping problem would remain (see Sangiorgi et al. 2009).

<sup>11</sup>Strausz (2005) and Bar-Isaac and Shapiro (2010) also model endogenous reputation for information intermediaries. Strausz (2005) provides interesting insights in line with our findings, as he argues that honest certification has some of the characteristics of a natural monopoly. Bar-Isaac and Shapiro (2010) incorporate economic shocks and show that CRA accuracy may be countercyclical, which is also consistent with our results.

<sup>12</sup>In the working paper version of this model, we allowed for a positive recovery value conditional on default and all of the same results hold, so we have chosen this specification for expositional purposes.

<sup>13</sup>We don't allow for unsolicited ratings. These ratings are rare in practice (see, Sangiorgi et al., 2009). In the online appendix we analyze the effects of restructuring an investment (e.g. a structured financial product). We find this is likely to decrease market efficiency, as the sole purpose of the restructuring is to be able to offer a better rating to the trusting investor clientele.

<sup>14</sup>Regulation that forces managers to only purchase investments with good ratings could also provide these incentives. Lower incentives to perform due diligence could also be exacerbated by investments which are more complex and difficult to value.

<sup>15</sup>Formally we can motivate this assumption by assuming that the recovery value in default is a random variable and even though the expected value is normalized to 0, the realizations differ depending on the signal  $\theta$  observed by the CRA ex-ante. The economic idea here is that the issuer also gets a noisy signal  $\theta$  ex-ante and takes greater precautions to salvage some recovery value when  $\theta = b$  than when  $\theta = g$ .

<sup>16</sup>This punishment may be more likely in the case of newer financial instruments like structured finance products where demand for the product may dry up. From a broader perspective, the punishment imposed may be from a change in the regulatory environment due to public outcry, such as enforcing liability claims. Lastly, although something similar has not occurred in the recent crisis, the downfall of Arthur Andersen represents a severe punishment to a certification intermediary.

<sup>17</sup>The specific form the reservation utility takes could be modeled in multiple ways and give the same results, this form is chosen for simplicity.

<sup>18</sup>For example, Mathis, McAndrews, and Rochet (2009) assume that in the absence of a CRA the investment will not be purchased, and the CRA can improve market efficiency by providing information about which investments are good.

<sup>19</sup>We define the marginal value  $V^B$  with respect to the first unit of investment and its reservation value  $u$  because investors will only purchase one unit of a bad investment. We define the marginal value  $V^G$  with respect to the second unit of investment and its reservation value  $U$  because investors will purchase two units of an investment they believe to be good and since issuers are assumed to use uniform pricing the price must be based on the marginal unit.

<sup>20</sup>There are situations where the report ‘Bad’ ( $m = B$ ) is off the equilibrium path. As we employ the concept of Perfect Bayesian Equilibrium, there is no restriction on off-the-equilibrium-path beliefs. However, we shall restrict attention to equilibria where off the equilibrium path beliefs are equal to ex-ante beliefs (that is, the investment is expected to be *good* with probability  $\frac{1}{2}$ ).

<sup>21</sup>The fee  $\alpha 2V^G - V^0$  represents selling 2 units of the investment to each trusting investor, who believes the  $G$  rating. This fee must subtract off  $V^0$ , because the issuer must be compensated for deciding to do business with the CRA, rather than sell to investors with ex-ante valuations.

<sup>22</sup>Without A4, there can still be equilibria where both CRAs tell the truth and equilibria where both CRAs always report  $G$  (and there would be no equilibria where one CRA tells the truth and one always reports  $G$ ). However, there would be multiple equilibria for each informational regime, there would need

to be another restriction on parameters to guarantee existence, and both types of equilibria could co-exist. Assumption A4 also places a lower bound on  $\alpha$ , which means some shopping will always occur. This plays a role in our analysis of market efficiency.

<sup>23</sup>Assumption (A6) fixes the cutoffs for which shopping will occur. When there are two  $B$  reports the issuer must decide between charging  $V^0$  to trusting investors or  $V^{BB}$  to everyone. There is then a cutoff  $\frac{V^{BB}}{V^0}$  for  $\alpha$  such that it is best to target trusting investors for  $\alpha$  higher than this cutoff (when there are two  $B$  reports), i.e.  $\max[\alpha V^0, V^{BB}] = \alpha V^0$ . This will be relevant in the proposition below and in the section on market efficiency.

<sup>24</sup>Note that this is a stronger assumption, since with two CRAs it might be that should one CRA be caught lying, the other CRA gets larger continuation profits. It might also be that a CRA only gets caught if it is lying and the other CRA is telling the truth (Stolper, 2009 examines this type of reputation in a game where a regulator is actively monitoring and punishing CRAs). Alternatively, it might be that both CRAs (the whole industry) get punished when any CRA is caught. Furthermore, there may be an added difference between monopoly and duopoly in the sense that when a monopoly CRA gets caught, there is nowhere to turn to, while when a duopoly CRA gets caught, there is a reasonable alternative (the other CRA). This approach is taken in the context of firms selling goods of varying qualities in Hörner (2002).

<sup>25</sup>As Calomiris (2008) has argued: “Subprime was a relatively new product, [...] Given the recent origins of the subprime market which postdates the last housing cycle downturn in the U.S. (1989-1991), how were the rating agencies able to ascertain what the LGD would be on a subprime mortgage pool?” Thus the lower precision of CRA’s information about subprime credit risk may have been a source of ratings inflation through greater shopping pressure by issuers. Charles Calomiris, (2008), *The subprime turmoil: What’s old, what’s new, and what’s next*. Vox: <http://www.voxeu.org/index.php?q=node/1561>

<sup>26</sup>In a previous version of the paper, we also used investor surplus to evaluate market efficiency. The results were the same when comparing truth-telling regimes, but stronger when comparing ratings inflation regimes (duopoly had strictly lower investor surplus than monopoly).

<sup>27</sup>In the model, this means purchasing from two CRAs. In practice, realistically this would imply pur-

chasing from the big three CRAs (Moody's, S&P, and Fitch).

<sup>28</sup>Issuers may lose out under this regulation if CRAs remain free to set prices since, as under a monopoly, the entire issuer surplus may be appropriated by the CRAs.

<sup>29</sup>See Bar-Isaac and Tadelis (2008) for a review of the literature.

<sup>30</sup>The agreement is reportedly for 3 years and on structured finance products only [*Big Credit-Rating Firms Agree to Reforms*, Aaron Lucchetti, Wall Street Journal, June 6, 2008].

<sup>31</sup>There is a fine point here which is that the deal specifies upfront payments for initial analysis but does not prevent subsequent payments. This is obviously an issue, but outside the scope of our model.

<sup>32</sup>It is of course possible through repeated interactions between an issuer and a CRA to dynamically create these incentives. This is out of the scope of our analysis, but certainly a caveat.

<sup>33</sup>An intriguing proposal to diminish conflicts of interest was taken out of the Dodd-Frank bill at the last minute (and was relegated to be the subject of a formal study by the SEC). The "Franken Amendment" proposed to set up a body which would randomly assign issuers of structured finance products to rating agencies. If fees were paid upfront to the body, this could eliminate both conflicts of interest and shopping.

<sup>34</sup>While quite intuitive, we prove this formally in a previous working paper version of this paper. An interesting unintended consequence of eliminating shopping is to reduce the number of ratings, which occurs because the rents to an extra rating decrease. This is not a complete surprise, as our model demonstrates that monopoly is more efficient than duopoly.

<sup>35</sup>If precision were not effort in performing the analysis on the investment, but quality of the analytic models used, then the CRAs would choose larger precision, since it would in essence be chosen *before* the fees were paid.

<sup>36</sup>The subordination level they use is the fraction of the deal that is junior to the AAA tranche. A smaller fraction means that the AAA tranche is less 'protected' from defaults, and therefore less costly from the issuer's point of view.

<sup>37</sup>They define larger by market share in terms of deals. As a robustness check, they also look at market share in terms of dollars and find similar results.

<sup>38</sup>Ashcraft, Goldsmith-Pinkham, and Vickery (2009) note, however, that only 1% of their deal sample has just one rating.

<sup>39</sup>The sign is the same for subprime deals but the coefficient is not significant.

<sup>40</sup>I.e. regulations that required investments to use the best or second best NRSRO rating and specifically around the investment grade threshold.

## References

- [1] Adelino, Manuel, 2009, Do Investors Rely Only on Ratings? The Case of Mortgage-Backed Securities, Unpublished manuscript Dartmouth.
- [2] Ashcraft, Adam, Goldsmith-Pinkham, Paul, and James Vickery, 2010, MBS ratings and the mortgage credit boom, Unpublished manuscript, Federal Reserve Bank of New York.
- [3] Ashcraft, Adam, Goldsmith-Pinkham, Paul, and James Vickery, 2009, The Role of Incentives and Reputation in the Rating of Mortgage-Backed Securities, work-in-progress, Federal Reserve Bank of New York.
- [4] Ashcraft, Adam, and Til Schuermann, 2008, Understanding the Securitization of Subprime Mortgage Credit, Unpublished manuscript, Federal Reserve Bank of New York.
- [5] Bar-Isaac, Heski and Joel Shapiro, 2011, Ratings Quality over the Business Cycle, Unpublished manuscript, NYU.
- [6] Bar-Isaac, Heski and Steve Tadelis, 2008, Seller Reputation, *Foundations and Trends in Microeconomics* 4:4, 273-351.

- [7] Becker, Bo, and Todd Milbourn, 2011, How did increased competition affect credit ratings?, forthcoming, *Journal of Financial Economics*.
- [8] Benmelech, Efraim, and Jennifer Dlugosz, 2009, The Credit Rating Crisis, *NBER Macroeconomics Annual 2009*, 161-207.
- [9] Benabou, Roland, and Guy Laroque, 1992, Using privileged information to manipulate markets: insiders, gurus, and credibility, *Quarterly Journal of Economics* 107, 921–958.
- [10] Biglaiser, Gary, 1993, Middlemen as Experts, *The RAND Journal of Economics* 24 (2), 212-223.
- [11] Bolton, Patrick, Freixas, Xavier, and Joel Shapiro, 2007, Conflicts of Interest, Information Provision, and Competition in the Financial Services Industry, *Journal of Financial Economics* 85:2, 297–330.
- [12] Boot, Arnoud W.A., Milbourn, Todd T., and Anjolein Schmeits, 2006, Credit Ratings as Coordination Mechanisms, *Review of Financial Studies* 19:1, 81-118.
- [13] Bongaerts, Dion, Cremers, K.J. Martijn, and William N. Goetzmann, 2011, Tiebreaker: Certification and Multiple Credit Ratings, *Journal of Finance*, forthcoming.
- [14] Durbin, Erik and Ganesh Iyer, 2009, Corruptible Advice, *American Economic Journal: Microeconomics*, 1:2, 220–42.
- [15] Faltin-Traeger, Olivier, 2009, Picking the Right Rating Agency: Issuer Choice in the ABS Market, Unpublished manuscript, Columbia Business School.
- [16] Farhi, Emmanuel, Lerner, Josh and Jean Tirole, 2010, Fear of Rejection? Tiered Certification and Transparency, Unpublished manuscript, Harvard University.
- [17] Faure-Grimaud, Antoine, Peyrache, Eloic, and Lucia Quesada, 2009, The Ownership of Ratings, *Rand Journal of Economics* 40:2, 234-257.

- [18] Griffin, John M., and Dragon Y. Tang, 2010, Did Subjectivity Play a Role in CDO Credit Ratings? Unpublished manuscript, UT-Austin.
- [19] Harrison, J. Michael, and David M. Kreps, 1978, Speculative Investor Behavior in a Stock Market with Heterogeneous Expectations, *Quarterly Journal of Economics* 92, 323–36.
- [20] He, Jie, Qian, Jun, and Philip E. Strahan, 2010, Credit Ratings and the Evolution of the Mortgage-Backed Securities Market, Unpublished manuscript, Boston College.
- [21] Hirshleifer, David, and Siew Hong Teoh, 2003, Limited Attention, Information Disclosure and Financial Reporting, *Journal of Accounting and Economics* 36, 337-386.
- [22] Hörner, Johannes. 2002, Reputation and Competition, *American Economic Review* 92:3, 644-663.
- [23] Inderst, Roman and Marco Ottaviani, 2009, Misselling through Agents, *American Economic Review* 99:3, 883–908.
- [24] Kartik, Navin, 2009, Strategic Communication with Lying Costs, *Review of Economic Studies* 76:4, 1359-1395.
- [25] Kartik, Navin, Ottaviani, Marco, and Francesco Squintani, 2007, Credulity, Lies, and Costly Talk, *Journal of Economic Theory* 134, 93–116.
- [26] Kisgen, Darren J., and Philip E. Strahan, 2010, Do Regulations Based on Credit Ratings Affect a Firm’s Cost of Capital?, *Review of Financial Studies*, forthcoming.
- [27] Laffont, Jean-Jacques and Jean Tirole, 1993, *A theory of incentives in procurement and regulation* (MIT Press, Cambridge)
- [28] Lehman Brothers Securitized Products Research (2008), “Residential Credit Losses – Going Into Extra Innings?” .

- [29] Lizzeri, Alessandro, 1999, Information Revelation and Certification Intermediaries, *The RAND Journal of Economics* 30:2, 214-231.
- [30] Mariano, Beatriz, 2008, Do Reputational Concerns Lead to Reliable Ratings, Unpublished manuscript, Universidad Carlos III.
- [31] Mathis, Jerome, McAndrews, Jamie, and Jean-Charles Rochet, 2009, Rating the Raters: Are reputational concerns powerful enough to discipline rating agencies?, *Journal of Monetary Economics*, doi:10.1016/j.jmoneco.2009.04.004
- [32] Morgan, John, and Philip C. Stocken, 2003, An analysis of stock recommendations, *The RAND Journal of Economics* 34, 183–203.
- [33] Ottaviani, Marco, and Peter Norman Sorensen, 2006, Reputational Cheap Talk, *The RAND Journal of Economics* 37, 155-175.
- [34] Pagano, Marco, and Paolo Volpin. (2010), Securitization, Transparency, and Liquidity, Unpublished manuscript, Università di Napoli Federico II and London Business School.
- [35] Partnoy, Frank, 2002, The Paradox of Credit Ratings, in Levich, Richard M., Giovanni Majnoni and Carmen Reinhart, eds. *Ratings, Rating Agencies and the Global Financial System* (Kluwer Academic Publishers, Boston).
- [36] Sangiorgi Francesco, Sokobin Jonathan, and Chester Spatt, 2009, Credit-Rating Shopping, Selection and Equilibrium Structure of Ratings, Unpublished manuscript, Carnegie Mellon University.
- [37] Scheinkman, Jose, and Wei Xiong, 2003, Overconfidence and Speculative Bubbles, *Journal of Political Economy* 111:6, 1183-1219.
- [38] Stolper, Anno, 2009, Regulation of Credit Rating Agencies, *Journal of Banking & Finance* 33:7, 1266-1273.

- [39] Strausz, Roland, 2005, Honest Certification and the Threat of Capture, *International Journal of Industrial Organization*, 23:1-2, 45-62.
- [40] United States Securities and Exchange Commission, 2008, *Summary Report of Issues Identified in the Commission Staff's Examinations of Select Credit Rating Agencies*.
- [41] White, Lawrence J., 2002, The Credit Rating Industry: An Industrial Organization Analysis, in Levich, Richard M., Giovanni Majnoni and Carmen Reinhart, eds. *Ratings, Rating Agencies and the Global Financial System* (Kluwer Academic Publishers, Boston).
- [42] White, Lawrence J., 2010, Markets: The Credit Rating Agencies, *Journal of Economic Perspectives* 24:2, 211-226.

## Internet Appendix to “The Credit Ratings Game”\*

\* Patrick Bolton, Xavier Freixas, and Joel Shapiro, 2011, Internet Appendix to “The Credit Ratings Game”, *Journal of Finance* [vol #], [pages], [http://www.afajof.org/IA/\[year\].asp](http://www.afajof.org/IA/[year].asp). Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the authors of the article.

**Lemma 1** *Given the fee  $\phi$ , the CRA's reporting strategy is:*

1. *For  $\phi > ep\rho$ , the CRA inflates ratings (always reports  $G$ )*
2. *For  $0 < \phi < ep\rho$ , the CRA reports the truth, relaying its signal perfectly.*

**Proof:** Given that the issuer may not purchase after a given report, we will label the fee  $\phi$  as two different fees, the fee collected after a “G” report,  $\phi_G$  (which could be  $\phi$  or zero) and the fee collected after a “B” report,  $\phi_B$  (which could be  $\phi$  or zero).

Conditional on receiving a good signal, the CRA may report “G”, in which case it earns

$$\pi(G | g) = \phi_G + \rho.$$

It receives a fee  $\phi_G$  for its report  $m = G$  and subsequently earns its full future rent. If the CRA were to report  $m = B$  conditional on receiving a good signal, it would earn

$$\pi(B | g) = \phi_B + \rho,$$

as there is no punishment for having said the investment was bad. Similarly, conditional on receiving a bad signal, the payoff of rating  $m = B$  is

$$\pi(B | b) = \phi_B + \rho.$$

Reporting  $m = G$  conditional on a bad signal  $\theta = b$ , however, yields:

$$\pi(G | b) = \phi_G + (1 - ep)\rho,$$

since now with probability  $ep$  the investment defaults and the CRA is punished, while with the complementary probability there is no default and the CRA earns  $\rho$ .

Conditional on receiving the good signal, the incentive to report  $m = G$  depends on the difference in payoffs:

$$\pi(G | g) - \pi(B | g) = \phi_G - \phi_B.$$

Conditional on receiving the bad signal, the report to say  $m = B$  is:

$$\pi(B | b) - \pi(G | b) = \phi_B - \phi_G + e\rho\rho.$$

This yields three possible information regimes: if  $\phi_G - \phi_B > e\rho\rho$ , the CRA always reports  $G$ , if  $0 < \phi_G - \phi_B < e\rho\rho$ , the CRA reports truthfully, and if  $\phi_G - \phi_B < 0$ , the CRA always reports  $B$ .

There is no informational regime where a report of  $B$  increases the valuations of sophisticated investors above their ex-ante valuation of  $V^0$ . Moreover, by assumption, a report of  $B$  decreases the valuations of trusting investors below  $V^0$ . Therefore, there is no reason for an issuer to purchase a  $B$  report, making the CRA's return on a  $B$  report equal to  $\phi_B = 0$ .

■

**Proposition 1** *The equilibrium of the fee setting game is:*

1. If  $\alpha 2V^G - V^0 > e\rho\rho$ , the CRA inflates ratings, sets  $\phi = \alpha 2V^G - V^0$  and has profits

$$\alpha 2V^G - V^0 + (1 - \frac{e\rho}{2})\rho,$$

2. If  $\alpha 2V^G - V^0 < e\rho\rho$ , the CRA reports truthfully, sets  $\phi = \min[2V^G - \max[\alpha V^0, V^B], e\rho\rho]$ , and has profits

$$\frac{1}{2} \min[2V^G - \max[\alpha V^0, V^B], e\rho\rho] + \rho.$$

**Proof:** If the CRA always reports  $m = G$ , the issuer is willing to purchase this rating as long as the fee is not above

$$\alpha 2V^G - V^0$$

the incremental profit obtained from trusting investors. There are many beliefs off the equilibrium path for sophisticated investors such that no deviation will occur. Always reporting  $m = G$  is feasible when

$$\alpha 2V^G - V^0 > e\rho$$

(from Lemma 1) and CRA profits are then

$$\alpha 2V^G - V^0 + \left(1 - \frac{e\rho}{2}\right)\rho.$$

If the CRA reveals its signal truthfully, the  $m = G$  report induces the highest valuations from both trusting and sophisticated investors buying two units, while the  $m = B$  report induces the lowest valuations for sophisticated investors and the ex-ante valuation for trusting investors (because it is not disclosed). So that the maximum fee is given by:

$$\phi \leq 2V^G - \max[\alpha V^0, V^B].$$

In order to report truthfully, the CRA must respect the limitations given by Lemma 1 and ensure that the rating fee is not above  $e\rho$ . Therefore,

$$\phi = \min[2V^G - \max[\alpha V^0, V^B], e\rho]$$

Profits from reporting truthfully therefore are given by

$$\frac{1}{2} \min[2V^G - \max[\alpha V^0, V^B], e\rho] + \rho.$$

Lastly, notice that for  $\alpha 2V^G - V^0 > e\rho$ , both always reporting  $m=G$  and truthtelling are feasible but it is easy to check that the CRA's profits are higher by always reporting  $m = G$ , as the following expression always holds:

$$\alpha 2V^G - V^0 + \left(1 - \frac{e\rho}{2}\right)\rho > \left(1 + \frac{e\rho}{2}\right)\rho \geq \frac{1}{2} \min[2V^G - \max[\alpha V^0, V^B], e\rho] + \rho$$

■

**Proposition 2** *The equilibrium of the fee setting subgame (assuming A4-A6 hold) is:*

1. *If  $\alpha 2(V^{GG} - V^G) > ep\rho^D$ , both CRAs always report  $G$ ,  $\phi_k = \alpha 2(V^{GG} - V^G)$  for  $k = 1, 2$  with CRA profits given by*

$$\alpha 2(V^{GG} - V^G) + (1 - \frac{ep}{2})\rho^D.$$

2. *If  $\alpha 2(V^{GG} - V^G) < ep\rho^D$ , both CRAs report truthfully,  $\phi_k = \min[2(V^{GG} - V^G), ep\rho^D]$  for  $k = 1, 2$  with CRA profits given by*

$$\min[2(V^{GG} - V^G), ep\rho^D] + \rho^D.$$

**Proof:** First, consider the case where issuers have approached both CRAs and both CRAs always report  $G$ . If the issuer buys no reports, its profit is  $V^0$ .<sup>1</sup> If the issuer buys one report its profit is

$$\alpha 2V^G - \min[\phi_1, \phi_2].$$

If the issuer buys two reports, it gets

$$\alpha 2V^{GG} - (\phi_1 + \phi_2).$$

The issuer thus prefers two  $G$  reports to one when

$$\alpha 2(V^{GG} - V^G) \geq \phi_k, k = 1, 2.$$

If each CRA sets its fee  $\phi_k$  equal to  $\alpha 2(V^{GG} - V^G)$ , the issuer is willing to buy both reports as long as this is preferable to purchasing no reports, which is true if

$$\alpha 2V^{GG} - \alpha 4(V^{GG} - V^G) > V^0$$

which can be rewritten as

$$\alpha 2V^G - V^0 > \alpha 2(V^{GG} - V^G).$$

This condition is satisfied by assumption A4. These fees yield profits

$$\alpha 2(V^{GG} - V^G) + (1 - \frac{ep}{2})\rho^D$$

for each CRA.

Note that there can't be an equilibrium where both CRAs set higher fees of  $\alpha 2V^G - V^0$  such that the issuer would only want to purchase a single  $G$  report. Indeed, since the reports are homogeneous goods, each CRA would profit by deviating and lowering its price as in Bertrand competition, eliminating this possible equilibrium. Also, note that a deviation from the equilibrium by firm  $k$  of  $\phi_k = \alpha 2V^G - V^0$  isn't a profitable deviation from the equilibrium by assumption A4, which guarantees that this deviation total fee is larger than  $\alpha 2(V^{GG} - V^G)$ , so that the issuer simply wouldn't pay the high fee. Furthermore, a deviation by a CRA intending to tell the truth would not be profitable: if the fee for truthtelling is less than  $\alpha 2(V^{GG} - V^G)$ , it is not profitable, and if the fee is more than  $\alpha 2(V^{GG} - V^G)$ , since we know that ratings inflation is feasible ( $\alpha 2(V^{GG} - V^G) > ep\rho^D$ ) the CRA who attempts to deviate will not tell the truth.

Now assume that both CRAs rate the investment truthfully. If the CRAs set their fees to sell their reports when two  $G$  reports are issued, the maximum ratings fee for each CRA is

$$\phi_k = \min[2(V^{GG} - V^G), ep\rho^D]$$

since  $2(V^{GG} - V^G)$  is the maximum fee that makes the issuer prefer two reports rather than one, and since  $ep\rho^D$  is the upper bound of the truthtelling constraint. When there are two  $G$  reports, Assumption A4 implies that the issuer prefers to purchase two reports to none.<sup>2</sup> When there is a  $G$  report and a  $B$  report, assumption A4 also tells us that the issuer will

purchase the  $G$  report.

When both CRAs are hired, a CRA may want to deviate by setting high fees  $\phi_k = \alpha 2V^G - V^0$  and always report  $G$  to earn rents when the other CRA truthfully issues a  $B$  report. This deviation is ruled out by assumption A5.

Finally, if  $\alpha 2(V^{GG} - V^G) > e p \rho^D$  then deviating to a fee of  $\alpha 2(V^{GG} - V^G)$  and always reporting  $G$  is profitable for a CRA. This sets a boundary on the parameters for which truthtelling can be an equilibrium.

There cannot be an equilibrium where CRA  $k$  reveals truthfully and CRA  $-k$  always reports  $G$ . If this was an equilibrium, we would need  $\phi_k < e p \rho^D$  and  $\phi_{-k} > e p \rho^D$ . However, CRA  $k$  has a profitable deviation to set  $\phi_k = \phi_{-k} - \varepsilon$  and always report  $G$ . For the same reason, there can't be an equilibrium where the issuer only purchases one report since any fee that CRA  $-k$  would set would be undercut by a deviating CRA  $k$ . ■

**Proposition 3** *Given Assumptions A0-A6, a truthtelling monopoly strictly dominates a truthtelling duopoly.*

**Proof:** Total Surplus with a truthtelling duopoly depends on how large the fraction of trusting investors is; that is, what interval  $\alpha$  is in:  $[\frac{V^0}{2V^G}, \frac{V^{BB}}{V^0}]$  or  $[\frac{V^{BB}}{V^0}, 1]$ .

In the first interval, total surplus  $W_{DT1}$  given by equation 4 in the paper is increasing in  $\alpha$

$$\frac{d}{d\alpha} W_{DT1} = e(1-e)(2R - 2U + 2(1-p)R - 2u).$$

And in the second interval, total surplus  $W_{DT2}$  given by equation 5 in the paper has a larger positive slope than in the first interval.

Total surplus in the first interval is larger than in the second for all  $\alpha$  except at the top when  $\alpha = 1$ . Total surplus in the two intervals is equal to

$$V^0 + \frac{1}{2}(e^2 + (1-e)^2)V^{GG} + 2e(1-e)(V^0 + u - U),$$

at their maximum point of  $\alpha = 1$ .

In sum, the composite total surplus curve increases in the first interval and jumps down and increases in the second interval.

Total Surplus with a truthtelling monopoly also depends on what interval  $\alpha$  is in:  $[\frac{V^0}{2V^G}, \frac{V^B}{V^0}]$ , or  $[\frac{V^B}{V^0}, 1]$ .

Over the first interval total surplus is independent of  $\alpha$  (see equation 2 in the paper), while over the second interval it jumps down and is increasing (see equation 3 in the paper).

We compare first  $W_{MT1}$  and  $W_{DT1}$ : When  $\alpha = 0$ , the difference in total surpluses is:

$$\begin{aligned}
W_{MT1}(\alpha = 0) - W_{DT1}(\alpha = 0) &= [V^0 + \frac{1}{2}[(e - (1 - e))(R - U) + (1 - e)2(V^0 + u - U)]] \\
&\quad - [(e^2 + (1 - e)^2)V^0 + \frac{1}{2}(e^2 - (1 - e)^2)(R - U) + (1 - e)^2(V^0 + u - U)] \\
&= 2e(1 - e)V^0 + e(1 - e)(V^0 + u - U) \\
&= e(1 - e)(3V^0 + u - U).
\end{aligned}$$

This expression is positive since  $2V^0 + u - U = V^G + V^B > 0$ .

When  $\alpha = 1$ , the difference in total surpluses is:

$$\begin{aligned}
W_{MT1}(\alpha = 1) - W_{DT1}(\alpha = 1) &= \frac{1}{2}V^G - [\frac{1}{2}(e^2 - (1 - e)^2)(R - U) \\
&\quad + (2e(1 - e) + (1 - e)^2)(V^0 + u - U)] \\
&= \frac{1}{2}[(e - (1 - e))(R - U) + (1 - e)2(V^0 + u - U)] \\
&\quad - [\frac{1}{2}(e - (1 - e))(R - U) + (1 - e)(1 + e)(V^0 + u - U)] \\
&= -e(1 - e)(V^0 + u - U)
\end{aligned}$$

This expression is again positive as  $V^0 + u - U < 0$  by A3.

As we have already shown,

$$W_{DT1}(\alpha = 1) = W_{DT2}(\alpha = 1),$$

and

$$W_{DT1}(\alpha = 0) > W_{DT2}(\alpha = 0).$$

And since both are linearly increasing in  $\alpha$ , the argument above implies that  $W_{MT1} > W_{DT2}$ .

Lastly, we must examine whether  $W_{DT2}$  and  $W_{MT2}$  can cross. We know that

$$W_{DT2}(\alpha = 1) < W_{MT2}(\alpha = 1)$$

(since  $W_{DT1}(\alpha = 1) = W_{DT2}(\alpha = 1)$  and also since  $W_{MT1}(\alpha = 1) = W_{MT2}(\alpha = 1)$ ).

Furthermore, we can establish that  $W_{DT2}(\alpha = 0) < W_{MT2}(\alpha = 0)$ :

$$\begin{aligned} W_{MT2}(\alpha = 0) - W_{DT2}(\alpha = 0) &= \\ &= \frac{1}{2}[e(2R - u - U) + (1 - e)(2(1 - p)R - u - U)] \\ &\quad - \frac{1}{2}[e^2(2R - u - U) + (1 - e)^2(2(1 - p)R - u - U)] \\ &= e(1 - e)(2V^0 + u - U) > 0. \end{aligned}$$

Given that both  $W_{DT2}$  and  $W_{MT2}$  increase linearly in  $\alpha$ , they cannot cross. This establishes the proof. ■

**Lemma 3** *Total surplus for a truthtelling duopoly is larger than when there is a monopoly CRA who inflates ratings.*

**Proof:** The total surplus when two CRAs report truthfully given in equation 5 in the paper ( $W_{DT2}$ ) is less than or equal to  $W_{DT1}$  for all  $\alpha$ . We therefore compare this expression to the total surplus when one CRA always reports  $G$ , which is given by equation 1 in the

paper.

First, total surplus when the two CRAs report truthfully and  $\alpha = 0$  can be written as:

$$W_{DT2}(\alpha = 0) = \frac{1}{2}[e^2(2R - 2U) + (1 - e)^2(2(1 - p)R - 2u) + (e^2 - (1 - e)^2)(U - u)] > 0$$

while total surplus when both CRAs always report  $G$  and  $\alpha = 0$  is equal to zero.

Both total surpluses are increasing linearly in  $\alpha$  since

$$\begin{aligned} \frac{d}{d\alpha}W_{DT2} &= e(1 - e)(2R - 2U + 2(1 - p)R - 2u) \\ &\quad + \frac{1}{2}[(1 - e)^2(R - u) + e^2((1 - p)R - u)], \end{aligned}$$

and

$$\frac{d}{d\alpha}W_M^G = (R - U) + ((1 - p)R - u),$$

are both positive.

Finally, when  $\alpha = 1$ , the difference between the total surpluses is:

$$\begin{aligned} W_{DT2}(\alpha = 1) - W_M^G(\alpha = 1) &= \left[ \frac{1}{2}(e^2 - (1 - e)^2)(R - U) + (2e(1 - e) + (1 - e)^2)\left(1 - \frac{p}{2}\right)(R - U) \right] \\ &\quad - \left[ \left(1 - \frac{p}{2}\right)(R - U) \right] \\ &= \frac{1}{2}(e^2 - (1 - e)^2)(R - U) - e^2\left(1 - \frac{p}{2}\right)(R - U) \end{aligned}$$

which is larger than zero by A3 and  $e \geq \frac{1}{2}$ . This completes the proof. ■

# 1 Rating Asset-Backed Securities and Structuring to the Rating

Our analysis so far does not capture an important aspect of the ratings process for structured finance products, namely the back and forth negotiations between issuers and CRAs, and the active structuring of asset-backed securities by issuers. As Fender and Mitchell (2005), Gorton (2008), Ashcraft, Goldsmith-Pinkham, and Vickery, (2010) and Benmelech and Dlugosz (2009a, 2009b) among others have highlighted, issuers of structured finance products could *design* the default risk of an asset-backed security both by manipulating the risk characteristics of the asset pool, and by tranching the issue to obtain a higher rating for the senior tranche. We argue in this section that this *strategic structuring activity* by issuers of structured products is another important form of ratings shopping that can give rise to excessively rosy ratings in equilibrium.

## 1.1 Equilibrium Tranching and Credit Enhancement

To allow for the issuer's structuring activity, we extend the model by (i) introducing a new stage in the credit ratings game following the announcement by the rating agency of a bad rating and (ii) enriching the CRA rating technology. In the new stage, we give the issuer the choice to restructure the issue and solicit another rating. Define  $p^*$  as the default probability where an investor's valuation is the same when she has 1 unit of the investment and 2 units of the investment:

$$(1 - p^*)R = U. \tag{1}$$

We enrich the CRA rating technology by allowing it to detect whether investors prefer one unit (i.e. the probability of default is larger than  $p^*$ ) or two units (i.e. the probability of default is smaller than  $p^*$ ).<sup>3</sup> To keep the analysis of this more complex game as tractable as possible we also make some simplifications, which mainly reduce the number of cases we

need to consider. We now assume that all investors are trusting ( $\alpha = 1$ ) and that the CRA obtains a perfectly informative signal about the underlying risk of the issue ( $e = 1$ ).

Consider first the monopoly case. The credit ratings game with restructuring we consider here is a simple extension of our previous framework:

1. The CRA posts two fees, one for initial ratings  $\phi^i$  and one for rating the product if it has been restructured  $\phi^r$ .<sup>4</sup> The issuer follows by deciding whether to seek a rating on an issue or not.
2. If the issuer decides to seek a rating, the CRA obtains either signal  $g$  or  $b$ . We restrict attention to the truthtelling regime, formalized in assumption A8 below.<sup>5</sup> Therefore, if the truthfully announced rating is  $G$ , the issuer responds by purchasing it as long as the fee  $\phi^i$  satisfies his participation constraint:

$$\phi^i \leq 2V^G - V^0.$$

3. If the rating is  $B$  for the unstructured issue, the issuer can now restructure the issue so as to reduce the probability of default of the senior tranche sufficiently to get the CRA to issue a  $G$  rating on that tranche. More precisely, the issuer can propose to split the issue into a *senior* and a *junior tranche*, where the probability that the senior tranche defaults is decreased to  $\mu p$ . The issuer then holds on to the junior tranche and enhances the credit quality of the senior tranche. This involves a unit loss for the issuer of

$$(1 - \mu p)R - (1 - p)R = (1 - \mu)pR,$$

which is equal to the expected value of one unit of the senior tranche minus the expected value of the original investment. The probability  $\mu$  is a choice variable for the issuer.

4. The CRA responds to a restructured issue by giving a good rating as long as  $\mu p \leq p^*$ , for then the benefit of selling a  $G$  rating exceeds the expected reputation cost.

The *equilibrium best response for the CRA* in this game is then to set an initial fee at  $\phi^i = 2V^G - V^0$  for an initial  $G$  rating, and a restructuring fee  $\phi^r = 2V^G - 2(p - p^*)R - V^0$  for a  $G$  rating on the senior tranche of the restructured issue. And an *equilibrium best response of the issuer* is then to purchase the initial  $G$  rating at fee  $\phi^i$  when it is offered, to restructure the issue after an initial  $B$  rating so that  $\mu = \frac{p^*}{p}$ , the minimum level needed to get a  $G$  rating on the senior tranche, and to purchase the  $G$  rating for the senior tranche at  $\phi^r$ .

We assume that the fee  $\phi^r$  is positive (so that restructuring following a  $B$  rating for the unstructured issue will occur) in the following assumption:

**Assumption A7:**  $2V^G - 2(p - p^*)R - V^0 > 0$ .

To ensure that the CRA does not gain from inflating its initial rating in the game with restructuring we must make sure that  $p\rho > (\phi^i - \phi^r) = 2(p - p^*)R > 0$ .

**Assumption A8:**  $p\rho > 2(p - p^*)R$ .

Under these assumptions, the equilibrium outcome of the monopoly credit ratings game with restructuring is then as described in the proposition below.

**Proposition 1** *Under Assumptions A0-A3, A7 and A8, the equilibrium tranching and credit enhancement is such that:*

1. *Following an initial  $B$  rating, the issuer restructures the initial issue by splitting it into a junior tranche and a senior tranche, where the senior tranche gets a credit enhancement  $\mu$  such that the probability of default of the senior tranche is reduced from  $p$  to  $\mu p = p^*$ .*
2. *The issuer retains the junior tranche, thereby incurring an expected loss of  $2(p - p^*)R$ .*
3. *The senior tranche obtains a rating  $G$  and is entirely sold to investors.*

Consider next the case of a CRA duopoly, where each CRA competes by offering fees  $(\phi^i, \phi^r)$  for ratings. It turns out that under our simplifications ( $e = 1$  and  $\alpha = 1$ ) this game has a straightforward solution and, except for the distribution of surplus, an equilibrium outcome that is basically the same as under a CRA monopoly. Indeed, with  $e = 1$  both CRAs

have the same information and the marginal value of a second rating is zero:  $V^{GG} = V^G$ . This implies that Bertrand competition in fees  $(\phi^i, \phi^r)$  between the two CRAs will drive the fees to zero, leaving the entire surplus to the issuer. It then follows from Proposition 2 that since the CRAs obtain no positive profits from selling ratings, they have a strict preference for truthfully disclosing their ratings.

The game proceeds as under the game with a monopoly CRA: i) the issuer approaches one of the two CRAs, and gets a rating. If the rating is  $B$ , the issuer doesn't purchase it and decides to restructure, setting  $\mu = \frac{p^*}{p}$ . It then approaches one of the two CRAs for a new rating, and receives a rating  $G$ , which is purchased by investors. While the split of the rents has changed from monopoly, the information revealed and product sold to investors has not changed at all.

## 1.2 The Welfare Costs of Credit Enhancement

Does the ability to restructure an issue and engage in credit enhancement improve efficiency? We provide an unambiguous negative answer to this question in this section. At best, in an efficient capital market where all the actors are rational, credit enhancement neither adds nor subtracts value. This observation simply follows from straightforward application of Modigliani-Miller neutrality logic to the asset-backed securities market. Moreover, as all debt issues benefit from the same favorable tax treatment of interest payments, there is no obvious tax benefit to be obtained from credit enhancement. In practice, as in our model, credit enhancement and tranching is driven by a preference for high ratings by some investors, over and above the preference for higher risk-adjusted returns. We model this preference for higher ratings as arising from a form of investor naivete. But, as we have argued, it can also arise from particular institutional arrangements, such as restrictions on permissible asset classes and compensation practices of pension fund managers.

We compare the total surplus of the game with and without restructuring. Without the

possibility of restructuring an issue, the ex-ante surplus following a  $B$  rating is just

$$W^{NR} = (1 - p)R - u.$$

In contrast, under restructuring following a  $B$  rating the total ex-ante surplus is:

$$W^R = [(1 - p)R - u] + [(1 - p)R - U]$$

The second term is negative given A3. We summarize this discussion in the proposition below.

**Proposition 2** *Equilibrium Tranching and Credit Enhancement results in a Net Efficiency Loss of*

$$\frac{1}{2}[U - (1 - p)R].$$

Notice that this result is the same for both monopoly and duopoly. The monopoly CRA strictly benefits from the restructuring since it gets paid  $\phi^r$  and the issuer just breaks even. The issuer strictly benefits from the restructuring and the CRAs just break even in a duopoly. Either way, the entire efficiency loss is borne by trusting investors, who overpay after seeing the  $G$  rating and create wasteful excess demand for the investment. Credit enhancement here is a socially wasteful activity that only serves the purpose of deceiving trusting investors.

## Notes

<sup>1</sup>As in the monopoly case, we will restrict off the equilibrium path beliefs to be the ex-ante beliefs.

<sup>2</sup>Since no reports purchased is now on the equilibrium path, the issuer would get a return of  $\max[\alpha V^0, V^{BB}]$  if it purchased no reports. Given that  $\max[\alpha V^0, V^{BB}] < V^0$ , it is easy to see that the statement holds.

<sup>3</sup>The initial investment is still either good or bad, with respective default probabilities of 0 and  $p$ . The rating technology thus is consistent with our previous model. This further elaboration is important for understanding the situation where restructuring may occur.

<sup>4</sup>In a previous version, we considered the case of just one fee which would be paid by the issuer each time it asks for a rating. Two fees is more general and yields the same results.

<sup>5</sup>There is no need for restructuring in the ratings inflation regime.

## References

- [1] Ashcraft, Adam, Goldsmith-Pinkham, Paul, and James Vickery, 2010, MBS ratings and the mortgage credit boom, Unpublished manuscript, Federal Reserve Bank of New York.
- [2] Benmelech, Efraim, and Jennifer Dlugosz, 2009a, The Alchemy of CDO Credit Ratings, *Journal of Monetary Economics* 56, 617–634.
- [3] Benmelech, Efraim, and Jennifer Dlugosz, 2009b, The Credit Rating Crisis, *NBER Macroeconomics Annual 2009*, 161-207.
- [4] Fender, Ingo and Janet Mitchell, 2005, Structured Finance: Complexity, Risk and the Use of Ratings, *BIS Quarterly Review*.
- [5] Gorton, Gary, 2008, The Panic of 2007, Unpublished manuscript, Yale University.