The economics of investor-paid credit rating agencies*

Dion Bongaerts†

Abstract

Recent crises triggered regulatory discussions on the issuer-paid model of credit rating agencies (CRAs). Using a heterogeneous competition model, I investigate whether investor-paid ratings can serve as viable and welfare improving alternatives. In the model, frictions among issuers or investors induce rating inflation from issuer-paid CRAs. Investor-paid ratings may induce separating behavior from high quality issuers leading to more accurate ratings. However, investor-paid CRAs suffer from three types of free-riding and are generally not competitive enough. Even if issuer-paid CRAs were banned, welfare improvements would be limited by redundancy in information production and free-riding among investor-paid CRAs. My results provide an explanation for the marginal role played by investor-paid CRAs in today's credit markets.

JEL classification: G24, G28, L14.
Keywords: Credit Rating Agencies, Competition, Reputation, Regulation, Investor-Paid

*I would like to thank Mark Van Achter, James McAndrews, Marc Arnold, Bo Becker, Kimberly Cornaggia, Mathijs van Dijk, Sarah Draus, Joost Driessen, Andrei Dubovik,Felix Flinterman, Andrea Gamba, Rob Jones, Frank de Jong, Volker Lieffering, Arjen Mulder, Marcus Opp, Frederik Schlingemann, Joel Shapiro, Steffen Sorensen, Marti Subrahmanyam, Dragon Tang, conference participants at the First Annual Conference on the Regulation of Financial Markets, NBER SI 2013 on CRAs, EFA 2012 Annual Meeting, ESSFM Gerzensee 2012, 6th Swiss Winter Conference on Financial Intermediation and seminar participants at Erasmus University, The University of Hong Kong and WHU for useful discussions and helpful comments. This paper has been prepared by the author under the Lamfalussy Fellowship Program sponsored by the ECB. Any views expressed are only those of the author and do not necessarily represent the views of the ECB or the Eurosystem.

†Rotterdam School of Management, Erasmus University. e-mail: dbongaerts@rsm.nl

1 Introduction

After the sub-prime crisis of 2007-2009, credit rating agencies (CRAs), like Moody's, S&P and Fitch, have come under increased public scrutiny. Globally, estimated losses on structured products such as sub-prime residential mortgage-backed securities (RMBSs) are estimated at $4 trillion.[1] Since many of these losses were incurred on highly (often AAA) rated products by the major issuer-paid CRAs, the accuracy of credit ratings has been severely criticized. Several recent articles such as Griffin and Tang (2012) show that ratings on structured products were indeed inflated. He, Qian and Strahan (2012) show that investors charged higher spreads on products with an inflated rating, suggesting market awareness.

The role CRAs played in the sub-prime crisis and their subsequent role in the European sovereign debt crisis motivated politicians and regulators to reassess regulation concerning CRAs. Proposed regulatory measures include requiring investors to do their own credit assessments, encouraging the use of investor-paid ratings and stimulating competition among CRAs.[2] However, the progress on this agenda is limited. Some new (primarily issuer-paid) CRAs have entered European and U.S. markets, but have failed to attract substantial market shares so far. Most notably, some high-profile investor-paid CRA initiatives have been withdrawn altogether. For example, Markus Krall, senior managing partner at Roland Berger has tried to set up an investor-paid, not for profit CRA in Europe. This plan was abandoned due to insufficient interest from investors for such an initiative.[3] Another initiative by the French credit insurer Coface to issue investor-paid ratings also never got started.[4]

[1] IMF estimation. See IMF (2009)

[2] Other measures include increased transparency requirements, legal liability for CRAs, hurdles to downgrade sovereigns and the instatement of a pan-European regulatory body, ESMA, that will supervise CRAs (primarily on a procedural basis). See among others European Parliament (2013).

[3] See Spiegel (2012) and Nielsen (2013)

[4] See Coface (2010); when contacted, Coface was unwilling to motivate this decision.

One could wonder why the reform of the CRA industry progresses so slowly. With the reputation of the major issuer-paid CRAs and their business model severely damaged, one would expect other parties with different business models to gain market share quickly. This paper answers this question by conducting a comparative analysis of investor-paid and issuer-paid ratings. To this end, I set up a heterogenous competition model of credit and ratings markets with issuers, investors and issuer- and investor-paid CRAs. The focus of the model is on the screening role of CRAs, in line with many recent studies (e.g. Bolton, Freixas and Shapiro (2012) and Mathis, McAndrews and Rochet (2009)).

To analyze the potential welfare improvement and competitive power of investor-paid CRAs, I introduce a model of credit and rating markets. The model focuses on the screening role of CRAs, in line with most recent theoretical studies on ratings markets. A more elaborate motivation for focusing on the screening role of CRAs can be found in Section 6.

The baseline model features issuers, issuer-paid CRAs and investors. All players are rational and know all parameters. Issuers have access to investment opportunities of unknown quality. For tractability and in line with e.g. Mathis et al. (2009), issuers are unaware of their own quality.[5] Unconditionally these projects have negative NPV. However, CRAs can overcome this problem by exerting costly screening effort to generate informative signals about project qualities. CRAs charge fees for their services and compete among each other. Funding comes from investors that compete among each other for profitable investment opportunities. As CRAs are disciplined by reputation, they need reputation rents.[6] These rents lower the quality demanded by issuers and hence, result in mild rating inflation (see also Shapiro (1983)).[7]

[5] One could think about an investment banker that structures a pool of mortgages with unknown documentation standards. I relax this assumption later on and show that results are robust.

[6] The concept of reputation employed in this paper is in the sense of Klein and Leffler (1981).

[7] As credit ratings are advertised as *relative* measures of creditworthiness, aggregate rating inflation may technically not be well defined. In the model, rating inflation refers to exerting lower than first-best rating effort.

More severe rating inflation is generated in the model by including a friction in the form of private benefits for issuers, conditional on funding. Such private benefits could result from employment concerns of managers/investment bankers or compensation schemes that condition on successful issuance. In order for private benefits to be real frictions and generate rating inflation, private benefits should not add to aggregate social welfare. This is the case when private benefits are large for the manager, but negligibly small for the economy at large [8]. Absent private benefits, one would expect any gains[9] from rating inflation to be (more than) offset by higher interest rates. In other words, market discipline would prevent rating inflation. However, private benefits increase issuer utility derived from high ratings disproportionately. If CRAs compete among each other, issuers will push for rating inflation (i.e. rating shopping by issuers that induces catering by CRAs; see also Griffin, Nickerson and Tang (2013)). Private benefits for investors instead of issuers have similar effects on the issuers' desire for inflated ratings. Note that private benefits induce rating inflation even from a monopolistic CRA, allowing it to capture more value than the aggregated economic surplus generated.

Investor-paid CRAs are then allowed to enter the market. In the model, investor-paid CRAs sell their ratings to subscribing investors. Issuers can then either issue debt to subscribing investors or solicit issuer-paid ratings and issue debt to non-subscribers. Subscribers may choose to privately disclose to each issuer the investor-paid rating it received before issuers select their financiers. This disclosure may shift the preferences of high quality issuers towards separation and hence higher rating accuracy.

The competitiveness of investor-paid CRAs is low compared to that of issuer-paid CRAs, due to several forms of free-riding. All other player types, issuers, investors and even issuer-paid CRAs can free-ride on investor-paid CRAs. Issuers with low investor-paid

[8]This setup is in line with traditional agency models where private effort costs are large for a CEO, but negligible for the economy at large

[9]from the issuers' perspective

ratings will not be granted funding and hence do not generate income for subscribers; this is free-riding by issuers. Next, there is the traditional argument that intellectual property rights are hard to protect. As a result, a certain fraction of the ratings produced will become known to investors without generating revenues. This is free-riding by investors. Both types of free-riding described above lead to higher fees and hence lower competitive power compared to issuer-paid CRAs. Finally, if subscribers choose to disclose ratings, issuers with low, disclosed investor-paid rating may become discouraged and leave the market. The remaining pool of issuers will then be of relatively high quality. Because of this 'positive selection', issuer-paid CRAs can produce relatively uninformative ratings without undermining their track-record. As the resulting effort costs for issuer-paid CRAs are low, they can price more aggressively and capture large market shares. This is free-riding by issuer-paid CRAs.

The option to disclose ratings provides subscribers and investor-paid CRAs with a mechanism to overcome their competitive cost disadvantage, despite the potential free-riding by issuer-paid CRAs. Issuers with high disclosed investor-paid ratings may change preferences towards separation and more accurate ratings. In such situations, separating equilibria can arise in which high quality issuers cluster around subscribers to investor-paid CRAs. These separating equilibria can only arise when issuer-paid CRAs cannot commit to exert sufficiently high effort to offer better terms to issuers with high disclosed investor-paid ratings. When issuer-paid CRAs compete among each other, limited future profits may limit committable effort for issuer-paid CRAs. A monopolistic issuer-paid CRA however, stands to lose such a valuable position that it can always commit to exert sufficient effort to compete the investor-paid CRA out of the market. In practice, this may prevent investor-paid CRAs from ever becoming dominant and even discourage them from entering. After all, successful entry of an investor-paid CRA would drive issuer-paid CRAs out of the market until only one remains that as a monopolist ruins the investor-paid CRA. In a restricted version of the model, I show that if issuer-paid CRAs were to be banned, investor-paid CRAs may try to free-ride on each other using positive selection. This prevents high accuracy equilibria from materializing in certain parameter ranges.

My results are robust to relaxing several modeling assumptions. Private benefits of investors lead to similar (or even worse) rating inflation as private benefits of issuers. Noisy self-knowledge of issuers shifts their demand towards higher rating accuracy, but the issuer preference for issuer-paid over investor paid ratings is not materially affected in large parameter ranges. Neither is this issuer preference affected much by the timing of investor-paid rating disclosure to issuers.

To my knowledge, this paper is the first to develop a heterogeneous competition model of the credit ratings industry. Furthermore, it is also one of the few -if not the only- papers that, using rigorous economic modeling, explains why the market structure for CRAs has evolved as it has. As such, it contributes to the growing literature about role and functional design of CRAs and the market structure CRAs operate in.

My results relate and contain smaller contributions to a variety of sub-fields of this literature. For example, the paper contributes to results by Bar-Isaac and Shapiro (2013) and Mathis et al. (2009) by highlighting different channels from theirs through which rating inflation can arise. Rating inflation in this paper arises even in a fully transparent and rational setting without business cycle fluctuations. Similarly, while several papers have linked rating inflation to regulatory importance (e.g. Bongaerts, Cremers and Goetzmann (2012), Kisgen and Strahan (2010), Ellul, Jotikasthira and Lundblad (2011) and Opp, Opp and Harris (2013)), I show that rating inflation can arise even in the absence of regulatory importance. My findings also add to earlier empirical (Becker and Milbourn 2011) and theoretical (e.g. Bolton et al. (2012), Sangiorgi, Sokobin and Spatt (2009), Skreta and Veldkamp (2009), Camanho, Deb and Liu (2012)) research on competition among CRAs. These existing papers focus on the detrimental effect of rating shopping *within* the class of issuer-paid CRAs. I show that rating shopping *across* business models can impede the adoption of alternative, potentially welfare enhancing business models. While this paper agrees with Pagano and Volpin (2010) that the adoption of investor-paid ratings might improve rating accuracy, it questions the size of these gains. Moreover, it questions the viability of the investor-paid CRAs under heterogeneous competition, because issuer-paid CRAs are more cost effective and can deter entry by temporarily increasing accuracy. This protective behavior of issuer-paid CRAs off the equilibrium path aligns with empirical findings by Xia (2014).

Methodologically, the model used is rather close to the model employed by Opp et al. (2013). One of the main differences between their model and my baseline model is that I model the interactive aspects of competition, whereas Opp et al. (2013) model competition by a static outside option. My model also shares similarities with Kashyap and Kovrijnykh (2013). Yet Kashyap and Kovrijnykh (2013) use a single period model and hence can only capture reputational concerns in reduced form. A mechanism similar to 'positive selection' can be found in a recent paper by Ahmed (2014). None of the three papers do however allow for heterogeneous competition on price and quality, which is crucial ingredient for obtaining my results.[10]

The remainder of the paper is structured as follows. Section 2 describes the model, introduces the players, sets a time line and derives the first-best solution as a benchmark for model outcomes with respect to social welfare. Section 3 analyzes base case equilibrium without investor-paid CRAs. In section 4, I derive equilibria with investor-paid CRAs entering the market. Section 5 shows robustness of the results to for example a setting in which investors instead of issuers have a private benefit of operating. Section 6 discusses the relation of the findings of this paper and empirically observed patterns in more detail. Finally, section 7 concludes.

[10] Ahmed (2014) and Opp et al. (2013) for example use fixed outside options.

2 Model setup and socially optimal outcomes

The model consists of an infinitely repeated game. All players in this economy, are risk-neutral and all model parameters are known by all players. Moreover, at the beginning of stage game t, the complete history of all actions and realizations, denoted by $\mathcal{F}^{t-1}$ is observed by all players. Finally, I assume that a player chooses randomly among equally valued alternatives. Below I describe the players, their action spaces and a detailed time line of each stage game. In the remainder of the paper, I will use subscripts for decision variables only. There is notation overview in Appendix B.

The game has four player types: issuers, investors, issuer-paid CRAs and investor-paid CRAs. To start with, there are Q issuers in every stage game, where Q is large. Each issuer j lives for one period and has one project available. For a project to be undertaken, a unit capital investment is needed. The project has a quality $q^j \in \{G, B\}$, where $P(q^j = G) = \theta$. Hence, θ measures market-wide average credit quality. If $q^j = G$ the project has a payoff $R > 1$, while if $q^j = B$, it has a payoff of zero. Unconditionally, the project has a negative NPV, that is $\theta R < 1$. Each issuer has an initial cash budget ζ, from which it can pay rating or transaction fees. After fees have been paid, the issuer pays out the residual endowment to its shareholders as a dividend, such that it is not pledgable in case an issuer defaults.[11] As in e.g. Mathis et al. (2009), the issuer does not know the quality of its own project. Finally, the issuer has a private benefit $\beta \geq 0$ of operating the firm. This private benefit gives rise to an economic friction. Therefore it is assumed to be a welfare loss to unmodeled parties in the economy. β is the main source of ratings inflation in the model and can have many different causes. One can think about inefficient compensation plans for investment bankers issuing CDOs, job-security concerns of issuer employees or regulatory benefits of having high ratings.

[11] The budget ζ will limit the value a (monopolistic) CRA can extract from good projects. Collateral considerations could for example limit the debt capacity expressed as a percentage of assets employed by the issuer, hence giving rise to ζ.

Second, there are N identical, and infinitely lived issuer-paid CRAs. I assume that this number is fixed due to entry barriers. Each CRA c can exert effort $e_c \in [0, 1]$ to obtain a signal $s^{j,c} \in \{G, B\}$ about issuer j, such that $P(s^{j,c} = G|q^j = G) = 1$ and $P(s^{j,c} = B|q^j = B) = e_c$. That is, a good project is always correctly identified, but a bad project is only identified correctly with probability e_c.[12] Hereafter the CRA will truthfully issue this signal as a rating.[13] The CRAs experience a quadratic effort cost Ce_c^2, where $C > 0$. The number of defaulted issuers with a high rating is perfectly observable at the end of each stage game.[14] Each CRA c charges issuers rating fees f_c for its rating efforts, which it quotes publicly.[15] Rating fees are paid irrespective of the rating outcome. Each CRA discounts future payoffs with a discount rate $r \in (0, 1)$ and maximizes the present value of its contemporaneous and future expected cash flows.

Third, there are M investor-paid CRAs, indexed by m. Once again, their number is fixed due to entry barriers. As investor-paid CRAs are entrants into the market, they need to publicly decide on participation at the start of each stage game. There is no explicit participation cost in the model, but investor-paid CRAs are assumed to choose not to participate if expected profits are not strictly positive.[16] Investor-paid CRAs have the same technology as issuer-paid CRAs. However, investor-paid CRAs sell their ratings to investors for a fee f_m. As investor-paid CRAs do not know ex-ante for which issuers ratings are required, they rate all issuers in the market. A fraction $\psi \geq 0$ of investor-paid ratings leaks to the market upon production, reflecting difficulties in enforcing intellectual

[12]The intuition behind this assumption is that issuers are likely to share positive information more willingly than negative information. See also Cohn, Rajan and Strobl (2014).

[13]As producing the signal is costly, signals of low project quality will always be truthfully reported even if lying is allowed (it would be irrational to exert costly effort if one wants to inflate the result anyway).

[14]And hence, market participants can, depending on the exact equilibrium, infer the exerted e_c ex-post.

[15]In reality, rating fees are not quoted publicly, but this assumption may be less problematic than it seems at first glace. First, issuers can in reality obtain price quotes for having their issue rated. Second, many of the largest investors also issue a diversity of products themselves and are therefore well aware of prevalent rating fees.

[16]This is equivalent to having an infinitesimal participation cost.

property rights. The base case in Section 3 does not feature investor-paid CRAs, so in that case, $M = 0$.

Finally, in each stage game, there are $W > 1$ investors. Each investor has unlimited capital at its disposal to lend out and there are no (dis)economies of scale. This way, there is an over-supply of funds and investors compete.[17] Each investor lives for one period and maximizes its own expected profit. An endogenously determined number of investors $H \in \{0, .., W\}$ chooses to purchase investor-paid ratings and become subscribers. Subscribers are indexed by h whereas non-subscribing investors are indexed by b. Subscribers publicly quote a transaction fee f_h^m and an interest rate ι_h^m they charge to issuers with a rating $s^m = G$. [18] Subscribers can privately disclose the investor-paid rating to each issuer before issuers choose their financiers.[19] Non-subscribers quote interest rates ι_b^c at which they are committed to fund issuers with $s^c = G$. An investor can decide not to quote an interest rate and/or transaction fee for a CRA c or m. In that case, it will simply disregard any rating issued by that CRA and never fund based on that rating.

Each stage game t then proceeds as displayed in Figure 2.

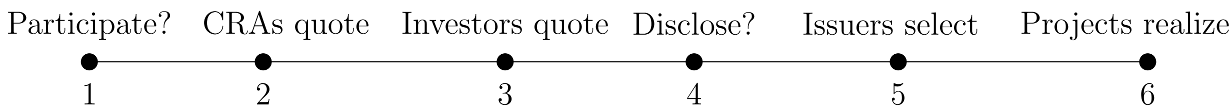

Figure 1: Time line of a stage game.

In step 1, investor-paid CRAs publicly decide whether to participate or not.

In step 2, all CRAs publicly quote rating fees f_c, f_m and privately plan effort e_c, e_m to be exerted. Participating investor-paid CRAs conduct ratings. A fraction ψ of all

[17]The over-supply of funds is a crucial assumption in the model. When capital is in short supply, investor-paid CRAs may perform (somewhat) better and generate more business. However, rating inflation tends to arise exactly when markets are flushed with funds and these benefits arise when least needed (see also Bar-Isaac and Shapiro (2013)).

[18]The transaction fee allows subscribers to recoup/pass on rating fees. The alternative is to let them charge a higher interest rate.

[19]In reality, this disclosure can be implicit. For example, the subscriber can inform the issuer that it can unconditionally commit to funding.

investor-paid ratings becomes public.

In step 3, investors publicly set interest rates ι_b^c, ι_h^m, transaction fees f_h^m and decide to become subscriber or not.

In step 4, subscribers privately receive investor-paid ratings and choose to privately disclose them to issuers or not.

In step 5, issuers choose either a subscriber h or a pair $\{c, b\}$ consisting of an issuer-paid CRA and a non-subscribing investor to apply for funding.

In step 6, projects are realized and investors that invested in projects with quality $q = G$ are repaid principal plus interest. Defaulted issuers pay nothing to investors. The number of defaults and the issued ratings are publicly observed.

2.1 First best outcome

In this sub-section, I derive the first best outcome, that is, the outcome that a social planner would choose if he could control actions of all market participants perfectly. In the model, social welfare is created by implementing high quality projects (i.e. $q^j = G$). Social welfare is destroyed by defaults and rating effort exerted. Naturally, the first best outcome is dependent on parameter values. Typically, if rating production costs are relatively low, producing ratings causes little social welfare loss. In that case, a social planner would let a CRA (irrespective of the business model) produce ratings with high accuracy. Thereafter, it would mandate investment in all highly rated projects (i.e. $s^{j,c} = G$). If credit assessment technology is very expensive compared to welfare gains to be realized, it may not be worthwhile to produce any ratings at all.

Proposition 1. *If* $\frac{(1-\theta)^2}{4C} \geq (1 - \theta R)$*, the first best outcome generates a social welfare of* $\min\left(\frac{(1-\theta)^2}{4C} - (1-\theta R), \theta(R-1) - C\right)$ *and is attained by letting a CRA c rate all debt with effort* $e_c = \min\left(\frac{1-\theta}{2C}, 1\right)$ *and let investors fund all projects with rating* $s^{j,c} = G$*. If* $\frac{(1-\theta)^2}{4C} < (1 - \theta R)$*, the first best outcome generates a social welfare of 0 and is attained by* *conducting no ratings at all and making no investments whatsoever.*

Proof. See Appendix. □

The intuition behind Proposition 1 is relatively straightforward. It is only worthwhile producing ratings when conducting ratings is sufficiently cheap and the social value of a rating is sufficiently high. Naturally, the unit support for probabilities binds exerted effort by 1 from above. Thus, with very low production costs relative to the social value of ratings, it is optimal to produce fully revealing ratings. In the remainder of the paper, I will refer to rating inflation as exerted rating effort falling short of the first best effort level.

3 Basic equilibrium analysis

In the rest of the paper, I will explore equilibria with and without investor-paid CRAs. However, before doing so, I need to define the type of equilibria I will look at.

3.1 Equilibrium definition

Because the game is strategic in nature, I will look at Nash equilibria. Under this definition, we have an equilibrium if every player's strategy is (weakly) optimal given the strategies of all other players.[20] Additionally, I will look for equilibria that do not differ from one period to the other, in other words, that are steady state. Hence, the equilibria I look at can be characterized by a set of strategies over one stage game. Moreover, by studying steady-state equilibria, I can focus on long run effects of policy measures, which should be the focus of most regulations. Finally, I focus on sub-game perfect equilibria to avoid equilibria involving threats that are not credible.

[20] Including the players that have only participated or will only participate in previous or subsequent stage games respectively

In the process of exploring equilibria, I will as much as possible try to derive general results that hold broadly and build towards more specific equilibria.

To establish a benchmark, I first explore a base case equilibrium in which investor-paid CRAs are not present, i.e. $M = 0$.

3.2 Base case

In this section, I derive the base case equilibrium involving investors, issuers and issuer-paid CRAs. I show that social welfare in the base case falls short of first best and can even be negative if private benefits for issuers are large. In other words, if issuers want the 'wrong things', financial intermediation can destroy more social value than it creates.

Any equilibrium that involves the three basic players needs to satisfy four basic conditions or constraints. These are zero investor profit, pledgeability, CRA incentive compatibility and affordability.

Let us start with zero investor profit. As investors have short horizons, have constant returns to scale and an over-supply of capital, they compete on an equal basis for profitable deals. Standard economic results then apply and investors must break even in expectation. Therefore, given a sufficiently high equilibrium effort level $\tilde{e}_c$, each investor b quotes interest rate

$$\tilde{\imath}_b^c = \frac{(1-\theta)(1-\tilde{e}_c)}{\theta}. \tag{1}$$

Given that investors break even in expectation, not all effort levels can be sustained in equilibrium. After all, the (limited) surplus generated by good projects is the only source for interest payments. Therefore, only effort levels that generate sufficiently low expected default losses to be covered by maximum pledgeable interest can be sustained in equilibrium. Therefore, the minimum pledgable equilibrium effort level is given by

$$\underline{e} = \frac{1 - \theta R}{1 - \theta}. \tag{2}$$

Equation (2) implies that CRAs need to exert strictly positive effort in equilibria with investment. As contemporaneous CRA profits decline in exerted effort, such discipline can only be achieved through reputation. The threat of investors ignoring CRAs in the future (and hence take away all demand for those CRAs' services) can contemporaneously discipline CRAs. For reputation to be effective, the contemporaneous gain from misbehaving should be more than offset by the expected loss of future cash flows. To maximize the disciplining effect of reputation, I focus on grim-trigger punishment strategies. With grim-trigger punishment, the following incentive compatibility condition arises

$$Ce_c^2 \leq \frac{f_c - Ce_c^2}{r}. \tag{3}$$

Making equation (3) bind and solving towards f_c gives the lowest incentive compatible rating fee and hence the fee that materializes with competition among CRAs:

$$f_c = (1 + r)Ce_c^2. \tag{4}$$

This fee strictly exceeds information production costs, hence leaving economic profits (reputation rents) for CRAs. Therefore, with reputation-based discipline equilibrium effort levels generally fall short of the first-best effort level (see also Shapiro (1982)).

The combination of limited budgets for rating fees and the incentive compatibility requirement together lead to the affordability constraint that binds committable effort from above:

$$\zeta \geq f_c \Rightarrow \qquad e_c \leq \bar{e} = \sqrt{\frac{\zeta}{C(1+r)}}. \tag{5}$$

Let us for the rest of this paper assume that $\underline{e} \leq \bar{e}$.

A large shortfall in effort can materialize in the presence of issuer private benefits as in that case, issuers gain an additional and potentially large benefit from low effort. As a consequence, issuers will put pressure on CRAs to inflate ratings.

Proposition 2. *The following strategies constitute an equilibrium:*

1. *CRAs are permanently ignored if they ever have exerted effort $e_c < e^*$ or quoted $f_c < f^*$,*

2. *Investors fund issuers at competitive interest rates conditional on high ratings from trusted CRAs,*

3. *Issuers select combinations of investors and trusted CRAs minimize the sum of rating fees, private benefits and expected interest rates,*

4. *CRAs exert effort $e_c = e^*$ for fees $f_c = f^*$ if they are trusted and $e_c = 0$ for a fees $f_c = \zeta$ otherwise,*

5. *With CRA competition ($N > 1$), e^* and f^* are given by*

$$f^* = C(1+r)(e^*)^2, \tag{6}$$

$$e^* = \max\left(\underline{e}, \min\left(\frac{(1-\theta)(1-\beta)}{2C(1+r)}, 1, \bar{e}\right)\right). \tag{7}$$

6. *With a monopolistic CRA ($N = 1$), e^* and f^* are given by*

$$f^* = \min(\zeta, \theta(R-1) - (1-\theta)(1-\beta)(1-e^*)), \tag{8}$$

$$e^* = \max\left(\underline{e}, \min\left(\frac{(1-\theta)(1-\beta)}{2C}, 1, \bar{e}\right)\right). \tag{9}$$

Proof. See appendix. □

The equilibrium in Proposition 2 highlights some interesting features. First, we see that in the absence of private benefits for the issuer ($\beta = 0$), a monopolistic CRA can lead to first best outcomes if it can capture all generated surplus. However it exerts too little effort if the amount of surplus it can capture is limited by a low initial endowment ζ. For interior solutions, competing CRAs can never generate first-best. To see this, take the competitive equilibrium effort level. At interior values, we have that e^* equals the first best effort level multiplied with $\frac{1-\beta}{1+r} < 1$. The denominator in this fraction is due to the need for reputation rents. The numerator reflects the dampening effect private benefits have on market discipline through interest rates. With positive private benefits, more inefficiencies show up. First best can then never be attained (not even with a monopolistic CRA) and rating accuracy and welfare drop. This is easily proven for interior equilibrium effort levels:

Corollary 1. *The social welfare in equilibria with interior effort levels is always strictly lower than first best when $\beta > 0$. When $\beta = 0$ social welfare in a competitive rating market with interior effort levels is also strictly lower than first best as long as $r > 0$.*

Proof. See appendix. □

Note that welfare can even turn negative. Negative welfare can for example materialize when accuracy drops by so much that the pledgeability constraint starts to bind (i.e.

$e^* = \underline{e}$). In that case, all surplus from good projects is used as interest to compensate investors for default losses, while costly resources are spent on credit assessment.

4 Investor-paid CRAs

4.1 Entry of investor-paid CRAs in a free market

One of the most prominently proposed solution to the problem of low ratings accuracy is the use of investor-paid CRAs, such as Egan-Jones Ratings (see e.g. Pagano and Volpin (2010)). Below, I analyze the economics of investor-paid ratings in my model. I show that the best an investor-paid CRAs can hope for is to let issuers learn about their own quality and thereby induce preference for separation from high quality issuers. However, several sorts of free-riding may make this hard to achieve in a cost-efficient manner. As a result, there may for large parameter ranges be no equilibria in which investor-paid CRAs participate.

The traditional competitive disadvantage of investor-paid CRAs is a free-riding concern related to the difficulty to enforce intellectual property rights. This is captured by the leakage fraction ψ. The leakage reduces the mass of issues that generate revenue and hence, subscribers need to increase transaction fees to recoup their costs. In addition to this first type of free-riding, there are two other types. The second type concerns free-riding by issuers that only pay transaction fees when funded and hence when high investor-paid ratings are issued. The third type involves free-riding by issuer-paid CRAs in case of private disclosure by subscribers. Issuer-paid CRAs can exert low effort and charge high fees when issuers with a rating $s^m = B$ find it prohibitively expensive to solicit issuer-paid ratings. For issuers with high investor-paid ratings, it is then optimal to solicit issuer-paid ratings and fund from non-subscribers. The first two types of free riding lead to the cost disadvantage described in the following Lemma:

Lemma 1. ***(Cost disadvantage)****: Given equilibrium effort level $\tilde{e}_m$, the lowest incentive compatible transaction fee an investor h subscribing to investor-paid CRA m can quote is given by*

$$\underline{f}_h \geq \frac{(1+r)C\tilde{e}_m^2(1-\psi)^{-1}}{\theta + (1-\theta)(1-\tilde{e}_m)}. \tag{10}$$

Proof. See Appendix. □

In order for an investor-paid CRA to survive, it needs to prevent issuers from soliciting issuer-paid ratings. In view of the investor-paid CRA's cost disadvantage, competing on fees is not an option. However, issuers can learn their investor-paid ratings if subscribers choose to disclose. Given effort level e_m and a disclosed high investor-paid rating, issuers can lock in private benefits β by either taking subscriber funding or by soliciting an issuer-paid rating from CRA c that exerts $e_c \leq e_m$. In those cases, β will be conditioned on and its distortive effect on CRA selection shrinks. As a result, issuer preferences may shift from pooling towards separation. Hence, disclosure of accurate ratings can shift issuer preferences towards more accurate ratings. If investor-paid CRAs can better commit to deliver accurate ratings, they may be able to pick up market share from issuer-paid CRAs for some parameter ranges.

Lemma 2. ***(Disclosure)****: For investors, the combination of subscribing to m and non-disclosure is never optimal.*

Proof. See Appendix. □

However, issuer-paid CRAs may in turn try to prevent entry of investor-paid CRAs. This can be done by engaging in either positive selection or outbidding if m ever were to enter. With positive selection, issuer-paid CRAs try to get into a separating equilibrium in which issuers with $s^m = B$ leave the market after disclosure. Because the remaining pool of issuers is of high quality, issuer-paid CRAs can guarantee low interest rates to this pool while exerting low or even zero effort. As a consequence, issuer-paid CRAs can offer more competitive fees than investor-paid CRAs and capture the whole market. Positive selection typically takes place when private benefits β are low as in that case, issuers with $s^m = B$ are easily encouraged to leave the market. When positive selection is not possible, issuer-paid CRAs can try to outbid investor-paid CRAs. With outbidding, issuer-paid CRAs exert equal or (somewhat) lower effort at (much) lower fees than the investor-paid CRA and hence offer better value to issuers. The required effort levels for outbidding may not always be committable for issuer-paid CRAs if $N > 1$. In such scenarios, investor-paid CRAs can start to dominate the market. Naturally, outbidding is easier (and therefore possible for larger parameter ranges) when the investor-paid CRA has a larger cost disadvantage. The intuition outlined above is formalized in the following Proposition.

Proposition 3. *If $N > 1$, issuer-paid CRAs can deter entry to an investor-paid CRA m if for all effort levels e_m issuer-paid CRAs can either free-ride on positive selection or credibly outbid investor-paid CRAs. Positive selection is possible for large parameter ranges when private benefits β are small. Outbidding is possible for large parameter ranges when the investor-paid CRA has a large cost disadvantage.*

Proof. See Appendix. The exact parameter ranges are derived in the proof and summarized at the bottom of it. □

A consequence of Proposition 3 and Lemma 1 is that if there is a role to be played for investor-paid CRAs, then investor-paid CRAs must exert higher effort levels than those exerted by issuer-paid CRAs in the base case. Moreover, the presence of investor-paid CRAs may put upward pressure on issuer-paid CRA effort.[21] One reason for this is that

[21] Typically, this will be off the equilibrium path.

the market for issuer-paid CRAs is smaller in the presence of investor-paid CRAs, for example due to leakage (i.e. ψ). As a result, future profits (conditional on the expectation that m will leave the market in the future) are relatively more important and higher effort levels can be committed to. Higher effort levels are useful in outbidding strategies. These results are in line with recent empirical findings by Xia (2014).

Summarizing, if $N > 1$, an investor-paid CRA m can only capture the ratings market in a very limited parameter range at an effort level exceeding the base case effort level. With the threat of issuer-paid CRAs trying to re-capture market share, social welfare would (most likely) increase.

On the other hand, for a monopolistic issuer-paid CRA (i.e. $N = 1$) the required effort level for outbidding is always committable as the monopoly position is too valuable to be lost.

Lemma 3. ***(Monopolistic power)****: A monopolistic issuer-paid CRA can always deter entry to an investor-paid CRA, for example by matching effort at a lower fee.*

Proof. See Appendix. □

In practice, Lemma 3 in combination with fixed costs for market presence and entry could make it very unlikely that investor-paid CRAs ever gain meaningful market share, even when initially $N > 1$. If $N > 1$ and issuer-paid CRAs lose market share, they will start to drop out until only one survives, which yields the situation where $N = 1$.

Taken together, these results indicate that there is little scope for investor-paid CRAs in a screening role. The recent withdrawals of investor-paid rating initiatives of Roland Berger and Coface and the change of heart at Kroll Bond Ratings from investor-paid to issuer-paid[22] are in line with this result.

[22] See Bloomberg (2012)

4.2 Imposing investor-paid ratings on the market

One could choose to ban issuer-paid CRAs and only license investor-paid CRAs to conduct ratings. In this sub-section, I explore whether such measures could help to avoid social welfare losses imposed by ratings inflation. To analyze this scenario, I set $M = 2$ and $N = 0$. Within this section, the term CRA refers to investor-paid CRA only.

As investor-paid CRAs are disciplined by reputation, incentive compatibility needs to be satisfied. Moreover, a monopolistic investor-paid CRA will try to capture all surplus plus private benefits generated and therefore display similar behavior to a monopolistic issuer-paid CRA. This includes inflating ratings in the presence of private benefits. Hence, the interesting case to analyze is when the two CRAs compete. As there is homogeneity within player types and there are no capacity constraints on investors and CRAs, two types of equilibria can arise. The first type is a symmetric type in which both CRAs play identical strategies. The second type is an asymmetric type in which one CRA conducts ratings and the other drops out. One of the reasons that an asymmetric equilibrium is possible here is that in order to operate, each investor-paid CRA needs to rate all issues. This is like a fixed cost of operating. If there is insufficient surplus in the economy to cover this 'fixed cost' twice, non-participation is optimal for one of the CRAs.

In a symmetric competitive equilibrium, it should be optimal for both CRAs to exert equal and positive effort. However, if β is relatively low and e_m is relatively high, issuers with low, privately disclosed ratings may not find it worthwhile to apply for funding.[23] If CRA m exerts effort $e_m > \underline{e}$, it may be optimal for the other CRA to free-ride and exert low or even zero effort at a fee slightly lower than f_m. As a consequence, the equilibrium would unravel. This type of free-riding by positive selection is similar to the free-riding of issuer-paid CRAs in Section 4. Issuers will avoid investors subscribing to m because

[23] In this case, the only benefit would be the potential private benefit, but this would come at the cost of a transaction fee. If the transaction fee exceeds private benefit, funding application for such issuers is sub-optimal.

identical private benefits and interest rates can be obtained for a lower fee from investors subscribing to the other CRA. Hence, when β is low, (pure strategy) symmetric equilibria may arise only at low effort levels if at all.

When β is sufficiently high, it is optimal even for low quality issuers to always apply for funding. In this case, issuers with only high disclosed ratings condition on receiving β and try to minimize interest expenditures, thereby pushing CRAs to higher effort levels (as if β were zero). Hence, with large β, a competitive equilibrium with higher rating accuracy than in the base case may materialize. These effects are summarized in the proposition below:

Proposition 4. *Suppose $M = 2$ and $N = 0$. An equilibrium with $e_m = e^*_{\mathcal{M}} > \underline{e}\ \forall m$ can only exist if 1.) Fees are affordable, 2.) There is no free-riding by positive selection at $e^*_{\mathcal{M}}$ and 3.) $e^*_{\mathcal{M}}$ is the highest effort level at which issuers with only high ratings would not prefer lower rating effort. Condition 2.) is satisfied when private benefits β are sufficiently large. In such an equilibrium, disclosure always takes place.*

Proof. See Appendix. The precise (mathematical) conditions for conditions 1.) to 3.) to hold are provided in the proof. □

Competitive investor-paid equilibria only improve on accuracy when β is sufficiently large.[24] However, higher exerted effort in this case is not guaranteed to lead to increased welfare. The reason is that the two CRAs each rate all issues, and hence each dollar allocated to credit assessment only yields half its potential value. In other words, half of the produced ratings are redundant.

[24]That is, when the base case equilibrium generates low social welfare.

5 Robustness tests and extensions

In this section, I explore the robustness of my findings. In particular, I show that the results derived above hold true when investor rather than issuer private benefits are the source of rating inflation in the model. Moreover, I show that my findings are robust to alternative assumptions on timing and to issuers having noisy information about their own quality.

5.1 Private benefits of investors

In this robustness test, I show that in the base case private benefits of investors resort similar effects as private benefits for issuers. Private benefits for investors can arise if portfolio managers are subject to convex compensation schemes such as option and bonus plans, which reward risk taking. Alternatively, size related benefits such as empire building concerns or bailout expectations for too-big-too-fail institutions can stimulate demand and create a tolerance for inflated ratings. Regulatory importance considered by Opp et al. (2013) would also give rise to such private benefits. As is shown below, the presence of private benefits to investors is sufficient to induce rating inflation.

In this setting, issuers have no private benefit of operating (i.e. $\beta = 0$), but investors do (measured by $\alpha > 0$). As was the case with β, α is assumed to be a real economic friction and therefore is either negligible in view of the economy at large or an unmodeled negative externality onto other players in this economy. As is shown below, private benefits for investors have two effects. First, investors will lower interest rates as competition dictates that investors have zero expected utility in equilibrium. The private benefits move the expected utility of investors upwards. As a result, the pledgeability constraint is effectively relaxed, allowing for more extreme forms of rating inflation (i.e. lower effort) in equilibrium (this gives rise to the first occurrence of α in equation (11) below). Second, as private benefits are conditional on funding, investor preferences for high accuracy are lowered and rating inflation will only be partially reflected in higher interest rates. As a result, issuers will prefer high over accurate ratings as before (this gives rise to α showing up in the coefficient on e^* in equation (11)). In other words, market discipline fails in the presence of investor private benefits.

Lemma 4. *Given $\beta = 0$, $\alpha > 0$ and any equilibrium effort level e^* from CRAs, investors charge an equilibrium interest rate of*

$$\iota^* = \frac{(1-\theta) - \alpha - (1-\alpha)(1-\theta)e^*}{\theta}. \tag{11}$$

Proof. See Appendix. □

5.2 Noisy self-knowledge

One feature of the model is that issuers are assumed to be unaware of their own quality. This assumption may be violated in practice. Moreover, different types of issuers may be aware of their own quality to different degrees. For example, given the complex and opaque nature of the market for complex securitizations, self awareness may have been lower than in for example the corporate bond market. In this section, I test the robustness of my results to issuers having noisy information on their own quality. In particular, I assume that in the disclosure stage, each issuer receives a private signal s^n generated by nature for free. These signals cannot be credibly communicated to investors or CRAs. The nature-induced signals are similar to the rating signals. As with rating signals, issuers with $q = G$ always receive signals $s^n = G$, whereas issuers with $q = B$ receives signals $s^n = B$ with probability $(1 - e^n)$ and signals $s^n = G$ otherwise.[25]

Self awareness creates several partially offsetting effects. First, an issuer with $s^n = G$

[25] This corresponds for example to investment banks being aware of the danger of no-documentation sub-prime mortgages with probability e^n or managers being overconfident with probability $(1 - e^n)$.

will be more eager to do the project as expected profits are larger. Yet, this is partially offset by the higher probability of having to pay interest. Similarly, such an issuer will be more likely to pocket private benefits β, but is also more likely to have to pay f_h if subscriber funding is chosen. On aggregate, equilibrium effort will increase.

Lemma 5. *Absent investor-paid CRAs and positive selection, demanded rating effort by issuers with $s^n = G$ increases with e^n.*

Proof. See Appendix. □

Lemma 5 provides a possible explanation as to why complex products experienced more rating inflation than corporate bonds. High quality corporate issuers would be more self aware than high quality CDO issuers and therefore demand higher rating accuracy.

Absent an investor-paid CRA, Lemma 5 also implies that either issuer-paid CRAs will cater to high-quality issuers and exert higher effort or that positive selection will take place in every stage game. As a result, positive selection by issuer-paid CRAs off the equilibrium path becomes more feasible.

Lemma 6. *The range of e_m for which issuer-paid CRAs can engage in positive selection expands with e^n.*

Proof. See Appendix. □

Lemma 6 highlights a channel through which noisy self knowledge of issuers strengthens the competitive power of issuer-paid CRAs vis-a-vis investor-paid CRAs.

Noisy self knowledge also affects the parameter range for which outbidding is possible. Outbidding is affected by two opposing effects. On the one hand, a higher e^n leads to higher reputation rents absent investor-paid CRAs and positive selection. As a result, issuer-paid CRAs can commit to higher effort levels off the equilibrium path. On the other hand, when e^n is very high, issuers with $s^n = G$ will benefit more from a separating equilibrium and therefore push for higher effort.

Lemma 7. *The parameter range for which issuer-paid CRAs can outbid an investor-paid CRA is affected by* e^n *through two opposing channels. Which effect dominates depends on model parameters.*

Proof. See Appendix. □

One should note that the importance of outbidding decreases with e^n since the parameter range for successful positive selection increases with e^n. Hence, we can conclude that the results in Section 4 are largely robust to the introduction of noisy self-knowledge.

5.3 Robustness on timing of investor-paid ratings

In section 4, I show that investor-paid CRAs are very unlikely to survive in equilibrium when investor-paid ratings are disclosed before issuer-paid CRAs can be selected. This allows for free-riding by issuer-paid CRAs through positive selection. In this section I show that this finding is robust to the timing of investor-paid rating disclosure.

Suppose disclosure of investor-paid ratings could take place after issuer-paid ratings had been disclosed to the market, but before issuers select financiers. Now issuer-paid CRAs would be unable to benefit from positive selection. However, with investor-paid disclosure after issuer paid disclosure, outbidding for issuer-paid CRAs is even easier, because the rating fee f_c is now a sunk cost that is irrelevant for the selection decision.

Proposition 5. *If disclosure of investor-paid ratings takes place after issuer-paid ratings are published, outbidding by issuer-paid CRAs is successful in even larger parameter ranges than before. Moreover, investor-paid CRAs cannot free-ride on issuer-paid CRAs.*

Proof. See Appendix. □

6 Discussion

The results put forward in this paper predict that there is little to no room for investor-paid CRAs in financial markets. This is consistent with issuer-paid CRAs covering the vast majority of the market as well as the recent failure of several investor-paid CRA initiatives to even get started. Yet, one could put forward that some investor-paid CRAs do exist. One such example is Egan Jones Ratings, which is also an NRSRO. How can the existence of investor-paid CRAs, even when their market share is small, be reconciled with the predictions of my model?

There are in my view two possible reasons for investor-paid CRAs to exist. First, markets may in the short run be out of equilibrium. Hence, investor-paid CRAs may temporarily show up off the equilibrium path, even if they have no role in a long term equilibrium. Section 4.1 predicts that if that happens, issuer-paid CRAs will engage in positive selection or outbidding. Empirical results reported by among others Xia (2014) support the outbidding response of issuer-paid CRAs to the existence of investor-paid CRAs.

The second raison d'être for investor-paid CRAs may be a monitoring rather than the screening role that is emphasized in this paper. In this situation, investor-paid CRAs would primarily cater to a secondary market clientele. If this clientele largely consists of unregulated investors with a speculative motive, a demand for more accurate and timely ratings is likely to arise. Such demand would be higher for more active and accessible markets such as corporate bond markets (as opposed to structured product markets). Investor-paid CRAs could then acquire market share by catering to this demand with accurate and timely ratings. Such a role is in line with empirical results reported by Bruno, Cornaggia and Cornaggia (2013) and Bhattacharya, Wei and Xia (2014).

My paper focuses on the screening rather than monitoring role of CRAs for several reasons. Screening prevents negative NPV projects to be undertaken in the first place.

Monitoring leads to i) improvements in asset allocation after issuance, and ii) management discipline for going concern entities. In my view, there is a natural hierarchy with screening superseding monitoring in the sense that monitoring without screening is unlikely to work, while the reverse is not the case. Moreover, due to the discrete effect of screening (fund or not fund) rather than the more continuous effect of monitoring on yield spreads, screening is likely to matter more at the margin. In addition, management discipline is most likely to arise only with repeated issuers. However, for those issuers, repeated screening at each issuance can, at least partially, substitute this role. Finally, the recently observed rating inflation of structured products gave reason to focus on the screening role of CRAs. Management discipline through improved monitoring would not have resorted much effect as these products were typically passively managed and one-off. Moreover, asset allocation effects of improved monitoring would have led to even more overpricing of structured products. The only benefit of improved asset allocation would have been a lower multiplier effect of the sub-prime losses on the real economy.

7 Conclusion

In this paper, I have explored the potential of investor-paid ratings as alternative to issuer-paid ratings to improve on rating accuracy and social welfare. For limited parameter ranges investor-paid ratings may have some limited potential to improve social welfare if imposed on the market. It will be very hard for investor-paid ratings to compete with issuer-paid ratings in a free market.

While the model goes a long way in explaining why the issuer-paid CRAs have become and still are the dominant players in this market, some concessions to reality have been made. These provide avenues for further research. For example, one could verify how results change if exerted effort is hard to verify ex-post. In this context, the comparison between issuer-paid CRAs and investor-paid CRAs would be particularly interesting as issuer-paid CRAs would ex-post be more transparent by definition. Another way of extending the model is to increase the granularity of issuer quality and rating scales. This could on the one hand reduce the severeness of ratings inflation. On the other hand, increased granularity could also facilitate rating inflation as it is harder to be detected ex-post and therefore more likely to go unpunished.

The results in this paper suggest alternative avenues to explore in terms of addressing incentive-based problems with CRAs. The main drivers behind ratings inflation in this paper are the private benefits for issuers and investors. Measures that lower these private benefits, for example by reducing regulatory importance of ratings or by limiting bonus-based compensation schemes and too-big-to-fail subsidies fall in this category.

Finally, one should note that the effort cost coefficient typically ends up in the expression for optimal effort and that social welfare is decreasing in this coefficient. This is true irrespective of the market structure. Hence, measures that could reduce effort costs such as standardized reporting requirements and technological and academic advances would help in increasing social welfare. Those could even help to get rid of ratings inflation. Even with issuer private benefits the boundary solution of maximal accuracy (i.e. $e_c = 1$) might arise, which must in that case coincide with the first best outcome.

References

Ahmed, J.: 2014, Competition in lending and credit ratings. Working paper.

Bar-Isaac, H. and Shapiro, J. D.: 2013, Ratings quality over the business cycle, *Journal of Financial Economics* **108**(1), 62–78.

Becker, B. and Milbourn, T. T.: 2011, How did increased competition affect credit ratings?, *Journal of Financial Economics* **101**, 493–514.

Bhattacharya, U., Wei, K. D. and Xia, H.: 2014, Follow the money: Investor trading around investor-paid credit rating changes. Working Paper.

Bloomberg: 2012, Kroll sees supplanting s&p in rating commercial mortgage bonds, `http://www.bloomberg.com/news/2012-05-21/kroll-sees-supplanting-s-p-in-rating-commercial-mortgage-bonds.html`.

Bolton, P., Freixas, X. and Shapiro, J.: 2012, The credit ratings game, *Journal of Finance* **67**(1), 85–111.

Bongaerts, D., Cremers, K. and Goetzmann, W.: 2012, Tiebreaker: Certification and multiple credit ratings, *Journal of Finance* **67**(1), 113–152.

Bruno, V., Cornaggia, J. and Cornaggia, K. R.: 2013, Does regulatory certification affect the information content of credit ratings?, *Management Science* **Forthcoming**.

Camanho, N., Deb, P. and Liu, Z.: 2012, Credit rating and competition. Working Paper.

Coface: 2010, Press release, `http://www.coface.com/CofacePortal/ShowBinary/BEA%20Repository/HK/en_EN/documents/wwa_news_events/20100729CofaceCESR-HK_en`.

Cohn, J., Rajan, U. and Strobl, G.: 2014, Credit ratings: Strategic issuer disclosure and optimal screening. Working paper.

Ellul, A., Jotikasthira, P. and Lundblad, C. T.: 2011, Regulatory pressure and fire sales in the corporate bond market, *Journal of Financial Economics* **101**(3), 596–620.

European Parliament: 2013, Legislative resolution of 16 january 2013 on the proposal for a regulation of the european parliament and of the council amending regulation (ec) no 1060/2009 on credit rating agencies, `http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P7-TA-2013-0012+0+DOC+XML+V0//EN&language=EN`.

Griffin, J. M., Nickerson, J. and Tang, D. Y.: 2013, Rating shopping or catering? An examination of the response to competitive pressure for CDO credit ratings, *Review of Financial Studies* **26**(9), 2270–2310.

Griffin, J. M. and Tang, D. Y.: 2012, Did subjectivity play a role in CDO credit ratings?, *Journal of Finance* **67**(4), 1293–1328.

He, J., Qian, J. and Strahan, P. E.: 2012, Are all ratings created equally? The impact of issuer size on the pricing of mortgage-backed securities, *Journal of Finance* **67**(6), 20972137.

IMF: 2009, World economic outlook: Crisis and recovery, `http://www.imf.org/external/pubs/ft/weo/2009/01/`.

Kashyap, A. K. and Kovrijnykh, N.: 2013, Who should pay for credit ratings and how? NBER Working Paper.

Kisgen, D. J. and Strahan, P. E.: 2010, Do regulations based on credit ratings affect a firm's cost of capital?, *Review of Financial Studies* **23**(12), 4324–4347.

Klein, B. and Leffler, K. B.: 1981, The role of market forces in assuring contractual performance, *Journal of Political Economy* **89**, 615–641.

Mathis, J., McAndrews, J. and Rochet, J.-C.: 2009, Rating theraters: Are reputation concerns powerful enough to discipline rating agencies?, *Journal of Monetary Economics* **56**, 657–674.

Nielsen, N.: 2013, EU-based credit rating agency buried, `http://euobserver.com/foreign/120005`.

Opp, C. C., Opp, M. M. and Harris, M.: 2013, Rating agencies in the face of regulation, *Journal of Financial Economics* **108**(1), 46 – 61.

Pagano, M. and Volpin, P.: 2010, Credit ratings failures and policy options, *Economic Policy* **25**(62), 401–431.

Sangiorgi, F., Sokobin, J. and Spatt, C.: 2009, Credit-rating shopping, selection and the equilibrium structure of ratings. Working paper.

Shapiro, C.: 1982, Consumer information, product quality, and seller reputation, *The Bell Journal of Economics* **13**(1), 20–35.

Shapiro, C.: 1983, Premiums for high quality products as returns to reputations, *The Quarterly Journal of Economics* **98**(4), 659–680.

Skreta, V. and Veldkamp, L.: 2009, Ratings shopping and asset complexity: A theory of ratings inflation, *Journal of Monetary Economics* **56**(5), 678–695.

Spiegel, D.: 2012, Dearth of investors: Plan to set up european rating agency under threat, `http://www.spiegel.de/international/europe/plan-to-set-up-european-rating-agency-is-failing-according-to-newspaper-a-827876.html`.

Xia, H.: 2014, Can investor-paid credit rating agencies improve the information quality of issuer-paid rating agencies?, *Journal of Financial Economics* **111**(2), 450468.

Appendices

A Proofs

Proof of Proposition 1

Total welfare WF generated in this economy is given by

$$WF = \theta R - 1 + (1-\theta)e_c - Ce_c^2. \tag{12}$$

Equation (12) is a quadratic function in e_c that can be maximized by imposing a first order condition. As $C > 0$, the second order condition for a maximum is always satisfied. Taking the FOC of (12), setting it to zero and solving towards e_c yields

$$e_c = \frac{1-\theta}{2C}, \tag{13}$$

which is always strictly positive. However, e_c is also a probability and hence needs to lie in the unit interval: $e_c \in [0,1]$. Imposing this constraint yields

$$e_c = \min\left(\frac{1-\theta}{2C}, 1\right). \tag{14}$$

Substituting (14) into (12) gives the first best welfare level

$$WF = \min\left(\frac{(1-\theta)^2}{4C} - (1-\theta R), \theta(R-1) - C\right). \tag{15}$$

It is only socially optimal to invest and produce ratings if $WF \geq 0$. This is the case when

$$\frac{(1-\theta)^2}{4C} \geq (1-\theta R). \tag{16}$$

Proof of Proposition 2

We need to prove optimality of each strategy given all the others.

Given CRA strategy 4., ratings issued by CRAs that have ever exerted effort $e_c < e^*$ or quoted fees $f_c < f^*$ have zero accuracy and do not help in screening. Hence, it is optimal for investors to ignore them as in strategy 1.

Given CRA strategies 5. and 6., ratings contain information and pledgeability is satisfied. Hence profitable lending is possible. Lending needs to happen at break-even interest rates, because of competition among investors. This proves optimality of strategy 2.

Issuer strategy 3. is optimal by definition.

Given investor strategy 1., equation (3) implies that the fees in 5. and 6. are incentive compatible. By definition of incentive compatibility, it is optimal for a CRA c to stick to e^* and f^* as long as it is trusted. Given investor strategy 1., it is optimal to never exert effort anymore for a CRA that is not trusted as it cannot expect to gain any future profits while contemporaneous profits are decreasing in e_c. This proves optimality of CRA strategy 4.

The optimal fee and effort expressions (6) and (7) in 5. follow from maximizing the constrained optimization problem for issuers over e_c:

$$\max_{\{e_c, f_c\}} \theta(R-1-\iota) - f_c + \beta(1-e_c(1-\theta)), \tag{17}$$

Subject to

$$e_c \in [\underline{e}, 1], \tag{18}$$

$$\zeta \geq f_c \geq (1+r)Ce_c^2. \tag{19}$$

because of competition, the second inequality in (19) binds yielding (6). Substituting f^* and ι from (6) and (1) respectively into (17) yields an objective function that is quadratic in e_c:

$$\max_{e_c} \theta R - 1 + \beta + (1-\theta)(1-\beta)(1-e_c) - C(1+r)e_c^2 \tag{20}$$

Imposing a FOC, solving towards e_c and imposing constraints (18) and (19) yields (7). Non-negativity of C and r ensures that the required second-order condition is satisfied.

The monopolist in 6. has the crucial scarce resource and hence will capture the full sum of economic surplus and private benefits created. Hence the monopolist maximizes

$$\max_{e_c} f_c - Ce_c^2 \Rightarrow \qquad \max_{e_c} \min(\zeta, (1-\theta)(1-\beta)(1-e_c) + \theta(R-1)) - Ce_c^2, \tag{21}$$

Subject to constraints (18) and (19). Imposing a FOC solving towards e_c and imposing constraints (18) and (19) yields (9). Non-negativity of C ensures that the required second-order condition is satisfied. Issuer utility in this case has to equal 0 or (19) must bind in which case $f_c = \zeta$. Issuer utility is given by (17). Setting this to zero, solving for f_c and combining with constraint (19) yields (8).

Proof of Corollary 1

Social welfare is given by equation (12). In the competitive case, substituting the interior solution $e^* = \frac{(1-\theta)(1-\beta)}{2C(1+r)}$ gives social welfare:

$$WF = \frac{(1-\beta)(1-\theta)^2}{2C(1+r)} - \frac{(1-\beta)^2(1-\theta)^2}{4C(1+r)^2} - (1-\theta R), \tag{22}$$

$$= \frac{(1-\theta)}{4C}\left[\frac{(1-\beta)(1+\beta+r)}{(1+r)^2}\right] - (1-\theta R). \tag{23}$$

When the part in the square brackets equals 1, equilibrium welfare equals first best welfare. Working out the part in square brackets, we get

$$\frac{(1-\beta)(1+\beta+r)}{(1+r)^2} = \frac{1-\beta^2+2r(1-\beta)}{1+2r+r^2}. \tag{24}$$

When $\beta \geq 0$, $r \geq 0$ and at least one of these inequalities is strict, this multiplication factor is smaller than one and social welfare is strictly lower than first best.

For the monopolistic case we substitute $e^* = \frac{(1-\theta)(1-\beta)}{2C}$ to get:

$$WF = \frac{(1-\beta)(1-\theta)^2}{2C} - \frac{(1-\beta)^2(1-\theta)^2}{4C} - (1-\theta R), \tag{25}$$

$$= \frac{(1-\theta)}{4C}\left[(1-\beta)(1+\beta)\right] - (1-\theta R). \tag{26}$$

When the part in the square brackets equals 1, equilibrium welfare equals first best welfare. Working out the part in square brackets, we get

$$(1-\beta)(1+\beta) = 1-\beta^2. \tag{27}$$

When $\beta > 0$, this multiplication factor is strictly smaller than one and social welfare is strictly lower than first best.

Proof of Lemma 1

As m can only be disciplined by reputation, condition (3) applies. The equilibrium fee income received from subscribing investors must be bounded from below according to

$$Hf_m \geq (1+r)Ce_m^2. \tag{28}$$

All subscribers are homogeneous and there are no scale (dis)advantages. Therefore all subscribers in equilibrium employ identical strategies. Because investors can only charge a transaction fee when they fund an issue, transaction fees are only paid conditional on high ratings. Hence, transaction fees are collected by subscribers only on a fraction $\theta + (1-\theta)(1-e_m) = 1 - e_m(1-\theta) \leq 1$ of all issues. For a subscriber h expected revenues from transaction fees are given by

$$E(f_h) = \frac{1}{H}(1 - e_m(1-\theta))f_h, \tag{29}$$

while expected costs equal f_m. Participation is only optimal if expected revenues at least cover expected costs:

$$\frac{1}{H}(1 - e_m(1-\theta))f_h \geq f_m. \tag{30}$$

Substituting (28) into (30) and rewriting yields (10).

Proof of Lemma 2

The only material differences between investor-paid CRAs and issuer-paid CRAs are i) which party selects and pays, and ii) the option to have investor-paid ratings disclosed prematurely. Because capital is in abundance, investors break even and issuers effectively select the CRA that is used. Hence, the distinction in which party pays does not matter in equilibrium. Therefore, the only material difference is the option to disclose. Given subscribing and non-disclosure, Lemma 1 implies that there will be no demand for investor-paid CRAs while f_m is strictly positive. Hence, subscribing to m while not disclosing ratings cannot be optimal.

Proof of Proposition 3

In order for issuer-paid CRAs to deter entry to m, issuers need to prefer issuer-paid CRAs over m. Due to Lemma 2 this is always the case in equilibrium when non-disclosure is chosen by subscribers. Hence, we only look at equilibria with disclosure by subscribers.

Let us prove the result for positive selection first. Consider an issuer that learned that its investor paid rating was $s^m = B$. A subscriber observing this rating will never grant funding as repayment is impossible. The expected utility of soliciting a rating with $e_c < e_m$ and applying to a non-subscriber is then given by

$$E(u|e_m, s^m = B) = \beta(1-\theta)(1-e_c) - f_c, \tag{31}$$

which is increasing in β and decreasing in f_c. If issuers with $s^m = B$ could be prevented from soliciting an issuer-paid rating, issuer-paid CRAs could exert effort $e_c < e_m$ and charge fees $f_c < f_h$. If all issuers were to solicit an issuer-paid rating, interest rates quoted by non-subscribers would equal interest rates quoted by subscribers as all issuers with $s^m = G$ would also have $s^c = G$ and the pool of issuers requesting funding would be the same. Because interest rates are unaffected and $f_c < f_h$, issuer-paid ratings strictly dominate issuer-paid ratings. As a consequence, investors optimally refrain from purchasing investor-paid ratings, as they will not be able to recover purchasing costs. The only thing left to show is the parameter range for which issuers with $s^m = B$ leave the market. This happens when (31) is negative. However, fees f_c cannot exceed

$f_h = \frac{C(1+r)e_m^2(1-\psi)^{-1}}{1-e_m(1-\theta)}$ as otherwise, issuers with $s^m = G$ would find it optimal to fund from subscribing investors. Moreover, while high effort reduces expected private benefits in (31), not all effort levels e_c are committable. The maximum committable effort for issuer-paid CRAs for positive selection is derived as follows.

If positive selection works, in every stage game, the expected payoff for a CRA equals the payoff in the base case. The present value of this income stream is given by $\frac{f_c^* - C(e^*)^2}{r}$. Conditional on m being present and positive selection taking place, only a fraction $(1 - e_m(1-\theta))(1-\psi)$ of all issuers will apply for issuer-paid ratings. Hence, the maximum contemporaneous benefit of exerting zero effort is given by $(1 - e_m(1-\theta))(1-\psi)Ce_c^2$. Incentive compatibility holds as long as

$$(1 - e_m(1-\theta))(1-\psi)Ce_c^2 \leq \frac{f_c^* - C(e_c^*)^2}{r}. \tag{32}$$

We now make (32) bind and substitute f^* and e^* from (6) and (7) respectively. Solving towards e_c and imposing pledgeability and the natural upper bound of 1, we obtain the maximum committable effort for issuer-paid CRAs for positive selection:

$$\hat{e} = \max\left(\underline{e}, \min\left(\frac{(1-\theta)(1-\beta)}{2C(1+r)}\sqrt{\frac{(1-\psi)^{-1}}{(1-(1-\theta)e_m)}}, 1, \sqrt{\frac{\zeta(1-\psi)^{-1}}{C(1+r)(1-(1-\theta)e_m)}}\right)\right). \tag{33}$$

Hence, positive selection can only take place when

$$\frac{C(1+r)e_m^2(1-\psi)^{-1}}{1-e_m(1-\theta)} \geq \beta(1-\theta)(1-\hat{e}). \tag{34}$$

If the required effort for positive selection is not committable, issuer-paid CRAs can try to outbid m by offering a service to issuers with $s^m = G$ that (weakly) dominates that of m. If issuer-paid CRAs fail to outbid m, subscribers get all issuers with $q = G$. In that case, it is never profitable for non-subscribers b to fund and hence, it is sub-optimal for issuers with $s^m = B$ to solicit an issuer-paid rating. Therefore, I will for the rest of the proof only focus on the preferences of the issuers with $s^m = G$.

Issuers strictly prefer issuer-paid ratings when $e_c = e_m$ due to Lemma 1 and outbidding naturally takes place. Therefore, I will only focus on cases where $e_c \geq e_m$ is not committable. This gives rise to the lower bound $\tilde{e}$ for e_m in equation (47) below.

When $e_c \leq e_m$ and s^m is privately disclosed to issuers, β is guaranteed and can be conditioned on. It is then optimal for issuers to solicit issuer-paid ratings if the sum of rating fees and expected interest payments are lower than those resulting from funding by subscribers. In the latter case, the most competitive, incentive compatible transaction fees amount to $f_h = \frac{Hf_m(1-\psi)^{-1}}{1-e_m(1-\theta)} = \frac{(1+r)Ce_m^2(1-\psi)^{-1}}{1-e_m(1-\theta)}$. Expected interest payments due to subscribers for issuers with a high investor-paid rating are given by:

$$E(\iota_h) = P(q = G|e_m, s^m = G)\iota_h, \tag{35}$$

where

$$\iota_h = \frac{(1-\theta)(1-e_m)}{\theta} \tag{36}$$

as before and

$$P(q = G|e_m, s^m = G) = \frac{\theta}{1-e_m(1-\theta)} \tag{37}$$

by Bayes' Rule. Similarly, we have that

$$E(\iota_b) = P(q = G|e_c, e_m, s^c = G, s^m = G)\iota_b, \tag{38}$$

where

$$\iota_b = \frac{(1-\theta)(1-e_c)}{\theta} \tag{39}$$

as before and

$$P(q = G|e_c, e_m, s^c = G, s^m = G) = P(q = G|e_m, s^m = G). \tag{40}$$

The minimum fee that issuer-paid CRAs can afford in a strategy off the equilibrium path of a subgame perfect equilibrium equals their production cost. Therefore, for a given e_m and if (44) does not hold, there is a committable e_c that deters entry to m if

$$E(\iota^c) + f_c \leq E(\iota^m) + f_h \tag{41}$$

$$-Ce_c^2 + P(q = G|e_m, s^m = G)\frac{1-\theta}{\theta}(e_c - e_m) + \frac{(1+r)Ce_m^2(1-\psi)^{-1}}{1-e_m(1-\theta)} \geq 0 \tag{42}$$

$$-Ce_c^2 + \frac{(1+r)Ce_m^2(1-\psi)^{-1}}{1-e_m(1-\theta)} + \frac{1-\theta}{1-e_m(1-\theta)}(e_c - e_m) \geq 0. \tag{43}$$

$\check{e}_c$ in equation (46) maximizes the LHS of (43) over the support of e_c. If such a value $\check{e}_c$ exists such that $e_c = \check{e}_c$ satisfies (43), issuer-paid CRAs can outbid m.

Putting everything together, we have that issuer-paid CRAs can deter entry to m if for all $e_m \in (\tilde{e}, 1]$ we have that

$$\frac{C(1+r)e_m^2(1-\psi)^{-1}}{1-e_m(1-\theta)} \geq \beta(1-\theta)(1-\hat{e}), \quad \text{or} \tag{44}$$

$$0 \leq -C\check{e}^2 + \frac{C(1+r)e_m^2(1-\psi)^{-1} + (1-\theta)(\check{e}-e_m)}{1-e_m(1-\theta)}, \quad \text{where} \tag{45}$$

$$\check{e} = \arg\max_{e_c \in [\underline{e}, \tilde{e}]} -Ce_c^2 + \frac{C(1+r)e_m^2(1-\psi)^{-1} + (1-\theta)(e_c-e_m)}{1-e_m(1-\theta)}, \tag{46}$$

$$\tilde{e} = \max\left(\underline{e}, \min\left(\frac{(1-\theta)(1-\beta)}{2C(1+r)}(1-\psi)^{-1}, 1, \sqrt{\frac{\zeta(1-\psi)^{-1}}{C(1+r)}}\right)\right), \tag{47}$$

$$\hat{e} = \max\left(\underline{e}, \min\left(\frac{(1-\theta)(1-\beta)(1-\psi)^{-1}}{2(1-(1-\theta)e_m)C(1+r)}, 1, \sqrt{\frac{\zeta(1-\psi)^{-1}}{C(1-(1-\theta)e_m)(1+r)}}\right)\right). \tag{48}$$

Proof of Lemma 3

It is sufficient to show that there exists a strategy for issuer-paid CRA c that for issuers strictly dominates any strategy m can play. This strategy does not need to be optimal for c. If, whenever m is in the market, c matches m in effort (i.e. $e_c = e_m$) at marginally lower fees (i.e. $f_c < f_h$), and non-subscribing investors price competitively, opting for issuer-paid ratings is strictly optimal for issuers, as the same service is purchased at a lower price. When m is not present, c can play the same equilibrium strategy as in the base case. The only thing left to show is that this strategy is committable for c. Because of Lemma 1, a monopolistic issuer-paid CRA will always have higher margins than a monopolistic investor-paid CRA. Therefore, future value to be lost for a monopolistic issuer-paid CRA exceeds future value to be lost for a monopolistic investor-paid CRA. As a consequence, a monopolistic issuer-paid CRA can always commit to at least the same effort level as a monopolistic investor-paid CRA. Moreover, we have with $r > 0$ that

$$Ce_m^2 < f_m \leq f_h. \tag{49}$$

Therefore, c's strategy is possible without incurring losses (i.e. $f_c \geq Ce_c^2$) and hence sub-game perfect.

Proof of Proposition 4

We will first derive some exact necessary conditions for a symmetric equilibrium with effort level $e^*_{\mathcal{M}}$ to exist. In order for $e^*_{\mathcal{M}}$ to be feasible, we need at least the following.

1. Incentive compatible rating fees should be affordable from initial endowments,
2. $e^*_{\mathcal{M}}$ should satisfy the pledgeability constraint and lie within the unit interval,
3. There is no positive selection for issuers at effort levels marginally lower than $e^*_{\mathcal{M}}$.

Incentive compatibility is required as before, since discipline is reputation induced. Because no transaction fees can be collected from issuers with a low rating, and only half of each CRA's ratings are used, competitive incentive compatible fee levels are at

$$f_h = \frac{2C(1+r)(e^*_{\mathcal{M}})^2(1-\psi)^{-1}}{1-(1-\theta)e^*_{\mathcal{M}}}. \tag{50}$$

In order for affordability to hold, this fee cannot exceed ζ.

Condition 2. is required due to the pledgeability requirement and the trivial restriction that precludes probabilities exceeding 1. Formally, it is satisfied when

$$e^*_{\mathcal{M}} \in (\underline{e}, 1] \tag{51}$$

For condition 3. to hold, given $e^*_{\mathcal{M}}$, the equilibrium should not be separating at an effort level slightly below $e^*_{\mathcal{M}}$.

To see this, suppose it was separating at an effort level slightly below $e^*_{\mathcal{M}}$. Given $e^*_{\mathcal{M}}$, there would be a level $e_m < e^*_{\mathcal{M}}$ that provides issuers with a high first rating lower fees, equal private benefits and equal quoted interest rates. In that case, exerting $e^*_{\mathcal{M}}$ is not competitive and cannot be optimal. Equal interest rates can be offered with strictly lower effort, because the separating nature of the equilibrium implies that issuers with a low first rating find the fees prohibitively high to apply for funding.

Positive selection cannot occur if the expected utility of a firm with two low ratings turns positive when effort is lowered by an arbitrarily small amount. This is the case when

$$\beta(1-\theta)(1-e^*_{\mathcal{M}}) - f_h(1-\theta)(1-e^*_{\mathcal{M}}) > 0, \Rightarrow \qquad \beta > f_h. \tag{52}$$

Conditions 1. and 3. combined yield

$$\min(\beta,\zeta) \geq 2C(1+r)\frac{(e^*_{\mathcal{M}})^2(1-\psi)^{-1}}{1-(1-\theta)e^*_{\mathcal{M}}}. \tag{53}$$

One can make (53) bind, solve for the positive root and combine with condition 2. to get the range for $e^*_{\mathcal{M}}$ that satisfies conditions 1. to 3.:

$$e^*_{\mathcal{M}} \in \left(\underline{e}, \min\left(1, \frac{-(1-\theta)\min(\beta,\zeta) + \sqrt{(1-\theta)^2\min(\beta^2,\zeta^2) + 4\min(\beta,\zeta)2C(1+r)(1-\psi)^{-1}}}{4C(1+r)(1-\psi)^{-1}}\right)\right]. \tag{54}$$

We now still need to show that $e^*_{\mathcal{M}}$ is the highest effort level at which issuers with only high ratings would not prefer lower rating effort and that disclosure always takes place. As before, subscribers compete for the top of the market, that is the issuers with high ratings from both CRAs. Take an effort level e_k satisfying (54) exerted by one of the CRAs, say k.

In case of non-disclosure by both CRAs, expected utility of any issuer from selecting a subscriber to the other CRA m depends on rating effort e_m according to

$$E(u) = \theta(R - 1 - \iota_h^m) + (1 - e_m(1-\theta))(\beta - f_h^m). \tag{55}$$

Substituting $\iota_h^m = \iota^*$ from (1), f_h^m from (50) and rewriting yields

$$E(u) = \theta R - 1 + e_m(1-\theta)(1-\beta) - 2C(1+r)(1-\psi)^{-1}e_m^2. \tag{56}$$

Imposing a FOC and solving towards e_m yields

$$e^{ND} = \frac{(1-\theta)(1-\beta)(1-\psi)}{4C(1+r)}. \tag{57}$$

Given disclosure of the signal s^k we can calculate the expected utility of an issuer with high ratings as a function of e_m, where $e_m \leq e_k$:

$$E(u|e_k, s^k = G, e_m \leq e_k) = \frac{1}{1 - e_k(1-\theta)}\theta(R - 1 - \iota_h^m) + \beta - f_h^m. \tag{58}$$

Substituting $\iota_h^m = \iota^*$ from (1), f_h^m from (50) and rewriting yields

$$E(u|e_k, s^k = G, e_m \leq e_k) = \frac{1}{1 - e_k(1-\theta)}(\theta R - 1 + e_m(1-\theta)) + \beta - \frac{2C(1+r)(1-\psi)^{-1}e_m^2}{1 - e_m(1-\theta)}. \tag{59}$$

Differentiating with respect to e_m yields the marginal issuer utility of rating effort

$$\frac{\partial E(u|e_k, s^k = G, e_m \leq e_k)}{\partial e_m} = \frac{1-\theta}{1 - e_k(1-\theta)} - \left(\frac{4C(1+r)(1-\psi)^{-1}e_m}{1 - e_m(1-\theta)} + \frac{2C(1+r)(1-\psi)^{-1}(1-\theta)e_m^2}{(1 - e_m(1-\theta))^2}\right). \tag{60}$$

Setting this equation equal to zero and solving comes down to solving a quadratic polynomial. One root is typically outside of the unit interval and therefore irrelevant. The other is given by

$$e^D(e_k) = \frac{1 + 2C(1+r)(1-\psi)^{-1}(1 - e_k(1-\theta))}{(2C(1+r)(1-\psi)^{-1}(1 - e_k(1-\theta)) + (1-\theta)^2)(1-\theta) - 2\theta + \theta^2}$$

$$+ \frac{\sqrt{2C(1+r)(1-\psi)^{-1}(1 - e_k(1-\theta))(2C(1+r)(1-\psi)^{-1}(1 - e_k(1-\theta)) + (1-\theta)^2)}}{(2C(1+r)(1-\psi)^{-1}(1 - e_k(1-\theta)) + (1-\theta)^2)(1-\theta)}. \tag{61}$$

Given disclosure of the signal s^k we can also calculate the expected utility of an issuer with high ratings as a function of e_m, where $e_m \geq e_k$:

$$E(u|e_k, s^k = G, e_m \geq e_k) = \frac{\theta(R - 1 - \iota_h^m)}{1 - e_k(1-\theta)} + P(s^m = G|s^k = G)(\beta - f_h^m). \tag{62}$$

By Bayes rule, we have that

$$\begin{aligned} P(s^m = G|s^k = G) &= \frac{P(s^m = G, s^k = G)}{P(s^k = G)} \\ &= \frac{P(s^m = G)}{P(s^k = G)} \\ &= \frac{1 - e_m(1-\theta)}{1 - e_k(1-\theta)} \end{aligned} \tag{63}$$

Substituting $\iota_h^m = \iota^*$ from (1), f_h^m from (50), (63) and rewriting yields

$$E(u|e_k, s^k = G, e_m \geq e_k) = \frac{1}{1 - e_k(1-\theta)} E(u). \tag{64}$$

Differentiating with respect to e_m yields

$$\frac{\partial E(u|e_k, s^k = G)}{\partial e_m} = \frac{1}{1 - e_k(1-\theta)}((1-\theta)(1-\beta) - 2C(1+r)(1-\psi)^2 e_m^2), \tag{65}$$

which is always downward sloping beyond e^{ND}.

Hence, given effort $e_k < e^{ND}$, m can capture the whole market by exerting e^{ND} irrespective of disclosure by k. Given effort $e_k \geq e_m$, issuers with $s^k = G$ would (weakly) prefer subscribers to k over subscribers to m if ratings were to be disclosed and (60) is (weakly) positive at $e_m = e_k$. Because this holds for any effort level e_k the symmetric equilibrium materializes at the maximum feasible effort level $e^*_{\mathcal{M}}$ for which (60) is positive at $e_m = e_k$.

Proof of Lemma 4

The equilibrium interest rate follows from perfect competition as before. However, now the zero utility condition for investors reads

$$\theta\iota^* + (\theta + (1-\theta)(1-e^*))\alpha - (1-\theta)(1-e^*) = 0, \tag{66}$$

where the first term captures expected interest income, the second term expected private benefits and the last term expected default losses. Solving towards ι^* gives

$$\iota^* = \frac{(1-\theta) - \alpha - (1-\alpha)(1-\theta)e^*}{\theta}. \tag{67}$$

Proof of Lemma 5

Given e^n, the expected utility of an issuer with $s^n = G$ is given by

$$E(u|s^n = G, e^n, e_c) = \begin{cases} \frac{1}{1-e^n(1-\theta)}(\theta R - 1 + e_c(1-\theta)) + \beta - C(1+r)e_c^2 \text{ if } e_c \leq e_n, \\ \frac{1}{1-e^n(1-\theta)}(\theta R - 1 + \beta + e_c(1-\theta)(1-\beta)) - C(1+r)e_c^2 \text{ if } e_c > e_n. \end{cases} \tag{68}$$

Imposing a FOC and solving towards e_c yields

$$e_c = \begin{cases} \frac{1-\theta}{(1-e^n(1-\theta))2C(1+r)} \text{ if } e_c \leq e_n, \\ \frac{(1-\theta)(1-\beta)}{(1-e^n(1-\theta))2C(1+r)} \text{ if } e_c > e_n, \end{cases} \tag{69}$$

in case of an interior solution. If

$$e^n \in \left(\frac{(1-\theta)(1-\beta)}{(1-e^n(1-\theta))2C(1+r)}, \frac{1-\theta}{(1-e^n(1-\theta))2C(1+r)} \right) \tag{70}$$

we have a boundary solution $e_c = e^n$. The other natural bounds apply as before. All these possible optimal effort levels are increasing in e^n.

Proof of Lemma 6

Absent investor-paid CRAs. there are two scenarios with noisy self knowledge. Either noisy self knowledge leads to positive selection in every stage game or it does not. If it does lead to positive selection in every stage game without investor-paid CRAs, positive selection must be possible with investor-paid CRAs, as the required effort level for positive selection is always committable for issuer-paid CRAs.

If noisy self knowledge does not lead to positive selection in the absence of investor-paid CRAs, then Lemma 5 implies that the equilibrium effort level in the absence of investor-paid CRAs goes up. Because reputation rents are an increasing function of equilibrium effort, higher effort levels can be committed to in the presence of investor-paid CRAs off the equilibrium path. As the RHS of the condition for positive selection in (31) is decreasing in e_c, higher committable effort means a larger range of e_m for which positive selection can take place.

Proof of Lemma 7

With noisy self knowledge, condition (43) changes to

$$-Ce_c^2 + \frac{(1+r)Ce_m^2(1-\psi)^{-1}}{1-e_m(1-\theta)} + \frac{1-\theta}{\theta+(1-\theta)(1-\max(e_m,e^n))}(e_c - e_m) \geq 0. \tag{71}$$

The $\max(e_m, e^n)$ in the denominator of the third term tightens the constraint and hence reduces the range for e_c in which outbidding is successful. However, due to Lemma 5, the range of committable effort levels e_c expands with e^n.

Proof of Proposition 5

Suppose an issuer j has solicited, received and paid for an issuer-paid rating from CRA c. In case $s^c = B$, there is no point in disclosing an investor-paid rating to j as for each subscriber h, funding j will be loss making. If $s^c = G$, there are two scenarios. If $s^m = B$ there is no point in disclosing the issuer-paid rating to j as for each subscriber h, funding j will be loss making. If $s^m = G$, the investor-paid CRA will not benefit from positive selection for $e_m \leq e_c$. Interest rates quoted from subscribers and non-subscribers should be the same, while $f_h \geq 0$ and there are no transaction fees for funding by non-subscribers. After all, f_c is already a sunk cost. For $e_m > e_c$ effort costs are incurred and issuers only prefer investor-paid ratings if

$$E(\iota^c) > E(\iota^m) + f_h \tag{72}$$

$$P(q = G|e_m, s^m = G)\frac{1-\theta}{\theta}(e_c - e_m) + \frac{(1+r)Ce_m^2(1-\psi)^{-1}}{1-e_m(1-\theta)} < 0 \tag{73}$$

$$\frac{(1+r)Ce_m^2(1-\psi)^{-1}}{1-e_m(1-\theta)} + \frac{1-\theta}{1-e_m(1-\theta)}(e_c - e_m) < 0. \tag{74}$$

Condition (74) is more stringent than (43) and therefore satisfied in a smaller parameter range.

B Notation Summary

Parameters		
Symbol	*Support*	*Description*
β, α	$[0, \infty]$	private benefits for issuers and investors respectively
C	$[0, \infty]$	rating production cost
θ	$[0, 1]$	fraction of high quality issuers
ζ	$[0, \infty]$	initial endowment
r	$[0, \infty]$	CRA discount rate
R	$(1, \theta^{-1})$	good project payoff
ψ	$[0, 1]$	Investor-paid rating leakage fraction
e^n	[0,1]	Accuracy of issuer self-knowledge
States of nature		
q	$\{G, B\}$	project quality
s	$\{G, B\}$	signal/rating
$\mathcal{F}$	–	filtration/information set
Indices		
x	–	rater
c	$\{1, .., N\}$	issuer-paid CRA
b	$\{1, .., (W - H)\}$	(non-subscriber) investor
j	$\{1, .., Q\}$	issuer
m	$\{1, .., M\}$	investor-paid CRA
h	$\{1, .., H\}$	investor subscribing to investor-paid ratings
t	$\{1, .., \infty\}$	time (i.e. stage game)
Decision variables		
$f_{c,m,h}$	$[0, \infty)$	rating or transaction fee
$e_{c,m}$	$[0, 1]$	rating effort
$\iota_{b,h}$	$(-\infty, \infty)$	interest rate
Market segments		
$\mathcal{M}$	–	investor-paid rating segment

Moreover, as a general rule, only decision variables have subscripts, with the party making the decision in the subscript.