ALTERNATIVES FOR ISSUER-PAID CREDIT RATING AGENCIES

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Abstract

This paper investigates the economic viability and welfare contribution of alternatives to issuer-paid credit rating agencies (CRAs). To this end, it introduces a heterogeneous competition model for credit and ratings markets. Frictions among issuers or investors induce rating inflation from issuer-paid CRAs. Investor-paid CRAs suffer from three sources of free-riding and are generally not economically viable when competing with issuer-paid CRAs. Only for very limited parameter ranges can investor-paid CRAs thrive and counter rating inflation. Other proposed alternatives such as investor-produced ratings and CRA co-investments employ skin-in-the-game to induce proper screening accuracy. However, as traditional issuer-paid CRAs can cater better to issuers, such alternatives generate little demand or are implemented ineffectively. Hence, this paper provides an explanation for the evolution, dominance and resiliency of issuer-paid CRAs.

Non-technical summary

Ever since the outbreak of the sub-prime crisis, allegations of inflated ratings issued by credit rating agencies (CRAs) have regularly made the headlines. The IMF has estimated that the losses incurred on largely AAA rated structured products amount to $3.4trln globally. Allegedly, a substantial fraction of these losses could have been prevented if ratings had reflected default risk in the same way as those do for regular bonds. Interestingly, issuance volumes, CRA profits and CRA profit margins peaked just before the burst of the sub-prime bubble. In the aftermath of the sub-prime crisis, CRAs and in particular the issuer-paid business model have been criticized heavily. Consequently, policy makers around the world are designing new regulations aimed at lowering conflicts of interests that CRAs experience. These suggested market reforms include stimulating competition, making CRAs more responsible for their actions, stimulating investor-paid CRAs and stimulating investors to produce their own credit assessments.

This research paper constructs a theoretical model of the markets for (structured) debt issues and the associated credit ratings. The model emphasizes the ex-ante screening role of CRAs (rather than ex-post monitoring of issues) and their ability to produce new information rather than summarizing existing information. In the context of the framework chosen it aims to generate understanding on how things could have gone so wrong. Moreover, the model is used as a theoretical workhorse for assessing the effectiveness of suggested policy proposals relating to the introduction of alternative business models. Next, it investigates the competitive power of such alternatives. In other words, it analyzes whether market forces will ensure that issuer-paid CRAs are replaced by more desirable alternatives, if any.

An important assumption of the model is that issuers have an appetite for high rather than accurate ratings, for example due to fixed compensations for placing debt issues. This seems to be in line with recent practices in the structured product market. The results derived from the model suggest that alternative business models based on investor-paid ratings, investor-produced ratings, or mandatory co-investments for CRAs have only limited potential to improve social welfare, if at all. But even if welfare improving, demand for these alternatives will be low when issuer-paid CRAs are present. This finding is in line with the apparent dominance of issuer-paid CRAs and the failure for alternatives to really take hold or even get started.

When faced with issuer-paid CRAs, investor-paid CRAs face a severe cost-

disadvantage. This cost-disadvantage stems among others from the inability to fully enforce intellectual property rights on produced ratings and the inability to collect fees from issuers that receive low ratings. Nevertheless, in certain situations, investor-paid ratings could still be valuable if investors purchasing these ratings could capture the high-quality issuers at an early stage before issuer-paid ratings are solicited. The issuer-paid CRAs then risk being left with only low-quality issuers that are hardly worth rating. This mechanism of overcoming the desire for high instead of accurate ratings becomes more effective as the investor-paid CRAs increase accuracy. To prevent the loss of market share, issuer-paid CRAs can temporarily lower fees and increase rating accuracy as long as investor-paid CRAs are present. However, in most scenarios cost-disadvantages dominate and investor-paid CRAs will not even try to enter the market.

If the party that rates the product (investor or CRA) takes a position in the product when a high rating is issued, ratings are more likely to be accurate. After all, inaccurate ratings would lead to losses for the party conducting the rating. This effect is increasing in the stake the rating party takes. However, as issuers prefer high over accurate ratings, issuers would opt for (other) issuer-paid CRAs without a stake in the product rather than these socially preferable alternatives.

Since banks have not been free from incentive problems in the past crisis years either, it is relevant to study the effect of misaligned bank incentives on these alternatives too. If banks instead of issuers get a fixed compensation for investing in debt issues, irrespective of quality (conforming to bonus schemes), similar outcomes arise. The only difference is that in this case, investor-produced ratings or a Franken Rule (i.e. issuer-pays and investor selects) always lead to rating inflation.

Putting everything together, this paper provides an explanation for the recent failure of several investor-paid CRA initiatives and the observed dominance and resiliency of issuer-paid CRAs. From a theoretical perspective, one can show that a monopolistic CRA with large mandatory co-investments (i.e. an obligation for the CRA to invest sizable amounts in the debt instruments it rates) in issues that receive high ratings is socially optimal. The co-investment requirement gives incentives to deliver high accuracy. Interestingly, these results go against the common perception that a CRA should be independent and that competition among CRAs is beneficial. Moreover, from a practical perspective, CRAs are unlikely to have sufficient capital available to commit to such large co-investments. When products are complex and therefore incentive problems are severe (implying a lot of issuer pressure for inflated ratings), the model suggests that welfare may in some cases be improved by only

allowing investor-paid ratings for that specific type of product.

While the model employed in the paper generates novel insights, there are some caveats. The model focuses on the screening role of CRAs, not so much on the monitoring role. Some of the alternatives to issuer-paid CRAs such as mandatory co-investments or investor-produced ratings may suffer from incentives to opportunistically delay downgrades, hence undermining the monitoring role of CRAs. Moreover, in this model, CRAs have a proprietary skill of analyzing (structured) debt issues and are relatively efficient at doing so. Hence, CRAs produce information rather than summarizing it. As such, the results in the paper would more readily apply to the structured product market than to the corporate debt market. Future research should give a clearer picture on the extent to which the results carry over to the corporate debt market and whether the proposed solutions interfere with the monitoring role of CRAs.

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) amount to \$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. The profitability of these products to the CRAs, has fueled this criticism even further and given rise to suspicions of intentional rating inflation.[2] Several recent articles such as Griffin and Tang (2012) show that ratings on structured products were indeed inflated. Interestingly, recent research by He, Qian and Strahan (2012) shows that investors charged higher spreads on products with an inflated rating. Hence, their evidence suggests that investors were aware of misaligned rating incentives and priced these in.

The role CRAs played in the sub-prime crisis and their subsequent role in the 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.[3,4] 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. Some initiatives that aligned well with regulatory ambitions were even withdrawn altogether. For example, Markus Krall, senior managing partner at Roland Berger has tried to set up an investor-paid, European, not for profit CRA. This plan was abandoned due to insufficient interest from investors for such an initiative.[5] Another initiative by the French credit insurer Coface to sell investor-produced ratings to other investors also never got started.[6]

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[1]IMF estimation. See IMF (2009)

[2]For example, anecdotal evidence reports rating fees of 2 to 4 bps on corporate bonds compared to fees of 13 to 16 bps on structured products in addition to surveillance fees. For Moody's, these complex products had a profit margin of around 50% and generated about 50% of total profit by the end of 2006.

[3]See, for example, the testimony by SEC deputy director John Ramsay: "The Commission's efforts in this area have been designed to [...] and promote competition among rating agencies that are involved in this business." (Ramsay 2011)

[4]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).

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

[6]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 severely damaged, one would expect other parties to gain market share quickly. This paper answers this question by conducting a comparative analysis of alternatives to issuer-paid ratings. To this end, I introduce a heterogeneous competition model for credit and rating markets. To get rating inflation, I introduce a friction on the issuers' side leading to demand for high instead of accurate ratings, despite the upward effect of rating inflation on interest rates.[7] Such frictions could for example result from employment concerns of managers/investment bankers or compensation schemes that condition on successful placement of debt issues.

My first main finding is that several proposed alternatives such as investor-paid or investor-produced ratings may reduce rating inflation if imposed by regulation. However, welfare improvements (if any) are limited and may be hard to realize from a practical perspective. Take for example the investor-paid CRAs. A monopolistic investor-paid CRA will behave exactly the same profit maximizing way as a monopolistic issuer-paid CRA, as there are no outside options for issuers and investors. Hence, at least two investor-paid CRAs are required to generate any welfare improvements. Therefore, at least two investor-paid CRAs need to spend effort to produce identical information on each issue. Especially when rating effort is costly, this redundancy (partially) offsets welfare gains induced by higher rating accuracy. Moreover, free-riding concerns may even prevent equilibria with multiple investor-paid CRAs from materializing.

The second main finding is that, in a free market with issuer-paid CRAs, these proposed alternatives suffer from either insufficient demand or ineffective implementation. The reason is that issuer-paid CRAs have an incentive structure that allows them to cater well to issuer demands and hence, inflate ratings. In contrast, take for example investor-produced ratings. Those will be less inflated if (partially) funded by the rating party, due to a skin-in-the-game effect. However, issuers prefer inflated ratings and therefore either opt for issuer-paid ratings or pressure rating producing investor to reduce their skin-in-the-game to the minimum. This undermines the disciplining incentive structure of investor-produced ratings. The adoption of a Franken rule (i.e. investor selects, issuer-pays model) leads to similar problems unless investors are completely insensitive to rating fees. In that case, investors would push for maximum rating effort, which generally leads to wasteful over-spending on

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[7]This is a friction rather than a zero-sum effect as it stimulates the funding of socially wasteful projects.

rating effort.

My 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. Unconditionally these projects have negative NPV. However, CRAs can overcome this problem by exerting costly 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. These rents lower the quality demanded by issuers and hence, result in mild rating inflation (see also Shapiro (1983)).[8] More severe rating inflation can however take place when issuers prefer high over accurate ratings as is described below.

The issuer preference of high over accurate ratings results from the main friction in the model, namely private benefits for the issuer of operating the firm. Absent private benefits, one would expect any gains 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)). The use of private benefits allows me to get undesirable opportunistic behavior in a fully rational model as also in for example Opp, Opp and Harris (2013) and Winton and Yerramilli (2011)). Hence, rating inflation does not result from naive investors (as in Bolton, Freixas and Shapiro (2012)) or naive/ethical CRAs (as in Mathis, McAndrews and Rochet (2009)). Private benefits for investors instead of issuers have similar effects on the issuers' desire for inflated ratings.

There are two other, less important frictions in the model that are mainly there for tractability reasons. The first is that issuers are unaware of their own quality.[9] In an extension of the model, I relax this friction to show how selection effects can induce much higher ratings inflation in the structured product market than in the corporate bond market. The second is a fixed ex-ante budget for rating fees. [10]

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[8]As credit ratings are advertised as *relative* measures of creditworthiness, aggregate rating inflation may technically not be well defined. However, it is natural that the meaning of a rating is benchmarked to historical performance of identical ratings, possibly in other product categories. In the model, rating inflation refers to exerting lower than first-best rating effort.

[9]One could think about an investment banker that, for a largely fixed fee upon placement, structures a pool of mortgages with unknown documentation standards.

[10]Such a friction could be a result of limited debt capacity of a project (due to e.g. limited

This friction also makes the analysis for a monopolistic CRAs more interesting by preventing it from capturing all surplus generated by the projects.

The model is then extended to allow for alternative business models and market structures. First, investor-paid CRAs are added to the baseline model. Investor-paid CRAs suffer from several forms of free-riding that undermine their competitiveness compared to issuer-paid CRAs. All other player types, issuers, investors and even issuer-paid CRAs can free-ride on investor-paid ratings as is described in more detail below. In the model, investor-paid CRAs sell their ratings to subscribing investors. These subscribers in turn use this information in quoting interest rates to issuers. From these quotes, issuers can learn the investor-paid ratings they got. Issuers with low investor-paid ratings will not apply for funding and hence do not generate income for subscribers; this is free-riding by issuers. Next, issuers can either take credit from subscribing investors (conditional on a high investor-paid rating) or solicit issuer-paid ratings and get credit from non-subscribers. If soliciting issuer-paid ratings is costly, issuers with low investor-paid rating will find soliciting for issuer-paid ratings prohibitively expensive and leave the market. As a result, the remaining pool of issuers is of high quality. Because of this positive selection, issuer-paid CRAs can produce ratings with little effort without undermining their track-record. As effort cost is low, issuer-paid CRAs can price somewhat more aggressively and capture large market shares. This is free-riding by issuer-paid CRAs. Finally, there is the traditional argument that intellectual property rights are hard to protect. As a result, a certain fraction of the ratings produced will not generate revenue. Therefore, the total required rating fees need to be recovered from a smaller mass of issues (it is effectively like the production cost per revenue-generating rating is higher). This is free-riding by investors. These types of free-riding all lead to higher fees and hence lower competitive power compared to issuer-paid CRAs.

Investor-paid CRAs can only gain market share if their ratings are more accurate and lead to much lower interest rates than issuer-paid 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. Exerting high rating effort is under certain parameter ranges incentive incompatible for issuer-paid CRAs when they compete among each other, as future profits are limited. A monopolistic issuer-paid CRA however, stands to lose such a valuable position that

collateral value).

it can always commit to match effort at lower fees and compete the investor-paid CRA out of the market. In practice, this will 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 in turn can commit to ruining the investor-paid CRA.

Next, investors could be allowed to produce ratings for projects they partially fund.[11] Skin-in-the-game would then induce them to exert high rating effort (in line with e.g. Grossman (1981)). Rating effort is then increasing in the funding share of the rating party.[12] However, if issuers prefer inflated ratings and investors can set the funding shares they solicit freely, issuers select investors that solicit low funding share in order to maximize rating inflation. Because investors compete for projects, they will only solicit low funding shares. This effectively undermines the disciplining effect of skin-in-the-game. To protect investors incentives, a regulator could bound funding shares for investors from below. However, in this case, issuer-paid CRAs act as outside options that can cater better to issuer preferences and hence investors lose all rating business. Providing CRAs with skin-in-the-game (e.g. by requiring a mandatory co-investment by CRAs in issues that receive high ratings) yields similar problems.

Even the introduction of a Franken rule under which issuers pay for ratings but investors select the CRAs offers little solace. If issuers can (indirectly) influence the CRA selection process, for example by the choice of investor syndicate, investors can maximize market share by making a credible commitment to catering to issuers. As a result, the Franken rule would be ineffective in countering rating inflation. Only when investors are completely insulated from issuer influence can a Franken rule induce accurate ratings. Yet, in such situations investors opt for CRAs that provide maximum accuracy. Typically, maximum accuracy exceeds first-best accuracy and hence socially wasteful over-spending on credit assessment takes place. This result corroborates findings by Kashyap and Kovrijnykh (2013).

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

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[11]See Becker and Opp (2014) for a recent, concrete example of investor-produced ratings.

[12]Investors such as large banks also have the technology to do this readily available due to the requirements for Basel II IRB-Advanced. Of course, banks may have their own frictions that may induce rating biases, especially when leverage is high and the effective skin-in-the-game is limited. This issue is addressed in Section 6.

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), El-lul, Jotikasthira and Lundblad (2011) and Opp et al. (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, 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 also question the viability of the investor-paid CRAs under heterogeneous competition, because an issuer-paid CRA can deter entry for example by using an effort-matching strategy. This protective behavior of issuer-paid CRAs aligns with empirical findings by Xia (2014). However, my findings suggest that the increased accuracy of issuer-paid CRAs in the presence of investor-paid CRAs, as documented by Xia (2014), takes place 'off the equilibrium path' and is unsustainable in the long run. The theoretical results this paper puts forward regarding investor-produced ratings align well with the empirical results reported by Becker and Opp (2014). They find that investor-produced ratings if anything under-perform issuer-paid credit ratings and are slightly more inflated. Consistently, Behn, Haselmann and Vig (2014) find that bank internal rating estimates are inaccurate and over-optimistic.

Methodologically, the model used is rather close to the model employed by Opp et al. (2013).[13] The main difference 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

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[13]In fact, the main result obtained in Opp et al. (2013) can be obtained as a special case of my model with investor private benefits.

Kashyap and Kovrijnykh (2013). Yet Kashyap and Kovrijnykh (2013) use a single period model and hence can only capture reputational concerns in reduced form. Both Kashyap and Kovrijnykh (2013) as well as Opp et al. (2013) do not allow for heterogeneous competition, which is crucial for my results.

Finally, this paper also relates to the body of literature analyzing the effects of regulation on the performance of CRAs. Several papers written from a legal perspective suggest regulatory fixes for the apparent dysfunctionality of CRAs, for example by paying CRAs in bonds rated by themselves (Listokin and Taibleson 2010). In contrast to those more qualitative papers, my study provides rigorous economic analyses of some of the proposed solutions and thereby highlights potential caveats. For example, I show that the skin-in-the-game proposed by Listokin and Taibleson (2010) may have to be enlarged to unrealistic proportions in order to be sufficiently effective.

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. In section 4, I derive equilibria under different alternative market structures such as investor-produced and investor-paid ratings in a free market. Section 5 analyzes the performance of such business models in a market where issuer-paid CRAs are banned. Section 6 shows robustness of the results to for example a setting in which investors instead of issuers have a private benefit of operating. Finally, section 7 concludes.

2 Model setup and socially optimal outcomes

The baseline 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 time 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 three player types: issuers, investors and issuer-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.[14] 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 is assumed to be a welfare loss to unmodeled parties in the economy (e.g. an inefficient compensation contract of an investment banker issuing a CDO). 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, job-security concerns of issuer employees or regulatory benefits of having high ratings.

Second, there are N identical, and infinitely lived 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.[15] Hereafter the CRA can truthfully issue this signal as a rating.[16] 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.[17] Each CRA c charges issuers rating fees f_c for its rating efforts, which it quotes publicly.[18] Rating fees are paid irrespective of the rating outcome.[19] Each CRA discounts future payoffs with a discount rate $r \in (0, 1)$ and maximizes the present value of its contemporaneous

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

[15]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).

[16]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). The truth-telling assumption is required to prevent situations with zero rating effort and only B ratings. This is particularly important for investor-produced ratings which are introduced later on.

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

[18]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.

[19]Most results are qualitatively the same when the rating fee is due only for high ratings.

and future expected cash flows.

Finally, 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 as a consequence investors compete.[20] Each investor b lives for one period and maximizes its own expected profit.

Each stage game t then proceeds as follows.

1. Short-lived players are added and everyone observes $\mathcal{F}^{t-1}$

2. Each investor publishes CRA blacklisting criteria Z_b and quotes interest rates ι_b^c for funding conditional on a rating $s^c = G$ from a trusted CRA

3. Each CRA c publicly quotes a rating fee f_c and privately determines effort plans e_c

4. Issuers select CRAs and investors

5. Ratings are produced and issued, rating fees are paid and residual endowment is paid out, loans are granted and investments are made

6. Projects are realized, interest is paid, and project performance is observed

7. Start period $t + 1$

In step 2, conditional on the information set $\mathcal{F}^{t-1}$ each investor selects and announces the criteria Z_b for CRAs to be banned. Hence, investors can play strategies that condition on future actions of CRAs, such as the rating fees $f_c \; \forall c$. Each investor b also quotes interest rates ι_b^c at which it commits to fund projects with a rating $s^{j,c} = G \; \forall c \notin Z_b$.

In step 3, CRAs publicly quote rating fees f_c conditional on their information set $\{\mathcal{F}^{t-1}, \iota_b^c, Z_b \; \forall \; b, c\}$. Each CRA also plans to exert effort e_c to produce a signal $s^{j,c}$ for each issuer j that selects CRA c.

In step 4, each issuer selects one single CRA and any number of investors conditional on the information set $\{\mathcal{F}^{t-1}, \iota_b^c, Z_b, f_c \; \forall \; b, c\}$. That is, each issuer j chooses $I_j^{c,b} \in \{0,1\}$ such that $\sum_{b,c} I_j^{b,c} = 1$.

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[20]The over-supply of funds is a crucial assumption in the model. When capital is in short supply, the alternatives discussed in this paper may perform (somewhat) better. 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)).

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 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 under different types of market organization. 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.[21] 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.

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 to compare the alternative business models to, I first explore the base case equilibrium.

3.2 Base case

In this section, I derive the base case equilibrium involving investors, issuers and CRAs. Moreover, I show that social welfare in the base case can be negative if private benefits for issuers are large. In other words, if issuers want the 'wrong things', financial intermediation destroys 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 a short horizon, 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 make zero economic profit. Therefore, given a sufficiently high equilibrium effort level $\tilde{e}_c$, each investor b quotes interest rate

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

and breaks even in expectation. Given that investors break even in expectation, not all effort levels can be sustained in equilibrium. After all, the (limited) surplus

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

generated by good projects is the only source of 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

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

Finally, in equilibria with investment, CRAs need to exert strictly positive effort. As contemporaneous CRA profits decline in exerted effort, such discipline can only be achieved through reputation. The threat of investors blacklisting CRAs in the future (and hence take away all demand for that CRA's 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:

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

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 blacklisted 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. $\qquad\square$

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, large inefficiencies can show up. First best can then never be attained 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 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 $r > 0$.*

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 Alternative market structures

4.1 Investor-paid CRAs

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. The best an investor-paid CRAs can hope for is to provide the market with all the information it needs and thereby remove the need to use issuer-paid ratings. As I will show, several sorts of free-riding make this hard to achieve in a cost-efficient manner.

In the model, I introduce an investor-paid CRA in the following way. Between steps 1. and 2., two extra steps are inserted. In step 1.a, an investor-paid CRA m using the same technology as issuer-paid CRAs spends effort $e_m \in [0, 1]$ to generate signals s^m for all issuers and quotes a fee f_m to investors. In step 1.b an endogenously determined number of investors, H, decides to purchase ratings from m at f_m or not. Step 2. stays the same, but additionally, each subscribing investor h can quote an issuer-specific interest rate $\iota_h^{j,m}$ to each issuer j using ratings from m. Subscriber h also quotes a transaction fee f_h to be collected when the loan is issued (this way, rating fees can be passed on to issuers). The interest rate quotes offered by subscribing investors can inform an issuer about the rating m assigned to it and hence about its own quality.

The traditional competitive disadvantage of investor-paid CRAs is a free-riding concern related to the difficulty to protect intellectual property. As a result, some of the rating information produced may end up with investors that have not paid for it, while production is costly. Hence, the total required compensation for rating production needs to be covered by fees on a smaller mass of ratings that will generate

revenue. In the model, this is captured by a fraction ψ of produced ratings that leak away without being paid for. For tractability purposes, I assume that issuers for which ratings have leaked have no interest in obtaining issuer-paid ratings.[22] 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 ratings are issued. The third type concerns free-riding by issuer-paid CRAs as a result of positive selection. Issuer-paid CRAs can exert low effort and charge high fees when issuers with $s^m = B$ find it prohibitively expensive to solicit issuer-paid ratings. 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*

$$\underline{f}_h \geq \frac{f_m(1-\psi)^{-1}}{\theta + (1-\theta)(1-\tilde{e}_m)}, \tag{10}$$

$$f_m \geq (1+r)C\tilde{e}_m^2. \tag{11}$$

Proof. See Appendix. $\square$

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 (indirectly) learn their investor-paid ratings through interest rate quotes. Given effort level e_m, private benefits β are guaranteed for issuers with high investor-paid ratings when they apply for issuer-paid ratings from CRAs c with $e_c \leq e_m$. As a result, the distortive effect of β on CRA selection shrinks and elevated interest rates resulting from inflated ratings become relatively more important. Hence, by learning about their own quality, issuer preferences may shift towards more accurate ratings.

However, issuer-paid CRAs may in turn try to prevent entry of investor-paid CRAs. This can be done either by positive selection or outbidding. With positive selection, issuer-paid CRAs try to get into a separating equilibrium in which issuers with $s^m = B$ leave the market. 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

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[22]This constraint will hardly ever bind.

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 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. Naturally, outbidding is easier when investor-paid CRAs have a larger cost disadvantage. 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. 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 issuer-paid CRAs free-ride on positive selection or can credibly outbid investor-paid CRAs. Positive selection is likely when private benefits β are small. Outbidding is more likely when the investor-paid CRA has a larger cost disadvantage.*

Proof. See Appendix. □

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. The reason for this is that the market for issuer-paid CRAs is smaller in the presence of investor-paid CRAs, for example due to leakage (i.e. $\psi > 0$). 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. 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, when $N = 1$, an issuer-paid CRA can always commit to outbidding m, because the monopoly position is too valuable to be lost.

Lemma 2. *(**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 2 in combination with fixed costs for market presence and entry makes 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. 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[23] are in line with this result.

Yet, there could be conditions not captured in the model such as segmentation under which investor-paid CRAs could attract some business, but would not become dominant. For example, there could situations in which investors are hit by random liquidity shocks inducing them to trade in the secondary market. Because issuers will have less or no influence on the selection of secondary market buyers, there is room for investor-paid ratings purchased by secondary market traders. This setting would be consistent with market segmentation findings reported by Cornaggia and Cornaggia (2013).

4.2   Investor-produced ratings

In the wake of the sub-prime crisis, several policy makers have called on (the larger) market parties to do their own credit assessment, instead of relying on CRA ratings. Moreover, some investors are now offering ratings or other forms of credit assessment to the market. Examples are BlackRock (for Commercial Mortgage-Backed Securities) and PIMCO (for Residential Mortgage-Backed Securities).[24]

The hope with investor-produced ratings is that investors will do a better job at conducting credit assessments than external CRAs because of their skin-in-the-game (in line with Grossman (1981)). In this subsection, I analyze a market structure in which investors can earn fees by producing public ratings while committing to partially fund projects they assign a high rating to. Hence, one investor per issue provides certification.

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[23]See Bloomberg (2012)

[24]The association of State insurance regulators in the US, the NAIC, has adopted these PIMCO and BlackRock ratings for determining capital requirements. See also Becker and Opp (2014).

For this market structure, the model is extended by also giving investors the opportunity to produce ratings. Investors still only live for one period, but now possess the same technology as the CRAs. When a investor b is selected as a rater, it needs to fund a fraction $\phi_b > 0$ of the project upon issuing a high rating. Investors solicit ϕ_b publicly. Other investors compete for the remaining portion. I assume that investors are less efficient at credit assessment, which is reflected in a higher effort cost parameter $C^{\mathcal{B}} > C$.

Each stage game is then adjusted as follows. In step 2., each investor b also quotes interest quotes for funding upon a high rating from each of the rating producing investors. In step 3., each rating producing investor b now publicly quotes a rating fee f_b, publicly solicits a funding fraction ϕ_b, and privately determines planned effort e_b. In step 4., issuers can now select CRAs or investors to conduct ratings.

The resulting equilibrium looks very similar as the base case, but with some notable differences. First, in order to gain market share, investors solicit lower funding shares and exert lower effort as the private benefit β increases. Second, investors are disciplined by their funding shares and do not require reputation rents. As a consequence investor rating fees equal production costs. Third, investor-produced ratings serve as outside options and hence, profits of a monopolistic CRA are constrained. Finally, which party conducts ratings in equilibrium depends on parameter values.

Proposition 4. *In equilibrium, investors solicit low funding shares, exert low effort (i.e. inflate ratings) and quote competitive fees. More concretely, all investors b optimally play*

$$\phi_b = \phi_{\mathcal{B}}^* = \min\left(1, \max\left((1-\beta), \frac{2C^{\mathcal{B}}(1-\theta R)}{(1-\theta)^2}\right)\right), \quad f_b = f_{\mathcal{B}}^* = C^{\mathcal{B}}(e_{\mathcal{B}}^*)^2,$$

$$e_b = e_{\mathcal{B}}^* = \min\left(\frac{(1-\theta)\phi_{\mathcal{B}}^*}{2C^{\mathcal{B}}}, 1, \sqrt{\frac{\zeta}{C^{\mathcal{B}}}}\right). \tag{12}$$

Proof. See appendix. $\square$

Even when a investor has chosen $\phi_{\mathcal{B}}^*$ optimally, it may not attract any rating business if issuer-paid CRAs can cater better to issuers. On the one hand, investors do not earn rents in equilibrium, which lowers fees. On the other hand, investors are less efficient than CRAs because $C^{\mathcal{B}} > C$. Which party ends up conducting ratings depends on which of the two dominates.

Proposition 5. (***CRAs vs investors***): *CRAs will not lose rating business to rating-producing investors if their efficiency advantage is sufficiently high and their discount rates are sufficiently low. More specifically, this is true when $C(1+r) < C^{\mathcal{B}}$.*

Proof. See appendix. □

Propositions 4 and 5 have important regulatory implications. First, Proposition 5 tells us that there is only scope for investor-produced ratings (and hence potential welfare improvements) when those can be produced efficiently enough. Second, even if the efficiency hurdle is met, Proposition 4 shows that competition will limit the potential of overcoming rating inflation drastically. In other words, if issuers prefer inflated ratings, they will have little demand for ratings from parties that commit to issuing accurate ratings. In that case, social welfare gains are small and merely caused by the absence of reputation rents. Higher welfare can only be induced in this setting by banning issuer-paid CRAs while simultaneously imposing a minimum on ϕ_b. Merely imposing a minimum on ϕ_b in an otherwise free market would drive all rating business towards the CRAs, yielding the solution completely ineffective. When issuer-paid CRAs are banned, exogenously fixing $\phi_b = 1$ maximizes social welfare.[25] However, first best is not attainable, as $C^{\mathcal{B}} > C$.

4.3   Contingent CRA profits

Instead of letting investors produce ratings, one could also link CRA compensation to rating accuracy. This provides similar skin-in-the-game based incentives. One could for example think about a mandatory co-investment, posting a bond, taking on first loss pieces of RMBSs or take short CDS positions in products with high ratings. Outcomes may differ from the case with investor-produced ratings because of the reputational concerns and low number of CRAs. In this section, I analyze the viability and desirability of such market practice.

In the model, incentive alignment of CRAs is achieved by adjusting each stage game in the following way (compared to the base case). In step 3. each CRA c can solicit co-investments comprising of a fraction $\phi_c \in [0, 1]$ of the rated issues conditional on receiving a high ratings. By assumption, the compensations received for taking on these exposures conform to market interest rates set by investors and are paid in step 6. conditional on high quality project realization.

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[25]But this would defy the purpose of a public rating.

If $N > 1$, results are virtually identical to those in the previous section. CRAs will solicit low co-investments to signal willingness to cater to issuers.[26] Because CRAs in this setting do not need reputation rents, social welfare improves slightly compared to the base-case, even when $\beta > 0$.

With a monopolistic CRA ($N = 1$), co-investments will not work either. The CRA cannot expect to earn positive profits on the co-investment because its returns are in line with market interest rates and hence yield zero expected profits. Therefore, the CRA optimally sets $\phi_c = 0$. In many cases, setting $\phi_c = 0$ is even strictly optimal as a strictly positive co-investment would induce the CRA to exert costly effort while ζ binds fees from above.

Lemma 3. (***Monopolistic independence***): *If $N = 1$ it is always optimal for the CRA c to set $\phi_c = 0$. For wide parameter ranges, this optimality is strict.*

Proof. See Appendix. □

In contrast to the setting with investor-produced ratings, regulation imposed co-investments may also lead to unexpected problems if another type of equilibrium materializes. If a minimum were imposed on ϕ_c by a regulator, reputational concerns of CRAs could lead to captive equilibria. In such equilibria, issuers pay premium fees for 'perverse incentive compatibility' to hold. That is, CRAs pocket rents for exerting lower effort levels than those induced by ϕ_c. As before, r is a crucial component of the fee premium needed to seduce CRAs to act contrary to their contemporaneous incentives. Hence, such an equilibria are only feasible if r is sufficiently small compared to ϕ_c.[27]

4.4   Franken Rule

As a part of the negotiations concerning the implementation of the Dodd-Frank financial sector reform act, senator Al Franken has put forward an amendment for a so-called platform-pays rule as suggested in Mathis et al. (2009). Congress accepted this amendment. Under such a 'Franken Rule', issuers pay into a market-wide fund from which rating fees are paid to CRAs. CRA selection in such a system is done by some selection committee. The investment community would provide many of the committee members. For the moment, the Franken Rule has been postponed while the SEC investigates other solutions.

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[26]That is, Proposition 4 applies with ϕ_c instead of ϕ_b and $\mathcal{C}$ instead of $\mathcal{C}^{\mathcal{B}}$.

[27]As such a captive equilibria are relatively unstable, have low tractability and do not comprise a main result of the paper, those are not worked out in detail.

I work out this market structure in two ways that differ by the way of (indirect) influence issuers have on the process.

In the first way (call this the 'pass-through' setup), the base case stage game is modified in the following way. In step 2., investors quote a transaction fee f_b along with their interest rates ι_b and funding shares ϕ_b. In step 4. issuers select a (combination of) investor(s). The investor with the highest funding share collects the transaction fee and selects and pays the CRA. The transaction fee is paid irrespective of the rating outcome.

The problem with this mechanism is that it will induce investors to cater to issuers and keep funding shares small as was the case with investor-produced ratings in Section 4.2. The investor that selects the CRA will opt for inaccurate ratings if its skin-in-the-game is only small. As before, issuers can effectively optimize over ϕ_b by selecting (a) investor(s) that maximize(s) their utility. Ex ante, investors will anticipate this shopping behavior and solicit low funding shares. Hence, accuracy is unaffected.

Proposition 6. *Under a Franken Rule where investors pass through rating fees, it is optimal for investors to quote low fees and solicit small funding shares such that the resulting effort level reflects the issuer's preference.*

Proof. See Appendix. □

Alternatively, one could consider a setup without pass-through of rating fees. In that case, each stage game is adjusted from the base case as follows. In step 2., investors quote their interest rates ι_b and funding shares ϕ_b. In step 4. issuers again select investors and the investor with the highest funding share selects the CRA. However, now the issuer has to pay the selected CRA directly.

As investors have no way to commit to inaccurate ratings, they will choose the CRA that can be expected to exert maximum effort. While this does prevent rating inflation, it may be inefficient if too many resources are allocated to credit assessments. This result is similar to the result in Kashyap and Kovrijnykh (2013).

Proposition 7. *Under a Franken Rule without fee pass-through, it is optimal for investors to push for maximum effort, which is likely to be socially sub-optimal due to over-investment in credit assessments.*

Proof. See Appendix. □

Propositions 6 and 7 make clear that a Franken Rule is very sensitive to its exact setup, and tends to drift into extremes.[28] In order to prevent over-spending on credit assessments, issuers need to have influence on the CRA selection process. However, allowing for issuer influence in the selection process exposes the system to rating shopping and catering. In a model with a limited capital supply, one might be able to make such a system work as investors would be able to capture almost all economic surplus. Hence, the investors' optimization would be equivalent to the firm's optimization problem with $\beta = 0$. Note that even then the outcome realized falls short of first best because CRAs are disciplined by reputation and ratings are mildly inflated.

5 Results when issuer-paid CRAs are banned

In the previous sections, I analyzed heterogeneous competition models in the market for credit ratings. One of the results was that competition from issuer-paid CRAs prevents the other business models to gain market-share, because issuer-paid CRAs can generally commit to better cater to issuers. This section investigates whether the viability of these alternatives improves if issuer-paid CRAs were to be banned.

5.1 Imposing investor-paid ratings on the market

If issuer-paid CRAs were banned, one could choose to 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. This section uses the setup as section 4.1, but with $M = 2$ and $N = 0$. Within this section, the term CRA refers to investor-paid CRA.

As investor-paid CRAs are disciplined by reputation, incentive compatibility needs to be satisfied. Moreover, a monopolistic investor-paid CRA will display similar behavior to a monopolistic issuer-paid CRA. Hence, the interesting case to

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[28]As an alternative, one could think about passing through fees, but sharing transaction and rating fees proportionally among all participants is an issue. While this would make the system work, strategies could easily be devised to bypass the system. For example, one underwriter could take care of all fees and immediately after distribute issue shares among other syndicate participants. Because the underwriter endogenizes the redistribution of loan shares, it acts as in Proposition 6. For issuers, such a syndicate would be very attractive because it would cater well to their interests. The underwriter could also credibly signal commitment by quoting low transaction fees. Mild rating inflation induced by reputation rents would also persist under any implementation of the Franken Rule.

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: a symmetric type in which both CRAs play identical strategies and an asymmetric type in which one CRA becomes a monopolist and the other drops out. The reason that an asymmetric equilibrium is possible here is because 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. If β is relatively low, issuers with one low rating may not find it worthwhile to apply for funding and positive selection takes place. If CRA m exerts effort $e_m > \underline{e}$, it is then optimal for the other CRA to free-ride and exert low or even zero effort at a fee slightly lower than f_m. This type of free-riding is similar to the free-riding of issuer-paid CRAs in Section 4.1. Issuers will avoid investors subscribing to m because 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 might not arise at all. When β is sufficiently high, it is optimal even for low quality issuers to apply for funding. In this case, issuers with two high ratings condition on receiving β and try to minimize interest expenditures, thereby pushing CRAs for higher effort (as if β were zero). Hence, with large β, a competitive equilibrium with high rating accuracy may materialize. These effects are summarized in the propositions below:

Proposition 8. *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.) $e_{\mathcal{M}}^*$ is optimal for issuers with two high ratings and 3.) there is no free-riding by positive selection at $e_{\mathcal{M}}^*$. Condition 3.) is satisfied when private benefits β are sufficiently large. If more than one of such effort levels exist, an equilibrium will only materialize for the highest possible effort.*

Proof. See Appendix. □

Competitive investor-paid equilibria only improve on accuracy when β is sufficiently large and the base-case equilibrium generates low social welfare. 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.

5.2 Requiring investor-produced ratings from all investors

In section 4.2, I showed that competition among investors allows issuers to put pressure on funding shares as to lower investor screening incentives, irrespective of the presence of issuer-paid CRAs. Important here was that screening was delegated to the party with the largest stake. However, if regulators were to require *each* investor to conduct credit assessment before funding an issue and ban issuer-paid CRAs, things change.[29] In that case, lowering funding shares is expensive for issuers, because they will have to compensate each investor for the screening costs. As a result, if private benefits are relatively small, it is optimal to use $\phi_b = 1$, that is, placing the loan privately with one investor and shunning public debt markets. If on the other hand private benefits are large, incentives are to minimize funding shares. In other words, when distortions due to private benefits are largest, investor-produced ratings offer least solace.

Lemma 4. *If in a setting with investor-produced ratings and $N = 0$ where each investor with $\phi_b > 0$ needs to conduct a credit assessment, we have in equilibrium that $\phi_{\mathcal{B}}^* = 1$ if $\beta < \frac{1}{2}$, $\phi_{\mathcal{B}}^* = \frac{1}{W}$ if $\beta > \frac{1}{2}$ and can take on any value on the unit interval when $\beta = \frac{1}{2}$.*

Proof. See Appendix. □

6 Other robustness tests and extensions

In this section, I explore the robustness and extensions of the base case model. 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 how positive selection mechanisms can explain why rating inflation in the structured product market was much more prevalent than in the corporate bond market.

6.1 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. Moreover, I show that with private benefits of investors instead of private benefits for issuers, investor-produced

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[29]Regulators also could put a floor to funding funding shares, but this method is less imposing and can reach the same goal if β is sufficiently small.

ratings or a Franken rule will be even less helpful in overcoming rating inflation. Private benefits of investors arise from convex compensation schemes such as option and bonus plans, empire building concerns, but also the possibility to forward losses to debt holders or being bailed out under an implicit government put. The result for the base case presented here is similar to Opp et al. (2013), except for the fact that regulatory importance here plays no explicit role. 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 have (measured by $\alpha > 0$). These private benefits scale linearly with investor funding shares ϕ_b. As was the case with β, α is assumed to be 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 (13)). 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 (13)).

Lemma 5. *Given* $\beta = 0$, $\alpha > 0$ *and an equilibrium effort level* e^* *from CRAs, investors charge an equilibrium interest rate of*

$$\iota^* = \frac{(1-\theta) - \alpha - (1-\alpha)(1-\theta)e^*}{\theta}. \tag{13}$$

Proof. See Appendix. □

Most of the suggested solutions in this paper are unaffected by the exact source of rating inflation; what matters is that rating inflation is not fully endogenized by setting higher interest rates, i.e. market discipline fails. On top of this, investor-produced ratings and the Franken rule without pass-through are also affected by the exact source of rating inflation. As before, when investors conduct ratings, they can condition their rating efforts on the interest rates quoted. When investors have private benefits of investing, their expected losses due to rating inflation are partially offset by higher expected private benefits. Hence, even with efficient rating

production technology (e.g. $C^{\mathcal{B}} = C$) and high funding shares (e.g. $\phi_b = 1$), investors will inflate ratings.

Lemma 6. *Given $\alpha > 0$ an interest rate quote ι_b and a funding share ϕ_b, it is optimal for a rating-producing investor b to exert effort*

$$e_b = \max\left(\frac{\phi_b(1-\alpha)(1-\theta)}{2C^{\mathcal{B}}}, \frac{1-\theta R-\alpha}{(1-\theta)(1-\alpha)}, 0\right). \tag{14}$$

Proof. See Appendix. $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\square$

As one can see, the shortfall of rating effort is even larger than in the base case with investor-produced ratings. Hence, in the presence of investor private benefits of operating, rating inflation cannot be avoided.

6.2 Noisy self-knowledge and different markets

One can wonder why issuer-paid ratings showed such low accuracy in structured product markets, but performed reasonably well in other markets such as the corporate credit market. Opp et al. (2013) even argue that any model that wants to explain rating inflation should be able to explain such difference. The same positive selection mechanisms underlying the analysis on heterogeneous competition among investor-paid and issuer paid CRAs provide additional insights to this question. For this analysis, I extend the base case model by giving issuers noisy knowledge about their own quality. More concretely, a low quality issuer is aware about being of low quality with probability ξ.

Suppose that corporates have a reasonably good idea about their own quality (i.e. corporates have a high ξ), while managers of structured products are largely unaware about the real quality of their mortgage pool (i.e. structured products have a low ξ). The aggregate credit quality (i.e. θ) and rating technologies in both markets are assumed to be equal. Moreover, let us assume that private benefits of operating are identical across the two markets and not too large. Self-aware, low quality issuers in either market will be reluctant to spend money on rating fees if their businesses cannot generate substantial revenues in the future. The propensity of self-aware low quality issuers in the corporate segment is much larger than in structured product segment. As a result, the expected ex-ante benefit of rating inflation is higher for structured products. Moreover, with relatively low effort, corporate ratings can reach high (ex-post observed) accuracy as many low quality

issuers will not bother to solicit a rating. Because fees are proportional to production costs, rating fees on corporates can be much lower than on structured products, as is also observed empirically.

Alternatively, one could consider the situation where there is some degree of noisy self knowledge of issuers that is similar in both market segments (i.e. ξ is equal for both market segments). However, now private benefits of operating (i.e. β) are much higher for structured products compared to corporates. This is not an unreasonable premise in view of extremely generous short-term bonus plans for investment bankers putting these structured products into the market. The result is that in the structured product segment even self-aware low quality issuers apply for ratings and push for rating inflation. The private benefits of getting high ratings justify the fees, despite the low probability of actually getting these private benefits. Self aware low quality issuers in the corporate sector on the other hand, have little to gain from rating inflation as the potential gain of private benefits is insufficiently large to justify the rating fees. Once again, with relatively low effort, corporate ratings can reach high (ex-post observed) accuracy because of positive selection. In contrast, structured product issuers will engage in maximum rating shopping and put pressure on CRAs to cater to their demands. Hence, rating inflation in the structured product market is much more prevalent than in the corporate market.

7   Conclusion

In this paper, I have explored the potential of different alternatives to issuer-paid ratings to improve on rating accuracy and social welfare. Systems of investor-paid ratings, investor-produced ratings, and a Franken Rule all may have some limited potential to improve social welfare. However, for any of those to be effective, issuer-paid CRAs will need to be banned or very tightly regulated. These business models are unlikely to take hold by themselves as if there were an invisible hand leading all agents to socially sub-optimal outcomes.

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, it would be interesting to compare issuer-paid CRAs to investor-paid CRAs 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. Finally, this model focuses primarily on the screening role of ratings. While this is the most important aspect for infrequently traded assets such as structured products, for corporate bonds the monitoring role may also be important to consider. Business models with more investor influence could potentially fulfil this role better. Modeling such effects is intentionally left for future research.

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 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.

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Appendices

A   Proofs

Proof of Proposition 1

Total welfare WF generated in this economy is given by

$$WF = \theta(R - 1) - (1 - \theta)(1 - e_c) - Ce_c^2. \tag{15}$$

Equation (15) 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 (15), setting it to zero and solving towards e_c yields

$$e_c = \frac{1 - \theta}{2C}, \tag{16}$$

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

$$e_c = \min\left(\frac{1 - \theta}{2C}, 1\right). \tag{17}$$

Substituting (17) into (15) gives the first best welfare level

$$WF = \min\left(\frac{(1 - \theta)^2}{4C} - (1 - \theta R), \theta(R - 1) - C\right). \tag{18}$$

It is trivial to see that it is only socially optimal to do any investing and produce any ratings if $WF \geq 0$. This is the case when

$$\frac{(1 - \theta)^2}{4C} \geq (1 - \theta R). \tag{19}$$

Proof of Proposition 2

It is trivial to see that investor strategy 1. is optimal given CRA strategy 4. CRAs that have ever exerted effort $e_c < e^*$ or quoted fees $f_c < f^*$ can be expected to exert $e_c = 0$, which falls short of the hurdle $\underline{e}$. The optimality of investor strategy 2. follows trivially from the fact that investors compete perfectly. Given the expressions in 5. and 6., 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 not blacklisted. Given investor strategy 1., it is optimal to never exert effort anymore for a blacklisted CRA as it cannot expect to gain any future profits while contemporaneous profits are decreasing in e_c. Expression (6) for optimal fees in 5. follows from the fact that incentive compatibility has to bind due to competition. The optimal effort expression (7) in 5. follows from maximizing the constrained optimization problem for issuers over e_c:

$$\max_{e_c} \theta(R - 1 - \iota) - f_c \Rightarrow \qquad \max_{e_c} \; -(1-\theta)(1-e_c) - f_c, \qquad (20)$$

Subject to

$$e_c \in [\underline{e}, 1], \qquad (21)$$

$$\zeta \geq f_c \geq (1+r)Ce_c^2. \qquad (22)$$

Either an interior solution materializes or we have that the pledgeability constraint (2), the issuer budget constraint or the natural bound upper bound of 1 binds. The monopolist fee level in (8) follows from the issuer budget constraint and maximal rent extraction by a monopolist while keeping issuer utility non-negative. The monopolist effort equation (9) follows from the constrained maximization of surplus that can be captured by the CRA.

$$\max_{e_c} f_c - Ce_c^2 \Rightarrow \quad \max_{e_c} \; \min(\zeta, (1-\theta)(1-\beta)(1-e^*) + \theta(R-1)) - Ce_c^2, \quad (23)$$

Subject to constraints (21) and (22). Again, we have an interior solution or that one of the same constraints as in 5. binds.

Proof of Corollary 1

Social welfare is given by equation (15). Substituting $e_c = \frac{(1-\theta)(1-\beta)}{2C(1+r)}$ gives social welfare in the competitive case:

$$WF = \frac{(1-\beta)(1-\theta)^2}{2C(1+r)} - \frac{(1-\beta)^2(1-\theta)^2}{4C(1+r)^2} - (1-\theta R), \qquad (24)$$

$$= \frac{(1-\theta)}{4C}\left[\frac{(1-\beta)(1+\beta+r)}{(1+r)^2}\right] - (1-\theta R). \qquad (25)$$

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

$$\frac{(1-\beta)(1+\beta+r)}{(1+r)^2} = \frac{1-\beta^2 + 2r(1-\beta)}{1+2r+r^2}. \tag{26}$$

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 $e_c = \frac{(1-\theta)(1-\beta)}{2C}$ to get:

$$WF = \frac{(1-\beta)(1-\theta)^2}{2C} - \frac{(1-\beta)^2(1-\theta)^2}{4C} - (1-\theta R), \tag{27}$$

$$= \frac{(1-\theta)}{4C}[(1-\beta)(1+\beta)] - (1-\theta R). \tag{28}$$

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

$$(1-\beta)(1+\beta+r) = 1-\beta^2. \tag{29}$$

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

Proof of Lemma 1

As m can only be disciplined by reputation, equation (3) the fee charged to subscribing investors is bounded from below by $f_m \geq (1+r)Ce_m^2$. Because investors can only charge a transaction fee when they fund an issue, transaction fees are only paid conditional on high ratings. Hence, the rating fees f_m need to be recovered by transaction fees on a fraction $\theta + (1-\theta)(1-e_m) \leq 1$ of all issues. The lower bound then follows naturally.

Proof of Proposition 3

In order for issuer-paid CRAs to deter entry to m, issuers need to prefer issuer-paid CRAs over m. Let us look at two scenarios that span all possible outcomes: issuers with $s^m = B$ leave the market or they stay.

If issuers with $s^m = B$ leave the market, investors maximize market share by offering funding and competitive interest rates to any issuer with a rating. In par-

ticular, issuer-paid CRAs can exert low effort e_c and quote fees $f_c < f_h$. Issuers with $s^m = G$ would always strictly prefer to use issuer-paid CRAs as they get the same interest rates for a lower fee. As a consequence, investors optimally refrain from purchasing investor-paid ratings, as they will not be able to recover purchasing costs. Positive selection is most likely when expected private benefits are minimized (i.e. when committable effort is maximized) and fees are maximized to the level that still attracts issuers with $s^m = G$ (i.e. f_c marginally lower than f_h).

We can determine the conditions for positive selection to occur as follows. Issuers with $s^m = B$ derive the following utility from applying for issuer-paid ratings:

$$E(u|e_m, s^m = B) = \beta(1 - \theta)(1 - e_c) - f_c. \tag{30}$$

Positive selection takes place when this expression is negative. Positive selection is encouraged by issuer-paid CRAs by maximizing fees and minimizing expected private benefits for issuers with $s^m = B$. However, fees cannot exceed $f_h = \frac{C(1+r)e_m^2(1-\psi)^{-1}}{\theta+(1-\theta)(1-e_m)}$ as otherwise, issuers with $s^m = G$ would find it optimal to fund from subscribing investors. Moreover, while high effort reduces expected private benefits, 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 $(\theta + (1 - \theta)(1 - e_m))(1 - \psi)$ of all issuers will apply for issuer-paid ratings. Hence, the maximum contemporaneous benefit of exerting zero effort is given by $(\theta + (1 - \theta)(1 - e_m))(1 - \psi)Ce_c^2$. Incentive compatibility holds as long as

$$(\theta + (1 - \theta)(1 - e_m))(1 - \psi)Ce_c^2 \le \frac{f_c^* - C(e_c^*)^2}{r}. \tag{31}$$

Solving this inequality towards e_c yields the maximum committable effort for issuer-paid CRAs for positive selection:

$$\hat{e} = \max\left(\underline{e}, \min\left(\frac{(1-\theta)(1-\beta)(1-\psi)^{-1}}{2(1-(1-\theta)e_m)C(1+r)}, 1, \sqrt{\frac{\zeta(1-\psi)^{-1}}{C(1-(1-\theta)e_m)(1+r)}}\right)\right). \tag{32}$$

Hence, positive selection takes place when

$$\frac{C(1+r)e_m^2(1-\psi)^{-1}}{\theta + (1-\theta)(1-e_m)} \geq \beta(1-\theta)(1-\hat{e}), \quad \text{or} \tag{33}$$

If the required effort for positive selection is not committable, issuer-paid CRAs can try to outbid m. It is optimal for issuers solicit issuer-paid ratings if the sum of rating fees and expected interest payments are lower than those resulting from getting funding from investors that get ratings from m. In the latter case, (passed on) rating fees amount to $f_h = \frac{f_m(1-\psi)^{-1}}{\theta+(1-\theta)(1-e_m)} = \frac{(1+r)Ce_m^2(1-\psi)^{-1}}{\theta+(1-\theta)(1-e_m)}$ and expected interest payments for issuers that got a high rating from m are given by:

$$E(\iota^m) = P(q = G|e_m, s^m = G)\iota^m, \tag{34}$$

where

$$\iota^m = \frac{(1-\theta)(1-e_m)}{\theta} \tag{35}$$

as before and

$$P(q = G|e_m, s^m = G) = \frac{\theta}{\theta + (1-\theta)(1-e_m)} \tag{36}$$

by Bayes' Rule. Similarly, we have that

$$E(\iota^c) = P(q = G|e_c, e_m, s^c = G, s^m = G)\iota^c, \tag{37}$$

where

$$\iota^c = \frac{(1-\theta)(1-e_c)}{\theta} \tag{38}$$

as before and

$$P(q = G|e_c, e_m, s^c = G, s^m = G) = P(q = G|e_m, s^m = G). \tag{39}$$

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 when conditions 1. and 2. are not satisfied, there is a committable

e_c that deters entry to m if

$$E(\iota^c) + f_c \leq E(\iota^m) + f_h \qquad (40)$$

$$-Ce_c^2 + P(q = G|e_m, s^m = G)\frac{1-\theta}{\theta}(e_c - e_m) + \frac{(1+r)Ce_m^2(1-\psi)^{-1}}{\theta + (1-\theta)(1-e_m)} \geq 0 \qquad (41)$$

$$-Ce_c^2 + \frac{(1+r)Ce_m^2(1-\psi)^{-1}}{\theta + (1-\theta)(1-e_m)} + \frac{1-\theta}{\theta + (1-\theta)(1-e_m)}(e_c - e_m) \geq 0. \qquad (42)$$

$\bar{e}_c$ in equation (45) maximizes the LHS of (42) over the support of e_c. If such a value $\bar{e}_c$ exists, issuer-paid CRAs can play it and m will have no market share.

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

$$\frac{C(1+r)e_m^2(1-\psi)^{-1}}{\theta + (1-\theta)(1-e_m)} \geq \beta(1-\theta)(1-\hat{e}), \quad \text{or} \qquad (43)$$

$$0 \leq -C\check{e}^2 + \frac{C(1+r)e_m^2(1-\psi)^{-1} + (1-\theta)(\check{e} - e_m)}{\theta + (1-\theta)(1-e_m)}, \quad \text{where} \qquad (44)$$

$$\check{e} = \arg\max_{e_c \in [\underline{e}, \tilde{e}]} -Ce_c^2 + \frac{C(1+r)e_m^2(1-\psi)^{-1} + (1-\theta)(e_c - e_m)}{\theta + (1-\theta)(1-e_m)}, \qquad (45)$$

$$\tilde{e} = \max\left(\underline{e}, \min\left(\frac{(1-\theta)(1-\beta)}{2C(1+r)}(1-\psi)^{-1}, 1, \sqrt{\frac{\zeta(1-\psi)^{-1}}{C(1+r)}}\right)\right), \qquad (46)$$

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

Proof of Lemma 2

It is sufficient to show that there exists a strategy for issuer-paid CRA c that can keep investor-paid CRA m out of the market. 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 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

$$Ce_m^2 < f_m \leq f_h. \tag{48}$$

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

Because investors only have a short horizon, they cannot commit to any effort level ex-ante. Hence, conditional on the quoted interest rates, a funding fraction ϕ_b, and being selected by an issuer, a given investor b maximizes

$$\max_{e_b \in [0,1]} - \phi_b(1 - \theta)(1 - e_b) - C^{\mathcal{B}} e_b^2. \tag{49}$$

If the solution to (49) is an interior solution, optimal effort is derived by imposing a FOC and solving towards e_b:

$$e_b = e_{\mathcal{B}}^* = \frac{(1 - \theta)\phi_b}{2C^{\mathcal{B}}}. \tag{50}$$

$e_{\mathcal{B}}^*$ should also satisfy pleadgeability. Setting (50) equal to $\underline{e}$ and solving for ϕ_b yields the lower-bound $\frac{2C^{\mathcal{B}}(1-\theta R)}{(1-\theta)^2}$ for which it is still optimal for investors to trust a rating produced by b.

Competition drives fees down to production costs.

Ex-ante, in their selection phase, issuers optimize their own utility over b based on the solicited ϕ_bs. For investors, the market share maximizing (and hence optimal) funding share ϕ_b is then given by

$$\phi_b = \phi_{\mathcal{B}}^* = \arg\max_{\phi_b} -(1 - \beta)(1 - \theta)(1 - e_b^*(\phi_b)) - C^{\mathcal{B}}(e_b^*(\phi_b))^2. \tag{51}$$

Substituting (50) into (51), imposing a FOC with respect to ϕ_b and solving, yields

$$\phi_{\mathcal{B}}^* = (1 - \beta). \tag{52}$$

Combining these results with the rating budget constraints and the unit support for ϕ_b and e_b yields the expression for $\phi_{\mathcal{B}}$.

Proof of Proposition 5

Issuers select their own rater, and hence, maximize their own expected utility over the two types of raters. When $\phi_{\mathcal{B}}^* = (1 - \beta)$, the issuer optimizes in both cases a constrained quadratic function over e_b and e_c respectively. The only difference between the two optimization problems is the coefficient on the quadratic term, which equals $-C^{\mathcal{B}}$ for investors and $-(1+r)C$ for CRAs. Obviously, if $C(1+r) < C^{\mathcal{B}}$, CRAs offer higher utility and investors get no business. As $\phi_{\mathcal{B}}^*$ is chosen to maximize issuer utility, investors are even less competitive when a constraint on $\phi_{\mathcal{B}}^*$ binds and will certainly lose business to CRAs if $C(1 + r) < C^{\mathcal{B}}$.

Proof of Lemma 3

The CRA c needs to decide ex-ante on ϕ_c. Because investors compete and the CRA needs to be price taker on the loan, the expected return on the co-investment ϕ_c equals zero. If anything, $\phi_c > 0$ will have an upward effect on effort levels because it gives rise to a positive linear coefficient on e_c (conditional on the interest rate), while effort is costly. Hence, $\phi_c > 0$ cannot strictly increase returns while it can potentially increase effort costs. As a result, $\phi_c = 0$ is optimal.

Proof of Proposition 6

Suppose the investor b with the largest funding fraction ϕ_b is responsible for selecting a rater and can pass through (part of) the rating fees to issuers. If selected, this investor conditions on the quoted interest rates and transaction fees. Moreover, due to its short horizon, it has no reputational concerns that can affect current decision making. Hence, if CRAs compete, b effectively optimizes

$$\max_{e_c \in [\underline{e}, 1]} - \phi_b(1 - \theta)(1 - e_c) - C(1 + r)e_c^2. \tag{53}$$

The solution follows from solving a FOC and imposing the regular constraints on e_c:

$$e^* = \max\left(\underline{e}, \min\left(1, \frac{\phi_b(1 - \theta)}{2C(1 + r)}, \sqrt{\frac{\zeta}{C(1 + r)}}\right)\right). \tag{54}$$

As in Proposition 4 issuers can effectively optimize over ϕ_b. Investors maximize market share by setting $\phi_b = (1 - \beta)$. As a result, e^* under the Franken rule equals

e^* in the base case.

Proof of proposition 7

Suppose the investor b with the largest funding fraction ϕ_b is responsible for selecting a rater, while the issuer has to pay the rating fee to the CRA directly. Because, the CRA selection process can be conditioned on quoted interest rates, there is only upside for b from higher effort and hence b will choose CRAs as to maximize effort. Competition among CRAs then pushes e_c up to its maximum feasible level in equilibrium. Hence, by definition, one of the upper bounds (bound of unity or the one implied by the budget constraint) on e_c binds. If the first best effort level was an interior solution, then e_c exceeds the first best effort level and hence, socially sub-optimal over-investment in credit assessment takes place.

Proof of Proposition 8

Let us assume that we have an equilibrium in which each of the two investor-paid CRAs exerts effort $e_{\mathcal{M}}^*$. In order for $e_{\mathcal{M}}^*$ to be feasible, we need at least the following.

1. Incentive compatible rating fees should not violate the budget constraint resulting from the initial endowment

2. There is no positive selection for issuers at effort levels marginally lower than $e_{\mathcal{M}}^*$

3. $e_{\mathcal{M}}^*$ should satisfy the pledgeability constraint and be bounded from above by 1

Moreover, in order for $e_{\mathcal{M}}^*$ to be optimal, we additionally need

4. Given the information issuers have obtained from observing an interest quote corresponding to $e_{\mathcal{M}}^*$, issuers with two high ratings have no demand for even higher effort

5. Given the information issuers have obtained from observing an interest quote corresponding to $e_{\mathcal{M}}^*$, issuers with two high ratings have no demand for lower effort

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

$$f_h = \frac{2C(1+r)(e_{\mathcal{M}}^*)^2(1-\psi)^{-1}}{1-(1-\theta)e_{\mathcal{M}}^*}. \tag{55}$$

In order for condition 1. to hold, this fee cannot exceed ζ.

For condition 2. to hold, given $e_{\mathcal{M}}^*$, the equilibrium should not be separating at an effort level slightly below $e_{\mathcal{M}}^*$. Otherwise, given $e_{\mathcal{M}}^*$, there is 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 conditional on $e_{\mathcal{M}}^*$ issuers with a low first rating find the fees prohibitively high to apply for funding, even if private benefits were guaranteed. Positive selection can not occur if the expected utility of a firm with two low ratings turn positive when effort is lowered by an arbitrarily small amount. This is the case when

$$\beta(1-\theta)(1-e_{\mathcal{M}}^*) - f_h(1-\theta)(1-e_{\mathcal{M}}^*) > 0, \Rightarrow \tag{56}$$
$$\beta > f_h. \tag{57}$$

Conditions 1. and 2. combined yield

$$\min(\beta, \zeta) \geq 2C(1+r)\frac{(e_{\mathcal{M}}^*)^2(1-\psi)^{-1}}{1-(1-\theta)e_{\mathcal{M}}^*}. \tag{58}$$

Condition 3. is required due to the pledgeability requirement and basic probability theory that precludes probabilities exceeding 1. Formally, it is satisfied when

$$e_{\mathcal{M}}^* \in (\underline{e}, 1] \tag{59}$$

For condition 4. to hold, we need to have that the utility of the issuers with two high ratings is downward sloping in effort beyond effort level $e_{\mathcal{M}}^*$. Because an issuer still stands to lose β beyond $e_{\mathcal{M}}^*$, its utility function is unaffected by the expanded information set. Differentiating the original issuer utility function with respect to e_m and requiring a strictly negative slope gives

$$0 < (1-\theta) - \left(\frac{2(1+r)Ce_{\mathcal{M}}^*}{1-e_{\mathcal{M}}^*(1-\theta)} - \frac{(1+r)C(e_{\mathcal{M}}^*)^2(1-\theta)}{(1-e_{\mathcal{M}}^*(1-\theta))^2} \right)(1-\psi)^{-1}. \tag{60}$$

For condition 5. to hold, we need to have that the slope of the utility of the issuers with two high ratings is upward sloping in effort below effort level $e^*_{\mathcal{M}}$. However, it is impossible for an issuer with two high ratings to lose its private benefits at an effort level below $e^*_{\mathcal{M}}$ and hence, its utility function changes to

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

Differentiating with respect to e_m and requiring strict positivity gives

$$0 > (1 - \theta)(1 - \beta) - \left(\frac{2(1 + r)Ce^*_{\mathcal{M}}}{1 - e^*_{\mathcal{M}}(1 - \theta)} \frac{(1 + r)C(e^*_{\mathcal{M}})^2(1 - \theta)}{(1 - e^*_{\mathcal{M}}(1 - \theta))^2} \right) (1 - \psi)^{-1}. \tag{62}$$

Finally, when a range of such values exists rather than one unique value, setting e_m equal to the highest possible $e^*_{\mathcal{M}}$ would maximize the negative selection towards other CRAs as no issuer with $s^m = G$ will have demand for effort levels below e_m. Hence, the equilibrium should materialize at the top of this range.

Proof of Lemma 4

As before, investors will optimize the objective function (49), yielding the solution for optimal effort in (50). However, each investor now needs to produce ratings and hence pass through these costs as transaction fees. Competition ensures transaction fees will equal production costs. In selecting investors, the issuer effectively optimizes

$$\max_{\phi_b} - (1 - \beta)(1 - \theta)(1 - e_b) - \phi_b^{-1}C^{\mathcal{B}}e_b^2. \tag{63}$$

Substituting (50) into (63) and simplifying, the issuer optimization problem reduces to

$$\max_{\phi_b} \frac{\phi_b(1 - \theta)^2(2(1 - \beta) - 1)}{4C^{\mathcal{B}}}, \tag{64}$$

which is linear in ϕ_b. Hence, we obtain a corner solution. Which corner solution we obtain depends on the coefficient in front of ϕ_b. When $\beta < \frac{1}{2}$ this coefficient is strictly positive, while it is strictly negative when $\beta > \frac{1}{2}$. Therefore, it is optimal to choose the maximal value $\phi_b = 1$ when $\beta < \frac{1}{2}$ and the minimal value $\phi_b = \frac{1}{W}$ when $\beta < \frac{1}{2}$. If $\beta = \frac{1}{2}$, the coefficient on ϕ_b equals zero and the issuer is indifferent among all possible values of ϕ_b.

Proof of Lemma 5

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

$$\theta\iota^* + (\theta + (1-\theta)(1-e^*))\alpha - (1-\theta)(1-e^*) = 0. \tag{65}$$

Solving towards ι^* gives

$$\iota^* = \frac{(1-\theta) - \alpha - (1-\alpha)(1-\theta)e^*}{\theta}. \tag{66}$$

Proof of Lemma 6

Each rating-producing investor b maximizes

$$\max_{e_b} \phi_b(\theta\iota + (\theta + (1-\theta)(1-e_b))\alpha - (1-\theta)(1-e_b)) - C^{\mathcal{B}}e_b^2 + f_b. \tag{67}$$

Imposing a first-order condition and solving w.r.t. e_b yields

$$e_{\mathcal{B}}^* = \frac{\phi_b(1-\alpha)(1-\theta)}{2C^{\mathcal{B}}}, \tag{68}$$

if we have an interior solution. If we have a boundary solution than either pledgeability or the natural probability bounds bind. Pledgeability imposes that (67) can never fall below 0 in equilibrium. Setting equation (67) to zero, realizing that transaction fees will equal rating production costs and solving yields the optimal effort level when pledgeability binds:

$$\underline{e}_{\mathcal{B}} = \frac{1 - \theta R - \alpha}{(1-\theta)(1-\alpha)}. \tag{69}$$

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	$[0, 1]$	leakage fraction

	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	
$f_{c,m,b}$	$[0, \infty)$	rating or transaction fee
$\phi_{b,c}$	$[0, 1]$	funding share
$e_{c,m,b}$	$[0, 1]$	rating effort
Z_b	$\{1, .., N\}$	blacklist
ι_b	$(-\infty, \infty)$	interest rate
I_j	$\{0, 1\}$	counterparty selection

	Market segments	
$\mathcal{B}$	$-$	investor-produced rating segment
$\mathcal{M}$	$-$	investor-paid rating segment

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