OVERRATING AGENCIES: Competition, Collusion, Information and Regulation

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Abstract

Firms issue securities to fund projects in an opaque market in which investors cannot infer the value of assets. As a result, good firms, unable to differentiate themselves, bypass profitable investment opportunities: informational inefficiency leads to allocational inefficiency. A rating agency enters the market, providing certification for a fee; it not only fails to inform investors and encourage investment, but also captures a tidy share of firms' rents. With two agencies competing in fees and disclosure rules, though, problems disappear—information is complete and investment efficient.

When the agencies interact repeatedly they are prone to collusion. When investment opportunities are plentiful they rate honestly, but charge fees so high that some positive NPV projects go unfunded. On the other hand, when there are few investment opportunities in the economy they overrate and good firms don't invest.

Regulatory prescriptions of bundling ratings with CDS issues and flooring fees solve the problem.

1 Introduction

Credit rating agencies have received more attention than they are accustomed to in recent years. Pundits in the popular press and in politics have pointed fingers at them, suggesting their culpability in recent financial crises, namely the Great Recession of 2007-2012, largely attributed to the collapse of the US housing and subprime mortgage markets, and the continuing European debt crisis that still threatens to break up the European Monetary Union. They say that their ratings are wrong, and in particular that they "overrate"(they tend to understate the probability of default of the firms). In January 2011, the Financial Crisis Inquiry Commission reported that

> credit rating agencies were key enablers of the financial meltdown. The mortgage-related securities at the heart of the crisis could not have been marketed and sold without their seal of approval. Investors ... were obligated to use them, or regulatory capital standards were hinged on them. This crisis could not have happened without the rating agencies.

To analyse the insurgence of overrating before the financial crisis (and to suggest solutions) we study the industrial organisation of the ratings industry as White (2001) advocates. He underscores several salient features of the US business to emphasize the imperfection of agencies' competition. Firstly, there are very few major rating agencies in the US, namely Moody's, S&P and Fitch. The situation in Europe is not very different, with no country having more than two rating agencies. Secondly, the industry, in the years that led to the crisis, was very profitable.[1] Thirdly, regulation, up until recently, had produced an increase in the demand for rating services: for example, according to safety-and-soundness regulations, banks and other savings institutions could invest only in investment-grade securities as attributed by a Nationally Recognised Statistical Rating Organisation[2]; also, state regulators set capital requirements for insurance companies depending on their assets' ratings. Such regulation incentivised rat-

[1]Moody's operating income in 2006 was $1.259 billion and it had steadily increased over the years (e.g., in 1999 was $0.270 billion).

[2]The SEC, in order to provide rating consistency and standardisation, has designated some agencies to be the nationally recognised statistical rating organisations—there were only three NSRSO up to 2003.

ing agencies to inflate their ratings in order to generate demand that otherwise might not have been present.

We examine the effects of rating agencies as certification intermediaries on real investment, modelling them dynamically competing in fees and disclosure rules—namely their ratings policies. We focus on efficient symmetric outcomes of a repeated extensive game. The key determinant of overrating is the trade-off between high-fees and market share, which is absent from the stage game. Ratings' feedback into real investment and agencies' intertemporal collusion drive the effect.

The real economic consequences of overrating are serious. If ratings are uninformative, issuers will underinvest in enhancing their assets: Informational inefficiency leads to allocational inefficiency. Given the current (and widely criticised) issuer-pay market for ratings, we find that increased competition among agencies relieves the problem, but that regulation is necessary to prevent overrating that results from imperfect competition.

Absent such regulation agencies collude, either by rating informatively but setting prohibitively high fees and preventing some good projects from being funded, or by rating uninformatively and making it worthless to issuers to select good projects. The former behaviour occurs when many issuers have the option of enhancing their assets, and the latter when few do—the number of investment opportunities in the market is the key determinant of ratings behaviour. We interpret this by saying that overrating is more likely in periods of economic contraction, which precede busts, as in 2006–2007, when firms' growth opportunities were drying up and CRAs disclosure standards appeared to decay. Additionally, we suggest that overrating amplified the downturn, since our model predicts that it leads firms with remaining opportunities to pass them up.

Finally, we explore potential policies to break down collusion among rating agencies: in particular, we concentrate on fee regulation and insurance bundling. When agencies collude they behave like a monopolist and split the profit. The standard monopoly fee regulation that imposes upper bounds on fees does not prevent collusion, but only redistributes wealth between agencies and firms, leaving ratings informativeness unaffected. Imposing lower limits on fees can obviate collusion: it reduces the punishment that an agency can impose on a deviant. Lastly, we show that prescribing that agencies issue insurance—for example in the form of CDS—associated to the ratings they publicize eliminates overrating completely. In order for this strategy to be successful rating agencies must be allowed to supply CDS. The Dodd–Frank Act—which revises rating agencies' regulation in the US—limits the scope of the rating agencies and outlaws such insurance policies. Is the act then perhaps fomenting overrating rather than preventing it?

The framework is one in which an intermediary can credibly provide potential buyers with information and a seller can employ him to do so. Our stage game is similar to Lizzeri (1999) and Albano and Lizzeri (2001), but we consider simultaneously competition among intermediaries and the feedback of disclosure policy into asset quality. Further, different from the latter paper, our intermediaries cannot commit to a disclosure rule before sellers invest in quality enhancement. Like us, Doherty, Kartasheva, and Phillips (2012) enrich Lizzeri (1999)'s canonical framework, but while they add buyer-preference for precision (analogous to risk-aversion), we instead explore the benefits of informative intermediation through the channel of sellers' investment. They also focus on competition, but employ a Stackelberg-like setting to study a potential entrant's impact on ratings. Despite the modelling differences, the results are analogous: in their model, when investors' preference for precision is high, intermediaries set prohibitively high fees to exclude a proportion of the issuers, as we find that when sellers' investment opportunities are plentiful—the feedback from precision is significant—there is only partial market coverage.

Other papers, notably Camanho, Deb, and Liu (2010) study competition among rating agencies, but with a heavy focus on reputation and very different assumptions on the structure of fees and competition. The Mathis, McAndrews, and Rochet (2009) paper demonstrates that reputational incentives are not enough to eliminate overrating. In their model there are two rating agencies, an honest non-strategic one and a lax strategic one. Camanho et al. add competition among rating agencies to the framework of Mathis et al. and ask whether it reduces the lax's incentives to overrate. They show how this is not the case: agencies are more prone to overrate under competition. Competition reduces the lax agencies' rewards for honesty by reducing their market shares; this effect dominates the beneficial effect of competition of inducing agencies to be honest to gain market share. Becker and Milbourn (2010) show that increased competition lowers the ratings' quality by analysing the impact on S&P and Moody's rating of Fitch's entrance in the US market.

Bolton, Freixas, and Shapiro (2009) also modify Mathis, McAndrews and Rochet's framework, but they include not only competition but also ratings shopping, imperfect risk assessments, and investors' varying ability to see through ratings, all in an environment in which reputation stays exogenous. They examine those situations under which overrating is most likely, and show that greater competition threatens the accuracy of ratings. This follows from ratings shopping: with more rating agencies, the firms have more opportunity to shop for ratings and thus the average accuracy of ratings decreases. They further show that overrating is more likely to occur in booms when investors are most credulous. Bar-Isaac and Shapiro (2010) analyse a model of endogenous reputation, where the economic environment varies over time, and show that ratings are counter-cyclical: in booms rating agencies are more prone to issue worse ratings because it is less likely that defaults will occur, because competition in the labour market is tougher and because income fees are high.

Our paper is part of the literature that builds on Lizzeri (1999), to which our main contribution is to consider the dynamics of collusion among intermediaries, thereby endogenizing careerism to some extent, albeit in a simplified way. In all of the papers cited above that do not follow this literature, at least some agencies' disclosure rules are immutable, predetermined rather than chosen at equilibrium. Furthermore, even in an infinite-horizon setting, the above authors assume that rating agencies intrinsically care about their reputations, over and above their payoffs from collecting fees. There is no doubt that such career concerns are critical in the ratings industry, but they result from the future cash flows that they bring and thus we aim to avoid adding them exogenously.

Our paper proceeds as follows: The next section presents the stage game and the one-period equilibrium concept. Then the third section studies the stage game in isolation, considering in turn settings without rating agencies, with a monopolistic agency, and with competing agencies. The fourth section introduces the full model and presents the main results about the effects of collusion among agencies on the real economy. The fifth section suggests regulatory prescriptions to restore the efficiency that rating agencies can help to provide. The last section concludes.

2 Model

2.1 Players and Set-up

There are three types of players: credit rating agencies, issuers and investors, where rating agencies stand between issuers with valuable projects and investors with the money to fund them.

In the economy, issuers own projects that, if implemented at cost I, payoff v_B; they have positive NPV, $v_\mathrm{B} - I > 0$. We assume that the only way to fund the projects is to sell them off. A proportion α of issuers has the option to enhance the value of their assets to $v_\mathrm{G} > v_\mathrm{B}$ at a cost c, where $c < v_\mathrm{G} - v_\mathrm{B} =: \Delta v$.[3]

If the issuer is a firm, then such a decision might be interpreted quite literally as the choice to expend more human capital in order to sell a more valuable asset; perhaps more pertinent, though, is the metaphorical interpretation in which the issuers are big financial institutions selling off complex securities, and the enhancement reflects the inclusion of (for example) better mortgages in a SIV's tranched products.

Issuers are profit maximising. Firstly, they decide wether to invest in the enhancement of their assets' value if they have the option to. Then they either all select a rating agency to employ or they stay out of the market.

Agencies choose to use one of two extreme disclosure rules, defining their rating behaviour. We refer to this as the *quality* q_a of an agency a. They are either honest ($q_a = \mathrm{H}$) or lax ($q_a = \mathrm{L}$). An honest agency always reveals the issuer's true type (she awards rating R_G to assets worth v_G and R_B to assets worth v_B, while a lax one always gives top ratings independently of the issuer's type (she gives a rating of R_G to assets worth both v_G and v_B). There is no asymmetry of information between the agencies and the issuers.

All agencies simultaneously commit to a quality and a fee. An agency a chooses her quality $q_a \in \{\mathrm{H}, \mathrm{L}\}$ and charges the issuers $\varphi_a > 0$ uniformly for her service.[4]

[3] An identical interpretation of the model is one in which $v_\mathrm{B} = X(1 - p_\mathrm{B})$ and $v_\mathrm{G} = X(1-p_\mathrm{G})$, where X is the project's payoff in case of success, p_B and p_G are the probabilities of default of the bad and good issuers respectively and $p_\mathrm{B} > p_\mathrm{G}$.

[4] In our model agencies do not price discriminate. Rating agencies do not charge different prices according to issuers' types, but rather according to the size of their issues (assumed fixed in the model), or the "complexity" of the securities they have to rate. Ac-

Lastly, risk-neutral competitive investors buy the assets in the market; they can buy only rated assets[5] from the issuers.

2.2 Sequencing and Equilibrium

Agents play an extensive game of incomplete information in four rounds. In the first round the α issuers with the enhancement option decide whether to take advantage of it; they decide whether to invest c and increase their assets' value to v_G. Call the proportion of issuers who do in fact invest, and hence the proportion of good assets in the economy, $\iota \leq \alpha$. In the second round all agencies a simultaneously choose fee-quality pairs (q_a, φ_a). In the third round all issuers simultaneously choose either to stay out of the market or to sell their assets after employing a credit rating agency a for a fee φ_a who awards them a rating according to the disclosure rule implied by her quality. Finally, in the fourth round, investors observe the ratings and the quality of the agencies awarding them, but not the issuers' types directly, and buy the assets from the issuers.

Our stage-game equilibrium is characterised by an action profile (q, φ) for the agencies, a strategy profile s for the issuers, and beliefs μ for the investors. The only heterogeneity of information is between issuers and investors. In the last round, investors infer what they can about the value of an issuer's asset—seen as the random variable $\tilde{v}$ realising in $\{v_B, v_G\}$—from its rating, and the fee and quality of the agency who published it. The average value of an asset given the investments in round one is $\bar{v} := \iota v_G + (1 - \iota)v_B$.

Since players act anticipating future moves, we solve the model backwards.

Investors set prices so that their expected zero-profit condition binds; these prices constitute the revenue that accrues to issuers from selling their assets.

In the third round, issuers observe the fees and qualities of the

cording to Fridson (1999) Moody's and S&P have the following prices: 3.25 basis points on issues up to \$500 million, with a minimum fee of \$25,000 and a maximum fee of \$125,000 (S&P) and \$130,000 (Moody's) with an additional 2% for issues bigger than \$500 million. Fitch's fee structure is similar to the other two agencies', but its fees are slightly lower.

[5]A few motivations for this assumption: firstly, we are modelling the rating of tranches which cannot be issued without a rating; secondly, we can think of investors as pension funds, savings institutions, or insurance companies that are limited in their investment by regulation, as stated in the introduction.

agencies. They infer the price their assets would recieve in the marketplace conditionally on their choice of agency. If they enter the market, they choose the agency that will maximize their profits. Their profits are the price they receive from investors less the fee they pay to the agency they employ and the possible cost they have incurred from value enhancement.

Each agency charges the same fee to all her costumers and has zero operating costs. In the second round, she chooses her quality and the fee to maximise her profits, which amount to the fee she charges times the number of issuers who employ her[6]. Finally, in the first round, issuers anticipate the behaviour of the other players and decide whether to invest and enhance their assets' quality.

3 The Static Model: Competition cures all

3.1 Benchmark

Before studying the behaviour of the agencies, we note that in the economy without an intermediary, no investor has the ability to discern issuers' asset values. Thus they all offer the average value $\bar{v} - I$. However, since no issuer can distinguish himself and each is infinitesimally small, he will sell his asset for exactly $\bar{v} - I$ whether or not he invests, that is to say his payoffs are

$$\begin{cases} \bar{v} - I - c & \text{if invests,} \\ \bar{v} - I & \text{if doesn't invest,} \end{cases}$$

therefore, à la prisoners' dilemma, it is a dominant strategy in round one for all firms to issue low quality assets, and the average quality in the economy is $\bar{v} - I = \iota v_{\mathrm{G}} + (1-\iota)v_{\mathrm{B}} - I = v_{\mathrm{B}} - I$ since $\iota = 0$.

Due to the assumption that investors cannot themselves determine the value of assets, the equilibrium in the benchmark is informationally inefficient. More importantly, the informational inefficiency leads to allocational inefficiency in the sense that issuers decide not to make positive NPV investments. The sequel explores whether the introduction of credit rating agencies into this framework can mitigate these inefficiencies.

[6] This characterisation of agency's profits is an important driver of our results: fees are continuous whereas the number of issuers employing the agency jumps.

3.2 Monopoly

Our analysis begins with the examination of an economy in which there is a single rating agency. Our first significant result says that a monopolistic agency will always rate uninformatively and, further, that her behaviour leads to no investment in value-enhancement. The allocation is informationally inefficient as in the benchmark.

Here the issuers' decision is either to employ the monopolist or to stay out of the market. If the agency is honest then she reveals assets' values and the market prices all issues fairly. She will either service the whole market at the highest price she can without forcing anyone out—that is, she will make the bad issuers indifferent between entering and staying out—or she will accept a smaller market share for a higher price—in fact, she will set her fees so high that the bad issuers will not enter and the good issuers' participation constraint will bind.

If instead she is lax, then she pools issuers on the common rating R_{G} and investors can make no inference about asset values. Thus, the market gives all assets the same price, equal to which the agency sets her fee.

Naturally the agency picks the quality that yields her higher profit given the optimal fee structure.

Proposition 3.1.

(i) A monopolistic agency always systemically overrates ($q_a = L$).

(ii) No issuer invests in quality enhancement ($\iota = 0$).

Corollary 3.1. *A monopolistic agency makes profit $\bar{v} - I = v_B - I$ and all issuers make zero profits.*

Proof. The proof of proposition 3.1 makes heavy use of figure 3.2, which gives a graphical representation of the monopolist's demand as a function of her fees. Thus her profits are just the areas under the functions depicted. Recall that the agency's profits depend directly on the fee that she uniformly charges issuers and indirectly on the number of issuers that employ her.

The top graph shows the honest monopolist's profits and the bottom figure shows the lax monopolist's profits.

The honest monopolist faces a trade-off: by setting high fees, between $v_{\mathrm{B}} - I$ and $v_{\mathrm{G}} - I$, the number of issuers that employ her decreases (she forces the bad issuers out of the market and only $(1 - \iota)$

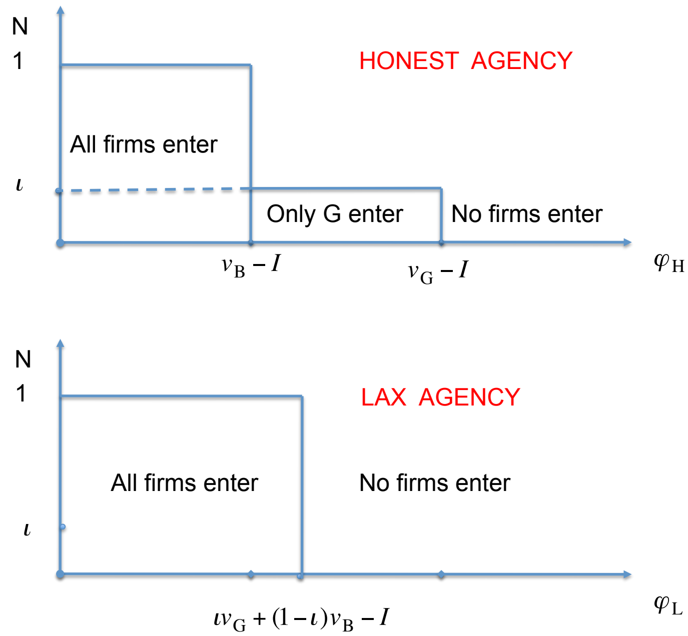

Figure 1: Monopoly

issuers employ her), whereas by setting her fees below $v_B - I$ she allows all issuers to participate but she makes less money from each issuer. An honest monopolist's fee choice is

$$\varphi_a = \begin{cases} v_B - I & \text{if } v_B - I > \iota\,(v_G - I) \\ v_G - I & \text{otherwise.} \end{cases} \tag{1}$$

The lax monopolist does not face this trade-off; investors that observe the high rating published by the lax agency are willing to buy any asset at the average price. The lax agency, anticipating this, will set fees that extract all of the issuers' revenues. A lax monopolist's optimal fee is $\varphi_a = \bar{v} - I$ and her profits always exceed the honest agency's. In fact:

$$\bar{v} - I \geq \max(\iota(v_G - I), v_B - I), \tag{2}$$

which proves proposition 3.1(i).

To conclude the proof, observe that given that issuers will be rated by a lax monopolist, none invests in quality enhancement: if a fixed fraction of the α issuers with the enhancement opportunity invest in enhancement, then an (infinitesimally small) issuer's payoff is

$$\begin{cases} \bar{v} - I - c - \varphi_a & \text{if invests,} \\ \bar{v} - I - \varphi_a & \text{if doesn't invest.} \end{cases} \tag{3}$$

Thus, exactly as in the benchmark, no issuer invests in quality enhancement.

In fact, if the issuer invested in quality enhancement he would obtain a negative profit: the agency would reap all the benefits of the quality enhancement and the issuer would pay the additional cost c of enhancing the quality. By not investing in quality enhancement all issuers' projects are worth v_{B} and the agency's profit is $v_{\mathrm{B}} - I$. $\square$

Critically, while the agency can commit to her disclosure rule, she cannot commit to it until after the issuers have already decided whether to invest in quality enhancement. If she were able to commit to be honest at a reasonable fee before the investment decision, she could in fact make more money whenever $\alpha(v_{\mathrm{G}} - I - c) > v_{\mathrm{B}} - I$. Thus the equilibrium is not only informationally inefficient and allocationally inefficient as in the benchmark, but may be inefficient from the point of view of the agency as well, in the sense that she charges lower fees and makes lower profits than she would could she commit to her actions before issuers decided whether to invest.

Lizzeri (1999) omits the investment in quality enhancement but then shows the stronger result that out of all possible disclosure rules a monopolist will be completely lax even when issuers can sell directly to the market. Later, Albano and Lizzeri (2001) consider a much more general problem of costly quality enhancement with commitment, where the inefficiency we document is typically mitigated.

Given proposition 3.1, rating agencies have no economic function. The subsequent sections show, however, that an informational intermediary paid by the issuers can indeed achieve both informational and allocational efficiency in the economy.

3.3 Duopoly

We have just shown how having only one rating agency in the economy can be harmful: she ends up being lax and issuing ratings that are uninformative and inaccurate, and in so doing she causes underinvestment.

We now ask whether introducing competition between rating agencies can mitigate these problems.

Although our results will seem very similar to the Betrand class of results, our setting is very different. While agencies compete on fees à la Betrand, they also have another important dimension of competition, quality[7]. Intuitively, if agencies are offering perfect substitutes (they restrict to the same disclosure rule) then they are trapped in the Betrand setting and make no profit; thus, you would suspect that agencies will differentiate their qualities in equilibrium. The main result of this section shows that this intuition is wrong.

Proposition 3.2.

(i) Duopolists competing perfectly on price are always honest and they rate for free.

(ii) All α issuers invest in the duopolistic stage game.

Corollary 3.2. *Agencies make zero profits and all issues are fairly priced.*

We will prove the proposition with three lemmata and with the help of figure 3.3.[8] The first lemma characterises an equilibrium and

[7]Since the agencies observe the issuers' type costlessly, there is no place for quantity competition in the model. However, rating practices in the real world do in fact reflect quantity constraints. Commentators have speculated that in the boom of structured products starting around 2005, rating agencies lacked the resources to handle the demand for rating and shifted their business toward complex securities, since they brought in more fees than corporate bonds. Kreps and Scheinkman (1983) tell us that if such quantity constraints are fixed, then Cournot competition may be the appropriate analytical tool. The assumptions of our model do not allow for such quantity constraints, reflecting our opinion that agencies' real asset is their technological and legal ability to learn asset's types, not an inelastic amount of manpower that restricts the number of firms they can rate.

[8]Figure 3.3 depicts the equilibrium behaviour of the issuers as a function of the duopolistic agencies' fee, given that one agency is lax and the other honest. The lax agency's fee is on the horizontal axis and the honest agency's fee is on the vertical axis. The labels should be self-explanatory. In the "Pooling on lax" region, all the issuers frequent the lax agency and the honest agency has no market share; in the "Separating" region all the good issuers frequent the honest agency and all the bad issuers frequent the lax agency; and so on. Point A is there to represent a conjectured equilibrium point and the arrows moving to the north-east from it are agencies' profitable deviations as described in the proof of lemma 3.3.

Lastly, note that this picture represents the issuer behaviour given the most extreme it asserts that it is the only one in which both agencies are honest; the other two show that this equilibrium is unique.

Lemma 3.1. *The only equilibrium in which both agencies are honest involves both agencies charging fees equal to zero.*

Sketch of proof. If there is an equilibrium when both agencies are honest, it must be one in which they both offer zero fees—we are in Bertrand's set-up, with marginal costs equal to zero. This is indeed an equilibrium outcome, since no agency has an incentive to become lax. In fact, if an agency deviates to lax she cannot get any market share with a positive fee: all good issuers would strictly prefer to employ the honest agency for zero fees, the bad issuers would then be revealed to be bad by frequenting the lax agency[9], and hence would themselves rather frequent the honest one for zero fees. □

Lemma 3.2. *There is no equilibrium in which both agencies are lax.*

Sketch of proof. For the same reason as above, if there is an equilibrium in which both agencies are lax, it must be one in which they both offer zero fees. But this cannot be an equilibrium: one of the agencies can indeed deviate to being honest and charge a small positive fee (less than Δv), and capture all the good issuers in the market. □

Lemma 3.3. *There is no equilibrium in which agencies offer differentiated services.*

Sketch of proof. That this equilibrium does not exist is not obvious and the proof is by exhaustion (details in Appendix 3). In figure 3.3 we have drawn the exhaustive set of separating regions as a function of the fees; here we show only that there is no equilibrium in what we call the "Separating region", in which good issuers go to the honest agency and bad issuers go to the lax agency. This class of equilibria is the most difficult to eliminate. Observe that for any point in this region other than that in which the lax agency charges $v_{\mathrm{B}} - I$ and the honest $v_{\mathrm{G}} - I$ there is another pair of fees maintaining separation—so that both agencies have the same market shares—but such that at

out-of-equilibrium beliefs for the investors: if no one is frequenting the lax agency then the market believes an asset would be worth v_{B} were an issuer to deviate and employ her. So long as the out-of-equilibrium beliefs are independent of the fees then similar pictures correspond to identical proofs for other market beliefs.

[9] For reasonable out-of-equilibrium beliefs.

least one agency has higher profit as a result of fee increases; namely there is always a profitable deviation[10]. Thus the only candidate for a pair of fees inducing separation is $(v_{\mathrm{B}} - I, v_{\mathrm{G}} - I)$ for the lax and honest agencies respectively. But this point is also not an equilibrium, since for a small decrease in her fees the lax agency can capture the whole market: if the honest agency is charging $v_{\mathrm{G}} - I$ and the lax agency charges $\varphi < v_{\mathrm{B}} - I$ all issuers frequent her. Thus there is no equilibrium in the separating region. □

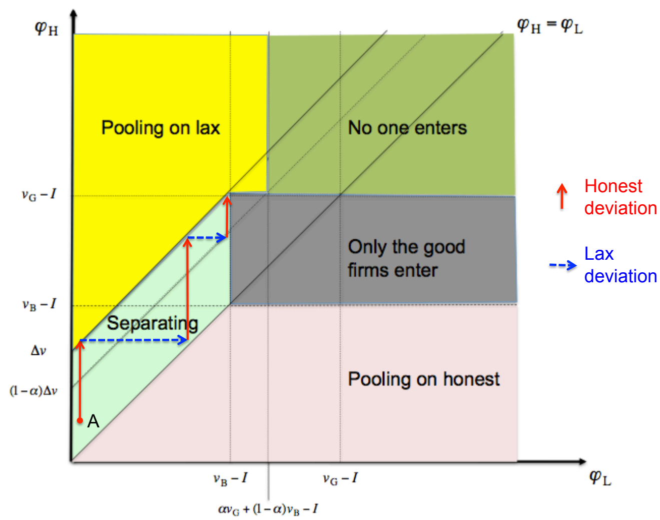

Figure 2: Duopoly

Proof of proposition 3.1(i). An immediate consequence of the three lemmata above.

Proof of proposition 3.1(ii). Since, in equilibrium the agencies allow good issuers to distinguish themselves from bad issuers at no cost (the fees are zero), the payoff of an issuer with the option to enhance quality is

$$\begin{cases} v_{\mathrm{G}} - I - c & \text{if invests,} \\ v_{\mathrm{B}} - I & \text{if doesn't invest} \end{cases}$$

[10]We have explicitly shown profitable deviations starting from a point A in the Separating region.

So $v_{\mathrm{G}} - c > v_{\mathrm{B}}$ since $\Delta v > c$ by assumption and all issuers now have a dominant strategy to invest in quality enhancement. $\square$

Now, in addition to being informative and accurate, ratings are also free! Since agencies make zero profits and perfectly differentiate the good from the bad assets, the issuers reap all the benefits of enhancing the quality of their projects. Accordingly, all α issuers invest and the equilibrium is both allocationally and informationally efficient.

This set-up seems close to reality: there is an oligopolistic market of rating agencies whose main features can be captured by a duopoly in which issuers pay a fixed fee to be rated. But why then were rating agencies being accused of overrating during the crisis? What is the missing element in our story? Time. Up to now we have modelled rating agencies interacting only once, whereas in reality rating agencies interact repeatedly over time.

The next section illuminates that, just as in Bertrand price competition, repeated interaction between informational intermediaries changes everything.

4 The Dynamic Model: The Costs of collusion

We now extend the setup dynamically. The stage game described above constitutes a single period in the dynamic model. In each period new issuers sell assets. The intertemporal interaction is thus only between the agencies; ratings updates and long-term relationships between issuers and agencies are left out. All payoffs are as above, except the agencies have a common discount factor $\delta < 1$ representing the relative value of time between interactions. If interactions are frequent—the time between repetitions of the stage game is low—typically δ is close to unity.

The explicit structure of the repeated game is as follows: the duopolistic agencies compete in each period for an issue from a new continuum of issuers. The stage game above repeats infinitely many times. We view issuers and investors as acting only once each.

Since both agencies' being honest and rating gratis is the unique equilibrium of the stage game, playing $(q_a, \varphi_a) = (\mathrm{H}, 0)$ forever constitutes a "grim-trigger" strategy—delivering the minimax payoff of zero—for both agencies. Given the severity of the available punishment, the price-quality set-up supports collusion on the monopoly action exactly as in Bertrand competition; note, however, that here the punishment and deviation phases may involve employing a different disclosure rule than the one in the cooperation phase.

As usual in repeated games, there is a great multiplicity of equilibria. We focus on the most natural ones, namely the symmetric, stationary, Pareto-dominant equilibria, where this last criterion is defined in the inter-agency game and amounts simply to assuming that the agencies' collusion occurs only on outcomes that maximize the per-period joint surplus—a rather natural assumption in a cooperative environment[11].

The propositions below characterize such equilibria, asserting that whenever $\delta > \frac{1}{2}$, agencies collude; again, this is the relevant case, since typically we imagine δ to be much closer to one than to a half.

Proposition 4.1. *Whenever $\delta \geq \frac{1}{2}$*

(i) if $\alpha(v_{\mathrm{G}} - I - c) > v_{\mathrm{B}} - I$, there is a unique Pareto dominant stationary symmetric equilibrium allocation, $\big(\mathrm{H}, v_{\mathrm{G}} - I - c\big)$ for each agency, in each period where all α issuers invest;

(ii) if $\alpha(v_{\mathrm{G}} - I - c) < v_{\mathrm{B}} - I$ there are two Pareto dominant stationary symmetric equilibrium allocations:

- *$\big(\mathrm{H}, v_{\mathrm{B}} - I\big)$ for each agency in each period where all α issuers invest,*
- *$\big(\mathrm{L}, v_{\mathrm{B}} - I\big)$ for each agency in each period where no issuers invest.*

Proof. If

$$\iota(v_{\mathrm{G}} - I - c) > v_{\mathrm{B}} - I, \tag{4}$$

the equilibrium allocation $\big(\mathrm{H}, v_{\mathrm{G}} - I - c\big)$ Pareto dominates any other symmetric allocation in the stage game. To show that this is an equilibrium allocation for $\delta \geq \frac{1}{2}$ we employ a standard "grim-trigger" strategy construction. Consider the strategies in which each agency plays $\big(\mathrm{H}, v_{\mathrm{G}} - I - c\big)$ if she has not observed an action other than $\big(\mathrm{H}, v_{\mathrm{G}} - I - c\big)$ and otherwise she plays $(\mathrm{H}, 0)$. The entering issuers

[11]Note that we don't require Pareto efficiency off the equilibrium path, so that harsh punishments are still allowed. The idea of Pareto dominance is that if the agencies coordinate they will coordinate on an allocation that they cannot mutually improve upon. On the other hand, if cooperation breaks down, of course no such restriction is appropriate.

are indifferent as to which agency to frequent and hence randomise fifty-fifty between them.

It suffices to check that colluding is a best response following any history of collusion:

$$\frac{1}{2}\sum_{t=0}^{\infty}\delta^t\iota(v_{\mathrm{G}}-I-c)\geq\sup\{\alpha\varphi_a\ :\ \varphi_a<v_{\mathrm{G}}-I-c\}\tag{5}$$

or

$$\frac{\iota}{2(1-\delta)}(v_{\mathrm{G}}-I-c)\geq\sup\{\alpha\varphi_a\ :\ \varphi_a<v_{\mathrm{G}}-I-c\}\tag{6}$$

which holds whenever $\delta\geq\frac{1}{2}$. If the agency colludes she gets half of $\iota(v_{\mathrm{G}}-I-c)$ profits in each period, whereas if she deviates, she gets the monopoly profits. Her most profitable deviation for the agency is to be honest, charge a slightly lower fee and service all the good issuers, since equation 4 holds.

If agencies collude on $\big(\mathrm{H},v_{\mathrm{G}}-I-c\big)$, issuers anticipate agencies' honesty and are indifferent between investing in quality enhancement and staying out of the market. In fact, the payoff of an issuer with the option to enhance quality is

$$\begin{cases}v_{\mathrm{G}}-I-c-\varphi_a=0 & \text{if invests,}\\ 0 & \text{if doesn't invest.}\end{cases}$$

They invest as per their tie-breaking rule and $\iota=\alpha$.

The proof of proposition 6 *(ii)* is similar. Just note that the grim-trigger strategies constitute the same punishment and that the most profitable single-period deviation for the agency is to be honest and charge slightly less then $v_{\mathrm{B}}-I$, in both equilibria. □

When Δv is very large or many issuers have the opportunity to enhance their assets, proposition 4.1 suggests that overrating is not a problem in the economy, but when $\alpha(v_{\mathrm{G}}-I-c)<v_{\mathrm{B}}-I$ the proposition does not deliver a clear prediction. The equilibrium in which agencies collude on the lax disclosure rule and charge $v_{\mathrm{B}}-I$ is both informationally and allocationally inefficient, while that in which they collude on honest is socially ideal, restoring efficiency completely. Unfortunately, it is the less plausible equilibrium here. Given the omitted due diligence costs, in reality it is likely that collusion on lax in fact yields a higher payoff. Hence we fixed the tie-breaking rule

toward lax and the Pareto-dominance criterion selects the $(\mathrm{L}, v_{\mathrm{B}} - I)$ allocation. It is further the more natural equilibrium because it consists of behaving like a monopolist in each period and halving the profits. Finally, regardless of equilibrium selection, it is important for a policy maker to focus on breaking down collusion on uninformative rating, so we devote attention to the inefficient equilibrium allocations above. The next proposition demonstrates magnitude of the social costs to agencies colluding.

Proposition 4.2. *Both* $\left(\mathrm{L}, v_{\mathrm{B}} - I\right)$ *and* $\left(\mathrm{H}, v_{\mathrm{G}} - I - c\right)$ *induce a deadweight loss—equal to*

(i) $\alpha \Delta v - c$ *for collusion on lax;*

(ii) $(1-\alpha)(v_{\mathrm{B}} - I)$ *for collusion on honest.*

Restricting attention to the two more plausible equilibria of Proposition 4.1 we notice that agencies' collusion always imposes a substantial social cost, even if agencies cooperate in such a way that they fully disclose all information, because they set fees so high as to stop positive NPV projects from receiving funding, as in Proposition 4.2. Otherwise, as above, they collude on uninformative ratings and prevent issuers from investing.

When few firms have the possibility of producing good assets, agencies prefer the uninformative disclosure rule, suggesting that agencies inflated the ratings of complex securities during the crisis because most of the issuers were holding only low quality assets, and few had the opportunity of producing legitimately triple-A securities.

Interestingly, collusion relies on agencies' being impatient. Following a financial meltdown in which the financial industries' perennially short-termist view has been condemned and even blamed for the disaster, our model suggests that impatience is our only hope to restore efficiency[12].

A policy maker should avoid the deadweight losses of proposition 4.2 by aiming to break down collusion. The next section demonstrates that appropriate fee regulation can make agencies act as if they are less patient and prevent collusion, and then outlines a very different potential policy that would relieve the problem: that of making the rating agencies get into the business of insuring financial products.

[12] Thanks to Amil Dasgupta for pointing this out.

5 Policies

Our initial focus was on potential for strategic (and transparent) overrating by credit rating agencies, for which our set-up holds tacit collusion culpable. When many issuers have the opportunity to produce high-quaility assets, overrating is less likely, but a fraction of issuers with positive NPV assets may in fact be kept out of the market due to prohibitively high fees.

Motivated by the desire to keep fees down to prevent such agency opportunism, we study the effects of fee regulation on rating behaviour. In what is (due to regulatory importance) a government imposed oligopoly, it seemed natural to consider imposing a maximum fee level (cap) on what agencies can charge. But because the cap does not affect the agencies' ability to punish each other, it does nothing to break down collusion.

On the other hand, putting a lower limit (floor) on agencies fees necessarily restricts the range of discount factors for which collusion arises at equilibrium, and if it is large enough it can ensure that there is no collusion.

Lastly we examine a very different policy, motivated by the regulatory stir focusing on limiting the scope of financial institutions. Unfortunately, if the scope of the agencies' business is limited to credit rating, they will never have any skin in the bigger economic game. Thus we suggest that rating agencies themselves enter the insurance market and bundle their soft product (information) with a hard product (credit default insurance). In our model this policy incentivizes agencies to produce accurate ratings even in a monopolistic market.

5.1 Fee regulation

The results below summarize the effects of fee regulation via simple caps and floors. Caps are ineffective but high floors can prevent collusion entirely.

Lemma 5.1. *With caps the equilibrium of the stage game is unchanged:* $(\mathrm{H}, 0)$ *is the unique equilibrium allocation of the stage game between the agencies.*

Sketch of proof. Since there were no profitable deviations from $\big((\mathrm{H}, 0), (\mathrm{H}, 0)\big)$ to a higher fee the equilibrium is unaffected.

The proof that this equilibrium remains unique is not obvious, because it greatly changes the subgame in differentiated qualities and the proof of lemma 3.3 is no longer valid—perhaps now if the honest agency charges his maximum fee and the lax agency best responds with $\varphi = v_{\mathrm{B}} - I$, this is the new Pareto dominant point in the separating region of figure 3.3? But, whether or not this be an equilibrium of the subgame, the lax agency always prefers to adopt the honest disclosure rule and undercut the other's price slightly, servicing the whole market. □

Corollary 5.1. *Regardless of the maximum fee, collusion on lax is supported for the same set of discount factors as it is in the repeated game without caps.*

Sketch of proof. Since the cap does not affect the punishment that one agency can impose on the deviant—namely playing (H,0) forever if the other deviates—then the Pareto dominant symmetric collusive equilibrium is achieved for the same set of discount factors as in proposition 4.2 ($\delta \geq 1/2$). □

The cap on the fee achieves only a reallocation of resources from agencies to firms by limiting the profits the agencies can achieve, but it does not break down collusion. Note, that this policy might actually eliminate the equilibrium in which both agencies are honest and charge $\alpha\bar{\varphi}_a$, where $\bar{\varphi}_a$ is the capped fee, if the caps on the fees are too low. In this case the unique Pareto dominant symmetric equilibrium would be the one in which both agencies are lax and charge $v_{\mathrm{B}} - I$ and no firm invests in quality enhancement.

Lemma 5.2. *With fees floored at $\underline{\varphi} \in (0, v_{\mathrm{B}} - I]$, $((H, \underline{\varphi})(H, \underline{\varphi}))$ is the unique equilibrium of the stage game.*

Lemma 5.3. *With fees floored at $\underline{\varphi} \in (0, v_{\mathrm{B}} - I]$, collusion on lax is supported only for*

$$\delta \geq \frac{1}{2 - \underline{\varphi}/(v_B - I)} > \frac{1}{2}.$$

Proof. The most severe punishment is now $(\mathrm{H}, \underline{\varphi})$ forever. Thus an agency does not deviate from collusion so long as

$$\frac{1}{2}\sum_{t=0}^{\infty}(v_{\mathrm{B}} - I) \geq v_{\mathrm{B}} - I + \frac{1}{2}\sum_{t=1}^{\infty}\underline{\varphi}$$

or

$$\frac{1}{2} \cdot \frac{v_{\mathrm{B}} - I}{1 - \delta} \geq v_{\mathrm{B}} - I + \frac{\delta\underline{\varphi}}{2(1 - \delta)},$$

manipulation of which yields the desired inequality. □

Corollary 5.2. *Floored fees with* $\underline{\varphi} > 0$ *always eliminate collusion among some agencies, for* $\underline{\varphi} = v_{\mathrm{B}} - I$ *we always break collusion on lax.*

5.2 Insurance

With the recent passing of the Dodd–Frank Bill in the US, which increases regulation of the financial industry and limits the scope of financial institutions (like the notorious big dealer banks largely held culpable in the press for the spreading of the subprime crisis into a global financial meltdown), we look at a solution to overrating that goes against these restrictions. The Bill is in ways analogous to the Glass–Steagall Act of 1932, passed as part of FDR's New Deal in response to the Great Depression and curbing the expansion of banks along with much else. Likewise after the Great Recession the State feels again inclined to intervene. Almost fifty years later, though, the benefits to deregulation seemed to outweigh those of state control—Cold War politics notwithstanding, and in 1980 much of the Act was repealed and, they say, the casino (i.e. the investment wing of the financial services industry) was back in the post office (retail and commercial banking). This deregulation did allow for the system to become both exceedingly complex and incredibly interconnected, both guilty-looking characteristics post-2008. However, perhaps this open scope would also allow for more innovative regulation, as we now suggest.

Enabling the rating agencies to issue CDS-style default insurance solves the problem of systematic overrating entirely via the innovative policy that when an agency awards a rating it must couple it with a supply of CDS. In our model the prescription goes as follows. The rating R_{G} corresponds to the default probability of $1 - v_{\mathrm{G}}$ where we suppose that the firms' projects are random variables $\tilde{X}_\theta \in \{0, 1\}$ for $\theta \in \{G, B\}$ so that $\mathbb{P}\left[\tilde{X}_{\mathrm{G}} = 1\right] = v_{\mathrm{G}}$ and similarly $\mathbb{P}\left[\tilde{X}_{\mathrm{B}} = 1\right] = v_{\mathrm{B}}$.

Suppose now that an agency is legislated to issue a security

$$\mathrm{CDS}(\tilde{X}_\theta) = \begin{cases} 1 & \text{if } \tilde{X}_\theta = 0, \\ 0 & \text{otherwise,} \end{cases} \tag{7}$$

and price it *actuarially fairly with respect to its rating* $R \in \{R_{\mathrm{G}}, R_{\mathrm{B}}\}$

so that the agency sets the price

$$p_{\text{CDS}}(R) = \begin{cases} 1 - v_{\text{G}} & \text{if } R = R_{\text{G}}, \\ 1 - v_{\text{B}} & \text{if } R = R_{\text{B}}. \end{cases} \tag{8}$$

Now observe that if a monopolist is lax it sets $\bar{v} - I = \iota v_{\text{G}} + (1 - \iota)v_{\text{B}} - I$ and everyone enters. Then the value of the default insurance on any firm is $1 - \bar{v}$, but since all firms are rated R_{G} the price the agency is legislated to charge for it is $p_{\text{CDS}}(R_{\text{G}}) = 1 - v_{\text{G}} \leq 1 - \bar{v}$ and since investors are risk neutral their demand for the insurance will be infinite. Since the lax monopolist is selling them at a loss it will go bust.

Thus with the insurance bundling a monopolistic agency must be honest. Now firms anticipate the monopolist's honesty and invest.

This stylized prescription finds a way of getting the raters to have some skin in the game, in general a big problem for informational markets, since it is impossible to incentivize them based on the ex post accuracy of their ratings. It creates both informational and allocational efficiency

In reality the big criticisms of the story should be that it depends firstly on the independence of the defaults, secondly on the risk-neutrality of the market, and finally on the agencies' inability to hedge their positions. Of these the first is the real killer, making the policy impossible to implement as is; however, it solves the problem in one fell swoop in the context of the model, suggesting that such "regulation by expanding scope and bundling" could be a useful tool and might make us question the wave of legislation restricting horizontal integration of finance firms.

6 Conclusion

Credit rating agencies have the ability to enhance both allocational and informational efficiency in the economy. While a monopolist is startlingly ineffective, simple competition between agencies drives prices down and shows that they have the potential to provide a valuable social service.

Absent appropriate regulation, they have a strong incentive to collude; typically collusion induces a substantial deadweight loss, either from preventing issuers from investing in worthwhile quality improvements by making it impossible for issuers to differentiate themselves, or by setting fees prohibitively high for some issuers with positive NPV projects.

Rating agencies' behaviour can foment business cycles. They are honest when the economy is on the rise and investment opportunities are abundant; it is thus worthwhile for firms to enhance their projects. At the height of a boom, when firms' have few good potential investments, agencies change their disclosure rules and are lax. The policy feeds back into the real economy as firms, unable to differentiate themselves, stop investing.

Regulators can prevent collusion by implementing either appropriate fee regulation or forcing agencies to issue fairly priced credit default insurance according to their own ratings.

We have not from modelled collusion between rating agencies and issuers, but concentrated only on collusion among rating agencies. Further, we restricted our attention to perfect disclosure rules. We believe that both agency-issuer collusion and noisy disclosure would be interesting extensions in this set-up.

A Appendix

To make our proofs complete unfortunately requires a good deal of cumbersome notation. In the appendix we first write down the game more mathematically and then proceed to formalize the proofs of the main propositions. Realize that they are so lengthy because the uniqueness results depend on examining numerous cases; if the proofs are essentially identical across cases we may omit the simpler ones.

A.1 Formalized game

The quality choice of the rating agency ($q_a \in \{\mathrm{H}, \mathrm{L}\}$) can be viewed as the selection of a "rating function" from the set $\{r_\mathrm{L}, r_\mathrm{H}\}$ where

$$\begin{cases} r_\mathrm{H}(v_\mathrm{G}) = R_\mathrm{G}, \\ r_\mathrm{H}(v_\mathrm{B}) = R_\mathrm{B}, \end{cases} \tag{9}$$

if the agency is honest and

$$\begin{cases} r_\mathrm{L}(v_\mathrm{G}) = R_\mathrm{G}, \\ r_\mathrm{L}(v_\mathrm{B}) = R_\mathrm{G}, \end{cases} \tag{10}$$

if she is lax, namely if she systematically overrates. Each a charges a fee φ_a uniformly for its service.

In the last round of the stage-game, investors price the assets according to their zero-profit condition. The price is:

$$P_{(\mu,s)}(a, R) = \mathbb{E}_\mu \left[\tilde{v} \,\middle|\, r_{q_a}(\tilde{v}) = R,\, s_{(q,\varphi)}(\tilde{v}) = a \right] - I, \tag{11}$$

where s denotes the issuers' strategy profile, (q, φ) is short-hand for the action profile $\{(q_a, \varphi_a)\}_a$ of the agencies, μ indicates investors' possible "out of equilibrium beliefs" and $R \in \{R_\mathrm{G}, R_\mathrm{B}\}$.

All ingredients in equation (11) in the expectation functional are essential since investors ultimately will play a perfect Bayesian equilibrium.

In the third round of the stage game each issuer maximises his profits over the set of agencies (his action space is the set of all agencies and staying out of the market, which we call $\varnothing$) given their fees and qualities:

$$s_{(q,\varphi)}(v) \in \arg\max_a \left\{ P_{(\mu,s)}\big(a, r_{q_a}(v)\big) - \varphi_a \right\}.$$

Each agency charges the same fee (φ_a) to all her costumers and has zero operating costs; anticipating the actions of the issuers and the investors, an agency chooses (q_a, φ_a) to maximise profits:

$$U(N, \varphi_a) = N\varphi_a, \tag{12}$$

where $N = n_a(q, \varphi; s)$ is the number of issuers who employ the agency,

$$n_a(q, \varphi; s) := \iota \mathbf{1}_{s^{-1}_{(q,\varphi)}(a)}(v_{\mathrm{G}}) + (1-\iota)\mathbf{1}_{s^{-1}_{(q,\varphi)}(a)}(v_{\mathrm{B}}),$$

and ι is the proportion of α issuers who invest in quality enhancement. This formula requires a word of explanation. While the notation is complicated, it should be read very simply. It says that the number of issuers frequenting a is ι if only good issuers go to her, $1-\iota$ if only bad issuers go to her, and unity if good and bad issuers go to her

Given the strategy profile of issuers the agencies play a Nash equilibrium in q_a and φ_a.

A.2 Monopoly proofs

Proposition A.1. *A monopolistic agency always systemically overrates.*

Proof. In order to solve the game backwards we partition the round two subgames into six generic classes:

(1) $q = L$ and $\varphi < v_{\mathrm{B}} - I$;

(2) $q = L$ and $\varphi \in (v_{\mathrm{B}} - I, \bar{v} - I)$;

(3) $q = L$ and $\varphi > \bar{v} - I$;

(4) $q = H$ and $\varphi < v_{\mathrm{B}} - I$;

(5) $q = H$ and $\varphi \in (v_{\mathrm{B}} - I, v_{\mathrm{G}} - I)$;

(6) $q = H$ and $\varphi > v_{\mathrm{G}} - I$,

where $\bar{v} := \iota v_{\mathrm{G}} + (1-\iota)v_{\mathrm{B}}$ is the average quality.

We find the following equilibrium outcomes in each of the six subgame classes:

(1) All issuers enter;

(2) All issuers enter;

(3) No issuer enters;

(4) All issuers enter;

(5) Only good issuers enter;

(6) No issuer enters.

All outcomes are unique except those of class (2) where they are unique up to a refinement imposed on the out-of-equilibrium beliefs. In this class there are two equilibrium outcomes: one in which all issuers enter and one in which none does. The latter requires that the market believes that all issuers that enter are below average quality: We assert that these beliefs are unreasonable. Our definition of reasonableness here is a refinement of the market's out-of-equilibrium beliefs. We eliminate a set of equilibria in which no issuers sell the assets because investors would perceive any issuer selling to be of the worst quality. Take any of the following three arguments to motivate this selection rule: (i) Selling the asset usually indicates issuers' having profitable projects and the market should not make negative inferences about them; (ii) here issuers' strategic interaction is limited to their effect on the market's beliefs, so if a bad issuer has incentive to enter so does a good one, thus such out-of-equilibrium beliefs are too extreme; (iii) last is the most conventional argument—simple payoff dominance—whereby we select the equilibrium in which both types enter since both the agency and the issuers strictly prefer the equilibrium in which they enter.

All proofs are wholly standard. We demonstrate explicitly for class (2), studying the reasonable equilibrium first and then showing that all other equilibria are unreasonable.

Employ the shorthand $s \equiv s_{(q,\varphi)}$—recalling that $q = \mathrm{L}$ and $\varphi \in (v_B - I, \bar{v} - I)$—to see that the strategy profile $s(v_{\mathrm{G}}) = s(v_{\mathrm{B}}) = a_{\mathrm{M}}$, where a_{M} denotes entering and employing the monopolist, is an equilibrium. Immediately:

$$\begin{aligned} P_s(a_{\mathrm{M}}, R_{\mathrm{G}}) &= \mathbb{E}\left[\tilde{v} \,\middle|\, r_{\mathrm{L}}(\tilde{v}) = R_{\mathrm{G}}, s(\tilde{v}) = a_{\mathrm{M}}\right] - I && (13)\\ &= \mathbb{E}\left[\tilde{v}\right] - I && (14)\\ &= \bar{v} - I, && (15) \end{aligned}$$

where the second equality results from neither of the conditioning variables containing any information—L rates everyone g and the issuers pool on "enter". Turning to the issuers' profits, observe

$$\Pi(a_{\mathrm{M}}, v, P_s(a_{\mathrm{M}}, R_{\mathrm{G}}), \varphi) = P_s(a_{\mathrm{M}}, R_{\mathrm{G}}) - \varphi \tag{16}$$
$$= \bar{v} - I - \varphi \tag{17}$$
$$> 0 \tag{18}$$
$$= \Pi(\varnothing, v, P_s(a_{\mathrm{M}}, R_{\mathrm{G}}), \varphi), \tag{19}$$

where the inequality comes from the restriction on the range of φ. The inequality above says that both good and bad issuers prefer to employ the monopolist than to stay out of the market, hence there is an equilibrium with pooling on entry.

Next observe that there is no equilibrium in which only the good issuers enter, namely $s(v_{\mathrm{G}}) = a_{\mathrm{M}}$ and $s(v_{\mathrm{B}}) = \varnothing$. Since the beliefs of the market are consistent with the strategies of the players, it deems all issuers who enter to be of good quality and

$$P_s(a_{\mathrm{M}}, R_{\mathrm{G}}) = v_{\mathrm{G}} - I. \tag{20}$$

Clearly the bad issuers have incentive to enter,

$$\Pi(a_{\mathrm{M}}, v_{\mathrm{B}}, P_s(a_{\mathrm{M}}, R_{\mathrm{G}}), \varphi) = v_{\mathrm{G}} - I - \varphi \tag{21}$$
$$> 0 \tag{22}$$
$$= \Pi(\varnothing, v_{\mathrm{B}}, P_s(a_{\mathrm{M}}, R_{\mathrm{G}}), \varphi), \tag{23}$$

i.e. the bad issuers prefer to enter and the strategy profile is not an equilibrium.

Exactly analogously you can show that there is no equilibrium in which only the bad issuers enter, namely $s(v_{\mathrm{G}}) = \varnothing$ and $s(v_{\mathrm{B}}) = a_{\mathrm{M}}$.

There are, however, perfect Bayesian equilibria of this subgame in which no issuers at all enter. Let $\mu(a_{\mathrm{M}})$ denote the probability that the market assigns to an issuer's being good if it frequents a_{M}. For any fixed φ, the out-of-equilibrium beliefs μ

$$\mu(a_{\mathrm{M}})v_{\mathrm{G}} + (1 - \mu(a_{\mathrm{M}}))v_{\mathrm{B}} - I < \varphi, \tag{24}$$

and strategies $s(v_{\mathrm{G}}) = s(v_{\mathrm{B}}) = \varnothing$ constitute an equilibrium. (If the inequality is reversed the beliefs cannot support an equilibrium.) This profile implies the price (never observed if no one enters)

$$P_{(\mu,s)}(a_{\mathrm{M}}, g) = \mu(a_{\mathrm{M}})v_{\mathrm{G}} + (1 - \mu(a_{\mathrm{M}}))v_{\mathrm{B}} - I. \tag{25}$$

The inequality (24) above implies that issuers' profits will be negative from entering, or $P - \varphi < 0$. As such (s, μ) is an equilibrium.

Notice firstly that this final equilibrium awards zero utility to the agency and to both types of issuers. Thus the pooling equilibrium on entering is strictly payoff dominant for all players.

You can find the equilibria in the other classes of subgames (1), (3), (4), (5), and (6) in a similar (although rather simpler) manner.

It remains to observe the monopolist's profits from choosing (q, φ).

(1) $N = 1$, $U(N, \varphi) = \varphi$;

(2) $N = 1$, $U(N, \varphi) = \varphi$;

(3) $N = 0$, $U(0, \varphi) = 0$;

(4) $N = 1$, $U(N, \varphi) = \varphi$;

(5) $N = \alpha$, $U(N, \varphi) = \iota\varphi$;

(6) $N = 0$, $U(N, \varphi) = 0$.

The agency will select (q, φ) to reach subgame (2) or (5) since she avoids regions (3) and (6) where she receives nothing and prefers region (2) to regions (1) and (4) since she has the same number of customers at a higher fee. It remains to compare the maximum profits she can attain by being lax—playing in region (2)—with the maximum she can attain by being honest—playing in region (5). In region (2) and region (5) respectively consider the maximal profits of the agency.

$$U^{(2)} := \sup\{\varphi \;;\; \varphi < \bar{v} - I\} = \bar{v} - I, \tag{26}$$

and in region (5)

$$U^{(5)} := \sup\{\alpha\varphi \;;\; \varphi \in (v_{\mathrm{B}} - I, v_{\mathrm{G}} - I)\} = \iota(v_{\mathrm{G}} - I). \tag{27}$$

Now, for any ι, v_{G}, and v_{B} $U^{(2)} > U^{(5)}$, in fact

$$U^{(2)} - U^{(5)} = (1 - \iota)(v_{\mathrm{B}} - I) > 0 \tag{28}$$

since all issuers have positive NPV projects or $v_{\mathrm{B}} > I$.

The agency plays into region (2) by choosing quality L. She systematically overrates. □

A.3 Duopoly proofs

Proof. Given agencies offer differentiated services, namely one is honest and the other lax, we proceed by considering the following exhaustive set of cases:

1. There is no equilibrium in which no issuers enter;
2. There is no equilibrium in which only bad issuers enter;
3. There is no equilibrium in which only good issuers enter;
4. There is no equilibrium in which issuers frequent only the honest agency;
5. There is no equilibrium in which issuers frequent only the lax agency;
6. There is no equilibrium in which good issuers frequent the lax agency and bad issuers frequent the honest one;
7. There is no equilibrium in which good issuers frequent the honest agency and bad issuers frequent the lax one.

Proof. The easiest way to prove lemma 3.1 is to look at figure 3.3.

We have drawn the regions in the figure for $\Delta v < v_{\mathrm{B}} - I$; in regions 1, 3 and 4 we need out-of-equilibrium beliefs for the case when issuers deviate and go to the lax agency. We have set this beliefs to be such that if you deviate you are believed to be bad. Regions 1, 3, and 4 would shift for different out-of-equilibrium beliefs, but the analysis would not change.

1. Empty region: No issuer enters;
2. Only-bad region: region in which only the bad issuers enter;
3. Only-good region: region in which only the good issuers enter;
4. Pooling on honest region;
5. Pooling on lax region;
6. Separating region: the good issuers go to the honest agency and the bad issuers go the lax agency.

We will show in detail how to derive only region 6—the fully separating region, where good issuers go to the honest agency and bad issuers go to the lax agency; a similar argument applies to the other regions.

In the fully separating region the belief of the investors are such that if the issuer goes to the honest agency she is good and if she goes to the lax agency she is bad. The strategies of the issuers in this region are such that $s(v_{\mathrm{G}}) = a_{\mathrm{D}}^{\mathrm{H}}$ and $s(v_{\mathrm{B}}) = a_{\mathrm{D}}^{\mathrm{L}}$ where $a_{\mathrm{D}}^{\mathrm{H}}$ denotes entering and employing the honest duopolist and $a_{\mathrm{D}}^{\mathrm{L}}$ denotes entering and employing the lax duopolist.

In this region the investors set the following prices

$$P_s(a_{\mathrm{D}}^{\mathrm{H}}, R_{\mathrm{G}}) = v_{\mathrm{G}} - I \tag{29}$$

and

$$P_s(a_{\mathrm{D}}^{\mathrm{L}}, R_{\mathrm{G}}) = v_{\mathrm{B}} - I \tag{30}$$

Fixing $(\varphi_{\mathrm{H}}, \varphi_{\mathrm{L}})$, the strategy of the good issuer is $s(v_{\mathrm{G}}) = a_{\mathrm{D}}^{\mathrm{H}}$ if:

$$\Pi(a_{\mathrm{D}}^{\mathrm{H}}, v_{\mathrm{G}}, P_s(a_{\mathrm{D}}^{\mathrm{H}}, R_{\mathrm{G}}), \varphi_{\mathrm{H}}) > \Pi(a_{\mathrm{D}}^{\mathrm{L}}, v_{\mathrm{G}}, P_s(a_{\mathrm{D}}^{\mathrm{L}}, R_{\mathrm{G}}), \varphi_{\mathrm{L}}) \Rightarrow \tag{31}$$

$$v_{\mathrm{G}} - I - \varphi_{\mathrm{H}} > v_{\mathrm{B}} - I - \varphi_{\mathrm{L}}. \tag{32}$$

and

$$\Pi(a_{\mathrm{D}}^{\mathrm{H}}, v_{\mathrm{G}}, P_s(a_{\mathrm{D}}^{\mathrm{H}}, R_{\mathrm{G}}), \varphi_{\mathrm{H}}) > \Pi(\varnothing, v_{\mathrm{G}}, P_s(a_{\mathrm{D}}^{\mathrm{H}}, R_{\mathrm{G}}), 0) \Rightarrow \tag{33}$$

$$v_{\mathrm{G}} - I - \varphi_{\mathrm{H}} > 0, \tag{34}$$

The strategy of the bad issuer is $s(v_{\mathrm{B}}) = a_{\mathrm{D}}^{\mathrm{L}}$ if:

$$\Pi(a_{\mathrm{D}}^{\mathrm{H}}, v_{\mathrm{B}}, P_s(a_{\mathrm{D}}^{\mathrm{H}}, R_{\mathrm{G}}), \varphi_{\mathrm{H}}) < \Pi(a_{\mathrm{D}}^{\mathrm{L}}, v_{\mathrm{B}}, P_s(a_{\mathrm{D}}^{\mathrm{L}}, R_{\mathrm{G}}), \varphi_{\mathrm{L}}) \Rightarrow \tag{35}$$

$$v_{\mathrm{B}} - I - \varphi_{\mathrm{H}} < v_{\mathrm{B}} - I - \varphi_{\mathrm{L}} \tag{36}$$

and

$$\Pi(a_{\mathrm{D}}^{\mathrm{H}}, v_{\mathrm{B}}, P_s(a_{\mathrm{D}}^{\mathrm{H}}, R_{\mathrm{G}}), \varphi_{\mathrm{H}}) > \Pi(\varnothing, v_{\mathrm{B}}, P_s(a_{\mathrm{D}}^{\mathrm{L}}, R_{\mathrm{G}}), 0) \Rightarrow \tag{37}$$

$$v_{\mathrm{B}} - I - \varphi_{\mathrm{L}} > 0 \tag{38}$$

From these equations we get the separating region that is delineated by the following equations:

$$\varphi_{\mathrm{H}} < \min\{\varphi_{\mathrm{L}} + \Delta v, v_{\mathrm{G}} - I\} \tag{39}$$

$$\varphi_{\mathrm{L}} < \min\{\varphi_{\mathrm{H}}, v_{\mathrm{B}} - I\} \tag{40}$$

Similarly, we find equations for the other regions.

Region 2, where only bad issuers enter, does not exist.

In some other regions there are multiple equilibria.

The graphs helps us to see that there is no pair $(\varphi_{\mathrm{H}}^*, \varphi_{\mathrm{L}}^*)$ that is a Nash equilibrium, namely that φ_{H}^* is a best response for the honest agency to φ_{L}^* and simultaneously likewise φ_{L}^* is a best response for the lax agency to φ_{H}^*. The only point in region 6 for which φ_{H} is a best response for the honest agency to φ_{L} and φ_{L} is a best response for the lax agency to φ_{H} in region 6 is the north-eastern most point (labelled A in figure 1) thus this is the only candidate for a Nash equilibrium in region 6, however it is not an equilibrium for the whole game because the lax issuers have an incentive to deviate to the left, capturing the whole market with a slightly lower fee. □

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