Models of Credit Ratings Failures

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Drawing on the recent theoretical literature on credit rating agencies (CRAs), we provide a simple model that nests the following frictions: conflicts of interest between CRAs and investors, regulatory reliance on ratings, investor naiveté and opacity in the rating process. These frictions cause ratings inflation and selective disclosure that distort the transmission of information from CRAs to investors, resulting in inefficient financing decisions. Rating-contingent regulation and investor naiveté exacerbate the conflicts of interest, but are neither necessary nor sufficient for the occurrence of inefficiencies. The model is used to discuss some of the regulatory response to the 2007-2009 financial crisis.

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1 Introduction

A striking feature of the 2007-2009 financial crisis is the poor performance of very highly-rated structured debt products. The value of AAA-rated mortgage-backed securities has fallen by 70 percent between January 2007 and December 2008 (Pagano and Volpin, 2010), suggesting a systematic misvaluation of risk in the initial ratings. Several recent empirical studies report evidence of "ratings inflation" for asset-backed securities (Benmelech and Dlugosz, 2009; Coval, Jurek and Stafford, 2009), and U.S. government inquiries concluded that inflated credit ratings contributed to the financial crisis by masking the true risk of many mortgage related securities.[1] Therefore, understanding the origins of these credit ratings failures is key to understanding the origin of the financial crisis and to informing the policy debate on financial market reform.

This paper draws on the recent theoretical literature on credit rating agencies (CRAs) and the phenomenon of ratings inflation. We provide a simple analytical framework that nests the main frictions singled out by this literature: conflicts of interest between CRAs and investors, regulatory reliance on ratings, investors' naiveté and lack of transparency in the rating process.

We consider a model in which firms of uncertain credit worthiness seek financing for their investment projects from investors. The premise of our analysis is that CRAs are information intermediaries with superior expertise in valuing credit risk. When effectively deployed, this expertise allows investors to make better financing decisions, increasing economic efficiency. For this to happen, however, credit ratings must efficiently transmit the CRA's information about issuers' credit worthiness. This paper illustrates how the above mentioned frictions impair such efficient transmission of information and result in a loss of economic efficiency.

There are two main mechanisms through which information about risk characteristics of issuers gets lost in equilibrium: ratings inflation and selective disclosure of ratings. Ratings inflation occurs when the CRA misreports its information and assigns a high rating to a negative NPV project. Selective disclosure of ratings occurs when a firm receives a low rating from the CRA but does not disclose it to investors. In both cases the project has negative NPV,

[1] United States Senate, Permanent Subcommittee on Investigations, "Wall Street and the Financial Crisis: An Anatomy of a Financial Collapse" (April 13, 2011).

so why would investors be willing to provide funding to such a firm?

A popular account for the build-up of the financial crisis is that investors naively based their investment decisions on ratings (or absence of ratings) without correcting asset valuations for ratings inflation and selective disclosure of ratings. While it is plausible that individual investors might have been confused by the complexity the securitization process, it is less so for sophisticated institutional investors like investment banks and large market makers. Investor irrationality is therefore unlikely to fully explain the plentiful evidence on ratings inflation.

In the model considered in this paper, investors are fully rational and yet, they will provide financing to firms with inflated ratings and to firms with low ratings that do not disclose, despite these firms being negative NPV. This is no paradox. If, for example, the overall pool of firms that disclose high ratings has positive NPV and investors cannot distinguish between good and bad firms within the pool, then it is optimal for investors to finance all firms that disclose a high rating, including bad firms with inflated ratings.[2] Ex-post, a large fraction of defaults of highly-rated firms is simply a consequence of these ex-ante inefficient financing decisions.

To illustrate how these effects can occur in equilibrium, we focus on two main frictions: conflicts of interest between CRAs and investors and lack of transparency of the rating process. In our analysis we relate these frictions to two common views of the behaviour of CRAs and issuers, often referred to as "rating catering" and "rating shopping" views.

Most CRAs operate under the "issuer-pays" business model, whereby rating fees are paid by the issuer of the rated security. This model is subject to a potential conflict in that the CRA may have an incentive to determine more favourable ratings than warranted in order to attract or retain business. According to the rating catering view, reputational concerns would not be sufficient for CRAs to resist from ratings inflation. This would be particularly true in light of the regulatory premium on higher-rated securities resulting from rating-based regulatory policies. Our analysis of the conflict of interest is consistent with this view. In equilibrium, whenever reputational concerns are below a given threshold, the CRA might offer high ratings

[2] The interest rate charged by investors will, obviously, reflect the average credit quality of the pool.

to bad firms in exchange of additional payments, in which case bad firms disclose a high rating and get funding. Furthermore, rating contingent regulation is shown to exacerbate the conflict of interest and to increase the likelihood of rating inflation.

An alternative account for the poor performance of credit ratings is that of rating shopping. According to this view, a possible source of ratings bias is the ability of issuers to obtain preliminary (or indicative) ratings from multiple rating agencies (Moodys', S&P and Fitch) and to disclose ratings selectively. For instance, an issuer could obtain preliminary ratings from all CRAs and then disclose to investors only the most favourable one, or, if all ratings are unfavourable, disclose none. Selective disclosure induces a selection bias in the ratings that are published and results in ratings inflation. Skreta and Veldkamp (2009) formalize this intuition under the assumption of naive investors. With rational investors, however, this intuition is far from obvious because of a standard “unraveling” argument (e.g., Grossman and Hart, 1980; Milgrom, 1981). Building on Sangiorgi and Spatt (2013), we illustrate how the degree of transparency in the rating process is key in this respect. If issuers are not required to disclose the receipt of preliminary ratings (a situation we refer to as the “opaque” regime), selective disclosure of ratings arises in equilibrium whenever investors are uncertain as to whether ratings are not being disclosed because they were not obtained and therefore unavailable, or because they were sufficiently adverse. In addition, we show how the CRA has an incentive to keep the rating process opaque because its opacity allows the CRA to extract rents it would not extract if the rating process were transparent.

Finally, the model is used to discuss the rationale and limitations of some of the regulatory response to the crisis and related policy proposals, such as the regulation of rating fees, making CRAs legally liable for inaccurate ratings, eliminating the regulatory reliance on ratings and mandating disclosure of preliminary ratings.

The paper is organized as follows. Section 2 presents the basic analytical framework. Section 3 considers equilibrium ratings inflation arising from conflicts of interests. Section 4 considers equilibrium selective disclosure arising from lack of transparency. Section 5 provides some further remarks. The Appendix contains details omitted from the main text, including proofs.

2 The model

2.1 The economic setup

We consider a model with a unit measure of firms, $n \geq 2$ investors and a credit rating agency (CRA). All agents are risk neutral and maximize expected profits.

Each firm (the issuer of the security) has access to a project that requires an initial investment of one unit of the consumption good and may either succeed or fail. Firms have not enough internal funds and therefore need investors to finance their project. Investors have enough resources to finance all projects, are competitive and will break even in equilibrium.

The return to each firm's project equals y in case of success and equals zero in case of failure. Firms differ with respect to their success probability and can be of two types, $\tau \in \{g, b\}$, where g and b stand for "good" and "bad," respectively. Good firms have success probability equal to one, while bad firms have success probability π_b, with $1 > \pi_b > 0$. We assume $y - 1 > 0 > \pi_b y - 1$, so that it is profitable to finance good firms but not bad firms. A firm's type is unobservable to investors and to the firm itself, so there is no ex-ante asymmetric information about firms' quality. A fraction $\gamma \in (0,1)$ of firms are of the good type and the remaining fraction $1 - \gamma$ are are of the bad type[3]. We assume that the fraction of good firms is sufficiently high that the average NPV is positive. This assumption is not crucial but it simplifies exposition. It implies that, without the CRA, all firms would be financed, resulting in an economic surplus of $\pi_0 y - 1$, where $\pi_0 \equiv \gamma + (1 - \gamma)\pi_b$ is the average probability of success.

The CRA is endowed with a technology to distinguish among good and bad firms. If a firm of type τ solicits a rating, the CRA can produce at some cost c a signal $r \in \{H, L\}$ such that $\Pr(r = H | \tau = g) = \Pr(r = L | \tau = b) = 1/2 + e,$ where $e \in [0,1/2]$ measures the precision of the screening technology. For the sake of the argument, we will assume $c = 0$ and $e = 1/2$, that is, that the CRA can perfectly identify a firm's type at no cost.

Our premise is that the CRA has the ability to enhance allocational efficiency in the economy. In the full-information efficient benchmark, all good firms but no bad firms are

[3] Equivalently, the setup can be interpreted as one in which there is a single firm and γ is the ex-ante probability that this firm is profitable.

financed, resulting in an economic surplus of $\gamma(y-1)$. Our assumptions imply that such benchmark can be implemented if ratings are produced by the CRA and truthfully disclosed to investors for all firms. By avoiding financing of bad firms, the gain in economic surplus, Ω, amounts to $\Omega=(1-\gamma)(1-\pi_b y)$. Then, Ω represents the potential value to the economy of the screening technology that is available to the CRA. This article is concerned with frictions that may hinder the realization of such value. We turn to the description of two such frictions next.

2.1.1 Conflict of interest

In the context of our model, the conflict of interest is modelled by assuming the CRA's signal to be verifiable by firms and contractible upon, but unobservable by investors. That is, investors have no way to tell whether a rating that is disclosed by the CRA corresponds to the CRA's signal or not. To distinguish the initial signal from the rating that is disclosed by the CRA, we denote the former with r and the latter with $\tilde{r}$. If a rating $\tilde{r}=H$ is published and the project fails, the CRA is assumed to face "reputation costs" equal to ρ. These costs are assumed exogenously and can be equivalently interpreted as any type of misreporting cost, market discipline or future regulation.

2.1.2 Market transparency

The relevant notion of transparency in the present context is as follows. The rating process is defined as *transparent* or *opaque*, depending on whether or not the contact between firms and the CRA, i.e., the act of soliciting a rating, is observable by investors. The distinction between transparent and opaque contacts matters when an unrated firm seeks to finance its project: a firm could be unrated either because it did not ask for a rating or because it asked for a rating but decided not to disclose it. Investors' contracts can distinguish between these two events only if the market is transparent.[4]

[4] Other aspects of the rating process, such as the exact content of communications between firms and the CRA, are not assumed to be transparent (i.e., visible to investors).

2.2 *The rating game*

At the beginning of the game the CRA offers a rating contract to firms. The terms of the contract specify a fee, f, to be paid for the CRA to produce the signal r.[5] If the firm pays the fee, it is entitled to the option to publish a rating equal to the realized signal. However, the CRA and the firm may engage in "discussions" over the rating. We assume the CRA can make a take-it-or-leave-it offer for an "adjustment" in the rating.[6] Specifically, right after the signal r is realized and observed by both the CRA and the firm, the CRA may offer to the firm a different rating, $\tilde{r} \neq r$, for an additional fee $\tilde{f}$ to be paid in case of success (if the firm refuses, it would still be entitled to the option to disclose a rating equal to r). These negotiations are not observed by investors, who only get to see the final rating that is disclosed in case the firm decides to publish it through the CRA. Without loss of generality, we only consider the case in which the CRA inflates its ratings, and model this formally with the probability ε that the CRA offers a high rating, $\tilde{r} = H$, when the realized signal is low, $r = L$. This setup is meant to capture in a simplified way the back-and-forth negotiations between CRAs and issuers that may result in a higher rating than originally proposed without an effective improvement in the intrinsic value of the security.[7]

The timing of the model is as follows.

1. CRA posts a rating fee f, which is observed by all players.
2. Firms decide whether to solicit a rating.
3. If a rating is solicited, the firm pays f, the CRA produces r and reveals it to the firm.
    - 3. i If $r = L$, the CRA decides whether to offer $\tilde{r} = H$ for an additional fee $\tilde{f}$.
    - 3. ii If the CRA made the offer, the firm decides whether to accept it.
4. The firm decides whether to disclose the rating to investors.

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[5] We are implicitly assuming that firms have enough cash to pay for the rating fee but not to finance the project (in equilibrium, rating fees are always less than one). Alternatively, we could assume that firms have zero internal funds and pay the fee only if the project succeeds; the results of the model would be unchanged.

[6] This assumption is for expositional purposes; the exact allocation of the bargaining power between the CRA and the firm is irrelevant for the results.

[7] In the context of CDOs, GRIFFIN and TANG (2012) document how CRAs make upward adjustments to their direct model outputs. As the amount of adjustment is shown to be positively related to future downgrades, their evidence is consistent with CRAs inflating the ratings

5. Investors offer interest rates for financing the project.
6. The firm decides whether to borrow from investors to finance the project.
7. If the project is financed and the outcome is successful, the firm repays investors and the CRA.

We will analyze a symmetric Perfect Bayesian Equilibrium of this game (in which all firms play the same strategy) and simply refer to it as an *equilibrium*, hereafter.

DEFINITION 1 An equilibrium is a pair of fees $f, \tilde{f}$, a probability ε that the CRA offers a high rating after a low signal, a set of interest rates offered by investors and a sequence of decisions for firms (whether to solicit the rating, to accept the offer made by the CRA, to disclose the rating to investors and to ask for financing) such that firms and the CRA maximize expected profits, investors break even, and firms and investors' expectations are correct.

3 Conflict of interest and rating catering

This section provides an analysis of ratings inflation arising because of conflicts of interest between the CRA and investors. First, we derive the equilibrium level of ratings inflation and its effect on economic efficiency in the basic model described in the previous section. Second, we extend the basic model to study the implications of rating contingent regulation and investor naiveté.

3.1 The basic model

We solve the model backwards, relegating omitted details to the Appendix. In order to isolate ratings inflation from selective disclosure, in this section we assume that contacts between firms and the CRA are transparent, i.e., the receipt of preliminary ratings is public information. As a first step toward the solution of the model, we start by assuming that all firms solicit a rating and determine the equilibrium level or ratings inflation.

Naturally, good firms that solicit a rating will disclose and get funding. What is key to the conflict of interest model, however, is the equilibrium of the subgame that starts with a bad firm that solicits a rating. Assume that investors expect the CRA to offer $\tilde{r} = H$ to such a firm with some probability ε, and the firm to accept it whenever such an offer is made. Then, if $\varepsilon > 0$, a high rating is only a noisy signal of the firm's type, as investors cannot distinguish between good firms and bad firms whose ratings are inflated. Given investors' conjecture on the behaviour of the CRA, the conditional probability of making a successful investment given a high rating equals $\pi_H = (\gamma + (1-\gamma)\varepsilon\pi_b)/(\gamma + (1-\gamma)\varepsilon)$. Intuitively, π_H is decreasing in ε; it equals the probability of success of good firms, one, if low signals are never inflated, and it equals the unconditional probability of success, π_0, if low signals are always inflated. In the latter case, a high rating is completely uninformative. Given π_H, investors are willing to finance H-rated firms at a rate R_H such that expected profits from lending, $\pi_H R_H - 1$, equal zero.

Next, consider a firm that solicits a rating and, after learning that $r = L$, is offered from the CRA $\tilde{r} = H$ for an additional fee $\tilde{f}$. Since its outside option is worth zero,[8] the firm will accept the offer only if the expected net gain from pooling with the good firms, $\pi_b(y - R_H - \tilde{f})$, is non-negative.

Finally, consider the trade-off faced by the CRA. If it offers a high rating to a bad firm such that the firm accepts and the project is funded, then, with probability π_b the firm will succeed and the CRA will collect the additional fee, and with probability $1 - \pi_b$ the firm will default, resulting in the reputation cost to the CRA. The next lemma describes the solution to this trade-off, i.e., the equilibrium level of ratings inflation, as a function of the reputation cost. We have,

LEMMA 1 *Three exist threshold values* $0 < \underline{\rho} < \overline{\rho} < 1$ *such that, when a firm solicits a rating and* $r = L$,

(i) *for* $\rho \geq \overline{\rho}$, *the CRA never offers a high rating and the firm does not get funding;*

(ii) *for* $\rho \in \left(\underline{\rho}, \overline{\rho}\right)$, *with probability* $\varepsilon^* \in (0,1)$ *the CRA offers a high rating for additional fee* $\tilde{f} = (\pi_b^{-1} - 1)\rho$, *the firm accepts the offer and gets funding at rate* $R_H = 1/\pi_H$; *with probability* $1 - \varepsilon^*$ *the CRA does not make the offer and the firm does not get*

[8] With disclosure of contacts between firms and the CRA, it is easy to see that investors will not finance firms that solicit a rating but do not disclose it. The reason is that, if they did, it is only negative NPV firms that would ask for financing as unrated firms, implying a loss for investors.

funding;

(iii) *for $\rho \leq \underline{\rho}$, the CRA always offers a high rating for additional fee $\tilde{f} = y - \pi_0^{-1}$, the firm accepts the offer and gets funding at rate $R_H = 1/\pi_0$.*

Case (i) in the lemma is intuitive: if the reputation cost is high enough, it is optimal for the CRA not to inflate ($\varepsilon = 0$). Case (ii) in the lemma implies that, for intermediate values of the reputation cost, the CRA inflates low signals with positive probability ε^*; investors anticipate it and adjust the interest rate they charge to H-rated firms. In equilibrium, the expected additional fee that the CRA collects from the rating adjustment is exactly offset by its expected reputation cost; as the CRA is indifferent between inflating or not, inflating with probability ε^* is in fact optimal. The proof of the lemma further shows that, intuitively, ε^* is decreasing in the reputation cost ρ. When the reputation cost is sufficiently low, as in case (iii), the CRA always inflates a low signal making high ratings completely uninformative. As a result, disclosing a high rating does not improve financing terms with respect to what a firm could obtain without soliciting a rating.

As a second step, we turn to the description of the equilibrium for the overall game, whereby the CRA sets the rating fee f and firms decide whether to ask for a rating or not, taking into account the unfolding of the game described by Lemma 1. The solution to the overall game is described in the next proposition. We have,

PROPOSITION 1 *There exists a threshold value $\hat{\rho} \in \left(\underline{\rho}, \overline{\rho}\right)$ such that, in the equilibrium of the overall game:*

1. *For $\rho \geq \hat{\rho}$, the CRA sets $f = \Omega - \gamma(R_H - 1)$, all firms ask for a rating and only H-rated firms get funding. Furthermore,*
   (i) *for $\rho \geq \overline{\rho}$, all good firms but no bad firms get funding and the equilibrium is efficient;*
   (ii) *for $\rho \in [\hat{\rho}, \overline{\rho})$, all good firms and a fraction $\varepsilon^* \in (0,1)$ of bad firms get funding; the resulting loss in economic surplus is $\varepsilon^*(1-\gamma)(1-\pi_b y)$.*
2. *For $\rho < \hat{\rho}$, no firm asks for a rating and all firms get funding; the resulting loss in*

economic surplus is $(1-\gamma)(1-\pi_b y)$.

For $\rho \in [\hat{\rho}, \overline{\rho})$, the equilibrium described in case 1 part (ii) of the proposition has a "signal jamming" nature: the CRA attempts to "fool" investors by inflating low ratings, but such behaviour is fully taken into account by the interest rate at which H-rated firms are financed. The fact that ratings inflation is accounted for by investors, however, does not mean that ratings inflation is without real consequences. In fact, a real inefficiency emerges as a fraction ε^* of firms with negative NPV get funding.

Since π_H decreases as ε^* increases, ratings inflation depletes the value of the information conveyed by ratings, lowers economic surplus, and reduces the maximum fee the CRA can charge to firms. In case 2 of Proposition 1, the conflict of interests is so severe that the market for information breaks down: because high ratings do not improve financing terms, firms have no reason to purchase them at any positive price.

An obvious limitation of this analysis is that the level of the reputation costs is exogenous to the model. The paper by Mathis, McAndrews and Rochet (2009) offers an interesting contrast in this regard. In a dynamic model of endogenous reputation, they show the emergence of reputation cycles, consisting of several phases. An opportunistic CRA may initially engage in a reputation building strategy, during which the CRA reports its information truthfully. As soon as its perceived reputation is high enough, the CRA engages in ratings inflation, is eventually discovered misreporting and its reputation is lost thereafter. In the context of our model, this reputation cycle would correspond to a gradual decrease of the parameter ρ over time.

Next, we relate our analysis to two regulatory attempts to deal with the conflict of interest.

Regulation of rating fees. Among the first policy responses to the crisis was the so-called "Cuomo plan", the New York State Attorney General's 2008 settlement with the three major rating agencies. This agreement attempted to reduce the conflict of interest by mandating issuers to pay the CRA up-front before it conducts its analysis (although not preventing subsequent payments).

The model of this section helps to illustrate both the rationale and the limitation of the Cuomo plan. In the model, the conflict of interest is solved if the CRA is paid *only* the up-front fee, irrespective of the final rating that is issued, as in this case inflating a low signal provides no additional revenue. However, for this policy to be effective, it should be augmented with a complete ban of any indirect payment by issuers to CRAs, such as the purchase of consulting and pre-rating services.

Expert liability. Historically, CRAs have been exempt from legal liability for inaccurate ratings, because U.S. courts viewed ratings as an opinion about the credit quality. As such, ratings were protected by the First Amendment (freedom of speech). The Dodd Frank Act removed this protection in 2010 exposing CRAs to liability as an "expert." The major CRAs responded by refusing to consent to reference to their ratings in registration statements of asset-backed securities (ABS). As a result, the ABS market froze in the summer of 2010, which led the SEC to exempt CRAs from expert liability in such asset class.

What is the consequence of making CRAs liable in the model? Let us reinterpret the parameter ρ as the probability that, if an H-rated firm defaults, the CRA is made liable by investors for misreporting and is forced to refund the unit investment in the bad project. The analysis of this section suggests that making the CRA liable is sufficient to restore efficiency. This conclusion, however, hinges on the extreme assumption that the CRA's screening technology is perfect. If it is imperfect, the CRA might have an incentive to be too stringent, possibly assigning low ratings after high signals in order to avoid liability in case the signal turns out to be incorrect, causing positive NPV projects not to be undertaken. In a model with endogenous ratings precision, Kartasheva and Yilmaz (2012) uncover a related form of inefficiency as the CRA might reduce market coverage to avoid liability risk. They also point out that a similar reaction was predicted by market participants as well. The desirability of legal liability for CRAs may therefore be more controversial than it initially appears.

3.2 Extension I: Rating-contingent regulation

Credit ratings are used for regulatory purposes such as bank capital requirements, as a result of which better-rated securities require lower regulatory compliance costs. Rating-based regulatory policies effectively impose a regulatory premium on higher rated securities. By affecting investor demand, this regulatory premium may have a non-trivial impact on asset pricing, and, therefore, on issuers' value for high ratings and CRA’s incentives to produce unbiased ratings.

To illustrate the impact of rating-contingent regulation in the context of our model, we assume, similarly as in Opp, Opp and Harris (2013), that the differential regulatory treatment of holding a H-rated security is worth to investors a fraction $\delta \in (0,1)$ of each unit lent to firms. As a consequence, investors are willing to finance the unit investment in H-rated firms at a rate R_H^δ such that $\pi_H R_H^\delta - (1-\delta) = 0$, which gives $R_H^\delta = (1-\delta)/\pi_H$. For a given probability of success of H-rated firms, therefore, the regulatory advantage of a high rating tends to reduce the cost of debt for H-rated firms. In turn, this increases a bad firm's willingness to pay for a high rating, exacerbating the conflict of interest faced by the CRA. The following corollary summarizes the effect of rating-contingent regulation on the equilibrium level of ratings inflation. We have,

COROLLARY 1 (RATING-CONTINGENT REGULATION) *Let* $\Delta \equiv (\pi_b^{-1} - 1)^{-1}\delta$. *Lemma 1 holds as stated replacing* $\overline{\rho}$ *with* $\overline{\rho}^\delta = \overline{\rho} + \Delta$, $\underline{\rho}$ *with* $\underline{\rho}^\delta = \underline{\rho} + \Delta$ *and* R_H *with* R_H^δ.

As $\Delta > 0$ and is increasing in the regulatory advantage parameter δ, the first effect of rating-contingent regulation is to shift up the critical threshold of reputation cost, making ratings inflation more likely.

The endogenous variables ε^* and R_H^δ obey the following comparative statics. When the reputation cost is below the threshold $\overline{\rho}^\delta$, a marginal increase in δ increases the equilibrium level of ratings inflation, ε^*, increasing the fraction of bad firms that get funding ex-ante, and the fraction of H-rated firms that default ex-post. The comparative statics of the equilibrium yields of H-rated bonds, R_H^δ, are more subtle. A marginal increase in δ reduces R_H^δ only if reputation costs are large enough that the CRA never inflates ratings, in which case δ does not influence the probability of success of H-rated firms, π_H. If, instead, reputation costs are below the threshold $\overline{\rho}^\delta$, a marginal increase in the regulatory advantage of high ratings also lowers π_H through its effect on ratings inflation ε^*. In this case, the CRA's indifference condition dictates $\pi_b(y - R_H^\delta) = (1-\pi_b)\rho$, implying that the two effects exactly offset each other, leaving the interest rate R_H^δ unchanged. Interestingly, these comparative statics imply that equilibrium yields may appear, empirically, not to be responsive to ratings inflation in the presence of rating contingent regulation.

In this model, ratings inflation depends on the parameter δ in a continuous fashion. This result depends on the precision of the screening technology being exogenous. In a model with endogenous precision, Opp, Opp and Harris (2013) show the effect to be more dramatic: if the regulatory benefit is above a given threshold, the CRA suddenly does not put any effort in information acquisitions and facilitates regulatory arbitrage through ratings inflation.

Reducing regulatory reliance on ratings. The Dodd-Frank Act mandates that U.S. regulators no longer rely on ratings for regulatory purposes. In December 2013 the Securities and Exchange Commission announced that it had removed references to ratings in several of its rules and forms. In this model, as in virtually any other model in the literature, eliminating the regulatory benefit of high ratings is welfare improving. An important caveat to this conclusion, however, is that rating contingent regulation may have other benefits that are not incorporated in the analysis (and that justify its existence in the first place). In absence of obvious alternatives to the current rating-based system, a complete welfare analysis of rating contingent regulation should take into account these other aspects as well.

3.3 Extension II: Naive investors

In our basic model, investors are fully rational. A different view of the mispricing whose correction triggered the crisis is that investors naively based their investments in asset-backed securities on inflated ratings. Related analyses of ratings bias arising in models with irrational investors are in papers by Bolton, Freixas and Shapiro (2012) and Skreta and Veldkamp (2009).

In the context of our model, consider what happens if investors holds fixed beliefs that $\varepsilon = 0$, regardless of the actual behavior of the CRA. This means that, whenever a firm discloses a high rating, the cost of debt is always equal to $R_H|_{\varepsilon=0} = 1$. Similarly to the case of rating-contingent regulation, investor naiveté heightens the conflict of interest (with respect to the model with rational investors) by increasing the value of pooling with good firms. The next corollary illustrates the main implication of this alternative assumption. We have, COROLLARY 2 (NAIVE INVESTORS) *If investors always believe H-rated firms to be good firms, then:*

(i) *for* $\rho \geq \overline{\rho}$, *the equilibrium is as described in Lemma 1 (i) and Proposition 1 (i),*

(ii) *for* $\rho < \overline{\rho}$, *all firms ask for a rating, low signals are inflated with probability one and all firms gets funding. Investors' expected losses amount to* $1 - \pi_0$.

The corollary implies that ratings inflation arises in the model with naive investors only if it does in the model with rational investor. The effect, however, is much more dramatic: all bad firms receive a high rating and get funding, resulting in a much larger fraction of defaults of highly-rated firms. As the interest rate at which naive investors finance *H*-rated firms is insensitive to ratings inflation, the model implies a massive mispricing of assets. However, the evidence on mispricing is rather mixed. For example, the evidence in He, Quian and Strahan (2012) and Kronlund (2011) in the corporate bond context highlights that investors required higher yields for issues that were more subject to ratings inflation.

4 Opacity and rating shopping

We begin the analysis of this section providing a simple illustrative example of the unraveling argument that was mentioned in the Introduction. Then we compare transparent and opaque market outcomes. Finally, we consider which outcome is more likely to arise in absence of disclosure regulation.

4.1 Selective disclosure and unraveling

Assume that in equilibrium the issuer of a security with uncertain payoff X purchases one rating and discloses it only if above a threshold, $\bar{r}$. Then, conditional on no disclosure, the asset price equals $\mathrm{E}(X|r < \bar{r})$. Clearly, the issuer will disclose the rating r if and only if it gets a better price by disclosing than by not disclosing, that is, if and only if $\mathrm{E}(X|r) \geq \mathrm{E}(X|r < \bar{r})$. Therefore, the threshold $\bar{r}$ has to satisfy $\mathrm{E}(X|r = \bar{r}) = \mathrm{E}(X|r < \bar{r})$, but this equality is only satisfied for $\bar{r}$ equal to the minimum of the support of r. In other words, the rating is always disclosed, and full disclosure is supported by off-equilibrium "worst case beliefs" that, if the rating is not disclosed, it is equal to the minimum of its support. The upshot of this example is that ratings bias can arise from selective disclosure only if the unraveling result is undone. Sangiorgi and Spatt (2003) show how *endogenous* uncertainty can emanate from the rating process, so investors do not know whether ratings are not being disclosed because they were not obtained and therefore unavailable, or because the ratings were sufficiently adverse. As a result, the unraveling result is undone, the issuer can avoid a completely adverse inference and selective disclosure arises in equilibrium.[9]

To illustrate the main results in Sangiorgi and Spatt (2003) while keeping the present analysis as simple as possible, we amend the basic model by assuming that a fraction q of firms, which we refer to as *latecomers* (as opposed to the remaining $1-q$ firms, which we refer to as *early*), is exogenously prevented from soliciting a rating. Whether a firm is latecomer or early is only known to the firm and is independent from the firm being good or bad, so the relative proportions of good and bad firms are unchanged. One interpretation of this assumption is that some projects need immediate financing, which makes undergoing the rating process too costly or unfeasible. In order to focus on the inefficiency arising from selective disclosure, the analysis in this section further assumes that reputation costs are sufficiently high that the CRA never inflates ratings.

4.2 The transparent market benchmark

To appreciate why opacity matters, it is instructive to consider as a benchmark the transparent case in which the receipt of preliminary ratings is public information. Having assumed away the conflict of interest, the analysis of the previous section implies that, in equilibrium, the CRA sets $f=\Omega$ and all early firms solicit a rating while latecomers remain unrated; early firms of the good type disclose a high rating and get funding at rate $R_H=1$, early firms of the bad type receive a low rating and do not get funding, and all latecomers get financing without a rating at rate $R_0=1/\pi_0$. In other words, the equilibrium is efficient

[9] In the disclosure literature, the unraveling result is undone if there are exogenous disclosure costs (e.g., VERRECCHIA, 1983) or some exogenous source of uncertainty about whether a player has information to disclose (e.g., DYE, 1985).

(under the constraint that latecomers remain unrated) under transparency. Key to this result, of course, is that investors can distinguish (and make the debt contracts dependent on) the two events in which a firm is unrated because it solicited a rating but did not disclose or because it did not solicit a rating. As a consequence, firms that receive a low rating do not disclose and do not get financing. In fact, this is simply a result of the unraveling principle in this setup.

4.3 The opaque market equilibrium

If contacts between firms and the CRA are opaque, then, debt contracts cannot distinguish between truly unrated firms and firms that do not disclose a low rating. The transparent benchmark equilibrium relies on this distinction and is therefore not viable. Then, what is an equilibrium of this model under opacity? Assume all early firms solicit a rating but disclose it to investors only if the rating is high. What should investors do with unrated firms that ask for financing? There are two possibilities: either investors do not offer financing to unrated firms, or, if they do, investors must take into account that early firms that received a low rating would not disclose in order to pool with latecomers. Both of these outcomes result in a loss of economic surplus with respect to the transparent benchmark. In the first case, latecomers do not get funding at all, which is inefficient because the average NPV of latecomers is positive. In the second case, all early firms get funding irrespective of their type, meaning that the credit quality information that is produced by the CRA is completely lost in equilibrium. As the next proposition shows, the equilibrium of the model is, in fact, of either of these two sorts. We have

PROPOSITION 2 *In the opaque market equilibrium the CRA sets* $f = \gamma(\pi_0^{-1} - 1)$, *early firms solicit a rating and, if* H*-rated, get funding at rate* $R_H = 1$. *For the remaining firms, there exists a critical value* $\bar{q}$ *such that:*

(i) *For* $q > \bar{q}$, *L-rated early firms do not disclose, pool with latecomers and get funding at some rate* $R_\emptyset < y$. *The resulting loss in economic surplus is* $(1-q)(1-\gamma)(1-\pi_b y)$.

(ii) *For* $q \leq \bar{q}$, *neither L-rated early firms nor latecomers receive funding. The resulting loss in economic surplus is* $q(\pi_0 y - 1)$.

The reason why the fraction of latecomers q plays a key role in the equilibrium described in Proposition 2 is as follows. In case (i), all unrated firms get financing. For this to be an equilibrium, the average unrated firm must have positive NPV, i.e., $\pi_{\emptyset} y > 1$, where $\pi_{\emptyset}$ denotes the conditional probability of success given that a firm does not disclose. Since the pool of unrated firms is comprised of q latecomers and $(1-q)(1-\gamma)$ bad early firms, Bayes' law gives $\pi_{\emptyset} = (\pi_b(1-\gamma) + \gamma q)/(1 - \gamma + \gamma q)$. Intuitively, $\pi_{\emptyset}$ is increasing in q; it equals the success probability of bad firms, π_b, for $q = 0$, and it equals the unconditional probability of success, π_0, if $q = 1$. The threshold value $\bar{q}$ is such that the NPV of the average unrated firm is strictly positive if and only if $q > \bar{q}$.

In case (i), selective disclosure of ratings results in overinvestment because negative NPV projects are funded that would not have been in a transparent market. Conversely, for $q \leq \bar{q}$, there is no actual selective disclosure of ratings in equilibrium. However, the potential for such selective disclosure results in underinvestment because latecomers are not funded despite being positive NPV on average. We remark that in the equilibrium of the previous section, ratings inflation driven by the conflict of interest distorts the information content of a high rating. By contrast, in the equilibrium of Proposition 2, it is the information conveyed by the *absence* of a high rating that is distorted because of selective disclosure driven by opacity.

The form of selective disclosure in this model is specific to the assumption one rating agency. With multiple rating agencies, Sangiorgi and Spatt (2013) show how an equilibrium emerges in which the issuer acquires a first rating and then a second one only if the first one is below a given threshold. If both ratings are acquired and the second rating is above the same threshold, the issuer will disclose the second but hide the first. The model implies that a lower number of ratings should predict higher default probabilities and/or future downgrades. This prediction is consistent with the empirical evidence in Benmelech and Dlugosz (2010).

4.4 Endogenous opacity

The analysis in this section has taken the opacity of the rating process as given. What are the incentives of the CRA to make the rating process transparent? To answer this question, assume the rating contract offered to firms by the CRA can specify both the fee, and whether the CRA would disclose to investors that the rating has been solicited. As disclosure of rating solicitation makes the process transparent, a simple comparison of the equilibrium profits of the CRA among the transparent and opaque regimes yields the following prediction.

COROLLARY 3 *In equilibrium, the CRA offers opaque contacts.*

When setting its fee, the CRA must leave early firms with at least the value of their outside option-the option to get financing without first soliciting a rating. With opacity, this value is depleted: either unrated firms do not get funding, or they do at a higher rate than if the market was transparent. The opaque regime generates less economic surplus, but the CRA can appropriate a larger fraction of it. As a result, it is the opaque regime that emerges as an equilibrium.

Mandating the receipt of preliminary ratings. The results in this section lead to the following normative implication: issuers should be required to disclose their receipt of preliminary ratings. Indeed, the SEC formally proposed such a rule in the fall of 2009, but the proposed regulation has not been adopted to date and became a lower regulatory priority once it was not included as part of the Dodd-Frank Act's requirements for credit rating agency regulation.

5 Concluding remarks

The analysis in this paper provides a simple model than nests several frictions of the credit rating market in a unified framework. Building on recent theoretical literature, our analysis highlights the informational inefficiency of the rating process as a common mechanism through which these frictions contribute to a misallocation of resources.

There are several related contributions that were left out from our account of the literature. Here we briefly reference to a few of them.

Pagano and Volpin (2012) model a different source of opaqueness, not related to the rating process itself, but rather to the content of the information released by issuers through the rating agencies. Ratings in their model are not inflated, but coarse. When some investors lack the necessary skills to process detailed information, releasing more public information may increase adverse selection and reduce primary market liquidity. As a consequence, issuers choose to release coarse ratings. In turn, this shifts the adverse selection to secondary markets, where, in case of default, it results in sharp price declines or even a market freeze.

Another element of the rating industry that has received some attention is the rating agencies' ability to issue unsolicited ratings. Fulghieri Strobl and Xia (2013) provide an analysis of unsolicited ratings in conjunction with the conflict of interest. They find that the possibility of issuing unsolicited ratings may lead to rating inflation by allowing CRAs to extract higher fees from issuers by credibly threatening to punish those that refuse to acquire a rating.

Last but not least, the debate on CRAs' business model. In light of the evident conflict of interest inherent to the issuer-pays model, several authors (e.g., Pagano and Volpin, 2010) have argued in favour of the investor-pays model as an alternative business model for CRAs. Aside from being a radical change, the investor pays model is subject to a potential free-riding problem which could lead to a collapse of the security rating market. A theoretical analysis of the pros and cons of the issuer- and investor-pays business models is in papers by Kashyap and Kovrijnykh (2013) and Bongaerts (2013).

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Appendix

Proof of Lemma 1.

Define the thresholds $\underline{\rho}, \bar{\rho}$ as

(1) $$\underline{\rho} \equiv (\pi_b^{-1} - 1)^{-1}(y - \pi_0^{-1}), \qquad \overline{\rho} \equiv (\pi_b^{-1} - 1)^{-1}(y - 1).$$

As $\pi_b < y^{-1}$ and $y > 1$, it immediately follows that $0 < \underline{\rho} < \bar{\rho} < 1$. Denote with $\Pi(\varepsilon)$ the CRA's expected profits from inflating a low signal as a function of investors' beliefs ε. As the CRA can charge at most $\tilde{f} = y - R_H$ for a rating adjustment, then $\Pi(\varepsilon) = \pi_b(y - R_H) - (1 - \pi_b)\rho$, where $R_H = 1/\pi_H$ is an increasing function of ε. An equilibrium probability of ratings inflation, ε^*, must be such that either (i) $\varepsilon^* = 0$ and $\Pi(0) \leq 0$, or (ii) $\varepsilon^* \in (0,1)$ and $\Pi(\varepsilon^*) = 0$, or (iii) $\varepsilon^* = 1$ and $\Pi(1) \geq 0$.

Case (i) For $\rho \geq \bar{\rho}$ we have $\Pi(\varepsilon) \leq 0$ for all $\varepsilon \in [0,1]$. Hence, regardless of investors' beliefs, the CRA's expected profits from inflating a low signal are negative, implying $\varepsilon^* = 0$.

Case (ii) For $\rho \in \left(\underline{\rho}, \bar{\rho}\right)$, we have both $\Pi(0) > 0$ and $\Pi(1) < 0$, implying $\varepsilon^* \notin \{0,1\}$. Since Π is strictly decreasing in ε, there exists a unique $\varepsilon^* \in (0,1)$ such that $\Pi(\varepsilon^*) = 0$ holds, and the CRA is indifferent between inflating and not inflating. Hence, inflating with probability ε^* is optimal. When the CRA offers to inflate a low signal, the CRA asks for $\tilde{f} = y - R_H|_{\varepsilon=\varepsilon^*}$, which, using $\Pi(\varepsilon^*) = 0$, simplifies to $\tilde{f} = (\pi_b^{-1} - 1)\rho$. Implicit differentiation of $\Pi(\varepsilon^*)$ shows that ε^* is decreasing in ρ.

Case (iii) For $\rho \leq \underline{\rho}$, we have $\Pi(1) \geq 0$ for all $\varepsilon \in [0,1]$. Hence, regardless of investors' beliefs, the CRA's expected profits from inflating a low signal are positive, implying $\varepsilon^* = 1$. The additional fee asked by the CRA is $\tilde{f} = y - R_H|_{\varepsilon=1} = y - \pi_0^{-1}$. ■

Proof of Proposition 1.

Ex-ante, a firm's outside option of financing without soliciting a rating is worth $\pi_0 y - 1$. Hence, a firm's ex-ante participation constraint reads

(2) $$-f + \gamma(y - R_H) + (1 - \gamma)\varepsilon^* \pi_b\left(y - R_H - \tilde{f}\right) \geq \pi_0 y - 1,$$

where R_H is valued at the ε^* implied by Lemma 1. Given $\tilde{f} = y - R_H$, solving (2) for f and rearranging gives $\leq \hat{f}$, where $\hat{f} \equiv \Omega - \gamma(R_H - 1)$ and Ω is defined in Section 2.1. Using the indifference condition $\Pi(\varepsilon^*) = 0$ into (2), it is immediate to verify that $\hat{f}$ is non-negative only if $\rho \geq \hat{\rho}$, where the threshold $\hat{\rho}$ is defined as $\hat{\rho} \equiv (\pi_b^{-1} - 1)^{-1}(\pi_0 y - 1)\gamma^{-1}$ and is such that $\underline{\rho} < \hat{\rho} < \bar{\rho}$.

Case 1. For $\rho \geq \hat{\rho}$ the CRA sets $f = \hat{f} \geq 0$ so that the participation constraint (2) is satisfied and all firms solicit a rating. *Part (i)* For $\rho \geq \bar{\rho}$, Lemma 1 implies $\varepsilon^* = 0$. Economic surplus equals the efficient benchmark $\gamma(y - 1)$. *Part (ii)* For $\in [\hat{\rho}, \bar{\rho})$, Lemma 1 implies $\varepsilon^* \in (0,1)$. Economic surplus equals $\gamma(y - 1) + \varepsilon^*(1 - \gamma)(\pi_b y - 1)$.

Case 2. For $\rho < \hat{\rho}$ we have $\hat{f} < 0$, implying that (2) is violated for any $f \geq 0$. All firms get funding without soliciting a rating. Economic surplus equals $\gamma(y - 1) + (1 - \gamma)(\pi_b y - 1)$. ■

Proof of Proposition 2.

Case (i): $q > \bar{q}$. As a first step, we show there is no equilibrium in which unrated firms are not funded. By contradiction, assume that in equilibrium investors do not offer funding to unrated firms, so that latecomers' expected payoff equals zero. Consider an investor that deviates by offering to finance unrated firms at some rate $R' \in (R_\emptyset, y)$, where $R_\emptyset = 1/\pi_\emptyset$ and $\pi_\emptyset$ is derived in the main text. Since $R_\emptyset < y$ for $q > \bar{q}$, the deviation is feasible. By financing all latecomers, the investor's expected profits are not less than $\pi_\emptyset R' - 1 > 0$, so the deviation is profitable. Next, we provide conditions under which financing unrated firms at $R_\emptyset$ is an equilibrium if all early firms solicit a rating and bad early firms do not disclose. For an investor not to deviate, it must not be profitable to offer financing to unrated firms at a rate $R'' \in (R_0, R_\emptyset)$ that attracts all early firms in the pool of unrated firms. In other words, it is necessary that an early firm's expected payoff from soliciting the rating and disclosing selectively exceeds the expected payoff from not soliciting the rating. Since the deviating investor can offer no less that R_0, then the requirement is

$$-f + \gamma(y - 1) + (1 - \gamma)\pi_b(y - R_0) \geq \pi_0(y - R_0),$$

which is equivalently expressed in terms of an upper bound for the fee, $f \leq \bar{f}$, where

(3) $$\bar{f} \equiv \frac{\gamma(1-\gamma)(1-\pi_b)}{\pi_b(1-\gamma)+\gamma} = \gamma(\pi_0^{-1} - 1).$$

Given that $R_H = 1 < R_\emptyset < y$, it is optimal for early firms that solicit a rating to disclose if $r = H$ and to pool with latecomers otherwise. Finally, consider early firms' decision to solicit a rating. Early firms have the outside option to get funding without soliciting the rating. Hence, early firms' participation constraint reads

$$-f + \gamma(y-1) + (1-\gamma)\pi_b(y - R_\emptyset) \leq \pi_0(y - R_\emptyset),$$

which is equivalently expressed in terms of a second upper bound, $f \leq \bar{\bar{f}}$ where

(4) $$\bar{\bar{f}} \equiv \frac{\gamma(1-\gamma)(1-\pi_b)}{\pi_b(1-\gamma)+\gamma q}.$$

Comparing (3) and (4), it is immediate that $\bar{f} < \bar{\bar{f}}$. The equilibrium fee, therefore, equals $f = \bar{f}$ and all early firms solicit a rating.

Case (ii): $q \leq \bar{q}$. The pool of unrated firms that include latecomers and bad early firms has negative NPV for $q \leq \bar{q}$. Hence, it cannot be that unrated firms get funding. Next, consider the equilibrium in which unrated firms are not funded. For an investor not to deviate by offering funding to unrated firms (and attract all early firms), the same analysis of case (i) implies that the fee set by the CRA can be no larger than $\bar{f}$. Since $-\bar{f} + \gamma(y-1) > 0$, early firms' participation constraint is satisfied for $f = \bar{f}$ and all early firms solicit a rating. ∎