Moral Hazard, Skin in the Game Regulation and Rating Quality

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March 2015

ABSTRACT

This paper investigates the implications of the "issuer skin in the game" regulation for the rating accuracy of a credit rating agency (CRA). An issuer solicits a rating from a CRA to sell a loan portfolio. The sale is subject to a retention requirement to mitigate a moral hazard problem. The CRA's optimal rating accuracy is shown to be increasing in the issuer’s skin. The analysis relates the optimal retention rule to the CRA's information acquisition problem. The issuer’s skin in the game and the CRA’s rating accuracy are shown to be substitute mechanisms for eliciting effort from the issuer.

Keywords: Credit rating agencies, skin in the game, rating accuracy, moral hazard, financial regulation.

JEL Codes: G24, G28, L5, D83

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1 Introduction

The unprecedented expansion of securitization and the explosive growth in Asset Backed Security (ABS) issuance are often cited as the primary causes of the financial crisis of 2007-2009.¹ Most of the policy debate after the crisis have focused on two actors who were identified as the main culprits of the debacle: the issuers who originated and securitized low quality loans and those credit rating agencies (henceforth CRAs) who provided high ratings to the securities backed by these low quality loans. For example, Stanton and Wallace (2012) report that by 2007 about 95% of all outstanding Commercial Mortgage Backed Securities were rated AA or above. Many critics argue that these lax rating standards fueled the securitization boom by allowing the issuers to transfer the risk of non-performing loans to investors (see, among others, Weber and Darbellay (2008), White (2010) and Krugman (2010)). The ease with which an issuer received a high rating led the critics to conclude that the issuers had little interest in the performance of the loans they originated. Similarly, given the large profits they received from the securitization deals they certified, CRA’s had little interest in providing accurate ratings.²

In the face of the public debate following the crisis, an important aim of the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 has been to improve the rating standards of CRAs and eliminate conflicts of interests in the securitization process. In particular, a complete section (Section 15G) of the Dodd-Frank Act is devoted to new "retention requirements" for issuers.³ The proposed rule requires the issuers the retention of a five percent interest in the assets they sell through securitization. In the legislative history of Section 15G, the idea behind this reform proposal is summarized as follows: "When the issuers retain a material amount of credit risk of the assets they securitize, they do have "skin in the game", aligning their economic interests with those of investors in asset backed securities."⁴

¹I refer to securitization as the financial practice of pooling various types of contractual debt such as residential and commercial mortgages, auto loans or credit card debt obligations and selling this consolidated debt as bonds or as collateralized debt obligations (CDOs) to various investors.
²For example, the Financial Crisis Inquiry Commission’s Final Report (2011) explicitly states that “the business model under which firms issuing securities paid for their ratings seriously undermined the quality and integrity of those ratings with the rating agencies placing profit considerations above the quality and integrity of their ratings...” and concludes that “this crisis could not have happened without the rating agencies.”
³The Dodd-Frank Act also requires the adoption of new provisions for CRAs including, among others, the disclosure of data and assumptions underlying credit ratings, conflicts of interest with respect to sales and marketing practices, credit rating standardization, disclosure of performance statistics, and the review of existing regulatory rules that rely on credit ratings.
⁴See Federal Register, Volume 76, No:83, April 29, 2011. The rule does not require the retention of any portion of the credit risk if the Asset Backed Security is exclusively collateralized by “qualified residential mortgages.” (see Levitin (2011)).
It is well understood in the literature that the retention of a stake in an asset can align an issuer’s incentives with those of the investors by mitigating moral hazard on the issuer’s side. Specifically, retaining a skin in the game can act as an incentive device for the issuers to exert costly monitoring effort and improve the asset payoff after the sale (see Penacchi (1988), Gorton and Penacchi (1995), Plantin (2011)); or to exert pre-sale screening effort to improve asset quality during the loan origination stage (see Chemla and Hennessy (2013) and Rajan et al (2010)). Furthermore, risk retention can also provide a credible signal of quality when the issuers have private information on the asset’s quality (see Leland and Pyle (1977), DeMarzo and Duffie (1999), DeMarzo (2005) and Hartman-Glaser (2013)). Although these moral hazard and signaling based theories provide a sound justification for the skin in the game regulation, the potential impact of this regulation on the information acquisition incentives of a CRA involved in the securitization process is not studied. Given the emphasis on the role CRAs played in the recent crisis and the policy proposals to improve their rating performance, it seems important to understand the implications of the proposed skin in the game regulation for the accuracy of a CRA’s ratings.

This paper contributes to the ongoing policy debate on securitization markets and rating quality by theoretically investigating how a skin in the game regulation imposed on an issuer affects a CRA’s incentives to provide accurate ratings prior to the sale of a loan portfolio. The analysis illustrates that a skin in the game regulation, which is designed to mitigate a moral hazard problem on the issuer’s side, can also improve the rating accuracy of a CRA. This result follows, because a portion of the surplus from the loan sale is independent of the information content of the rating. The skin in the game requirement reduces this surplus and hence the fee that the CRA can ensure for itself by adopting a lax rating standard. As a result, the informativeness of the CRA’s ratings increases as the issuer retains more skin in the game. The equilibrium analysis also endogenizes the issuer’s skin in the game and ties it to the determinants of the quality of information produced by the CRA. The results indicate that those factors that increase the accuracy of a CRA’s ratings, such as lower information acquisition and higher reputational/liability costs for the CRA should decrease the regulatory skin that the issuer is required to retain. In other words, the issuer’s skin in the game and the CRA’s rating accuracy serve as substitute mechanisms for eliciting effort from the issuer.

The model features a risk neutral issuer who seeks the sale of a loan portfolio with unknown quality (good or bad). The issuer has no ex ante private information on the portfolio’s quality and pursues the sale merely for liquidity reasons.\footnote{This liquidity benefit justification for loan sales follows from Parlour and Plantin (2008), Shleifer and Vishny (2010) and Plantin (2011). In those models, liquidity is valuable for an issuer because a loan on its balance sheet may prevent the issuer from redeploying capital in alternative investment opportunities.} The final portfolio
payoff depends on the portfolio’s unknown quality and also on whether the issuer ex-
pends costly and unobservable effort. In this environment, an endogenously determined
regulatory skin in the game rule aims to align the incentives of the issuer and potential
investors by ensuring that the issuer expends costly effort and improves portfolio payoff
after a portfolio fraction is sold to the investors.

The model introduces information production by a CRA into this otherwise standard
moral hazard setting. In particular, the ex ante portfolio valuation of the risk averse
investors is assumed to be too low, and hence a sale cannot take place unless the issuer
provides the investors with more information. This is achieved by soliciting a rating
from a monopolistic CRA who observes an information signal on the portfolio’s quality
and discloses a good or a bad rating. The CRA receives a fee only if the issuer asks the
rating to be made public.\footnote{Section 5.2 also analyzes the case when the CRA is paid a flat fee regardless of the particular rating provided and shows that the results continue to hold under this setting as well.} If a good rating subsequently proves to be inaccurate, the
CRA also incurs an exogenously given reputational cost.

The analysis shows that the issuer pays the rating fee and makes a rating public
only if the CRA provides a good rating with sufficient accuracy. With such a rating,
the CRA sells the permitted fraction of the portfolio in compliance with the skin in the
game regulation and expends effort. If the rating is bad, however, the portfolio quality
is revealed to be bad, and the issuer cannot sell any portion of the portfolio. In this case,
the issuer retains the whole portfolio, but does not expend costly effort because effort is
assumed to improve portfolio payoff only when the portfolio is good.

A more accurate rating reduces the uncertainty on the portfolio’s quality and hence
improves the risk averse investors’ portfolio valuation.\footnote{The assumption that the investors are risk averse is not essential for the results. Section 5.3 describes an alternative setting with risk neutral investors.} An accurate rating also allows
the issuer to make a more informed effort decision and can help the issuer save the effort
cost by revealing that the portfolio is bad. In this setting, the CRA’s endogenous rating
fee is shown to depend on three distinct components: (i) the issuer’s liquidity benefit
from the sale, (ii) the risk aversion discount in the investors’ portfolio valuation, and (iii)
the effort cost that the issuer expects to save if the rating is bad. The issuer’s liquidity
benefit from sale does not depend on the accuracy of the rating and hence provides the
CRA with a fee component independent of accuracy. On the other hand, the risk aversion
discount in the investors’ valuation is decreasing, and the issuer’s expected effort cost
saving is increasing in the rating’s accuracy. Therefore, the CRA’s fee is increasing in the
accuracy of the rating.

For a given skin in the game rule, the CRA’s optimal rating accuracy is increasing in
the portfolio fraction that the issuer retains, as long as the issuer’s liquidity benefit from
the sale is not too large. This result follows from the endogenous fee structure described above. More issuer skin in the game reduces the fee component that the CRA can charge independent of its rating accuracy, and improves rating accuracy. The CRA’s rating accuracy is also shown to be (i) decreasing in the issuer’s liquidity benefit from sale, (ii) increasing in the issuer’s effort cost to improve portfolio payoff, and (iii) increasing in the investors’ risk aversion. Hence, the analysis ties the CRA’s optimal rating accuracy to the regulatory retention rule, the specifics of the moral hazard problem that gives rise to this regulatory rule and the investors’ risk preferences.

In equilibrium, the regulator sets the skin in the game rule by taking into account the CRA’s subsequent optimal rating policy. The optimal retention rule itself depends on the accuracy of the CRA’s ratings, as the issuer’s decision to expend effort or not depends on the expected value of the portfolio stake that is retained. The accuracy of the CRA’s rating, therefore, does not only inform the investors’ portfolio valuation, but also affects the issuer’s beliefs on the portfolio’s quality and hence his effort incentives. When the issuer is more optimistic about the portfolio’s quality as a result of an accurate good rating, it takes a smaller stake to sustain effort incentives. Accordingly, the model suggests that those factors that increase the accuracy of the CRA’s ratings should reduce the skin that the issuer is required to retain. In particular, the issuer’s equilibrium skin in the game requirement is (i) increasing in the CRA’s information acquisition costs, (ii) decreasing in the CRA’s reputational/liability costs, (iii) increasing in the issuer’s liquidity benefit from sale, and (iv) decreasing in the investors’ risk aversion.

By tying the optimal retention rule to the specifics of the rating environment, the analysis provides some novel policy implications. For example, if one expects the CRA’s information acquisition costs to be increasing in the complexity of the underlying issue, the analysis suggests that skin in the game regulation should require the issuers to retain a larger stake in complex financial products. Interestingly, this is in contrast to the currently existing "one size fits all" retention rule. Furthermore, the planned introduction of a more strict liability rule that facilitates the litigation of CRAs and increase their costs for providing inaccurate ratings should be accompanied by a reduction in issuers’ skin in the game requirements (see Section 6 for a detailed discussion of the model’s implications).

The next section discusses the related theoretical literature. Section 3 presents the model. Section 4 includes the analysis and the main results. Section 5 presents some extensions of the basic model. Section 6 discusses the implications of the results. Section 7 discusses alternative justifications for skin in the game. Section 8 concludes. The formal proofs that are not presented in the text can be found in Appendix A. The formal analysis of the extensions considered in Section 5 is presented in Appendix B.
2 Related Literature

This paper is related to a growing theoretical literature that addresses the failures of the credit rating industry prior to the financial crisis of 2007-09. To analyze the implications of skin in the game regulation for a CRA’s optimal rating policy, the paper also builds upon a body of work that provide a justification for issuers to retain a skin in the game. Below, I review these two strands of literature separately.

■ Literature on CRA incentives: This paper contributes to a recent theoretical literature that analyzes the conflict of interests in the relationship between the issuers and the CRAs. In terms of the research question raised, the closest paper to this one is Opp et al. (2013). They study the implications of the rating contingent regulation for the accuracy of ratings. In their setting, the issuers have private information about the quality of their projects when they approach a CRA for a rating. Due to rating contingent regulation, the investors derive regulatory benefits from highly rated securities regardless of the information content of the rating. Opp et al. (2013) relate the CRA’s optimal rating policy to this exogenously given regulatory benefit from favorable ratings and derive a wide set of implications. The main message of Opp et al. (2013) is that rating contingent regulation may generate rating inflation even when all investors are rational, and the extent of rating inflation may differ across issuer and asset characteristics. My analysis makes a complementary point and shows that a skin in the game requirement that aligns the interests of the issuers and the investors by mitigating issuer moral hazard can also improve the informativeness of ratings by a CRA who is involved in the sale. Whereas Opp et al. (2013) take rating contingent regulation as given and study its implications for the CRA’s accuracy, in my setting the regulatory rule (how much skin the issuer is required to retain) is endogenous and itself depends on the factors that affect the CRA’s accuracy, such as the complexity of the underlying asset being sold, the CRA’s reputational/liability costs and the issuer’s liquidity benefit from sale.

A recent line of theoretical papers consider investors who display behavioral biases in their evaluation of the information content of ratings. The main focus of these papers is the impact of issuers’ rating shopping on rating accuracy. Bolton et. al (2012) develop a model with naive and trusting investors who take ratings at their face value along with sophisticated investors who rationally update their beliefs taking into account the CRA’s equilibrium rating strategy. The CRA’s optimal rating policy is determined by a trade-
off between its reputational costs from lying versus the revenues that can be extracted from naive investors. Bolton et. al (2012) show that when the size of the naive investors is sufficiently large, the CRA inflates ratings. Furthermore, competition between CRAs can actually reduce the information content of ratings as it facilitates rating shopping. Skreta and Veldkamp (2009) also consider investors who do not rationally account for the upward bias in the reported ratings. They find that the more complex the security and hence the less correlated the CRA’s signals are, the more room there is for rating shopping. My paper does not address ratings shopping, and instead studies the rating accuracy of a monopolistic CRA when the issuer is subject to a skin in the game regulation. Furthermore, I assume full investor rationality.

Another set of papers address the CRA’s reputational concerns for delivering accurate ratings in dynamic models. Mathis et al. (2009) show that reputational concerns are not sufficient when rating complex products become a major source of income for CRAs, as in this case the benefit of maintaining a reputation to capture future income from other sources is lower. For the same reason, they also predict that rating quality is lower in boom times. The relationship between rating quality and the business cycle is further studied in a dynamic setting by Bar-Isaac and Shapiro (2013). They show that rating quality is lower in boom times, unless the economic conditions are too persistent. Frenkel (2015) considers a “double-reputation” model in which the CRA has conflicting reputational concerns. It has an incentive to build a reputation for issuers as lenient by inflating ratings and also wants to build a truthful reputation for investors. Frenkel (2015) shows that greater rating inflation and higher fees will be observed in markets with a small number of issuers. Bouvard and Levy (2013) consider a two-sided reputation model in certification markets with costly information acquisition. None of these papers, however, examine the implications of regulatory retention rules imposed on the issuers for a CRA’s rating accuracy, which is the focus of this paper.

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11 In Pagano and Volpin (2012), only few potential buyers are sophisticated enough to understand the pricing implications of complex information from a rating, and hence releasing such information would create a winner’s curse problem for unsophisticated investors.

12 In other recent work, Kartasheva and Yilmaz (2013) extend Lizzeri (1999) by introducing fully rational but differentially informed buyers and type-dependent gains from trade for sellers. They show that some proposed policy reforms such as rating standardization and expert liability can reduce market efficiency. Manso (2013) incorporates the feedback effects of credit ratings on default risk, and shows that even when the CRAs adopt an accurate rating policy, immediate default can occur in response to small shocks to fundamentals and increased competition between CRAs can reduce welfare by increasing default frequency. Fulghieri et al (2014) show how CRAs can issue unsolicited credit ratings to extract higher fees from issuers by credibly threatening to punish those that refuse to acquire a rating. Sangiorgi and Spatt (2012) show that in the absence of disclosure requirements on produced but undisclosed ratings, which they refer to as opacity, rating bias can arise. Doherty et al. (2012) analyze the optimal entry strategy of a CRA into a market served by an incumbent.
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**Literature on Skin in the Game:** The objective of regulation in my setting is to ensure that the issuer expends costly effort to improve asset value after having sold the asset. This moral hazard framework primarily serves as a tool to provide a well understood economic rationale for skin in the game regulation. Although the analysis reveals a novel interaction between the endogenous retention requirement imposed on the issuer and the CRA’s optimal rating accuracy, the moral hazard framework I adopt is well known and borrows from earlier work by Penacchi (1988), Gorton and Penacchi (1995) and Plantin (2011). These papers study incentive compatible loan sale contracts to ensure that the issuer engages in costly monitoring of the borrowers after having sold the loan, but they do not have third party information acquisition. Therefore, these papers do not relate the optimal retention rule to the quality of information produced by a CRA. I discuss the relationship of these papers with this one further as I lay out the model in the next section.

Another line of research on skin in the game illustrates how retaining a skin can provide the issuer with effort incentives to improve loan quality prior to the origination of loans. These papers also do not have third party information acquisition undertaken by a CRA. Chemla and Hennessy (2013) address how the extent of interim stage asymmetric information that can be resolved through skin in the game affects an issuer’s incentives to exert effort before sale and increase the probability of originating a high value asset. Rajan et al. (2010) consider a bank that exerts unobservable screening effort prior to entering into loan sale/securitization contracts. They show that the bank exerts screening effort only when the exogenously given securitization probability is below a certain threshold. I further discuss how a model with pre-sale issuer effort would fit into my analysis in Section 7.

Apart from these moral hazard based theories, there are also papers that provide a signaling based rationale for skin in the game. Building on the classic paper by Leland and Pyle (1977), these signaling theories follow the idea that the sellers of high quality assets can credibly signal their private information by risk retention, as it is more costly for low quality sellers to retain a skin in the asset (see DeMarzo and Duffie (1999), DeMarzo (2005) and Hartman-Glaser (2013)).

13 As Chemla and Hennessy (2013) point out, the respective agency problems with pre-sale and post-sale effort are different: the pre-sale effort is akin to screening of loan applicants, while the post-sale effort considered here is akin to monitoring of loan recipients.

14 DeMarzo and Duffie (1999) describe how a debt security arises optimally by creating a more informationally sensitive security which the seller can retain in order to signal private information. DeMarzo (2005) extends this signaling argument to analyze the benefits of pooling and tranching of assets in asset backed securities. Hartman-Glaser (2013) shows that allowing an issuer to both signal current asset quality and build a reputation for honesty can lead the issuer to misreport private information even when owning a positive stake.
on asset quality is delegated to an information intermediary (CRA). In a model where the issuers retain a skin in the game to signal their private information on portfolio quality, information acquisition by a CRA could potentially be redundant, or at least its role would be very limited. Therefore, a signaling setting may not be ideal to study the implications of regulatory retention requirements for the rating accuracy of a CRA (see Section 7 for further discussion).

3 The Model

This section introduces a model with the following main features. There is an issuer who seeks the sale of a risky loan portfolio for liquidity reasons. The final portfolio payoff depends on the portfolio’s unknown type and the costly and unobservable effort expended by the issuer. To provide the issuer with effort incentives, there is a "skin in the game" regulation in place which requires the issuer to retain a specified stake in the portfolio if a sale is made. The ex ante portfolio valuation of the risk averse investors is such that a sale can proceed only if the issuer asks a CRA to produce and reveal information on the portfolio’s quality through a rating. In this environment, I study how the equilibrium rating accuracy of the CRA and the skin in the game rule imposed on the issuer are jointly determined. The model is detailed below.

■ The issuer: There is a risk neutral financial institution (henceforth referred to as "the issuer" or "the seller") who holds a risky loan portfolio (such as a mortgage pool) with a fixed size normalized to one. The portfolio can be either Good ($\theta = G$) or Bad ($\theta = B$) quality with $Pr(\theta = G) = \lambda \in (0, 1)$. The issuer does not have any private information on the portfolio’s type. Ex ante, all agents in the model share the same prior belief on the portfolio’s type which is summarized by the probability $\lambda$.\(^{15}\)

The portfolio’s final payoff depends on the portfolio’s unknown type $\theta \in \{G, B\}$, and also on whether the issuer expends costly and unobservable effort $e \in \{0, 1\}$ in a subsequent stage. If the portfolio is good, the issuer’s effort ($e = 1$) at a private cost $c > 0$ yields a final portfolio payoff of 1. If the issuer does not expend effort ($e = 0$), a good portfolio yields a payoff of $1 - \Delta > 0$. Therefore, the issuer’s effort improves the payoff of a good portfolio by $\Delta \in (0, 1)$. A bad portfolio always defaults and yields a zero payoff regardless of the issuer’s effort. Formally, the portfolio’s final payoff $\tilde{y}(e; \theta)$

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\(^{15}\)The assumption that the seller has no ex ante private information on asset quality is quite common in the literature on CRAs (see Bar-Isaac and Shapiro (2013), Bolton et al. (2012), and Mathis et al. (2009)). In contrast, in Opp et al. (2013) and Kartasheva and Yilmaz (2013), the sellers know their type when they solicit a rating. In Sangiorgi and Spatt (2013), the issuer has private information about which ratings are purchased.
is described as
\[ y(e; G) = 1 - (1 - e)\Delta \quad \text{for } e \in \{0, 1\}, \]
\[ y(e; B) = 0 \quad \text{for } e \in \{0, 1\}. \] (1)

The issuer’s effort cost \( c \) satisfies \( \lambda \Delta - c > 0 \). Therefore, it is efficient to expend effort if the issuer were to retain the whole portfolio until maturity. I assume, however, that retention is costly for the issuer. In particular, the issuer incurs a liquidity cost \( xL \) from retaining a portfolio fraction \( x \in [0, 1] \) where \( L > 0 \). In the current setting, the issuer’s motivation for selling the loan stems from this liquidity cost. This motivation follows from Parlour and Plantin (2008). They argue that the liquidity provided through securitization and loan sales enables banks and other lenders to quickly redeploy capital to more profitable investment opportunities. In that respect, \( L \) can be thought of the issuer’s opportunity cost of not being able to pursue another investment opportunity due to retaining the whole portfolio in its books until maturity.\(^{16}\)

**The investors:** The issuer can sell the portfolio to competitive, fully rational and risk averse investors. These investors value the portfolio according to the mean-variance preferences \( E[\hat{y}] - a \text{Var}[\hat{y}] \) where \( a > 0 \) denotes their coefficient of risk aversion. The investors’ portfolio valuation depends on their conjecture of the issuer’s subsequent effort decision and their beliefs about the portfolio’s type. If the issuer sells a fraction \((1 - x)\) of the portfolio, the total revenue that can be raised is given by
\[ p(x) = (1 - x)E[\hat{y}(\hat{e}(x))] - a(1 - x)^2 \text{Var}[\hat{y}(\hat{e}(x))] \] (2)
where \( \hat{e}(x) \) is the rational conjecture of the investors for the subsequent effort decision of an issuer who retains a portfolio stake \( x \). The assumption that the investors are risk averse is not essential in my analysis, but it serves two purposes. First, it allows me to describe in a straightforward manner a setting in which the issuer needs to receive a sufficiently accurate good rating from a CRA to be able to sell the portfolio (see equation 3 below). Second, since the risk aversion discount in \( p(x) \) is decreasing in the precision of a rating, investors’ risk aversion introduces an extra benefit from accurate ratings. The results, however, do not depend on this risk aversion related benefit. Section 5.3 describes an alternative set-up with risk neutral investors to illustrate this point.

I assume that the issuer’s private motivation for loan sale is strong enough compared to the efficiency benefit \((\lambda \Delta - c)\) from retaining effort incentives plus the risk aversion discount \( a \text{Var}[\hat{y}(e = 0)] \) in the investors’ portfolio valuation (conditional on no effort). Formally, I impose the following parametric restriction on the issuer’s liquidity cost \( L \).

\(^{16}\)Parlour and Plantin (2008) argue that the issuer’s liquidity benefit from loan sale can be justified by assuming that the issuer is more impatient than the investors.
Assumption 1: The issuer’s liquidity cost $L$ satisfies

$$L > L_\equiv \equiv aVar[\tilde{y}(e = 0)] + (\lambda \Delta - c). \quad (A1)$$

The above assumption allows me to introduce a role for skin in the game regulation, as it ensures that the issuer prefers to sell the whole portfolio rather than voluntarily retaining any positive fraction for subsequent effort incentives. This tension between post-sale effort incentives versus immediate liquidity benefits from sale is well-known and adopted from earlier work by Penacchi (1988), Gorton and Penacchi (1995) and Plantin (2011). These papers also consider an environment where (i) there is a gain from trade due to the issuer’s liquidity benefits from sale, (ii) the need to provide incentives to the issuer to improve asset payoff after the sale conflicts with reaping full gains from trade. The idea behind this formulation is that the seller/issuer can improve the odds of repayment of the loans and enhance final asset payoff by costly ex-post monitoring of the loan recipients.\(^{17}\)

**Skin in the Game:** The restriction in (A1) rules out any voluntary retention incentives. Hence, I introduce a regulator whose objective is to ensure that the issuer retains a sufficient stake in the portfolio and expends costly effort subsequent to a sale. Formally, let $\sigma \in \{0, 1\}$ denote the publicly observable state which indicates whether a sale is made ($\sigma = 1$) or not ($\sigma = 0$). If the issuer is required to retain a fraction $x$ of the portfolio by the regulator, he/she expends costly effort only when

$$x \left( E[\tilde{y}(e = 1) | \sigma = 1] - E[\tilde{y}(e = 0) | \sigma = 1] \right) \geq c \quad (R1)$$

where the expectation $E[\tilde{y}(e) | \sigma = 1]$ is taken using all the available information conditional on a sale. I refer to the fraction $x$ defined by (R1) as the issuer’s "skin in the game" requirement. Under the rule in (R1), the issuer is allowed to sell only a fraction $(1 - x)$ of the portfolio. It should be emphasized that the issuer’s skin in the game $x$ in (R1) is set "conditional on a sale". Therefore, when determining $x$ the regulator takes into account any information produced prior to a sale. This information production is introduced next.

**CRA and information production:** To introduce a role for information production by a third party such as a CRA, I assume that the ex ante portfolio valuation of the risk averse investors is too low, and hence a sale can only proceed if more information is

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\(^{17}\)The explicit modeling of this payoff enhancing monitoring activity is outside the scope of this paper. As in Plantin (2011), such monitoring can be interpreted as the issuer ensuring that the borrowers do not divert funds to inefficient but privately beneficial projects. Similarly, in Parlour and Plantin (2008) the costly monitoring activity by the bank improves asset payoff by reducing the borrower’s private benefit from shirking.
produced on the portfolio’s quality. Given the retention rule in (R1), ex ante the investors value the fraction \((1 - x)\) of the portfolio at

\[
p_0 \equiv (1 - x)(E[\tilde{y}(\hat{e} = 1)] - a(1 - x)Var[\tilde{y}(\hat{e} = 1)])
\]  

(3)

In what follows, the investors are assumed to be sufficiently risk averse so that \(p_0 < 0\). This restriction introduces a role for information production by a CRA, as it implies that the issuer needs to provide the investors with more information on the portfolio’s quality to be able to sell any portion of the portfolio. This information production is achieved by soliciting a rating from a monopolistic CRA who can provide either a good rating \((r = g)\) or a bad rating \((r = b)\). The CRA has access to an information production technology which can generate an information signal \(s \in \{g, b\}\) on the quality of the portfolio. The CRA receives a good signal \(s = g\) with probability one if the underlying portfolio is good, whereas a bad portfolio generates a bad signal \(s = b\) only with a probability \(z \in [0, 1]\). Formally,

\[
\Pr(s = g \mid \theta = G) = 1 \text{ and } \Pr(s = b \mid \theta = B) = z \in [0, 1].
\]  

(4)

The main policy debate regarding the rating industry is that the CRAs provide favorable yet inaccurate ratings for securities with high default probabilities. The signal technology in (4) is also adopted by Bar-Isaac and Shapiro (2013), and it aims to capture this concern in a simple manner. The parameter \(z\) in (4) refers to the likelihood that the CRA observes a bad signal when the portfolio is indeed bad. I refer to \(z\) as the CRA’s rating accuracy. The CRA’s cost of adopting an accuracy level \(z\) is given by \(C(z)\) where \(C(\_\_\_\_)\) is increasing and convex. Although (4) only allows the CRA to misidentify a bad portfolio as good, Section 5.1 also considers a signal technology that allows for symmetric errors.

■ CRA’s Fee: Consistent with the common industry practice, the CRA is assumed to operate under the issuer-pays business model. Following Opp et al. (2013), I assume that the publication of a rating involves the following steps. First, the CRA sets a fee \(\pi\) and adopts a rating accuracy \(z\). The issuer then decides whether to solicit a rating. If a rating is solicited, the CRA observes a signal and provides the issuer a free and truthful ‘indicative’ rating. This indicative rating becomes a public rating if the issuer decides to purchase it by paying the fee \(\pi\). Given (4), a bad rating perfectly reveals that the portfolio is of bad quality. Because the issuer would not pay a fee to make a bad rating public, the CRA receives the fee \(\pi\) only if the rating is good.\(^{18}\) Section 5.2 analyzes the

\(^{18}\)Bar-Isaac and Shapiro (2013), Bolton et al (2012) and Mathis et al. (2009) also consider models where the CRA receives a fee only when the rating is good.
case when the CRA is instead paid with a flat fee regardless of the rating.\footnote{An additional consideration is to make the non-disclosure option a part of the contract and charge the issuer for this option. This problem is analyzed in a mechanism design setting by Faure-Grimaud et al. (2009).}

- **CRA’s Reputation Cost:** Following Bolton et al (2012) and Morgan and Stocken (2003), I assume that the CRA incurs an exogenously given reputational cost if its rating proves to be inaccurate. In particular, if the portfolio defaults subsequent to a good rating, the CRA suffers an exogenous monetary loss $\beta > 0$. This cost can be thought of as the discounted sum of future profits lost by the CRA if its rating proves to be at odds with the actual performance of the loan portfolio.\footnote{Bolton et al (2012) argue that this lost future business may be more likely in the case of new financial instruments like structured products where demand for the product may dry up if CRA provides inaccurate ratings.} This formulation aims to capture the idea that the CRA’s future profits suffer if an asset that received a good rating performs poorly. The one shot reputational cost assumption is a reduced form approach, but as in Bolton et al (2012), it allows me to introduce a motivation for the CRA to provide accurate ratings in a simple manner.\footnote{In the dynamic model of Bar-Isaac and Shapiro (2013), when the CRA identifies a bad portfolio as good, the CRA loses all future profits as investors follow grim-trigger strategies to punish the CRA and no longer rely on its ratings.}

For a given accuracy $z$, the CRA’s ex ante expected reputational cost is given by $(1 - \lambda)(1 - z)\beta$. The cost parameter $\beta$ can also be interpreted as a liability cost. The implication of this alternative interpretation is discussed in Section 6.

- **Sequence of Events:** I summarize the sequence of events in the model below.

  - **Stage 1:** The issuer seeks to sell a loan portfolio. The regulator sets the "skin in the game" requirement and specifies the portfolio fraction $x$ the issuer must retain.

  - **Stage 2:** The issuer approaches the CRA for a rating. The CRA adopts a signal accuracy $z$ and sets a rating fee $\pi$. The issuer decides whether to solicit a rating. If a rating is solicited, the CRA observes a signal on the portfolio’s quality and provides a rating.

  - **Stage 3:** Given the rating, the issuer decides whether to pay the CRA the fee $\pi$ to make the rating public and to sell a fraction $1 - x$ of the portfolio. The risk averse investors decide whether to buy the portfolio and the price they are willing to pay taking into account the accuracy of the rating and the subsequent effort incentives retained by the issuer.

  - **Stage 4:** The issuer chooses whether to expend costly effort $e$ or not.

  - **Stage 5:** The portfolio payoff is realized. If the portfolio defaults subsequent to a good rating, the CRA suffers a cost $\beta$. 
4 Analysis

I first describe the posterior distribution of $\hat{y}$ conditional on a bad and a good signal that the CRA receives. This exercise allows me to establish when a sale takes place.

The signal technology in (4) implies that a bad signal fully reveals the portfolio’s quality as bad, and hence we have $E[\hat{y}(e) \mid s = b] = 0$ regardless of the issuer’s subsequent effort. In this case, no sale takes place as the investors valuation of a bad portfolio is negative. Furthermore, the issuer does not expend costly effort, because effort improves final portfolio payoff only when the portfolio is good. Conditional on a good signal with accuracy $z$ and with the skin in the game requirement (R1) that ensures $e = 1$, the expected final portfolio value is given by

$$A(z) \equiv E[\hat{y}(e = 1) \mid s = g] = \frac{\lambda}{\lambda + (1 - \lambda)(1 - z)}$$  \hspace{0.5cm} (5)

Similarly, given (R1) the variance of the final portfolio payoff conditional on a good signal with accuracy $z$ takes the form

$$V(z) \equiv \text{Var}[\hat{y}(e = 1) \mid s = g] = \frac{\lambda(1 - \lambda)(1 - z)}{[\lambda + (1 - \lambda)(1 - z)]^2}$$ \hspace{0.5cm} (6)

From (5), it can be seen that a higher accuracy $z$ increases the expected portfolio payoff conditional on a good signal. It also follows from (6) that a higher accuracy reduces $\text{Var}[\hat{y} \mid s = g]$, the variance of the payoff conditional on a good signal. Therefore, an accurate good rating improves the risk averse investors’ valuation of the portfolio by increasing $E[\hat{y}]$ and reducing $\text{Var}[\hat{y}]$.

Using (5) and (6), one can describe the investors’ portfolio valuation conditional on a good rating. Given the retention requirement (R1) and conditional on a good rating with accuracy $z$, the investors value a fraction $(1 - x)$ of the portfolio at

$$p(z) = (1 - x)A(z) - a(1 - x)^2V(z)$$ \hspace{0.5cm} (7)

In determining $p(z)$, the investors correctly conjecture that the issuer expends costly effort and sets $e = 1$ given that the sale occurs with the retention requirement (R1) in place. The investors’ valuation $p(z)$ in (7) is increasing in rating accuracy $z$ with $p(z = 0) = p_0 < 0$ and $p(z = 1) = 1 - x > 0$. Therefore, $p(z) \geq 0$ only if the rating is sufficiently accurate. In particular, given (R1) the issuer pays a fee to make a rating public and sells a fraction $(1 - x)$ of the portfolio if and only if the CRA provides a sufficiently accurate good rating with $z \geq z_{\text{min}}$. The minimum rating accuracy $z_{\text{min}}$ required for a sale is explicitly derived in Appendix A.
CRA’s Problem: One can now formally state the CRA’s problem as follows. For a given accuracy $z$, the CRA observes a good signal with the ex ante probability

$$\phi(z) \equiv \Pr(s = g) = \lambda + (1 - \lambda)(1 - z). \quad (8)$$

A higher signal accuracy $z$ reduces the ex ante probability of obtaining a good signal and providing a good rating. The CRA posts a fee $\pi$ and chooses a signal accuracy $z$ to maximize its ex ante expected profit

$$\Psi(z, \pi) \equiv \begin{cases} \phi(z)\pi - C(z) - (1 - \lambda)(1 - z)\beta & \text{for } z \geq z_{\text{min}} \\ 0 & \text{otherwise.} \end{cases} \quad (9)$$

subject to the issuer’s participation constraint for soliciting a rating, which is given by

$$\phi(z)[p(z) - \pi + xA(z) - xL - c] + (1 - \phi(z))(-L) \geq \lambda - L - c \quad (10)$$

In the above problem, the CRA’s expected profit $\Psi(z, \pi)$ in (9) incorporates the observation that the CRA receives the fee $\pi$ only when the rating is good and sufficiently informative ($z \geq z_{\text{min}}$) as the investors do not buy the portfolio otherwise. In writing the CRA’s expected profit in (9), the cost of producing a signal with accuracy $z$ is denoted by $C(z)$, and the term $(1 - \lambda)(1 - z)\beta$ stands for the CRA’s expected reputational cost.

The issuer’s participation constraint in (10) indicates that the sale takes place with the probability $\phi(z)$ given by (8). In this case the issuer pays the rating fee $\pi$ and receives the price $p(z)$ described in (7) for selling a fraction $(1 - x)$ of the portfolio. After this sale, the issuer retains a stake $x$ that he/she values at $xA(z)$ and incurs the liquidity cost $xL$. The skin in the game requirement in (R1) ensures that the issuer expends effort ($e = 1$), and incurs the effort cost $c$. With probability $(1 - \phi(z))$, the CRA provides a bad rating, fully reveals that the portfolio is bad and yields zero payoff regardless of the issuer’s effort. In this case, no sale takes place, the issuer does not pay a rating fee but incurs the full liquidity cost $L$. Furthermore, the issuer does not expend effort, as the portfolio is revealed to be bad. The right hand side of (10) captures the issuer’s ex ante payoff $\lambda - L - c$ from not soliciting a rating. Without a rating, the issuer retains the whole portfolio at a liquidity cost $L$ and expends effort, because $\lambda\Delta - c > 0$ and hence it is optimal to set $e = 1$ under full retention.

CRA’s Fee for a Rating: The monopolistic CRA’s fee $\pi$ can now be derived by using the issuer’s participation constraint in (10). The CRA sets the fee such that the

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22 This property follows from the signal technology in (4). In Section 5, I consider an alternative signal technology that allows for symmetric errors and illustrate that this property does not always follow.
issuer is ex ante indifferent between soliciting a rating or not, and (10) holds as an equality. Substituting the price \( p(z) \) from (7) into (10) yields

\[
\phi(z)[A(z) - (1 - x)^2 aV(z) - \pi - xL - c] + (1 - \phi(z))(-L) = \lambda - L - c. \tag{10a}
\]

From (5) and (8), one can note that \( \phi(z)A(z) = \lambda \). Hence, the above expression can be simplified as

\[
\phi(z)[\pi - (1 - x)L - a(1 - x)^2V(z)] = (1 - \phi(z))c \tag{10b}
\]

Solving for \( \pi \) yields the CRA’s endogenous rating fee which is stated below.

**Proposition 1** The CRA’s fee schedule \( \pi(z) \) is given by

\[
\pi(z) = \begin{cases} 
(1 - x) \left[ L - a(1 - x)V(z) \right] + \frac{(1 - \phi(z))c}{\phi(z)} & \text{for } z \geq z_{\text{min}} \\
0 & \text{otherwise.} \end{cases} \tag{11}
\]

where \( \phi(z) \equiv \Pr(s = g) = \lambda + (1 - \lambda)(1 - z) \).

**Proof:** Follows from (10b).

Provided that the rating has sufficient accuracy \( z \geq z_{\text{min}} \), the rating fee is driven by (i) the issuer’s surplus from selling a fraction \((1 - x)\) of the portfolio and, (ii) the issuer’s expected effort cost savings given the possibility of learning that the portfolio is bad. The first fee component

\[
(1 - x) \left[ L - a(1 - x)V(z) \right] \tag{11a}
\]
captures the issuer’s surplus from the sale. The monopolistic CRA’s fee in (11) completely extracts this surplus from sale. Although the portion \((1 - x)L\) of the surplus is independent from the CRA’s rating’s accuracy \( z \), the total surplus from sale is increasing in \( z \), as the investors’ risk aversion discount \( a(1 - x)^2V(z) \) is decreasing in \( z \). The intuition for the fee component

\[
\frac{(1 - \phi(z))c}{\phi(z)} \tag{11b}
\]
follows from the observation that if the CRA provides a bad rating, no sale takes place, but the issuer does save the effort cost \( c \). As the CRA provides a bad rating with probability \( 1 - \phi(z) \), the issuer’s ex ante expected rent due to the ability to save the effort cost is given by \((1 - \phi(z))c\). The CRA is only paid for a good rating, which occurs with probability \( \phi(z) \). Therefore, the CRA can extract this additional rent by increasing its fee by the amount given in (11b). This second fee component is also strictly increasing in the rating’s accuracy \( z \), as \( \phi(z) \) is decreasing in \( z \). To summarize, the endogenous fee
\( \pi(z) \) in (11) is increasing in the CRA’s rating accuracy \( z \) because (i) the investors’ risk aversion discount is decreasing in \( z \) and (ii) a more accurate rating standard detects a bad portfolio more frequently and saves the issuer the effort cost \( c \). The portion \( (1-x)L \) of the CRA’s fee, however, is independent from the rating’s accuracy \( z \).

**Optimal Rating Accuracy:** I now analyze the CRA’s optimal choice of rating accuracy \( z \). To describe the CRA’s trade-off in choosing \( z \), let us rewrite the CRA’s expected profits in (10) as

\[
\Psi(z) = \phi(z)\pi(z) - C(z) - (1-\lambda)(1-z)\beta \quad \text{for} \quad z \geq z_{\text{min}}.
\]  

(12)

By increasing its accuracy \( z \), the CRA makes a good rating less likely and hence reduces the probability \( \phi(z) \) of receiving the fee. Higher accuracy also increases the CRA’s information acquisition cost \( C(z) \). At the same time, higher \( z \) increases the fee \( \pi(z) \) and reduces the CRA’s expected reputational cost. After substituting for \( \pi(z) \) and eliminating the terms that do not depend on \( z \), the CRA’s problem becomes choosing its accuracy level \( z \) to maximize

\[
(1-\lambda)[\beta + c - (1-x)L]z - \phi(z)a(1-x)^2V(z) - C(z)
\]  

(13)

subject to \( z \geq z_{\text{min}} \).

A closer examination of (13) reveals how various parameters of the model affect the CRA’s optimal accuracy choice. Not surprisingly, the first term in square brackets indicates that the reputational cost \( \beta \) pushes the CRA to increase its accuracy. The effort cost \( c \) that the issuer ends up saving subsequent to a bad rating also improves the CRA’s incentives for higher accuracy. The part of the surplus from sale that does not depend on accuracy, captured by the term \( (1-x)L \), reduces the CRA’s incentives for acquiring accurate information. In other words, the liquidity benefit \( (1-x)L \) that the issuer obtains from the sale dilutes the incentive effect of the reputational cost parameter \( \beta \). The second term in (13) is related to the risk aversion discount in the investors’ valuation and captures two effects. As mentioned, the CRA’s fee improves from a more accurate rating given that the risk aversion discount is decreasing in \( z \). At the same time, higher accuracy reduces the probability that the sale takes place, which is captured by the term \( \phi(z) \).

It follows from (13) that the CRA’s optimal accuracy choice \( z^* \) is decreasing in the issuer’s liquidity saving \( L \) from the sale. This observation suggests that there is a threshold level of \( L \) beyond which the minimum accuracy constraint \( z \geq z_{\text{min}} \) becomes binding. The following Proposition describes the CRA’s optimal rating accuracy choice under the assumption that the information acquisition cost \( C(.) \) is not prohibitively high and
hence providing the minimum acceptable accuracy $z_{\text{min}}$ is feasible for the CRA, that is, $\Psi(z_{\text{min}}) \geq 0$.

**Proposition 2** There exists a threshold liquidity cost $\bar{L}$ such that (i) For $L \in (L, \bar{L})$, the CRA’s optimal accuracy $z^*$ solves

$$(1 - \lambda) [\beta + c - (1 - x)L] + \frac{\lambda(1 - x)^2aV(z)}{1 - z} = C'(z)$$

(ii) For $L \geq \bar{L}$, the CRA adopts the minimum acceptable rating accuracy $z_{\text{min}}$ provided that $\Psi(z_{\text{min}}) \geq 0$.

**Proof:** See the Appendix.

If the issuer’s liquidity cost exceeds $\bar{L}$, then the information acquisition incentives provided by the CRA’s reputational cost $\beta$ and other parameters of the model become mute. In this case, the CRA opts for providing the minimum acceptable rating accuracy $z_{\text{min}}$ provided that $\Psi(z_{\text{min}}) \geq 0$. The implicit equation that determines the endogenous threshold level $\bar{L}$ is described in the proof of the above Proposition.

It is useful to point out a similarity between the CRA’s optimal policy in Proposition 2 and those optimal policies described in Bolton et al. (2012) and Opp et al. (2013). In Bolton et al. (2012), the accuracy of the CRA’s information signal is fixed. The CRA’s optimal rating policy is determined by a trade-off between its reputational costs from lying versus the revenues that can be extracted from naive investors who take the rating at its face value. The existence of those naive investors provide the CRA with a fee component that is independent of the rating’s accuracy. This is somewhat similar to the role that the issuer’s liquidity benefit $L$ plays in my framework. Bolton et al. (2012) show that when the size of the naive investors is sufficiently large, the CRA inflates ratings. In Opp et al. (2013), the investors derive a regulatory benefit from a good rating which again provides a fee component for the CRA that is independent of the rating’s accuracy. When this regulatory benefit exceeds an endogenous threshold, their CRA stops information acquisition and engages in rating inflation. In that respect, the naive investors in Bolton et al. (2012), the regulatory benefits that investors derive from a good rating in Opp et al. (2013) and the issuer’s liquidity benefit $L$ in this paper play similar roles: they all provide the CRA with a fee component that is independent of the accuracy of the rating. When this fee component exceeds a certain endogenous threshold, the CRA reduces the information content of the rating.

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23 Opp et al (2013) also assume that the CRA’s cost of information acquisition is sufficiently low so that operating a rating agency is profitable. The proof of Proposition 2 in the Appendix illustrates the parameter requirements to ensure that this is the case.
Given my focus on the implications of the skin in the game regulation for the CRA’s information acquisition incentives, in what follows I consider the case when \( L \in (L, L) \) and hence the CRA’s optimal rating accuracy does respond to various factors in the model including the issuer’s skin in the game \( x \). Before endogenizing \( x \) using (R1), the Corollary below describes how, for a given \( x \), the CRA’s optimal rating accuracy \( z^* \) depends on \( x \) and the exogenous parameters of the model. For this comparative statics exercise, I assume that the CRA’s information acquisition cost has the specific functional form \( C(z) = k z^2 / 2 \) where \( k > 0 \) is a cost parameter.

**Corollary 1:** Suppose \( L \in (L, L) \). For a given issuer’s skin in the game \( x \), the CRA’s optimal rating accuracy \( z^* \) is

(i) increasing in issuer skin \( x \).

(ii) increasing in the CRA’s reputational cost \( \beta \).

(iii) decreasing in the CRA’s information acquisition cost parameter \( k \).

(iv) decreasing in the issuer’s liquidity cost \( L \).

(v) increasing in the issuer’s effort cost \( c \).

(vi) increasing in the investors’ coefficient of risk aversion \( a \).

**Proof:** See the Appendix

As illustrated in (13), the issuer’s liquidity benefit \((1 - x)L\) from the sale provides the CRA with a fee component that is independent of its rating accuracy. As a result, the fee component \((1 - x)L\) dilutes the incentive effect of the CRA’s reputational cost \( \beta \). More issuer skin in the game reduces this fee component and renders reputational considerations more important. As a result, the CRA acquires more precise information and increases its rating accuracy as a response to more issuer skin in the game. The reason why \( z^* \) is increasing in \( \beta \) but decreasing in \( L \) follows from a similar argument. The CRA acquires more accurate information as the investors’ coefficient of risk aversion increases. This relationship follows, because the investors’ risk aversion discount is decreasing in accuracy \( z \). More accurate ratings reduce the risk aversion discount and improve the investors’ portfolio valuation. Higher accuracy also increases the likelihood that the portfolio is revealed to be bad and the issuer saves the effort cost \( c \). As the CRA’s fee extracts this rent, the optimal rating accuracy is increasing in \( c \). Finally, as the CRA’s information acquisition cost parameter \( k \) increases, the CRA reduces its accuracy.

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**Endogenizing the Skin in the Game \( x \):** One can now endogenize the skin in the game requirement \( x \) described in (R1). In determining the fraction \( x \), the sole purpose of the regulator is to ensure that the issuer expends costly effort after the sale and improves portfolio value. It should be noted that forcing the issuer to retain a positive fraction in
the portfolio reduces the surplus from trade. Hence, the regulator sets \( x \) at the minimum level that satisfies (R1) and implements \( e = 1 \). In other words, the regulator reduces the surplus from trade only to the extent necessary to provide post sale effort incentives. Therefore, the condition in (R1) holds as an equality and \( x \) solves

\[
x \left( E[\tilde{y}(e = 1) \mid \sigma = 1] - E[\tilde{y}(e = 0) \mid \sigma = 1] \right) = c
\]

(15)

In the above expression, the expected portfolio payoff \( E[\tilde{y}(e)] \) is computed conditional on the event that a sale takes place, which is denoted by \( \sigma = 1 \). Recall from Lemma 1 that the issuer can proceed with a sale only if a good signal with sufficient accuracy \( (z \geq z_{\text{min}}) \) is observed. Hence, conditioning on \( \sigma = 1 \) is equivalent to conditioning on the CRA observing a good signal with \( z \geq z_{\text{min}} \). Furthermore, in setting \( x \) the regulator takes into account the CRA’s optimal accuracy choice preceding the sale as described in Proposition 2. The CRA’s optimal accuracy choice \( z^* \) itself depends on \( x \). For notational convenience, I refer to this choice as \( z^*(x) \). Using the payoff technology in (1), one can write

\[
E[\tilde{y}(e) \mid \sigma = 1] = E[\tilde{y}(e) \mid s = g] = \frac{\lambda(1 - (1 - e)\Delta)}{\lambda + (1 - \lambda)(1 - z^*(x))} \quad \text{for } e \in \{0,1\}.
\]

(16)

Combining (15) and (16) yields the following Proposition that describes the equilibrium skin in the game requirement.

**Proposition 3** Suppose \( L \in (L, \bar{L}) \) and hence \( z^*(x) \) is given by (15). The optimal skin in the game requirement \( x^* \) set by the regulator solves

\[
x \left( \frac{\lambda}{\phi(z^*(x))} \right) \Delta = c
\]

(17)

where \( \phi(z^*(x)) = \lambda + (1 - \lambda)(1 - z^*(x)) \).

**Proof:** Follows from substituting (16) into (15), and using the definition of \( \phi(z) \) in (8).

The left hand side of (17) captures the issuer’s expected payoff improvement from expending effort for the fraction \( x \) retained. The term \( \Pr(G \mid s = g) \) relates the CRA’s accuracy choice \( z^* \) to the issuer’s effort incentives. Because the issuer’s effort only improves the final portfolio payoff when the underlying portfolio is good, the accuracy of the CRA’s rating affects the issuer’s beliefs on the portfolio’s quality and hence the expected return from his effort. A more accurate good rating improves effort incentives as

\[
\Pr(G \mid s = g) = \frac{\lambda}{\lambda + (1 - \lambda)(1 - z^*(x))}
\]

(18)
is increasing in the CRA’s accuracy \(z^*(x)\). On the other hand, the CRA’s accuracy choice \(z^*(x)\) is itself increasing in \(x\). Hence, the equilibrium skin in the game requirement is determined through the feedback mechanism described in (17).

In the current framework, the CRA’s rating accuracy and the issuer’s skin in the game serve as substitute mechanisms to elicit effort: as the issuer becomes more optimistic about the portfolio’s quality as a result of a more accurate good rating, it takes a smaller stake to elicit effort. Therefore, those factors that improve the CRA’s rating accuracy should reduce the skin that the issuer is required to retain. The Corollary below describes the determinants of the equilibrium skin in the game \(x^*\). For this comparative statics exercise, I again assume that \(C(z) = kz^2/2\) where \(k > 0\).

**Corollary 2:** Suppose \(L \in (L_-, L_+)\). The equilibrium skin in the game requirement \(x^*\) is

(i) decreasing in CRA’s reputation cost \(\beta\).

(ii) increasing in the CRA’s information acquisition cost parameter \(k\).

(iii) increasing in the issuer’s liquidity cost \(L\).

(iv) decreasing in the investors’ coefficient of risk aversion \(a\).

(v) decreasing in the portfolio payoff improvement \(\Delta\) from issuer’s effort.

**Proof:** See the Appendix.

The comparative statics results for \(x^*\) with respect to \(\beta, k, L\) and \(a\) follow from the feedback effect of the CRA’s information acquisition behavior on the issuer’s belief \(\Pr(G \mid s = g)\) on portfolio quality. For example, the CRA’s optimal rating accuracy \(z^*\) is increasing in the CRA’s reputation cost \(\beta\). A more accurate good rating increases \(\Pr(G \mid s = g)\) and hence the expected payoff improvement from issuer’s effort. As a result, it takes a smaller issuer’s skin in the game to sustain effort incentives as \(\beta\) increases. Similarly, those factors that increase the CRA’s rating accuracy (lower liquidity cost \(L\) for the issuer, lower information acquisition cost \(k\) for the CRA and more investors’ risk aversion) reduce the equilibrium issuer skin in the game. Finally, it takes a smaller skin in the game to sustain effort incentives when the payoff improvement \(\Delta\) from expending effort is high.

5 Extensions

In this section, I consider three extensions: (i) symmetric errors in CRA’s signal technology, (ii) flat fee for the CRA instead of a rating contingent fee, and (iii) an alternative set-up with risk neutral investors. The analysis illustrates that the results are qualitatively robust with respect to these extensions. For brevity of exposition, most of the analysis for this section is presented in Appendix B.
5.1 Symmetric errors in signal technology

The CRA’s signal technology in (4) implies that the CRA can detect a good portfolio with probability one and can only make an error if the underlying portfolio is bad. Alternatively, one can also allow for symmetric errors and consider the following specification for the CRA’s signal technology:

\[ \Pr(s = g \mid \theta = G) = \Pr(s = b \mid \theta = B) = z \text{ where } z \in \left[\frac{1}{2}, 1\right]. \] (19)

According to (19), the CRA can now misidentify both a good and a bad portfolio with the same positive probability \((1 - z)\). In the above formulation, the accuracy of the CRA’s rating technology is again captured by the parameter \(z\). However, we now have \(z \in \left[\frac{1}{2}, 1\right]\) and the CRA’s information signal is completely uninformative when \(z = 1/2\). The CRA’s cost of information acquisition \(C(z)\) is convex and increasing for \(z \in (\frac{1}{2}, 1]\) with \(C(\frac{1}{2}) = 0\).

Under the signal specification in (19), one can again show that (i) a sale can only take place with a good rating with a minimum accuracy level \(z_{\text{min}}\), and (ii) the structure of the endogenous fee for the CRA is identical to the one derived in Proposition 1. These observations are formally stated in Appendix B. Furthermore, all the remaining results regarding the CRA’s optimal precision choice and the optimal retention rule for the issuer continue to hold provided that \(\lambda < 1/2\). This additional parametric restriction is required as when \(\lambda < 1/2\) a more accurate signal technology makes it less likely to disclose a good rating so that CRA’s trade-off in choosing its accuracy is preserved (see Appendix B).24

5.2 Flat rating fee

In the preceding analysis, the underlying payment regime implied that the CRA only received a fee for providing a good rating. One can consider an alternative regime in which the CRA receives a flat fee \(\pi_f\) regardless of the rating provided. In particular, suppose now that the CRA adopts a signal accuracy \(z\) and sets a flat fee \(\pi_f\). If the issuer solicits a rating, the CRA observes a signal, provides a good or a bad rating, but always receives the flat fee \(\pi_f\).

Under this regime, conditional on a good rating with accuracy \(z\) the investors still value a fraction \((1 - x)\) of the portfolio as in (7). Accordingly, a sale can again take place only if the CRA provides a good rating with sufficient accuracy \(z \geq z_{\text{min}}\) as in the main

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24The main concern regarding the rating industry is that the lax rating standards enabled the issuers to obtain favorable ratings too easily. Therefore, the more economically relevant scenario seems to be the one where a more accurate signal technology makes it less likely to receive a good rating.
analysis. With a flat fee, the issuer’s participation constraint in (10) for soliciting a rating takes the form

$$\phi(z)[p(z) + xA(z) - xL - c] + (1 - \phi(z))(-L) - \pi_f \geq \lambda - L - c$$  \hspace{1cm} (20)

In equilibrium, the CRA sets the flat fee $\pi_f$ to extract all the surplus. The equilibrium flat fee schedule $\pi_f(z)$ is then given by

$$\pi_f(z) = \begin{cases} \phi(z)(1 - x)[L - a(1 - x)V(z)] + (1 - \phi(z))c & \text{for } z \geq z_{min} \\ 0 & \text{otherwise.} \end{cases}$$  \hspace{1cm} (21)

where $V(z)$ and $\phi(z)$ are described in (6) and (8), respectively. It is immediate from the comparison of the above flat fee $\pi_f(z)$ in (21) with the rating contingent fee $\pi(z)$ in (11) that we have $\pi_f(z) = \phi(z)\pi(z)$. Therefore, the CRA’s expected fee is the same under both regimes. Whether the CRA is paid with a fee contingent on a good rating or a flat fee is hence immaterial for the CRA’s optimal information acquisition behavior and for the rest of my results (see Appendix B for further details).

### 5.3 An alternative set-up with risk neutral investors

As mentioned earlier, the assumption that the investors are risk averse is not essential for the analysis. This assumption allows me to describe, in a convenient manner, a setting in which the investors’ ex-ante portfolio valuation renders a sale impossible, unless the issuer receives a sufficiently accurate good rating from a CRA. In this section, I briefly describe an alternative setting which does not rely on investors’ risk aversion.

Following Opp et al. (2013), suppose that the investors are risk neutral, but due to rating contingent regulatory rules in place, they exogenously value a security with a good rating independently from its expected cash flow. Rating contingent regulation has been pervasive in the US prior to the financial crisis in 2007-2009, and can be found in bank capital requirements, investment class restrictions faced by regulated institutions and collateral requirements. The investors are routinely subjected to regulatory compliance costs which depend on whether the security they hold has a favorable rating from a "nationally recognized" CRA.25

To incorporate these considerations, as in Opp et al. (2013) suppose that due to exogenously imposed regulatory compliance costs, the investors’ initial valuation of a

25For example, in the United States regulated financial institutions such as pension funds are only allowed to purchase investment grade securities (see White (2010)). There is ample evidence that favorable credit ratings are valuable to investors not only because they contain valuable information, but also due to the regulatory privileges that they provide (see Weber and Darbellay (2008), White (2010), Kisgen and Strahan (2010), Stanton and Wallace (2012), Bongaerts et al. (2012) among others).
fraction \((1 - x)\) of an "unrated" portfolio is given by

\[
p_0 \equiv (1 - x)(E[\tilde{\partial}(\hat{\partial} = 1)] - v_n) = (1 - x)(\lambda - v_n) \tag{22a}
\]

where \(v_n\) is the regulatory compliance cost of holding the whole unrated portfolio. Suppose further that \(v_n > \lambda\) and hence \(p_0 < 0\). Therefore, the investors' initial valuation precludes the sale of an unrated portfolio. On the other hand, conditional on a good rating with accuracy \(z\), the investors value a fraction \((1 - x)\) of the portfolio at

\[
p(z) = (1 - x)(A(z) - v_g) \tag{22b}
\]

where \(v_g\) is the regulatory compliance cost for holding a security with a good rating and \(A(z)\) is again given by (5). Assume that a good rating lowers the regulatory compliance costs for investors and hence \(v_n > v_g\). Furthermore, consider the parametric configuration \(\lambda < v_g < L < v_n\) which is akin to (A1) and ensures that the issuer prefers to sell the whole portfolio rather than retaining it.

Under this configuration, one can show (see Appendix B) that a sale can only take place if a CRA provides a good rating with sufficient accuracy \(z_{\text{min}}\) and that the CRA's fee is given by

\[
\pi(z) = \begin{cases} 
(1 - x)(L - v_g) + \frac{(1 - \phi(z))c}{\phi(z)} & \text{for } z \geq z_{\text{min}} \equiv \frac{v_g - \lambda}{1 - \lambda} > 0 \\
0 & \text{otherwise.}
\end{cases} \tag{22c}
\]

Following similar steps as in the main analysis, one can then endogenize the CRA's accuracy \(z\) and the optimal retention rule \(x\) to arrive at qualitatively identical results.

### 6 Implications

**Effect of skin in the game on rating accuracy:** The main motivation of this paper is to investigate the implications of the skin in the game regulation in the Dodd-Frank Act for the rating accuracy of a CRA. The analysis illustrates that a skin in the game requirement which aims to align the interests of the issuers with those of the investors by mitigating a moral hazard problem can also improve a CRA's rating accuracy. When choosing its accuracy, the CRA's trade-off in the model is between ensuring that the sale takes place by adopting a lax rating standard versus the expected reputational costs from providing an inaccurate rating. The skin in the game regulation imposed on the issuer affects this trade-off in favor of more accuracy by restricting the surplus that CRA can extract from the sale. Accordingly, the model provides the following implication.
Implication 1: *The proposed skin in the game requirements for issuers can improve the rating accuracy of a CRA involved in the sale.*

An important aim of the skin in the game regulation is to reduce the issuers’ appetite for high volume loan origination and securitization deals. The analysis illustrates that the skin in the game requirements for issuers can also reduce a CRA’s fees from certifying these deals and improve rating accuracy. The underlying mechanism for the above implication is somewhat similar to the hypothesis in some empirical papers which suggests that the CRAs apply more stringent standards to those issuers who pay less. For example, Cornaggia et al. (2014) find empirical evidence that rating inflation increases with revenues by asset class. He et al. (2012) document that rating inflation is more pronounced among the CRA’s largest clients. Interestingly, the European regulators have not taken similar steps towards adopting retention requirements for issuers. The unilateral adoption of issuer skin in the game requirements in the U.S. could provide cross-country variation in terms of regulatory standards and might allow for a direct empirical assessment of the impact of this regulation on the accuracy of ratings.

Effect of asset complexity on issuer’s skin in the game: The analysis relates the optimal skin in the game requirement to various parameters of the CRA’s information acquisition problem. This exercise builds a novel link between the complexity of the underlying security being rated and the issuer’s optimal skin in the game requirement. If one expects the CRA’s information acquisition costs to be increasing in the complexity of the underlying security, the analysis implies that the issuers should be required to retain a larger skin in complex financial products such as Collateralized Debt Obligations (CDOs).

Implication 2: *The issuer’s skin in the game requirement should be increasing in the complexity of the underlying security.*

The above relationship between asset complexity and the issuer’s skin in the game does not rely on an assumption that complex financial securities are subject to a more severe moral hazard problem. Rather, the predicted relationship follows in the model because the issuer’s skin in the game and the CRA’s rating accuracy are substitute mechanisms for providing post-sale effort incentives to the issuer. The expected benefit from expending effort depends on the portfolio’s unknown quality. Therefore, the issuer’s effort decision relies on the informativeness of the CRA’s rating. It takes a smaller skin in the game to sustain effort incentives after the issuer obtains a more accurate good rating. If the CRA’s information acquisition costs are higher and hence its ratings are less accurate for complex financial securities, eliciting effort should require a larger skin in the game as the asset complexity increases.
The current skin in the game requirements proposed in the Dodd-Frank Act mandate the retention of a 5% skin in the security regardless of any security characteristics. Under the proposed rule, the so-called "qualified residential mortgages" (QRMs) are exempt from any retention requirements. The rule also permits the QRMs to be combined in asset pools with non-qualifying commercial real estate, automobile and credit card loans, and allows for these blended pools to be eligible for a reduced retention requirement which cannot be less than 2.5% (see Levitin (2011) and Greenberg-Traurig (2013)). The results in this paper suggests that a more nuanced retention requirement which accounts for the complexity of the different security classes can be beneficial from an optimal regulation perspective, rather than the current "one size fits all" rule in place.

Proposed liability rules for CRAs and the issuer’s skin in the game: The model suggests that the issuer’s optimal skin in the game should be decreasing in the CRA’s reputation cost (Corollary 2). This relationship again follows because the issuer’s skin in the game and the CRA’s rating accuracy serve as substitute mechanisms for eliciting effort. As the CRA provides more accurate ratings due to higher reputational costs, less issuer’s skin in the game is required to sustain effort incentives.

Although the model introduces the CRA’s cost for providing an inaccurate rating as a reputational cost, the same cost parameter $\beta$ can also be interpreted as a liability cost. With this alternative interpretation, the CRA suffers a liability cost $\beta$ when a good rating proves to be inaccurate. For example, the credit rating agency Standard & Poor’s recent settlement with the U.S. Department of Justice to compensate the federal government and the states for the money that they lost on mortgage-backed securities during the financial crisis can be seen as an example of a liability cost. This interpretation builds an interesting link between the skin in the game regulation and the attempts in the Dodd-Frank Act to make CRAs liable for providing inaccurate ratings. Historically, CRAs have been immune to civil and criminal liability in the United States as they have successfully defended themselves against the threat of litigation by arguing that their credit ratings are basically ‘published opinions’ protected under the First Amendment of the U.S. Constitution (see Partnoy (2006), Darbellay (2013)). The Dodd-Frank Act seeks to remove this special treatment of CRAs and make them more accountable. In particular, under the amendment of Securities Exchange Law of 1934, the Dodd-Frank

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26For example, Standard and Poor’s recent settlement with the US Department of Justice for 1.38 billion dollars to compensate the federal government and the states for the money that they lost on mortgage-backed securities during the financial crisis can be seen as a liability cost.

27This settlement for the amount of $1.38 billion also resolved the lawsuits filed by the Attorneys General of 19 States and the District of Columbia, most of which were filed in early 2013 following the Department of Justice lawsuit filed in February 2013. (see the recent Forbes article on March 2nd, 2015 by Daniel Fisher titled "Standard & Poor’s Settlement Shows Futility Of Fighting Government Policy").
Act facilitates litigation against a CRA on the basis of negligence.\textsuperscript{28} The regulators have also attempted to facilitate the litigation of CRAs under the expert liability clause in Section 11 of the Securities Exchange Act of 1933.\textsuperscript{29}

According to the model, the introduction of a liability rule that makes CRAs more accountable for their inaccurate ratings also has implications for the optimal skin in the game regulation. A more strict liability rule would imply an exogenous increase in the CRA’s cost from providing an inaccurate rating (higher $\beta$) and improve rating accuracy. As the issuer’s skin in the game and CRA’s rating accuracy are substitute mechanisms for eliciting effort, a more strict liability rule for CRAs would imply less stringent issuer skin in the game regulation. Therefore, the analysis delivers the following policy implication.

**Implication 3:** The introduction of a more strict liability rule that punishes CRAs for inaccurate ratings should be accompanied by a reduction in issuers’ skin in the game requirement.

**Effect of issuer’s liquidity demand on rating accuracy:** Although independent from the paper’s main focus on skin in the game regulation, another implication that follows from the model relates the CRA’s rating accuracy to the issuer’s liquidity benefits from securitization. In the model, the issuer’s liquidity cost for retaining the portfolio provides the CRA with a fee component that is independent of the accuracy of the rating. In a sense, this liquidity cost captures the issuer’s eagerness to pay for a good rating regardless of its accuracy just to be able to proceed with the sale of the portfolio. Accordingly, the model predicts that the CRA’s rating accuracy is decreasing in the liquidity benefits that issuers capture from securitization.

**Implication 4:** The CRA’s rating accuracy is inversely related to issuer’s liquidity benefits from securitization.

The issuer’s liquidity benefit in the model is motivated by the desire to redeploy capital in alternative investment opportunities. One could expect that the availability and profitability of such alternative opportunities are closely linked to the business cycle fluctuations. In particular, the issuers are more likely to pursue capital redeployment and originate new loans during boom times. Hence, the issuer’s liquidity benefits from securitization might be larger during boom cycles. This interpretation suggests that the predicted negative relationship between rating accuracy and the issuers’ liquidity benefits is akin to those found in Bolton et al. (2010) and Bar-Isaac and Shapiro (2012). These papers show that rating accuracy is countercyclical. On the empirical side, Ashcraft et

\textsuperscript{28}See Dodd-Frank Act, Section 933(b).

\textsuperscript{29}However, the provision that aims to include expert liability may have reached an impasse. This provision requires the issuers to seek the written consent of CRAs to include the ratings in their registration statements, and CRAs have refused to give this consent to avoid potential liability (see Darbellay (2013)).
al. (2010) find that as the volume of mortgage backed security issuance peaked from 2005 to mid 2007, the accuracy of ratings declines. Similarly, Griffin and Tang (2012) report a sudden improvement in rating standards in April 2007 just before the start of the recession. The liquidity benefit driven securitization framework in this paper suggests that the widespread availability and profitability of alternative investment opportunities during the boom cycle might have reduced rating standards by increasing the issuer’s liquidity benefits from securitization.

An alternative interpretation is that due to negative balance sheet shocks some issuers might enjoy larger liquidity benefits from loan sales. Titman and Tsyplakov (2010) find that those commercial real estate mortgages originated by institutions with large negative stock returns prior to origination tend to have higher default rates and are sold into Commercial Mortgage Backed Securities (CMBS) pools more quickly after origination. Faltin-Traeger et al. (2011) find strong evidence that the securitizations sponsored by better capitalized, more diversified, or vertically integrated issuers perform better and are less likely to be downgraded. They also find that the issues sponsored by banks tend to be downgraded later than those sponsored by non-bank entities holding less liquid assets.

7 Alternative rationales for skin in the game

To provide a rationale for skin in the game regulation, I have considered a moral hazard problem in which the issuer expends effort to improve asset payoff after the sale of the asset. The existing literature provides two other justifications for issuers to retain a skin in the game, (i) retention to signal private information and (ii) retention to mitigate an ex ante moral hazard problem where the issuer exerts effort to improve asset quality before the sale. Below, I briefly discuss the implications of these two alternative rationales in my framework.

**Signaling private information through retention:** Suppose the portfolio’s quality (good or bad) is the issuer’s private information, the good issuers can use retention of a stake in the portfolio to signal to the investors that the portfolio is good. In that setting, it is well known that skin in the game can serve as a costly signal of quality, given that it is more costly to retain a bad portfolio (See Leland and Pyle (1977), DeMarzo and Duffie (1999), DeMarzo (2005)). Such a setting may not be ideal to study the implications of regulatory skin in the game requirements for the rating accuracy of a CRA. There are two reasons. First, a costly signaling mechanism involves voluntary retention rather than a regulatory rule imposed by a regulator: there is room for a regulatory skin in the game rule only when privately optimal retention levels are socially suboptimal. Second,
and perhaps more crucially, in an equilibrium where a good issuer signals its quality through retaining a skin, information production by a third party such as a CRA might be redundant. If the investors learn about portfolio quality from the stake that the issuer retains, the role of a CRA who produces information on portfolio quality and reveal it to investors through a rating would be quite limited, if not completely moot. Therefore, a moral hazard setting, rather than a signaling one, seems to be a better fit to study the impact of skin in the game regulation for the accuracy of a CRA.

**Pre-sale effort:** Another way to justify the skin in the game regulation is to consider an alternative moral hazard setting and allow the issuer to exert effort to improve portfolio payoff *prior to the sale* of the loan portfolio (see Chemla and Hennessy (2013) and Rajan et al. (2010)). As argued in Section 2, the pre-sale effort setting is more akin to screening of loan applicants to improve portfolio quality at the origination stage, whereas the post-sale effort setting is more applicable to monitoring of loan recipients to improve the odds of repayment after the loan is originated.

For the focus of this paper, an important difference between the pre-sale and post-sale effort frameworks is concerned with the manner that the CRA’s rating affects the issuer’s effort choice. In my model, the issuer’s post-sale effort decision relies on the information provided by the rating. When the effort is undertaken before the sale, however, the issuer’s effort choice can not rely on any information from the CRA. Rather, the issuer’s pre-sale effort incentives would be driven by how much surplus the issuer captures in the subsequent rating stage. To see this point, suppose, as in the current framework, that the monopolistic CRA sets the rating fee to push the issuer down to its reservation payoff and extracts all the surplus from sale. This reservation payoff would be given by the issuer’s expected payoff from retaining the whole portfolio. At the origination stage, the issuer would then anticipate that soliciting a rating would yield the same expected payoff as full retention. Therefore, for any retention level the issuer’s pre-sale effort choice would be the same as the effort decision under full retention. The issuer’s skin in the game requirement would be irrelevant in a pre-sale effort setting when a monopolistic CRA extracts all the surplus from sale at the subsequent rating stage.

The above observation suggests that a satisfactory analysis with pre-sale effort would require a bargaining framework in which the surplus from the sale are shared between

\[30\] Chemla and Hennessy (2013) show that an optimal mandatory skin in the game scheme for promoting issuer effort at the origination stage can do so by increasing the spread between payoffs to high and low types at the loan sale stage. In their setting, the mechanism that provides the investors with information on portfolio quality is again costly signaling through retaining a skin in the game. Therefore, information acquisition and ratings by a CRA can at best play a limited role in their separating regulatory equilibrium. Rajan et al. (2010) show that the issuer expends pre-sale effort only if the exogenous loan sale probability is below a certain threshold. They assume each loan is sold with an exogenous probability and do not consider the involvement of a CRA in the sale.
the issuer and the CRA. Although such an analysis is outside the scope of this paper, one could expect that the main insights of the current analysis continue to be valid. Provided that the issuer receives a sufficient portion of the surplus from the subsequent sale and hence can sustain pre-sale effort incentives through retention of a stake, the issuer’s skin in the game would again reduce the rents that the CRA captures regardless of its rating accuracy. As a result, the insight that the issuer’s skin in the game improves the CRA’s rating accuracy could also extend to a setting in which the issuer exerts effort before the sale.

8 Conclusion

This paper considers the implications of the "issuer skin in the game" requirements proposed in the Dodd-Frank Act of 2010 for the information acquisition incentives of a CRA. The model features an issuer who seeks the sale of a risky loan portfolio for liquidity reasons. The final portfolio payoff depends on the portfolio’s unknown type and unobservable effort expended by the issuer. The aim of skin in the game regulation is to ensure that the issuer expends payoff enhancing effort subsequent to any sale. Due to the ex-ante valuation of the risk averse investors, a sale can only take place if an information intermediary such as a CRA produces and reveals information on the portfolio’s quality through a rating. In this setting, the paper analyzes how the equilibrium rating accuracy of the CRA and the skin in the game rule imposed on the issuer are jointly determined.

The analysis contributes to the existing literature on CRA incentives by relating the CRA’s optimal rating accuracy to a regulatory retention rule and the specifics of the moral hazard problem that gives rise to this regulatory rule. For a given skin in the game rule, I show that the CRA’s optimal rating accuracy is increasing in the portfolio fraction that the issuer retains. This result suggests that, as well mitigating a moral hazard problem on the issuer’s side, the proposed skin in the game requirements can also improve the rating accuracy of a CRA involved in the sale. The CRA’s rating accuracy is also shown to be decreasing in the issuer’s liquidity benefit from sale, increasing in the issuer’s effort cost and increasing in the investors’ risk aversion.

The regulator sets the equilibrium skin in the game rule by taking into account the CRA’s subsequent optimal rating policy. The reliance of the issuer’s effort decision on the accuracy of the rating gives rise to an interesting feedback effect. A novel insight of the analysis is that the issuer’s skin in the game and the CRA’s rating accuracy are substitute mechanisms for eliciting post-sale effort from the issuer. In contrast to the current "one size fits all" retention rule, the results suggest that the issuer’s skin in the game
requirement should be increasing in the complexity of the underlying security. Another policy implication of the model is that the planned introduction of more strict liability rules that facilitate the litigation of CRAs for inaccurate ratings should be accompanied by a reduction in skin in the game requirements for issuers.

To keep the model tractable and focus on the interaction between a regulatory retention rule and third party information production by a CRA, I have considered a setting with a monopolistic CRA. Incorporating competition between CRA’s could produce further insights. Finally, as mentioned in Section 6, another way to justify the skin in the game regulation is to consider a different moral hazard problem and allow the issuer to exert effort prior to the sale of the loan portfolio. These are left for future research.

9 Appendix A

Derivation of the minimum rating accuracy $z_{\text{min}}$ that ensures a sale: Consider the portfolio valuation $p(z)$ in (7). Substituting for $A(z)$ and $V(z)$ from (5) and (6) yields

$$p(z) = \left(\frac{(1-x)\lambda}{\lambda + (1-\lambda)(1-z)}\right) \left[1 - \frac{a(1-x)(1-\lambda)(1-z)}{(\lambda + (1-\lambda)(1-z))}\right] \quad (22)$$

Requiring $p(z) \geq 0$, one obtains that the risk averse investors’ valuation is positive if and only if

$$p \geq 0 \iff z \geq z_{\text{min}} \equiv \frac{a(1-\lambda)(1-x) - 1}{(1-\lambda)(a-1)} > 0 \quad (23)$$

where $z_{\text{min}} > 0$ follows from the fact that $p(z = 0) = p_0 < 0$ and $p(z = 1) = 1 - x > 0$.

One also needs to ensure that the issuer is better off from selling the fraction $(1-x)$ of the portfolio at $p(z)$ for $z \geq z_{\text{min}}$ rather than retaining all of it. This condition can be written as

$$\left(1-x\right)A(z) - a(1-x)^2V(z) + x\left(A(z) - L\right) - c \geq A(z) - L - c$$

(24)

Simplifying, the above condition becomes

$$\left(1-x\right)(L - a(1-x)V(z)) \geq 0 \quad (25)$$

which is always satisfied given (A1).
**Proof of Proposition 2:** Consider the CRA’s optimization problem described in (13). The CRA chooses \( z \) to maximize

\[
(1 - \lambda) [\beta + c - (1 - x)L] z - \phi(z) a (1 - x)^2 V(z) - C(z)
\]

subject to \( z \geq z_{\text{min}} \). As the liquidity benefit \((1 - x)L\) that the issuer obtains from sale dilutes the incentive effect of the reputational cost parameter \( \beta \), the CRA faces less incentives to acquire precise informations as \( L \) increases. The first order condition for the unconstrained optimization problem reads

\[
(1 - \lambda) [\beta + c - (1 - x)L] + a (1 - x)^2 \frac{d}{dz} [\phi(z^*) V(z^*)] - C'(z^*) = 0
\]

which implies that the solution \( z^* \) is strictly decreasing in \( L \). For notational convenience, let us denote the solution to the above first order condition with \( z^*(L) \). Due to the continuity and strict monotonicity of the unconstrained solution \( z^*(L) \), there exists a threshold value \( \bar{L} \) defined as \( z^*(\bar{L}) \equiv z_{\text{min}} > 0 \) such that for \( L \geq \bar{L} \), the constrained optimum is given by \( z_{\text{min}} \) provided that \( \Psi(z_{\text{min}}) \geq 0 \). For \( L \in (\bar{L}, \tilde{L}) \), the constraint \( z \geq z_{\text{min}} \) is not binding, and hence the CRA’s optimal accuracy choice is described by (27) from which one obtains (14). Finally, we have

\[
\Psi(z_{\text{min}}) = \frac{a [\lambda + (1 - \lambda)]} {a - 1} \left[ (1 - x)L - c - \beta \right] - a^2 x (1 - x)^2 + \beta \lambda - c - C(z_{\text{min}})
\]

which is positive when \( C(z_{\text{min}}) \) is not prohibitively high. This follows because \( z_{\text{min}} \) is the solution when \( L \geq \bar{L} \) and hence \((1 - x)L - c - \beta > 0\).

**Proof of Corollary 1:** The CRA’s maximization problem in (13) yields the following first order condition

\[
\Omega(z) \equiv (1 - \lambda) [\beta + c - (1 - x)L] + \frac{\lambda (1 - x)^2 a V(z)} {1 - z} - C'(z) = 0
\]

as described by (14) in the text. Since we have \( \frac{d\Omega}{dz} < 0 \) due to the strict concavity of the problem, for a given \( x \) the total differentiation of the above first order condition yields the following:

\[
\frac{dz^*}{dx} = \frac{-(1 - \lambda)L - \frac{2\lambda(1-x)aV(z)} {1-z}} {\frac{d\Omega}{dz}} > 0.
\]

(30)

\[
\frac{dz^*}{d\beta} = \frac{dz^*}{dc} = \frac{-(1 - \lambda)} {\frac{d\Omega}{dz}} > 0.
\]

(31)

\[
\frac{dz^*}{dL} = \frac{(1 - \lambda)(1 - x)} {\frac{d\Omega}{dz}} < 0.
\]

(32)
\[
\frac{dz^*}{da} = -\left(\frac{\lambda(1-x)^2V(z)}{1-z}\right) \frac{d\Omega}{dz} < 0.
\] (33)

Finally, using the functional specification \(C(z) = kz^2/2\) we have

\[
\frac{dz^*}{dk} = \frac{z}{d\Omega/dz} < 0.
\] (34)

**Proof of Corollary 2:** Given the comparative statics results in Corollary 1 for \(z^*\) with respect to \(x, \beta, L\) and \(a\), one can differentiate (17) to obtain

\[
\frac{dx}{d\Delta} = \frac{-\lambda x}{[\lambda \Delta + c(1-\lambda)\frac{dz^*}{dx}]} < 0 \text{ because } \frac{\partial z^*}{\partial x} > 0.
\] (35)

\[
\frac{dx}{d\beta} = \frac{-c(1-\lambda)\frac{dz^*}{d\beta}}{[\lambda \Delta + c(1-\lambda)\frac{dz^*}{dx}]} < 0 \text{ because } \frac{\partial z^*}{\partial \beta} > 0.
\] (36)

\[
\frac{dx}{dL} = \frac{-c(1-\lambda)\frac{dz^*}{dL}}{[\lambda \Delta + c(1-\lambda)\frac{dz^*}{dx}]} > 0 \text{ because } \frac{\partial z^*}{\partial L} > 0.
\] (37)

\[
\frac{dx}{da} = \frac{-c(1-\lambda)\frac{dz^*}{da}}{[\lambda \Delta + c(1-\lambda)\frac{dz^*}{dx}]} < 0 \text{ because } \frac{\partial z^*}{\partial a} > 0.
\] (38)

10 Appendix B

10.1 Symmetric errors in signal technology

Under the specification in (19), the ex ante probability that the CRA observes a good signal is now given by

\[
\phi_g(z) \equiv \Pr(s = g) = \lambda z + (1-\lambda)(1-z) = (1-\lambda) + (2\lambda - 1)z
\] (39)

Furthermore, we have

\[
E[\tilde{y}(e = 1) \mid s = g] = \frac{\lambda z}{(1-\lambda) + (2\lambda - 1)z}
\] (40)

\[
V_g(z) \equiv Var[\tilde{y}(e = 1) \mid s = g] = \frac{\lambda(1-\lambda)z(1-z)}{[(1-\lambda) + (2\lambda - 1)z]^2}
\] (41)
For ease of reference, let us first write down the conditional expectation and variance of the final portfolio payoff given a good and a bad signal when (R1) is in place and hence $e = 1$. With the signal technology in (19), we have

$$\phi^g(z) \equiv \Pr(s = g) = \lambda z + (1 - \lambda)(1 - z)$$

$$\phi^b(z) \equiv \Pr(s = b) = (1 - \lambda)z + \lambda(1 - z)$$

$$A^g(z) \equiv E[\hat{g}(e = 1) \mid s = g] = \frac{\lambda z}{\phi^g(z)} > \lambda \text{ for } z > \frac{1}{2}.$$  

$$A^b(z) \equiv E[\hat{g}(e = 1) \mid s = b] = \frac{\lambda(1 - z)}{\phi^b(z)} < \lambda \text{ for } z > \frac{1}{2}.$$  

$$V_i(z) \equiv \text{Var}[\hat{g}(e = 1) \mid s = i] = \frac{\lambda(1 - \lambda)z(1 - z)}{[\phi_i(z)]^2} \text{ for } i \in \{g, b\}.$$  

If the CRA provides a bad rating, the investors' valuation $p^b(z)$ for the fraction $(1 - x)$ of the portfolio is given by

$$p^b(z) = (1 - x)\frac{\lambda(1 - z)}{\phi^b(z)} \left(1 - \frac{a(1 - x)(1 - \lambda) z}{\phi^b(z)}\right) < 0$$

Hence, no sale takes place subsequent to a bad rating. If the CRA provides a good rating, the investors' valuation $p^g(z)$ for the fraction $(1 - x)$ of the portfolio takes the form

$$p^g(z) = (1 - x)\frac{\lambda z}{\phi^g(z)} \left[1 - \frac{a(1 - x)(1 - \lambda)(1 - z)}{\phi^g(z)}\right]$$

It follows that $p^g(z) \geq 0$ only when

$$z \geq \bar{z}_{\min} \equiv \frac{(a - 1)(1 - \lambda)(1 - x)}{a(1 - \lambda)(2\lambda - 1)} > \frac{1}{2}.$$  

One can now derive the CRA's rating fee. Under (19), the issuer's participation constraint now becomes

$$\phi^g(z)[p^g(z) - \pi + xA^g(z) - xL - c] + \phi^b(z)(A^b(z) - L) \geq \lambda - L - c$$

In equilibrium the above constraint holds as an equality. Using the expression for $p^g(z)$ above, the fact that $A^g(z)\phi^g(z) = \lambda z$ and $A^b(z)\phi^b(z) = \lambda(1 - z)$, one arrives at the following fee structure. Analogous to Proposition 1, for $z \geq \bar{z}_{\min}$ the CRA's fee $\pi(z)$
takes the form

\[
\pi(z) = (1 - x) \left[ L - a(1 - x)V_g(z) \right] + \frac{(1 - \phi_g(z)) c}{\phi_g(z)}
\] (51)

where \( \phi_g(z) \) is given by (39) and \( V_g(z) \) is given by (41).

For \( \lambda < 1/2 \), the rest of results continue to hold under the signal technology in (19) as well. In particular, there again exists a threshold value \( L^* \) such that for \( L \geq L^* \), the CRA adopts the minimum acceptable accuracy \( z_{\text{min}} \) in (49), whereas for \( L < L^* \) the optimal accuracy \( z^* \) solves

\[
\beta + (1 - 2\lambda)(c - (1 - x)L) + (1 - x)^2 a \frac{d}{dz} \left[ \phi_g(z^*) V_g(z^*) \right] = C'(z^*)
\] (52)

The comparative statics results in Corollary 1 can then be reproduced using the above first order condition. Denoting the optimal accuracy choice above with \( z^*(x) \), it can be shown that the equilibrium skin in the game requirement \( x^* \) set by the regulator now solves

\[
\frac{\lambda z^*(x)}{\phi_g(z^*(x))} \Delta = c
\] (53)

To see why the additional restriction \( \lambda < 1/2 \) is required, consider the CRA’s problem of choosing its optimal rating accuracy. The CRA’s ex ante expected profits take the form

\[
F(z) \equiv \phi_g(z) \pi(z) - C(z) - (1 - \lambda)(1 - z)\beta \text{ for } z \geq z_{\text{min}}
\] (54)

where \( \pi(z) \) is given by (51). Whether the CRA’s optimal accuracy choice above displays the same trade-off as in (13) depends crucially on the term \( \phi_g(z) \), the probability that the CRA provides a good rating. Given (39), the probability \( \phi_g(z) \) is decreasing in accuracy \( z \) for \( \lambda < 1/2 \), whereas it is increasing in \( z \) for \( \lambda > 1/2 \). Note that for \( \lambda > 1/2 \) and hence \( \phi_g(z) \) is increasing in accuracy \( z \), the CRA’s only incentive to reduce accuracy would come from its cost of accuracy \( C(z) \).

### 10.2 Flat rating fee

In both rating contingent and flat fee regimes, the expected surplus that the CRA extracts is the same and given by

\[
\phi(z)(1 - x) \left[ L - a(1 - x)V(z) \right] + (1 - \phi(z)) c
\] (55)
This surplus can be extracted either with the flat fee $\pi_f(z)$ in (21) or with the rating contingent fee $\pi(z)$ in (11). Under the flat fee, the CRA’s expected profits are given by

$$\Psi_f(z) \equiv \pi_f(z) - C(z) - (1 - \lambda)(1 - z)\beta$$ for $z \geq z_{\text{min}}$. (56)

Given $\pi_f(z) = \phi(z)\pi(z)$, the above expression is identical to the one that describes the CRA’s expected profits in (12). Therefore, the results derived in the main body of the paper continue to hold when the CRA is paid a flat fee $\pi_f$.

### 10.3 An alternative set-up with risk neutral investors

I first establish that, under the parametric restrictions $\lambda < v_g < L < v_n$, a sale can only take place if the issuer obtains a good rating from the CRA with sufficient accuracy. The restriction $\lambda - v_g < 0$ implies that the investors do not buy the loan portfolio based on a completely uninformative good rating. Under (R1) that ensures $e = 1$ and for a given rating accuracy $z$, the issuer is able to sell a fraction $(1 - x)$ of the portfolio if and only if the good rating is sufficiently informative and satisfies

$$p(z) \equiv (1 - x)(A(z) - v_g) = (1 - x)\left(\frac{\lambda}{\lambda + (1 - \lambda)(1 - z)} - v_g\right) \geq 0$$

$$\Rightarrow \quad z \geq z_{\text{min}} \equiv \frac{v_g - \lambda}{1 - \lambda}.$$ (57)

The condition $L > v_g$ ensures that the issuer purchases a sufficiently informative good rating and subsequently sells a fraction $(1 - x)$ of the portfolio rather than retaining the whole portfolio. This last observation follows since

$$\left(1 - x\right)(A(z) - v_g) + x\left(A(z) - L\right) > \left(A(z) - L\right)$$

$$\text{payoff from sale with a good rating} \quad \text{payoff from full retention with a good rating}$$ (58)

which holds for $L > v_g$.

The monopolistic CRA’s fee can now be derived by using the issuer’s participation constraint. The CRA sets the fee such that the issuer is ex ante indifferent between soliciting a rating or not. Substituting the price $p(z) \equiv (1 - x)(A(z) - v_g)$ into (10) yields

$$\phi(z)[A(z) - v_g - \pi - xL - c] + (1 - \phi(z))(-L) = \lambda - L - c.$$ (59)

Solving for $\pi$, one obtains the fee schedule in (22c). The remaining analysis to endogenize $z$ and $x$ follows the same steps as in the main analysis and yields qualitatively identical results. In particular, all the comparative static results in Corollaries 1 and 2 continue to hold without relying on investors’ risk aversion.
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