



Contents lists available at ScienceDirect

International Review of Economics and Finance

journal homepage: www.elsevier.com/locate/irefMoral hazard, skin in the game regulation and CRA performance[☆]Saltuk Ozerturk^{*}

Department of Economics, Southern Methodist University, USA

ARTICLE INFO

JEL classification:

G24
G28
L5
D83

Keywords:

Credit rating agencies
Skin in the game
Rating accuracy
Moral hazard
Financial regulation

ABSTRACT

This paper investigates the implications of the “issuer skin in the game” regulation for the rating accuracy of a credit rating agency (CRA). The analysis shows that, as well mitigating a moral hazard problem on the issuer's side, skin in the game requirements can also improve the rating accuracy of a CRA involved in the sale. The results also link the accuracy of the CRA's ratings to the severity of the issuer's moral hazard problem. A more nuanced skin in the game rule that accounts for the specifics of the underlying security class can be more desirable rather than the proposed “one size fits all” rule.

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

[☆] I am grateful to the Editor and an anonymous referee of this journal whose thoughtful comments considerably improved both the exposition and the content of the paper. I would also like to thank Heski Bar-Isaac, Hulya Eraslan, James Lake, Marcus Opp, Santanu Roy, Utku Unver and the participants at the Financial Regulation, Competition and Social Welfare session of the 13th International Industrial Organization Conference organized in Boston on April 24–26, 2015.

^{*} Southern Methodist University, Department of Economics, 3300 Dyer Street, Suite: 301, 75275 Dallas, TX, USA.

E-mail address: ozerturk@smu.edu.

¹ I 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.

² For example, the [Financial Crisis Inquiry Commission's Final Report \(2011\)](#) concludes that “this crisis could not have happened without the rating agencies.”

particular, a complete section (Section 15G) of the Dodd-Frank Act has been 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

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 issuers to exert costly monitoring effort and improve the asset payoff after the sale (see Pennacchi (1988), Gorton and Pennacchi (1995), Plantin (2011)); or to exert pre-sale screening effort to improve asset quality during the loan origination stage (see Chemla and Hennessy (2014), Rajan, Seru, and Vig (2010), Chemla and Hennessy (2014) 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 the existing 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 has not been studied. Given the emphasis on the role CRAs have 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 theoretically investigates how a retention rule imposed on an issuer affects a CRA's incentives to provide accurate ratings prior to the sale of a loan portfolio. The main result of the analysis is that a skin in the game requirement, which aims to mitigate a moral hazard problem on the issuer's side, can also improve the rating accuracy of a CRA involved in the sale.

The baseline model features a risk neutral issuer who seeks the sale of a loan portfolio with unknown quality (good or bad) for liquidity reasons.⁵ In this setting, the gains from trade arises due to the fixed and differential liquidity costs that the issuer and the investors incur from holding the portfolio until its maturity. The final portfolio payoff depends on the portfolio's unknown quality and also on whether the issuer expends 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 after a portfolio fraction is sold to the investors. The ex ante portfolio valuation of the investors, however, implies that a sale cannot take place unless the issuer provides the investors with more information on portfolio quality. 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 analysis shows that the sale takes place only if the CRA provides a good rating with sufficient accuracy. With such a rating, the issuer sells the permitted portfolio fraction in compliance with the retention rule and expends post-sale effort. Given the fixed liquidity costs for the issuer and the investors, the gains from trade is independent from the expected portfolio value at the time of the sale. A higher skin in the game requirement restricts the gains from trade and hence the fee that the CRA can secure by adopting a lax rating standard. Consequently, the accuracy of the CRA's ratings increases as the issuer retains more skin in the game.

In the baseline model, the result that establishes a positive link between the issuer's skin in the game and the CRA's rating accuracy is derived by assuming fixed liquidity costs for the issuer and the investors. Furthermore, the CRA's reputational considerations are specified through an exogenous reputation cost parameter. As a robustness check, I consider a modification to the baseline model in which (i) the liquidity costs of the issuer and the investors are represented by discount rates, and (ii) the CRA's reputation is endogenous. In this modified setting, the gains from trade and hence the fee that the CRA can extract are not fixed, but they are proportional to the expected portfolio value. I show that the main result continues to hold in this more general setting as well. Therefore, the result does not rely on fixed liquidity cost assumption when the CRA's reputation is endogenous. The key requirement to obtain the result is that the skin in the game regulation reduces the gains from trade and hence the CRA's fee from a good rating.

The analysis also endogenizes the skin in the game requirement and ties it to the specifics of the issuer's moral hazard problem. The results suggest that for those security classes in which the issuers face a less severe moral hazard problem, the CRA provides less accurate ratings. Although this observation should be interpreted with some caution, this potential link may help to provide additional clues to understand the variation in the CRA's rating accuracy across different asset classes. The analysis also illustrates that when the issuer's effort yields the same portfolio value improvement regardless of the portfolio's underlying quality, there is no feedback effect between equilibrium skin in the game rule and the CRA's rating accuracy. When the benefit from the issuer's effort does depend on the portfolio quality, however, there may be a potential feedback effect. If the issuer's effort is more payoff enhancing for a good portfolio, the skin in the game requirement and the CRA's rating accuracy serve as substitute mechanisms to elicit effort. If the issuer's effort is more beneficial for a bad portfolio, this feedback effect is reversed: the skin in the game requirement and the CRA's rating accuracy become complementary mechanisms to elicit effort.

These results can provide some new insights for the policy debate on reforming securitization markets and improving the rating performance of CRAs. An important aim of the proposed skin in the game regulation is to reduce the issuers' appetite for high volume loan origination and align their economic interests with those of investors. A novel observation that emerges from the analysis is that the retention requirements for issuers can also reduce CRA's fees from certifying high volume securitization deals and improve their rating

³ The 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.

⁴ See *Federal Register*, Volume 76, No:83, April 29, 2011.

⁵ This liquidity benefit justification for loan sales follows from Parlour and Plantin (2008, 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.

accuracy. Another potentially relevant observation is concerned with the “one size fits all” nature of the proposed skin in the game requirements. The proposals mandate the retention of a 5% skin in the security regardless of any security characteristics. The analysis suggests that, rather than a uniform rule, a more nuanced retention requirement that takes into account the underlying security class, the specifics of the issuer's moral hazard problem and the CRA's information acquisition problem might be warranted. These issues are discussed in Section 6.

The next section discusses the related literature. Section 3 presents the baseline model with fixed liquidity costs and exogenous CRA reputation. Section 4 includes the analysis and the main results. Section 5 presents a number of extensions by offering an alternative model with liquidation costs as discount rates and endogenous CRA reputation. Section 6 discusses the implications of some of the results. A discussion of alternative justifications for skin in the game regulation is included in Section 7. Section 8 concludes. The formal proofs that are not presented in the text can be found in the Appendix.

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.⁶ In terms of the research question raised, the closest paper to this one is [Opp, Opp, and Harris \(2013\)](#). 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.⁷ 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.⁸ 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.

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, Frexias, and Shapiro \(2012\)](#) 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, McAndrews, and Rochet \(2009\)](#) 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.

In other recent work, [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. [Kartasheva and Yilmaz \(2013\)](#) revisit [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. [Fulghieri, Strobl, and Xia \(2014\)](#) 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. [Doherty, Kartasheva, and Phillips \(2012\)](#) analyze the optimal entry strategy of a CRA into a market served by an incumbent. None of these papers examine the relationship between regulatory retention rules imposed on the issuers and a CRA's rating accuracy, which is the focus of this paper.

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. The moral hazard problem in the model primarily serves as a tool to provide a well understood economic rationale for skin in the game regulation. This moral hazard borrows from earlier work by [Penacchi \(1988\)](#),

⁶ See [Jeon and Lovo \(2013\)](#) for an excellent critical survey of the recent theoretical literature.

⁷ See also [Ozerturk \(2014a\)](#).

⁸ As [Opp et al. \(2013\)](#) argues, the Dodd-Frank Act also aims to reduce the reliance of regulatory practices on ratings provided by CRAs.

Gorton and Pennacchi (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.

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 (2014) 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.⁹ 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.

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)). Different than this literature, the issuer in my paper does not possess any private information, and the information acquisition 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 quite limited. A signaling setting may thus not be suitable to study the implications of retention requirements for a CRA's accuracy.¹⁰

3. The model

This section introduces a baseline model with the following main features. There is a risk neutral issuer who seeks the sale of a risky loan portfolio for liquidity reasons. The final portfolio payoff depends on the portfolio's unknown quality and the costly and unobservable effort expended by the issuer after the sale. 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 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 quality can be either Good ($\theta = G$) or Bad ($\theta = B$) 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 λ .¹¹

The portfolio's final payoff depends on the portfolio's unknown quality $\theta \in \{G, B\}$, and also on whether the issuer expends costly and unobservable effort $e \in \{0, 1\}$ in a subsequent stage.¹² 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 $1 - \Delta_G > 0$. If the portfolio is bad, the issuer's effort ($e = 1$) at the same private cost $c > 0$ yields a final portfolio payoff of 0. If the issuer does not expend effort ($e = 0$), a bad portfolio yields a payoff of $-\Delta_B < 0$. Therefore, the issuer's effort improves the payoff of a good portfolio by $\Delta_G \in (0, 1)$ and of a bad portfolio by $\Delta_B \in (0, 1)$.

Formally, the portfolio's final payoff $\tilde{y}(e; \theta)$ is described as

$$\begin{aligned} y(e; G) &= 1 - (1 - e)\Delta_G \text{ for } e \in \{0, 1\} \text{ and} \\ y(e; B) &= -(1 - e)\Delta_B \text{ for } e \in \{0, 1\}. \end{aligned} \quad (1)$$

Given the specification in (1), I assume that the issuer's effort cost c satisfies

$$c < \lambda\Delta_G + (1 - \lambda)\Delta_B \text{ and } c < \Delta_B. \quad (A1)$$

The first restriction in (A-1) implies that, given the ex ante beliefs on the portfolio's quality, it is efficient to expend effort if the issuer were to retain the whole portfolio until maturity. The second restriction $c < \Delta_B$ implies that it is efficient to expend effort when the portfolio is revealed to be bad. 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 fixed 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. Thus, the fixed liquidity cost 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. In Section 5, I introduce and analyze an alternative specification in which the

⁹ As Chemla and Hennessy (2014) 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.

¹⁰ The pre-sale effort and signaling based theories are further discussed in Section 7.

¹¹ 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.

¹² Section 5.2 presents an extension with continuous effort choice.

issuer's liquidity cost is captured by a discount rate.¹³

The investors' valuation: The issuer can sell the portfolio to competitive, fully rational and risk neutral investors whose valuation of a portfolio fraction $(1 - x)$ is given by

$$p(x) \equiv (1 - x)(E[\hat{y}(\hat{e}(x))] - v) \quad (2)$$

where $\hat{e}(x)$ is their rational conjecture for the subsequent effort decision of an issuer who retains a portfolio stake x . In this above formulation, the investor incurs a liquidity cost $(1 - x)v$ from retaining a portfolio fraction $1 - x$ where $0 < v < L$. The investors' fixed liquidity cost v is also independent of the portfolio value and can be thought as a regulatory compliance cost that the investors incur when holding a risky asset, most commonly due to higher capital requirements (see White (2010) and Opp et al. (2013)). The alternative specification in Section 5 drops the fixed liquidity cost assumption for the investors as well and captures their liquidity cost through a discount rate applied to the final portfolio value.

In what follows, I assume that the issuer's motivation for loan sale captured by L is strong enough compared to the efficiency benefit $\lambda\Delta_G + (1 - \lambda)\Delta_B - c$ from retaining effort incentives and the investors' liquidity cost v . Formally, I impose the following parametric restriction on the issuer's liquidity cost L .

$$L > \underline{L} \equiv (\lambda\Delta_G + (1 - \lambda)\Delta_B - c) + v. \quad (A2)$$

The restriction in (A-2) introduces 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 Pennacchi (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.¹⁴

Skin in the Game: The restriction in (A2) rules out any voluntary retention incentives for the issuer. Hence, I introduce a regulator whose objective is to ensure that the issuer retains a sufficient stake in the portfolio and expends costly effort to improve portfolio payoff subsequent to a sale. Formally, let $\sigma \in \{0, 1\}$ denote the publicly observable state which indicates whether a sale takes place ($\sigma = 1$) 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

$$x(E[\hat{y}(e = 1)|\sigma = 1] - E[\hat{y}(e = 0)|\sigma = 1]) \geq c \quad (3)$$

where the expectation $E[\hat{y}(e)|\sigma = 1]$ is taken using all the available information conditional on a sale.

Given the portfolio payoff specification in (3), the retention requirement in (3) can be rewritten as

$$x[\Pr(\theta = G|\sigma = 1)\Delta_G + \Pr(\theta = B|\sigma = 1)\Delta_B] \geq c.$$

I refer to the fraction x defined by (R1) as the issuer's *skin in the game* requirement. Under the retention 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 determined *conditional on a sale*. Therefore, when determining x the regulator takes into account any information on portfolio quality produced prior to a sale.

CRA and information production: To introduce a role for information production by a third party such as a CRA, I assume that the investors' liquidity costs are sufficiently high, and hence a sale can only proceed if more information is produced on the portfolio's quality. Under the retention rule in (R1) that ensures $\hat{e} = 1$, ex ante the investors value the fraction $(1 - x)$ of an unrated portfolio at

$$p_0(x) \equiv (1 - x)(\lambda - v). \quad (4)$$

In what follows, I assume that the investors's ex ante portfolio valuation is negative, that is, $p_0(x) < 0$. Formally, I maintain that $\lambda < v < 1$. This restriction introduces a role for information production by a CRA, as it implies that the issuer needs to improve the investors' valuation by providing them with more information on the portfolio's quality to be able to sell any portion of the portfolio.¹⁵

The issuer can provide the investors with more information on portfolio quality 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,

$$\Pr(s = g|\theta = G) = 1 \text{ and } \Pr(s = b|\theta = B) = z \in [0, 1]. \quad (5)$$

¹³ Instead of a fixed liquidity cost that is independent of the portfolio value, the alternative specification in Section 5 implies a liquidity cost which is proportional to portfolio value.

¹⁴ In the alternative specification of Section 5, the motivation for portfolio sale stems from differential discount rates of the issuer and investors applied to the portfolio value.

¹⁵ A setting in which the investors' ex ante expected valuation of the asset is negative is standard in the literature, and it introduces an economic role for information production by a certification intermediary such as a CRA (see, among others, Opp et al. (2013), Bolton et al. (2012) and Mathis et al. (2009)).

The signal technology in (5) is also adopted by Bar-Isaac and Shapiro (2013). The parameter z 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 $C(\cdot)$ is increasing and convex. It should be noted that the specification in (5) only allows the CRA to misidentify a bad portfolio as good. In an extension in Section 5.3, I consider 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 adopts a rating accuracy z . The issuer then decides whether to solicit a rating. If a rating is solicited, the CRA observes a signal, provides the issuer a free and truthful 'indicative' rating and sets a fee π . This indicative rating becomes a public rating if the issuer decides to purchase it by paying the fee π . Given (5), a bad rating perfectly reveals that the portfolio is of bad quality. Since the issuer would not pay a fee to make a bad rating public, the CRA sets a fee π only if the rating is good.¹⁶

CRA's Reputation Cost: In the baseline model, I assume that the CRA incurs an exogenously given reputational cost if its rating proves to be inaccurate (see Bolton et al. (2012)). 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 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. This reduced form formulation aims to capture the idea that the CRA's future profits suffer if an asset that received a good rating performs poorly. For a given accuracy z , the CRA's ex ante expected reputational cost is given by $(1 - \lambda)(1 - z)\beta$. The exogenous reputational cost assumption allows me to introduce a motivation for the CRA to provide accurate ratings in a simple manner in the baseline model. In Section 5, I drop the exogenous reputation cost assumption and model the CRA's reputational considerations explicitly, allowing for endogenous reputation.

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 . The issuer decides whether to solicit a rating.

Stage 3 If a rating is solicited, the CRA observes a signal on the portfolio's quality, sets a rating fee π and provides a rating.

Stage 4 The issuer decides whether to pay the CRA π to make the rating public and to sell a fraction $1 - x$ of the portfolio. The 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 5 The issuer chooses whether to expend costly effort e or not.

Stage 6 The portfolio payoff is realized. If the portfolio is revealed to be bad subsequent to a good rating, the CRA suffers a cost β .

4. Analysis

The analysis first establishes the conditions under which a sale takes place. Suppose first that the CRA observes a bad signal. The signal technology in (5) implies that a bad signal fully reveals that the portfolio's quality is bad. Since we have $E[\tilde{y}(\hat{e}(x))|s = b] = -(1 - \hat{e}(x))\Delta_B \leq 0$, no sale can take place with a bad rating. Suppose now the CRA observes a good signal. Conditional on a good signal with accuracy z , the posterior probability that the portfolio is good quality is given by

$$\hat{\lambda}(z) \equiv \Pr[\theta = G|s = g] = \frac{\lambda}{\lambda + (1 - \lambda)(1 - z)} \quad (6)$$

The posterior probability $\hat{\lambda}(z)$ in (6) is increasing in z . Given the retention rule in (R1) that ensures $e = 1$, conditional on a good rating the investors value a fraction $(1 - x)$ of the portfolio at

$$p(z) = (1 - x)(\hat{\lambda}(z) - v) = (1 - x) \left[\frac{\lambda}{\lambda + (1 - \lambda)(1 - z)} - v \right]. \quad (7)$$

The investors' valuation $p(z)$ in (7) is monotone increasing in rating accuracy z . One can note that $p(z = 0) \equiv p_0(x) < 0$ and $p(z = 1) = (1 - x)(1 - v) > 0$ for $x < 1$. Hence, there exists an accuracy level z_{\min} such that $p(z) \geq 0$ if and only if $z \geq z_{\min}$. In other words, a sale takes place if and only if the CRA provides a sufficiently accurate good rating. This observation is stated below.

LEMMA 1. For a given regulator mandated retention requirement x , 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 $z \geq z_{\min}$ where

$$z_{\min} \equiv \frac{v - \lambda}{1 - \lambda} \in (0, 1). \quad (8)$$

Proof. See the Appendix.

CRA's Fee for a Good Rating: The fee π that the monopolistic CRA can extract for a good rating can be derived as follows. Upon observing a good signal, the CRA sets the fee π such that the issuer is ex ante indifferent between paying this fee and making the rating public or proceeding with no sale. Formally, the issuer pays the fee π if and only if the following participation constraint is satisfied:

¹⁶ 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. Ozerturk (2014b) compares the performance of rating-contingent versus up-front fees for CRAs.

$$p(z) - \pi + x(\hat{\lambda}(z) - L) - c \geq \hat{\lambda}(z) - L - c \tag{9}$$

The left hand side of the participation constraint in (9) indicates that when a sale takes place with a sufficiently accurate good rating, the issuer pays CRA the rating fee π 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 in the portfolio and incurs the liquidity cost xL . The issuer also expends effort ($e = 1$) and incurs the effort cost c given the retention rule in (R1). The right hand side of (9) captures the issuer's payoff from declining to pay the rating fee π . In this case, the issuer retains the whole portfolio at a liquidity cost L and expends effort given (A1). Solving for π yields the CRA's rating fee which is stated below.

LEMMA 2. *The CRA's rating fee π is given by*

$$\pi = \begin{cases} (1 - x)(L - v) & \text{for } z \geq z_{\min} \\ 0 & \text{otherwise.} \end{cases} \tag{10}$$

Proof. See the Appendix.

Provided that the rating has sufficient accuracy ($z \geq z_{\min}$), the CRA's rating fee is driven by the issuer's surplus from selling a fraction $(1 - x)$ of the portfolio. This surplus is given by $(1 - x)(L - v)$.¹⁷ The monopolistic CRA's fee in (9) completely extracts this surplus. Given the fixed liquidity costs L and v for the issuer and the investors, respectively, the surplus from sale and hence the fee π in (9) are completely independent from the expected portfolio value at the time of the sale. Accordingly, in the baseline model of this section, as long as CRA's rating is sufficiently accurate, the gains from trade and the fee the CRA can extract does not depend on the accuracy of the rating.¹⁸

CRA's Optimal Accuracy: One can now formally state the CRA's problem of choosing the rating accuracy z . Given the signal technology in (5), the CRA observes a good signal with the ex ante probability

$$\varphi(z) \equiv \Pr(s = g) = \lambda + (1 - \lambda)(1 - z). \tag{11}$$

The CRA chooses z to maximize its ex ante expected profit given by

$$\Psi(z) \equiv \begin{cases} \varphi(z)\pi - C(z) - (1 - \lambda)(1 - z)\beta & \text{for } z \geq z_{\min} \\ 0 & \text{otherwise.} \end{cases} \tag{12}$$

After substituting the rating fee π derived in (10) into (12) and eliminating the terms that do not depend on z , the CRA's problem becomes choosing z to maximize

$$(1 - \lambda)[\beta - (1 - x)(L - v)]z - C(z), \tag{13}$$

subject to $z \geq z_{\min}$. In choosing its accuracy, the CRA trades off between expected fee that she can extract from a good rating which makes a sale possible versus higher expected reputational costs that arise from less accurate good ratings. The fee that the CRA expects to extract from a good rating is given by the gains from trade $(1 - x)(L - v)$. As this expected rating fee increases relative to the reputational cost captured by β , the CRA is more inclined to provide less accurate good ratings. The following Proposition characterizes the CRA's optimal rating accuracy.

PROPOSITION 1. *For a given retention rule x , there exists a threshold issuer liquidity cost \bar{L} such that for $L \in (\underline{L}, \bar{L})$, the CRA's optimal accuracy z^* solves*

$$(1 - \lambda)[\beta - (1 - x)(L - v)] = C'(z). \tag{14}$$

Proof. See the Appendix.

When the issuer's liquidity cost exceeds \bar{L} , the gains from trade and hence the CRA's fee in (10) become too large compared to the incentives to acquire more accurate information provided by the CRA's reputational cost β . In that case, the CRA opts for providing the minimum acceptable rating accuracy z_{\min} provided that $\Psi(z_{\min}) \geq 0$. My main focus is to analyze the implications of the skin in the game regulation on the CRA's rating accuracy. In what follows, I consider the economically more interesting case when $L \in (\underline{L}, \bar{L})$ and hence the CRA's optimal rating accuracy z^* does respond to various factors in the model including the issuer's skin in the game. Before endogenizing the issuer's skin in the game x using the retention rule in (R1), let us use (14) to describe how, for a given x , the CRA's optimal rating accuracy z^* depends on x and the exogenous parameters of the model.

It is straightforward to observe from (14) that the CRA's rating accuracy is increasing in the reputational cost β . Given the CRA's

¹⁷ When issuer skin in the game x is arbitrarily close to 1, the surplus from the sale and hence the CRA's rating fee approaches to zero. In this case, the CRA would find it unprofitable to provide a rating at any accuracy and refrain from participation. The analysis in this paper abstracts away from this possible corner solution and focuses on an interior solution for the CRA's accuracy.

¹⁸ As shown in Section 5, when the liquidity costs are modeled through discount rates applied to the final portfolio value, the liquidity costs of the parties are not fixed but are proportional to the portfolio's value. In that case, the gains from trade are no longer independent from the rating's accuracy.

trade-off between securing a higher expected fee through a lax rating standard versus higher expected reputational costs from inaccurate ratings, those factors that reduce the gains from trade and hence the rating fee that the CRA can extract from the issuer improve the CRA's accuracy.¹⁹ Since a higher skin in the game requirement restricts the gains from trade, the CRA's rating fee is decreasing in x . As a result, requiring the issuer to retain a larger fraction of the portfolio increases the CRA's accuracy. Similarly, the gains from trade and the CRA's rating fee is increasing in the issuer's fixed liquidity cost L from retaining the portfolio. Therefore, the CRA's optimal accuracy z^* is decreasing in L . For the comparative statics exercise below, I assume that the CRA's information acquisition cost has the specific functional form $C(z) = kz^2/2$ where $k > 0$ is a cost parameter. Using (14), one can formalize the following observations.

COROLLARY 1. Suppose $L \in (\underline{L}, \bar{L})$ For a given issuer's skin in the game x , the CRA's optimal rating accuracy z^* is increasing in x . Furthermore, CRA's optimal rating accuracy z^* is increasing in the CRA's reputational cost β , decreasing in the CRA's information acquisition cost parameter k and decreasing in the issuer's liquidity cost L .

Proof. See the Appendix.

An important question is whether the assumed fixed liquidity costs L and v for the issuer and the investors are crucial in obtaining the positive relationship between the CRA's optimal rating accuracy z^* and issuer's skin in the game x . These fixed liquidity costs give rise to gains from trade that are independent of the expected portfolio value. As a result, the CRA's rating fee derived in (10) is independent of the expected portfolio value. Is the particular form of the rating fee in (10) crucial for obtaining this main result? In Section 5, I assume that the liquidity costs are not fixed, but they are captured through differential discount rates applied to the final portfolio value. This alternative setting yields gains from trade and hence a rating fee for the CRA that are proportional to the portfolio's value. When the CRA's reputational considerations are explicitly modeled, the analysis in Section 5 shows that the main result continues to hold in this alternative setting as well. Hence, assuming fixed liquidity costs independent from the portfolio value for the parties is not essential for the result. What is essential, as shown in the extensions in Section 5, though is that the gains from trade between the issuer and the investors are decreasing in the issuer's skin in the game.²⁰

Endogenizing the Skin in the Game: 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 in the baseline model, forcing the issuer to retain a positive fraction in the portfolio reduces the gains 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 gains 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

$$x[\Pr(\theta = G|\sigma = 1)\Delta_G + \Pr(\theta = B|\sigma = 1)\Delta_B] = c \tag{15}$$

In the above expression, the probabilities $\Pr(\theta = G|\sigma = 1)$ and $\Pr(\theta = B|\sigma = 1)$ are 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 ($z \geq z_{\min}$) is observed. Hence, conditioning on $\sigma = 1$ is equivalent to conditioning on the CRA observing a good signal $s = g$ with $z \geq z_{\min}$. Furthermore, in setting x the regulator takes into account the CRA's optimal accuracy choice preceding the sale as described in Proposition 1. For notational convenience, I refer to this choice as $z^*(x)$ and define

$$\varphi(z^*(x)) \equiv \lambda + (1 - \lambda)(1 - z^*(x)). \tag{16}$$

Using (6) and (16), one obtains

$$\begin{aligned} \Pr(\theta = G|\sigma = 1) &= \Pr(\theta = G|s = g) = \frac{\lambda}{\varphi(z^*(x))}. \\ \Pr(\theta = B|\sigma = 1) &= \Pr(\theta = B|s = g) = \frac{(1 - \lambda)(1 - z^*(x))}{\varphi(z^*(x))}. \end{aligned} \tag{17}$$

Combining (15) and (17) yields the following result characterizes an interior equilibrium skin in the game requirement.

PROPOSITION 2. Suppose $L \in (\underline{L}, \bar{L})$ and hence $z^*(x)$ is given by (14). The equilibrium skin in the game requirement x^* is given by the unique solution to

$$x \left[\Delta_B + \frac{\lambda}{\varphi(z^*(x))} (\Delta_G - \Delta_B) \right] = c. \tag{18}$$

Proof. See the Appendix.

¹⁹ In Bolton et al. (2012), 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. 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. When this regulatory benefit exceeds an endogenous threshold, their CRA stops information acquisition and engages in rating inflation.

²⁰ The mechanism that generates the positive relationship between the CRA's optimal rating accuracy z^* and issuer's skin in the game x does not rely on the CRA's ability to extract full rents from the issuer. This result would continue to hold as long as the CRA has some bargaining power in setting its fee.

The condition in (18) identifies a potential feedback mechanism between the equilibrium retention rule x^* and the CRA's optimal rating accuracy z^* . The existence and direction of this feedback mechanism depends on the relative magnitudes of Δ_G and Δ_B . Recall that Δ_θ captures the payoff improvement achieved by the issuer's effort when the portfolio quality is $\theta \in \{G, B\}$. When $\Delta_G = \Delta_B = \Delta$, the issuer's effort yields the same payoff improvement regardless of θ and there is no feedback mechanism between equilibrium skin in the game x^* sets by the regulator and the rating accuracy z^* set by the CRA. In this case, we have $x^* = c/\Delta$.

When $\Delta_G > \Delta_B$ and hence the issuer's effort is more payoff enhancing for a good portfolio, the skin in the game requirement x^* and CRA's rating accuracy z^* serve as substitute mechanisms to elicit effort. This observation follows from (18), because a more accurate good rating increases the posterior belief $\Pr(\theta = G|s = g)$ described in (17) that the portfolio is good. If effort is more productive in the good state, the more optimistic beliefs about portfolio quality imply that it takes a smaller issuer skin in the game to elicit effort. Therefore, when $\Delta_G > \Delta_B$ those exogenous factors that improve the CRA's rating accuracy, such as lower issuer liquidity cost L and higher reputational cost β for the CRA should reduce the equilibrium retention requirement x^* . When $\Delta_G < \Delta_B$ and hence effort is more payoff enhancing for a bad portfolio, this feedback mechanism is reversed: the retention requirement x^* and CRA's rating accuracy z^* now become complementary mechanisms to elicit effort. A more accurate good rating lowers the posterior probability that the portfolio is bad. Since effort is more productive in the bad state, it now takes a larger skin in the game to elicit effort. These observations are summarized in the following **COROLLARY** and further discussed in Section 6.

COROLLARY 2. (i) When $\Delta_G = \Delta_B = \Delta$, the equilibrium retention requirement is given by $x^* = c/\Delta$. (ii) When $\Delta_G > \Delta_B$, the retention requirement x^* and CRA's rating accuracy z^* are substitute mechanisms to elicit effort. In this case, x^* is increasing in L and decreasing in β . (iii) When $\Delta_G < \Delta_B$, the retention requirement x^* and CRA's rating accuracy z^* are complementary mechanisms to elicit effort. In this case, x^* is decreasing in L and increasing in β .

Proof. Follows from (18) and Corollary 1.

Another observation that follows from (18) relates the CRA's rating accuracy z^* to the severity of the issuer's moral hazard problem. Lower effort productivity and/or higher effort cost increase the issuer's retention requirement. Since equilibrium rating accuracy z^* is increasing in x (**COROLLARY 1**), we have the following result.

COROLLARY 3. Suppose $\Delta_G = \Delta_B = \Delta$. The CRA's rating accuracy z^* is decreasing in the productivity Δ of the issuer's effort and increasing in the effort cost c .

Proof. Follows from (18) and **COROLLARY 1**.

5. Extensions

5.1. Liquidity costs as discount rates and endogenous CRA reputation

In the baseline model of Section 3, the gains from trade between the issuer and the investors stem from the difference between their *fixed liquidity costs*, L and v . Since these fixed liquidity costs are independent from the portfolio's valuation, the gains from trade in that setting are also independent from the portfolio's expected value. When a fraction $1 - x$ of the portfolio is sold, the gains from trade and hence the CRA's rating fee are given by $(1 - x)(L - v)$ (see **LEMMA 2**). The baseline model also adopts a reduced form specification to describe the CRA's reputational considerations. The CRA's trade-off in choosing the accuracy of its signal is driven by the desire to maximize her expected rating fee versus minimizing the reduced form *reputational cost* captured by the parameter β .

Does the main result which describes a positive relationship between the CRA's rating accuracy and issuer's skin in the game in Proposition 1 crucially depend on the fixed liquidity cost assumption? Does it depend on the reduced form specification for the CRA's reputational concerns? To address these questions, this section modifies the baseline model. I consider an alternative specification in which (i) the liquidity costs of the issuer and the investors are represented by discount rates, and (ii) the CRA's reputation is modeled explicitly.²¹ The difference between the respective discount rates give rise to gains from trade that are proportional to the portfolio's expected value. Furthermore, the CRA's reputational considerations are now modeled by introducing an explicit concern to maintain a public posterior belief that she is *ethical*.

As in the baseline model, the issuer seeks the sale of a portfolio with unknown quality. The portfolio can be either Good ($\theta = G$) or Bad ($\theta = B$) quality with $\Pr(\theta = G) = \lambda \in (0, 1)$. The portfolio's final payoff $\tilde{y}(e; \theta)$ is again described by (1). If the issuer expends costly effort ($e = 1$), a good portfolio yields a payoff of 1 whereas a bad portfolio yields 0. To provide the issuer with post-sale effort incentives, there is a retention rule x in place described by (R1).

Instead of the fixed liquidity costs L and v , I follow **DeMarzo and Duffie (1999)** and assume that the liquidity costs of the issuer and the investors are described by a pair of discount rates d_L and d_v , respectively, where $0 < d_L < d_v < 1$. In particular, given the retention rule x in (R1) that ensures $e(x) = 1$ and conditioning on any available information I_θ on the portfolio's unknown quality θ , the issuer's and the investors' valuation of the *whole* portfolio is given by

$$E[\tilde{y}(e = 1; \theta) | I_\theta] d_i \text{ where } i \in \{L, v\}. \quad (19)$$

The sale of a fraction $(1 - x)$ of the portfolio can again only take place if the issuer provides the investors with more information on

²¹ I am grateful to an anonymous referee for suggesting this alternative specification used in Section 5. This specification allowed for a more general interpretation of the mechanism that generates the main result and guided all the extensions that are analyzed in this section.

the portfolio's quality through a CRA. For simplicity, I assume that if a rating is solicited, the CRA *can perfectly observe the portfolio's quality* θ at no cost. Upon observing $\theta \in \{G, B\}$, the CRA issues a rating $r \in \{G, B\}$ where $r = G$ refers to a good rating and $r = B$ refers to a bad rating. At this stage, the CRA also sets a fee π for a good rating. Given the rating r and the fee π , the issuer chooses whether to pay the fee and make the rating public to proceed with a sale.

Rather than adopting a reduced form specification to capture the CRA's reputational considerations, I now model CRA reputation explicitly. Following Fulghieri et al. (2014), the CRA can be either ethical (denoted by type $\tau = E$) or opportunistic (denoted by type $\tau = O$). The ex ante probability that the CRA is ethical is given by $\gamma \in (0, 1)$. The rating of an ethical CRA always reveals the portfolio quality truthfully. The opportunistic type CRA, however, chooses her rating policy strategically to maximize the sum of her rating fee π and the public's posterior probability $\hat{\gamma}$ that she is ethical.

Specifically, let a_θ denote the probability that the opportunistic CRA issues a truthful rating $r = \theta$ after perfectly observing a portfolio quality θ . The opportunistic CRA's rating policy is described by

$$a_\theta = \Pr(r = \theta|\theta) \text{ for } \theta \in \{G, B\}. \tag{20}$$

Given the portfolio quality θ that she observes, the opportunistic CRA's chooses a_θ to maximize

$$\pi(a_\theta) + \hat{\gamma}(a_\theta|r, y) \tag{21}$$

where $\pi(a_\theta)$ is the CRA's fee and $\hat{\gamma}(a_\theta|r, y)$ is the posterior probability that the public assigns to the CRA being ethical conditional on observing a rating $r \in \{G, B\}$ and the portfolio's final payoff realization $y \in \{0, 1\}$.²² Since a sale can take place and a fee can be extracted only with a good rating and since issuing a bad rating to a good portfolio can only hurt the CRA's reputation, the opportunistic CRA always sets $a_G = 1$ and reveals a good portfolio truthfully. Therefore, in this new formulation the CRA's rating policy $a_B = \Pr(r = B|\theta = B)$ captures the accuracy of the rating.

If the opportunistic CRA assigns a good rating to a bad portfolio, she would be revealed as the opportunistic type. In his case, her posterior public reputation would be given by $\hat{\gamma} = 0$. If this CRA assigns a bad rating to a bad portfolio, however, her posterior reputation would be given by

$$\hat{\gamma}(a_B|r = B, y = 0) = \frac{\gamma}{\gamma + (1 - \gamma)a_B}. \tag{22}$$

To describe the opportunistic CRA's problem of choosing the accuracy a_B of her rating, let us first derive the CRA's fee $\pi(a_\theta)$. For notational convenience, let $\hat{\lambda}(a_B)$ denote the posterior probability that the portfolio is good conditional on a good rating $r = G$ with accuracy a_B . We have

$$\hat{\lambda}(a_B) \equiv \Pr(\theta = G|r = G) = \frac{\lambda}{\lambda + (1 - \lambda)(1 - \gamma)(1 - a_B)} \tag{23}$$

Given the retention rule in (R1) that ensures $e = 1$ and conditional on $r = G$, the investors' valuation of a fraction $(1 - x)$ of the portfolio is then given by

$$p(a_B) = (1 - x)\hat{\lambda}(a_B)d_v. \tag{24}$$

The issuer values the retained portfolio fraction x at $x\hat{\lambda}(a_B)d_L$. The issuer pays the fee π if and only if the following participation constraint is satisfied:

$$p(a_B) - \pi + x\hat{\lambda}(a_B)d_L - c \geq \hat{\lambda}(a_B)d_L - c. \tag{25}$$

Solving for π from (23) and using (21) for $\hat{\lambda}(a_B)$ yields the following result.

LEMMA 3. The fee that the CRA can charge for a good rating is given by

$$\pi(a_B) = (1 - x) \left[\frac{\lambda}{\lambda + (1 - \lambda)(1 - \gamma)(1 - a_B)} \right] (d_v - d_L). \tag{26}$$

The fee $\pi(a_B)$ is increasing in the accuracy a_B of the CRA's rating and decreasing in the issuer's skin in the game x .

Proof. See the Appendix.

A comparison of the CRA's fee in LEMMA 3 and the one derived in LEMMA 2 under the fixed liquidity cost assumption reveals a key difference. With discount rates as liquidity costs, the gains from trade and hence the CRA's fee are not independent of, but are proportional to the portfolio's expected value. Furthermore, the rating fee $\pi(a_B)$ in (26) is increasing in the CRA's rating accuracy a_B , unlike the fee derived in (10) in the baseline model which was independent from rating accuracy.

In equilibrium, the CRA's rating accuracy a_B is determined by the marginal condition that the opportunistic CRA is indifferent between providing a good or bad rating for a bad portfolio. This indifference condition requires

²² Given the retention rule (R1) in place that ensures the CRA expends effort ($e = 1$) and the portfolio payoff specification $\bar{y}(e; \theta)$ described by (3), the final portfolio payoff can be either $y = 1$ or $y = 0$.

$$\pi(a_B) = \widehat{\gamma}(a_B|r = B, y = 0). \tag{27}$$

In the equilibrium condition (27), the posterior public belief $\widehat{\gamma}(a_B|r = B, y = 0)$ that the CRA is ethical is given by (22). Since $\pi(a_B)$ is increasing in a_B and $\widehat{\gamma}(a_B|r = B, y = 0)$ in (22) is decreasing in a_B , when it exists, a solution to (27) is unique. One can also observe that the CRA's rating accuracy a_B^* that solves (27) is increasing in the issuer's skin x . To establish this claim, one can use (27) to obtain

$$\frac{\partial a_B^*}{\partial x} = \frac{-\frac{\partial \pi}{\partial x}}{\frac{\partial \pi}{\partial a_B} - \frac{\partial \widehat{\gamma}}{\partial a_B}}. \tag{28}$$

Given $\pi(a_B)$ is increasing in a_B and the public posterior belief $\widehat{\gamma}(a_B)$ is decreasing in a_B , the denominator on the right hand side of (28) is always positive. Therefore, the effect of the issuer skin in the game x on the CRA's rating accuracy a_B^* depends on the relationship between the CRA's rating fee π and x . Since $\pi(a_B)$ is decreasing in x , the CRA's rating accuracy a_B^* that solves (27) is increasing in x . The following result states these observations formally.

PROPOSITION 3. Let $\Delta_d \equiv d_v - d_L$. For a given issuer skin in the game x , the CRA's optimal rating accuracy a_B^* is given by

$$a_B^*(x) = 1 - \left(\frac{1 - (1-x)\Delta_d}{(1-x)\Delta_d - \gamma(1-\lambda)} \right) \left(\frac{\lambda\gamma}{1-\gamma} \right). \tag{29}$$

The CRA's optimal rating accuracy $a_B^*(x)$ is increasing in the issuer's skin in the game x .

Proof. See the Appendix.

The analysis in this section establishes that the fixed liquidity cost assumption and the rating fee in LEMMA 2 derived under this assumption in the baseline model are not crucial to obtain the main result. The result that the CRA's rating accuracy is increasing in the issuer's skin in the game continues to hold in a more general setting when (i) liquidity costs and hence the gains from trade and the fee that the CRA can extract are proportional to the expected portfolio value and (ii) the CRA's reputation is modeled explicitly. As long as the issuer's skin in the game reduces the gains from trade and hence lowers the CRA's rating fee, more issuer skin in the game reduces the CRA's incentives to inflate ratings and thus improves rating accuracy.

5.2. A countervailing force with continuous effort

The extension in the previous section established that the positive relationship between the CRA's rating accuracy and the issuer's skin in the game x crucially depends on the observation that the gains from trade is decreasing in x . This negative relationship between the gains from trade and the issuer's skin, however, might be an artefact of the binary effort choice framework adopted so far. In particular, when more issuer skin in the game results in more effort, the expected portfolio value and hence the gains from trade might be increasing in issuer's skin in the game. In other words, there might be a countervailing force to the main result described in the preceding analysis.

This section considers another extension by introducing the issuer's effort as a continuous choice variable. Under this new specification, more issuer skin in the game can result in a higher expected portfolio value, and therefore more gains from trade. This extension allows me to analyze the robustness of the main result with respect to this countervailing force.

Consider the modified model in Section 5.1 with liquidity costs as discount rates and endogenous CRA reputation. Suppose that, given the portfolio's quality $\theta \in \{G, B\}$ and issuer's continuous effort choice $e \geq 0$, the final portfolio payoff $\tilde{y}(e; \theta)$ is now given by

$$\tilde{y}(e; \theta) = \mu_\theta + \Delta e, \tag{30}$$

where $\Delta > 0$ is the productivity of effort. In this formulation, the term μ_θ captures the intrinsic value of the portfolio completely driven by its quality $\theta \in \{G, B\}$. The issuer's effort $e \geq 0$ improves this intrinsic portfolio value at the marginal rate Δ regardless of the portfolio's quality. I assume that $\mu_G > 0 > \mu_B$. The restriction $\mu_G > \mu_B$ implies that, for any given effort level $e \geq 0$, the good portfolio always yields a higher final payoff than the bad portfolio.²³ The issuer incurs a private cost of $c(e) = (\kappa/2)e^2$ from expending an effort level e where $\kappa > 0$.

The portfolio payoff technology specification in (30) distinguishes between the portfolio value component driven exclusively by the intrinsic portfolio quality (captured by μ_θ) and the component driven by the issuer's effort (captured by Δe). This distinction allows me to assess the relative importance of CRA's rating accuracy and the issuer's effort in improving expected portfolio value and hence gains from trade.

The CRA's rating policy a_θ is again described by (20). Conditional on a good rating $r = G$ with accuracy a_B and given a retention requirement x , the issuer's effort problem is to choose $e \geq 0$ to maximize

²³ The additional restriction $\mu_B < 0$ is not essential for the analysis, but as in the baseline specification in (3), it allows one to interpret the issuer's effort as loss mitigating effort in the case of a bad portfolio.

$$x[\widehat{\lambda}(a_B)(\mu_G + \Delta e) + (1 - \widehat{\lambda}(a_B))(\mu_B + \Delta e)] - \frac{\kappa}{2}e^2 \tag{31}$$

where $\widehat{\lambda}(a_B) \equiv \Pr(\theta = G|r = G)$ is described in (21). This optimization problem yields an optimal effort level

$$e^*(x) = \frac{\Delta}{\kappa}x. \tag{32}$$

Using (32), one obtains the expected portfolio value conditional on $r = G$ as

$$E[\widehat{y}(e^*(x); \theta)|r = G] = V(a_B) + \frac{\Delta^2}{\kappa}x \tag{33}$$

where

$$V(a_B) = \widehat{\lambda}(a_B)\mu_G + (1 - \widehat{\lambda}(a_B))\mu_B. \tag{34}$$

The expected portfolio value in (33) has two components. The first part $V(a_B)$ described by (34) captures the *expected intrinsic portfolio value* given the accuracy a_B of the CRA's rating policy. This part is independent of the issuer's effort. It is completely driven by the beliefs about the portfolio's quality induced by the CRA's rating. The second component in (33), given by $\frac{\Delta^2}{\kappa}x$, captures the expected portfolio value improvement generated by the issuer's optimal effort $e^*(x)$ described by (32). This second component is independent from portfolio's quality and captures a new effect as it is a direct consequence of allowing for continuous effort choice. Since $e^*(x)$ is increasing in the issuer's skin in the game x , this portion of the expected portfolio value is increasing in x .

The CRA's fee π for a good rating is again equal to the gains from trade when the issuer proceeds with the sale of a fraction $(1 - x)$ of the portfolio. Given the expected portfolio value in (33), we have

$$\pi(a_B) = (1 - x)\left(V(a_B) + \frac{\Delta^2}{\kappa}x\right)(d_v - d_L). \tag{35}$$

Since $V(a_B)$ is increasing in the CRA's rating accuracy a_B , the fee $\pi(a_B)$ in (35) is again increasing in a_B . However, note that $\pi(a_B)$ may not always be strictly decreasing in the issuer's skin in the game x due to the new effect described above. While more issuer skin in the game continues to reduce the gains from trade and hence the CRA's fee due to the term $(1 - x)$ in (35), there is now a countervailing force: more issuer skin in the game increases the expected portfolio value, thus the gains from trade and consequently the CRA's fee through the term $\frac{\Delta^2}{\kappa}x$.

After perfectly observing the portfolio quality $\theta \in \{G, B\}$ at no cost, the opportunistic CRA chooses its rating policy a_θ to maximize the sum of its rating fee and its endogenous posterior reputation as described by (21). The optimal rating accuracy a_B^* is determined by the marginal condition that the opportunistic CRA is indifferent between providing a good or a bad rating for a bad portfolio. This condition again requires $\pi(a_B) = \widehat{\gamma}(a_B)$. Using the posterior public belief $\widehat{\gamma}(a_B)$ in (22) that the CRA is ethical and the CRA's rating fee $\pi(a_B)$ in (35), the equilibrium condition $\pi(a_B) = \widehat{\gamma}(a_B)$ becomes

$$(1 - x)\left(V(a_B) + \frac{\Delta^2}{\kappa}x\right)(d_v - d_L) = \frac{\gamma}{\gamma + (1 - \gamma)a_B}. \tag{36}$$

Since $V(a_B)$ is increasing in a_B and $\widehat{\gamma}(a_B)$ is decreasing in a_B , when it exists, a solution a_B^* to (36) is unique. Furthermore, given (28), the effect of x on a_B^* again depends on the relationship between $\pi(a_B)$ and x . The result that the CRA's rating accuracy a_B^* is increasing in x continues to hold if and only if $\pi(a_B)$ is decreasing in x . Differentiating the rating fee $\pi(a_B)$ in (35) with respect to x , one obtains

$$\frac{\partial \pi(a_B)}{\partial x} < 0 \Leftrightarrow V(a_B) > \frac{\Delta^2}{\kappa}(1 - 2x). \tag{37}$$

The condition in (37) indicates that as long as the expected intrinsic portfolio value $V(a_B)$ conditional on a good rating with accuracy a_B is sufficiently high compared to the magnitude of the countervailing force captured by $\frac{\Delta^2}{\kappa}$, the CRA's rating accuracy $a_B^*(x)$ that solves (36) is increasing in x . A sufficient and economically intuitive condition which ensures that (37) holds for all x is that $V(a_B^*(x)) > \frac{\Delta^2}{\kappa}$. This observation is formally stated below.

PROPOSITION 4. Suppose $\widehat{y}(e; \theta) = \mu_\theta + \Delta e$ for $e \geq 0$ where $\Delta > 0$ is the productivity of the issuer's effort and μ_θ is the intrinsic value of the portfolio with quality $\theta \in \{G, B\}$. Let $V(a_B) = \widehat{\lambda}(a_B)\mu_G + (1 - \widehat{\lambda}(a_B))\mu_B$ denote the expected intrinsic portfolio value conditional on a good rating with accuracy a_B and let $a_B^*(x)$ denote the unique solution to (36). If $V(a_B^*(x)) > \frac{\Delta^2}{\kappa}$ then the CRA's rating accuracy $a_B^*(x)$ is increasing in the issuer skin in the game x .

Proof. Follows from (37) and the observation in (28) that a_B^* is increasing in x if and only if $\pi(a_B)$ is decreasing in x .

When the portfolio value component driven exclusively by the portfolio's intrinsic quality is more pronounced compared to the portfolio value driven by the issuer's effort, the main result that establishes a positive link between the CRA's rating accuracy and the issuer's skin in the game continues to hold. Since the key function of a CRA's ratings is to provide the investors with valuable information about the intrinsic asset quality (independent of the issuer's effort), ensuring rating accuracy is more of a concern precisely when the asset quality determines a sufficiently significant portion of the asset value. Therefore, a sufficient condition for the main result to apply is that information production by a CRA on asset quality is a more significant determinant of investors' asset valuation than the issuer's

effort. That is, the result continues to hold precisely when CRA's information production role is sufficiently valuable.²⁴

5.3. Symmetric errors in signal technology

The CRA's signal technology in (5) implies that the CRA can detect a good portfolio with probability one and can only make an error if the underlying portfolio is bad. In this section, I allow for symmetric errors in the CRA's signal technology and show that my main result is robust with respect to this extension.

Consider again the modified model in Section 5.1 with liquidity costs as discount rates and endogenous CRA reputation.²⁵ Instead of (5), suppose that the CRA's signal technology is now given by

$$\Pr(s = g|\theta = G) = \Pr(s = b|\theta = B) = z \text{ where } z \in \left[\frac{1}{2}, 1\right]. \tag{38}$$

In this formulation, the parameter z captures the precision of the CRA's signal. For simplicity, I assume that z is exogenous and observing a signal $s \in \{g, b\}$ with precision z is costless for the CRA.

The ex ante probability that the CRA is ethical is again denoted by $\gamma \in (0, 1)$. An ethical CRA always truthfully reveals its signal when assigning a rating. For a given z , the accuracy of the rating is again determined by the opportunistic CRA's rating policy. Let a_s denote the probability that the opportunistic CRA issues a truthful rating $r = s$ after observing a signal s . The opportunistic CRA's rating policy is thus described by

$$a_s = \Pr(r = s|s) \text{ for } s \in \{g, b\}. \tag{39}$$

The opportunistic CRA chooses its rating policy a_s to maximize the sum of its rating fee and its endogenous posterior reputation. Given a signal s she observes, the opportunistic CRA's objective is to choose a_s to maximize

$$\pi(a_s) + \hat{\gamma}(a_s|r, y) \tag{40}$$

where $\pi(a_s)$ is the CRA's fee for a good rating and $\hat{\gamma}(a_s|r, y)$ is the posterior probability that the public assigns to the CRA being ethical conditional on observing a rating $r \in \{g, b\}$ and the portfolio payoff realization $y \in \{0, 1\}$. As before, the opportunistic CRA always sets $a_g = 1$ and reveals a good signal truthfully. Hence, the probability that the opportunistic CRA truthfully reveals a bad signal, described by $a_b = \Pr(r = b|s = b)$, again captures the accuracy of her rating.

Different than Section 5.1, under the signal technology in (38) there is now a positive probability that the portfolio payoff is $y = 1$ even when the CRA misreports a bad signal. Furthermore, when the portfolio payoff turns out to be $y = 0$ after a good rating $r = g$, this event no longer perfectly indicates the CRA's type as opportunistic. This observation follows, because the portfolio can turn out to be bad and yield a zero payoff even when the CRA observes a good signal and truthfully reveals it.

For notational convenience, let us define

$$\hat{\gamma}(a_b|r, y) \equiv \Pr(\tau = E|r, y) \text{ for } r \in \{g, b\} \text{ and } y \in \{0, 1\}$$

as the public posterior belief that CRA is ethical conditional on a rating r and a portfolio payoff y . We have

$$\begin{aligned} \hat{\gamma}(a_b|g, 0) &= \frac{(1-z)\gamma}{(1-z) + z(1-\gamma)(1-a_b)} \\ \hat{\gamma}(a_b|g, 1) &= \frac{z\gamma}{z + (1-z)(1-\gamma)(1-a_b)} \\ \hat{\gamma}(a_b|b, 0) &\equiv \hat{\gamma}(a_b|b, 1) = \frac{\gamma}{\gamma + (1-\gamma)a_b} \end{aligned} \tag{41}$$

The CRA's rating fee $\pi(a_b)$ is again equal to the gains from trade between the issuer and the investors. Hence, the rating fee is given by

$$\pi(a_b) = (1-x)\hat{\lambda}(a_b)(d_v - d_l) \tag{42}$$

where $\hat{\lambda}(a_b) \equiv \Pr(\theta = G|r = g)$ is the posterior probability that the portfolio is good conditional on a good rating with accuracy a_b . The signal specification in (38) implies that $\hat{\lambda}(a_b)$ is given by

²⁴ One should also note that this is a sufficient and not a necessary condition for the main result to continue to hold. The condition in (35) is always satisfied for $x > 1/2$ regardless of $V(a_B)$, Δ and κ .

²⁵ The portfolio's final payoff $\tilde{y}(e; \theta)$ is again described by (3). If the issuer expends costly effort ($e = 1$), a good portfolio yields a payoff of 1 whereas a bad portfolio yields 0. To provide the issuer with post-sale effort incentives, there is a retention rule x in place again described by (R1). The discount rates d_l and d_v represent the liquidity costs of the issuer and the investors, respectively.

$$\widehat{\lambda}(a_b) = \frac{\lambda z + \lambda(1-z)(1-a_b)}{\lambda z + (1-\lambda)(1-z) + \lambda(1-z)(1-a_b) + (1-\lambda)z}. \tag{43}$$

Using (42) and (43), one can obtain the following observation.

LEMMA 4. The CRA's rating fee $\pi(a_b)$ in (42) is increasing in the accuracy a_b of the rating.

Proof. The result follows since $\widehat{\lambda}(a_b)$ in (43) is increasing in a_b for any $z \in (\frac{1}{2}, 1]$.

The CRA's equilibrium rating accuracy a_b^* is determined as follows. When the CRA observes a bad signal and truthfully issues a bad rating, trade does not take place and no fee is extracted. In this case, regardless of the realized final portfolio payoff y , the CRA's payoff is equal to her posterior reputation that obtains from truthfulness. This posterior reputation can be written as

$$\widehat{\gamma}(a_b|b, y) = \frac{\gamma}{\gamma + (1-\gamma)a_b} \text{ for } y \in \{0, 1\}. \tag{44}$$

If the opportunistic CRA issues a good rating after observing a bad signal, she extracts the fee $\pi(a_b)$ in (42). This time, however, her posterior reputation does not fall to zero. Providing a good rating despite observing a bad signal now yields an *expected* posterior reputation given by

$$\bar{\gamma}(a_b) = \Pr(\theta = G|s = b)\widehat{\gamma}(a_b|g, 1) + \Pr(\theta = B|s = b)\widehat{\gamma}(a_b|g, 0), \tag{45}$$

where $\widehat{\gamma}(a_b|g, 1)$ and $\widehat{\gamma}(a_b|g, 0)$ are described in (41). The expression in (45) follows, because conditional on a bad signal, the final portfolio payoff is $y = 1$ with probability $\Pr(\theta = G|s = b)$ and CRA ends up with a posterior reputation of $\widehat{\gamma}(a_b|g, 1)$. With probability $\Pr(\theta = B|s = b)$, however, the final portfolio payoff is $y = 0$ and the CRA achieves a posterior reputation $\widehat{\gamma}(a_b|g, 0)$ from inflating the rating. Using (5), one obtains

$$\Pr(\theta = G|s = b) = \frac{(1-\lambda)z}{(1-\lambda)z + \lambda(1-z)}. \tag{46}$$

Both $\widehat{\gamma}(a_b|g, 1)$ and $\widehat{\gamma}(a_b|g, 0)$ in (41) are increasing in a_b . Therefore, CRA's *expected* posterior reputation in (45) from inflating the rating is increasing in a_b .

In equilibrium, the CRA's rating accuracy a_b^* is determined by the marginal condition that the opportunistic CRA is indifferent between providing a good or bad rating after observing a bad signal. This condition now requires

$$\pi(a_b) + \bar{\gamma}(a_b) = \frac{\gamma}{\gamma + (1-\gamma)a_b}. \tag{47}$$

where the right hand side of (47) is given by the posterior reputation $\widehat{\gamma}(a_b|b, y)$ in (44) that obtains from truthfulness. Since $\pi(a_b)$ and $\bar{\gamma}(a_b)$ are both increasing in a_b , the left hand side of (44) is increasing in a_b , whereas the right hand side is decreasing in a_b . When it exists, a solution to (47) is thus unique. Furthermore, the rating fee $\pi(a_b)$ in (42) is decreasing in x . Therefore, the CRA's rating accuracy a_b^* that solves (47) is increasing in x . This observation that the main result is robust with respect to symmetric errors in the signal technology is stated formally below.

PROPOSITION 5. For a given issuer skin in the game x , the CRA's rating accuracy $a_b^*(x)$ is increasing in x when signal technology is given by (38) and hence allows for symmetric errors.

Proof. See the Appendix.

6. Discussion of implications

This section presents a discussion of some of the implications from the analysis.

Effect of issuer skin in the game regulation on CRA's rating accuracy: The main motivation of this paper is to investigate the implications of the proposed issuer skin in the game regulation for the rating accuracy of a CRA. The analysis illustrates that a skin in the game requirement that aims to mitigate a moral hazard problem on the issuer's side can also improve the rating accuracy of a CRA involved in the sale. The key mechanism for the result is that the skin in the game requirement reduces the gains from trade and hence the rating fee that the CRA can extract by inflating ratings. The extension analyzed in Section 5.2 identifies a countervailing force and provides a robustness check for the main result. When more issuer skin in the game yields more effort and a higher expected portfolio value, the gains from trade can potentially be increasing in issuer's skin the game. A sufficient condition for the main result to continue to apply is that the portfolio's intrinsic quality is a more significant determinant of the portfolio's value than the issuer's effort. In this case, the gains from trade and the CRA's rating fee are again decreasing in the issuer's skin in the game. The result thus continues to hold precisely when information production by the CRA on portfolio quality is sufficiently important.

The underlying mechanism for the main result is akin to the hypothesis in some empirical papers which suggests that the CRAs apply more stringent rating standards in securitization deals that generate less revenues. For example, [Cornaggia, Cornaggia, and Hund \(2014\)](#) find empirical evidence that rating inflation increases with revenues by asset class. [He, Qian, and Strahan \(2012\)](#) document that rating

inflation is more pronounced among the CRA's largest clients when client size is measured in terms of securitization volume and revenue. The investigation of the potential positive impact of skin in the game regulation on a CRA's rating performance is an empirical question. Interestingly, the European regulators have not taken similar steps towards adopting retention requirements for issuers. A unilateral adoption of issuer skin in the game requirements in the U.S. could provide cross-country variation in terms of the regulatory standards and might allow for a direct empirical assessment of the impact of this regulation on the accuracy of ratings.

Rating Accuracy and the Severity of the Issuer Moral Hazard: The results in this paper can also provide some useful insights that link the CRA's rating accuracy to the severity of the issuer's moral hazard problem. When the issuer faces a more severe moral hazard problem, the effort incentives can only be provided by a higher retention requirement. Given the mechanism described in the analysis, higher issuer skin in the game in turn increases the CRA's rating accuracy. In particular, as the benefit from the issuer's effort, captured by Δ , increases, the rating accuracy of the CRA decreases (**COROLLARY 3**).

While the exact empirical relevance of this link may be limited due to the stylized nature of the model, it seems plausible that the benefits from the issuer's effort, and hence the severity of the moral hazard problem, does depend on the underlying security class. For example, for highly leveraged securities such as Collateralized Debt Obligations (CDOs), there are considerable downside risks. An issuer's effort might thus be more effective in preventing significant losses for a CDO based portfolio compared to a more traditional asset portfolio. In other words, the issuer may face a less severe moral hazard problem in highly leveraged securities and a smaller skin in the game might suffice to induce effort. The analysis thus suggests that for those security classes in which the issuers face a less severe moral hazard problem, the CRA provides less accurate ratings. Although one should interpret this observation with some caution, this potential link may help to provide additional clues to understand the variation in the CRA's rating accuracy across different asset classes.

The analysis also illustrates that if the benefit from the issuer's effort depends on the portfolio's intrinsic quality, then there is a potential feedback effect between the equilibrium skin in the game rule and the CRA's rating accuracy. When the benefit from the issuer's effort depends on the portfolio's quality, the CRA's ratings not only provide information to investors for pricing assets, but they can also provide guidance for an issuer's effort decision. Whether the CRA's ratings play this additional role and guide an issuer's effort decision is an empirical question. One should note, however, that even when such a feedback effect exists, its particular policy implications may be limited, as these implications may again differ across different security classes.

A related and somewhat overlooked issue is whether the retention rule should depend on the particular asset class being securitized. The 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.²⁶ The analysis suggests that a more nuanced skin in the game rule which accounts for the specifics of the underlying security class can be more desirable from a regulatory perspective, rather than the proposed "one size fits all" rule.

Effect of issuer's liquidity demand on rating accuracy: The analysis relates the CRA's rating accuracy to the issuer's liquidity benefits from securitization. Both in the baseline model that captures the issuer's liquidity benefit from a sale with a fixed liquidity cost and in the modified model of Section 5 where the same benefit is captured by a discount rate, a higher liquidity demand by the issuer increases the fee that the CRA can extract. Accordingly, the model predicts that the CRA's rating accuracy is decreasing in the liquidity benefits that issuers capture from asset sales.

The issuer's liquidity demand in the model may be motivated by a desire to redeploy capital in an alternative investment opportunity. 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 deals might be larger during boom cycles.²⁷ On the empirical side, [Ashcraft, Goldsmith-Pinkham, and Vickery \(2010\)](#) 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 results in this paper suggests that the widespread availability of alternative investment opportunities during the boom cycle might have reduced rating standards.²⁸

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,

²⁶ 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 \(2011\)](#)).

²⁷ 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. \(2012\)](#) and [Bar-Isaac and Shapiro \(2013\)](#). These papers show that rating accuracy is countercyclical.

²⁸ 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, Johnson, and Mayer \(2011\)](#) 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.

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 in which the issuer exerts effort *prior to the sale* of the portfolio (see Chemla and Hennessy (2014) and Rajan et al. (2010)). Consider the baseline model in Section 4 where the gains from trade between the issuer and the investors arise from the difference between their *fixed* liquidity costs. Suppose, furthermore, that the issuer makes the effort decision prior to the sale. Since the gains from trade are independent from the expected portfolio value at the time of the sale, the issuer's pre-sale effort choice does not rely on the CRA's rating accuracy. However, when the liquidity costs of the issuer and the investors are represented by discount rates as in the modified model in Section 5, the gains from trade are proportional to expected portfolio value. In that case, the CRA's rating accuracy is relevant for the issuer's pre-sale effort decision. Provided that the issuer captures a portion of the benefits from more accurate pricing at the time of the sale due more informative ratings, a higher rating accuracy by the CRA would ensure that the issuer expends pre-sale effort. Although a formal analysis is outside the scope of this paper, the framework in Section 5.1 can thus be used to incorporate pre-sale effort.

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 rating accuracy 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 portfolio value enhancing effort subsequent to any sale. 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. I show that the CRA's optimal rating accuracy is increasing in the issuer's skin. 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 analysis also relates the CRA's rating accuracy to the severity of the issuer's moral hazard problem. The results suggest that for those security classes in which the issuers face a less severe moral hazard problem, the CRA provides less accurate ratings. This potential link may help to understand the variation in the CRA's rating accuracy across different asset classes. Furthermore, a more nuanced skin in the game rule that accounts for the specifics of the underlying security class can be more desirable from a regulatory perspective, rather than the proposed "one size fits all" rule. Finally, the model also predicts that the CRA's rating accuracy is decreasing in the liquidity benefits that issuers capture from asset sales.

9. Appendix

Proof of LEMMA 1: The posterior probability $\hat{\lambda}(z)$ in (6) is increasing in rating accuracy z . Hence, the investors' valuation $p(z)$ in (7) is monotone increasing in z . Requiring $p(z) \geq 0$, one obtains that

$$p(z) \geq 0 \Leftrightarrow \hat{\lambda}(z) \geq v \Leftrightarrow z \geq z_{\min} \equiv \frac{v - \lambda}{1 - \lambda} > 0 \text{ for } x \in [0, 1] \tag{A1}$$

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

$$(1 - x)(\hat{\lambda}(z) - v) + x(\hat{\lambda}(z) - L) - c \geq \hat{\lambda}(z) - L - c \tag{A2}$$

Simplifying, the above condition becomes $(1 - x)(L - v) \geq 0$ which is always satisfied by assumption.

Proof of LEMMA 2: Using the investors' valuation $p(z)$ in (7) and requiring that the participation constraint in (9) holds as an equality, for $z \geq z_{\min}$ one obtains

$$(1 - x)(\hat{\lambda}(z) - v) - \pi + x(\hat{\lambda}(z) - L) - c = \hat{\lambda}(z) - L - c \tag{A3}$$

Solving for π yields (10). For $z < z_{\min}$, no trade take places and hence the CRA cannot extract any fee.

Proof of Proposition 1: The CRA chooses z to maximize the objective function in (13) subject to $z \geq z_{\min}$. The first order condition for the unconstrained optimization problem reads

$$(1 - \lambda)[\beta - (1 - x)(L - v)] = C'(z^*) \quad (\text{A4})$$

which implies that the unconstrained solution z^* is strictly decreasing in L . Let us denote the solution to (A4) with $z^*(L)$. Due to the continuity and the strict monotonicity of $z^*(L)$, there exists a threshold value \bar{L} defined as $z^*(\bar{L}) = z_{\min}$ such that for $L \geq \bar{L}$, the constrained optimum is given by z_{\min} provided that $\Psi(z_{\min}) \geq 0$. For $L \in (L, \bar{L})$ the constraint $z \geq z_{\min}$ is not binding, and hence the CRA's optimal accuracy choice is described by (A4) as stated in the Proposition.

Proof of COROLLARY 1: For a given issuer's skin in the game x , the CRA's optimal rating accuracy z^* that solves (14) is increasing in x , since the left hand side of (14) is increasing in x . Similarly, one can observe that the left hand side of (14) is increasing in β and decreasing in L . Hence, z^* is increasing in the β and decreasing in L . Finally, given the specific functional form $C(z) = kz^2/2$ where $k > 0$, the right hand side of (14) is increasing in k , which implies that z^* is decreasing in k .

Proof of Proposition 2: The equilibrium condition in (18) follows directly from combining (15) and (17).

Proof of LEMMA 3: Using the investors' valuation $p(a_B) = (1 - x)\hat{\lambda}(a_B)d_v$ and solving the participation constraint in (25) as an equality, one obtains

$$\pi(a_B) = (1 - x)\hat{\lambda}(a_B)(d_v - d_L). \quad (\text{A5})$$

Substituting the expression for $\hat{\lambda}(a_B)$ in (23) into (A5) yields the rating fee in (26). The observation that $\pi(a_B)$ is decreasing in x is immediate. Since $\hat{\lambda}(a_B)$ in (23) is increasing in a_B , the rating fee in (26) is also increasing in a_B .

Proof of PROPOSITION 3: Using the posterior public belief $\hat{\gamma}(a_B|r = B, y = 0)$ in (20) and the expression for $\hat{\lambda}(a_B)$ in (23), the equilibrium condition (27) becomes

$$(1 - x) \left(\frac{\lambda}{\lambda + (1 - \lambda)(1 - \gamma)(1 - a_B)} \right) (d_v - d_L) = \frac{\gamma}{\gamma + (1 - \gamma)a_B}. \quad (\text{A6})$$

Solving (A6) for a_B^* yields (29). From the comparative statics exercise in (28), one can conclude that a_B^* that solves (27) is increasing in x , since $\pi(a_B)$ is decreasing in x .

Proof of Proposition 5: As shown in the main text, $\pi(a_b)$ and $\bar{\gamma}(a_b)$ are both increasing in a_b . Hence, the left hand side of (47) is increasing in a_b , whereas the right hand side is decreasing in a_b . A solution to (47) is thus unique when it exists. Furthermore, since $\pi(a_b)$ in (42) is decreasing in x , one can conclude from the comparative statics exercise in (28) that a_b^* that solves (47) is increasing in x .

References

- Ashcraft, A. B., Goldsmith-Pinkham, P., & Vickery, J. (2010). *MBS ratings and mortgage credit boom*. Working Paper, Federal Reserve Bank of New York Staff Report No. 449.
- Bar-Isaac, H., & Shapiro, J. (2013). Ratings quality over the business cycle. *Journal of Financial Economics*, 108(1), 62–78.
- Bolton, P., Frexias, X., & Shapiro, J. (2012). The credit ratings game. *Journal of Finance*, LXVII(1), 85–111.
- Chemla, G., & Hennessy, G. (2014). Skin in the game and moral hazard. *Journal of Finance*, 69(4), 1597–1641.
- Cornaggia, J., Cornaggia, K., & Hund, J. (2014). *Credit ratings across asset classes*. Working Paper, Available at: SSRN: <http://ssrn.com/abstract=1909091>.
- DeMarzo, P. (2005). The pooling and traching of securities: A model of informed intermediation. *Review of Financial Studies*, 18(1), 1–35.
- DeMarzo, P., & Duffie, D. (1999). A liquidity based model of security design. *Econometrica*, 67, 65–99.
- Doherty, N., Kartesheva, A., & Phillips, R. (2012). Information effect of entry into credit ratings market: The case of insurers' ratings. *Journal of Financial Economics*, 106, 308–330.
- Faltn-Traeger, O., Johnson, K., & Mayer, C. (2011). *Sponsor risk and the performance of asset-backed securities*. Columbia Business School Research Paper Series.
- Financial Crisis Inquiry Commission. (2011). *Final report of the national commission on the causes of the financial and economic crisis in the United States*. Washington DC.
- Fulghieri, P., Strobl, G., & Xia, H. (2014). The economics of solicited and unsolicited credit ratings. *Review of Financial Studies*, 27(2), 484–518.
- Gorton, G., & Pennacchi, G. (1995). Banks and loan sales: Marketing nonmarketable assets. *Journal of Monetary Economics*, 35, 389–411.
- Griffin, J. M., & Tang, D. Y. (2012). Did subjectivity play a role in CDO credit ratings. *Journal of Finance*, 67, 1293–1328.
- Hartman-Glaser, B. (2013). *Reputation and signaling in asset sales*. Working Paper.
- He, J., Qian, J., & Strahan, P. (2012). Are ratings all created equal? The impact of issuer size on the pricing of mortgage-backed securities. *Journal of Finance*, 67(6), 2097–2137.
- Jeon, D.-S., & Lovo, S. (2013). Credit rating industry: A helicopter tour of stylized facts and recent theories. *International Journal of Industrial Organization*, 31, 643–651.
- Kartasheva, A. V., & Yilmaz, B. (2013). *Precision of ratings*. Wharton: University of Pennsylvania. Working Paper.
- Krugman, P. (2010). *Berating the raters*. New York Times. April 26.
- Leland, H. E., & Pyle, D. (1977). Information asymmetries, financial structure and financial intermediation. *Journal of Finance*, 32(2), 371–387.
- Levitin, A. J. (2011). *Skin-in-the-game: Risk retention lessons from credit card securitization*. Georgetown Law and Economics Research Paper (pp. 11–18).
- Lizzeri, A. (1999). Information revelation and certification intermediaries. *Rand Journal of Economics*, 30, 214–231.
- Manso, G. (2013). Feedback effects of credit ratings. *Journal of Financial Economics*, 109(2), 535–548.
- Mathis, J., McAndrews, J., & Rochet, Jean-Charles (2009). Rating the raters: Are reputation concerns powerful enough to discipline rating agencies? *Journal of Monetary Economics*, 56, 657–674.
- Opp, C. C., Opp, M. M., & Harris, M. (2013). Rating agencies in the face of regulation. *Journal of Financial Economics*, 108(1), 46–61.
- Ozerturk, S. (2014a). Ratings as regulatory stamps. *Journal of Economic Behavior and Organization*, 105, 17–29.
- Ozerturk, S. (2014b). Upfront versus rating contingent fees: Implications for rating quality. *Finance Research Letters*, 11, 91–103.
- Parlour, C., & Plantin, G. (2008). Loan sales and relationship banking. *Journal of Finance*, 63(3), 1291–1314.
- Pennacchi, G. (1988). Loan sales and the cost of bank capital. *Journal of Finance*, 43, 375–395.
- Plantin, G. (2011). *Good securitization, bad securitization*. Institute for Monetary and Economic Studies Discussion Paper Series. Bank of Japan.
- Rajan, U., Seru, A., & Vig, V. (2010). Statistical default models and incentives. In *American economic review: papers and proceedings* (pp. 506–510).

- Sangiorgi, F., & Spatt, C. (2013). *Opacity, credit rating shopping and bias*. Working Paper. Stockholm School of Economics and Carnegie Mellon.
- Skreta, V., & Veldkamp, L. (2009). Ratings shopping and asset complexity: A theory of ratings inflation. *Journal of Monetary Economics*, 56, 678–695.
- Stanton, R., & Wallace, N. (2012). *CMBS subordination, ratings inflation and regulatory-capital arbitrage*. Working Paper. Berkeley: University of California.
- Titman, S., & Tsyplakov, S. (2010). Originator performance, CMBS structures and risk of commercial mortgages. *Review of Financial Studies*, 23(9), 3558–3594.
- Weber, R., & Darbellay, A. (2008). The regulatory use of credit ratings in bank capital requirement regulations. *Journal of Banking Regulation*, 10(1), 1–16.
- White, L. J. (2010). Markets: The credit rating agencies. *Journal of Economic Perspectives*, 24(2), 211–226.