Credit Rating Inflation and Firms' Investments

JF 2020.06

汇报人：李明燏

2021年09月15日

Author DORON LEVIT*

- **is the Joel S. Ehrenkranz Family Professor and a Professor of Finance at the Wharton School of the University of Pennsylvania.**
- Tel-Aviv University(2001)
- Tel-Aviv University(1998)
- Tel-Aviv University(1994)

Academic Expertise: corporate finance, feedback effects between financial markets and real economy, financial fragility and crises, financial institutions, financial markets

Itay Goldstein

Publications:

- Itay Goldstein, Hao Jiang, David T. Ng (2017), Investor Flows and Fragility in Corporate Bond Funds, Journal of Financial Economics.
- Indraneel Chakraborty, Itay Goldstein, Andrew MacKinlay (2018), Housing Price Booms and Crowding-Out Effects in Bank Lending, Review of Financial Studies
- Indraneel Chakraborty, Itay Goldstein, Andrew MacKinlay (2019), Monetary Stimulus and Bank Lending, Journal of Financial Economics.

Author DORON LEVIT*

Chong Huang

- **joined The Paul Merage School of Business in July 2012 as an Assistant Professor of Finance.**

Education

- PhD in Economics, University of Pennsylvania
- MPhil in Economics, The Chinese University of Hong Kong
- BA in Finance, Beijing University
- **Academic Expertise**: learning in financial markets, corporate finance, and financial crises

Publications:

- A Theory of Multiperiod Debt Structure. Chong Huang, Martin Oehmke. Review of Financial Studies(2019) 32(11):4447-4500
- Defending against Speculative Attacks: The Policy Maker's Reputation. Chong Huang. Journal of Economic Theory .June (2017)171.

1. Introduction

2. A Model of Corporate Credit Ratings

3. The Benchmark: No CRA

4. Credit Ratings

5. The CRA's Real Effects under Rating Inflation

6. Empirical Predictions

7. The Role of Dispersed Beliefs

8. Conclusion

Abstract

- We analyze credit rating effects on firm investments in a rational bond financing game that features a feedback loop.
- The credit rating agency (CRA) inflates the rating, providing a biased but informative signal to creditors. Creditors' response to the rating affects the firm's investment decision and thus its credit quality, which is reflected in the rating.
- The CRA might reduce ex ante economic efficiency, which results solely from its strategic effect: the CRA assigns more firms high ratings and allows them to gamble for resurrection.
- We derive empirical predictions on the determinants of rating standards and inflation and discuss policy implications

1.Introduction

1.1 CRA

1.2 问题提出

1.3 基本假设

1.4 内容简述及主要结论

1.5 意义

1.6 创新

1.1 CRA

- CRA, CREDIT RATING AGENCIES.
- the Financial Crisis Inquiry Report to conclude that“the failures of CRAs were essential cogs in the wheel of financial destruction.”
- The concern is that by misleading creditors, inflated credit ratings help risky investments get funded and as a result have negative real effects.

1.2 问题提出

- if CRAs provide informative (though potentially biased) signals, they should be able to increase, rather than decrease, economic effificiency, even if they do not lead to the first-best outcome.
- The question then is whether CRAs with a motive to inflate ratings can have negative effects on economic efficiency in a world with rational creditors.

1.3 基本假设

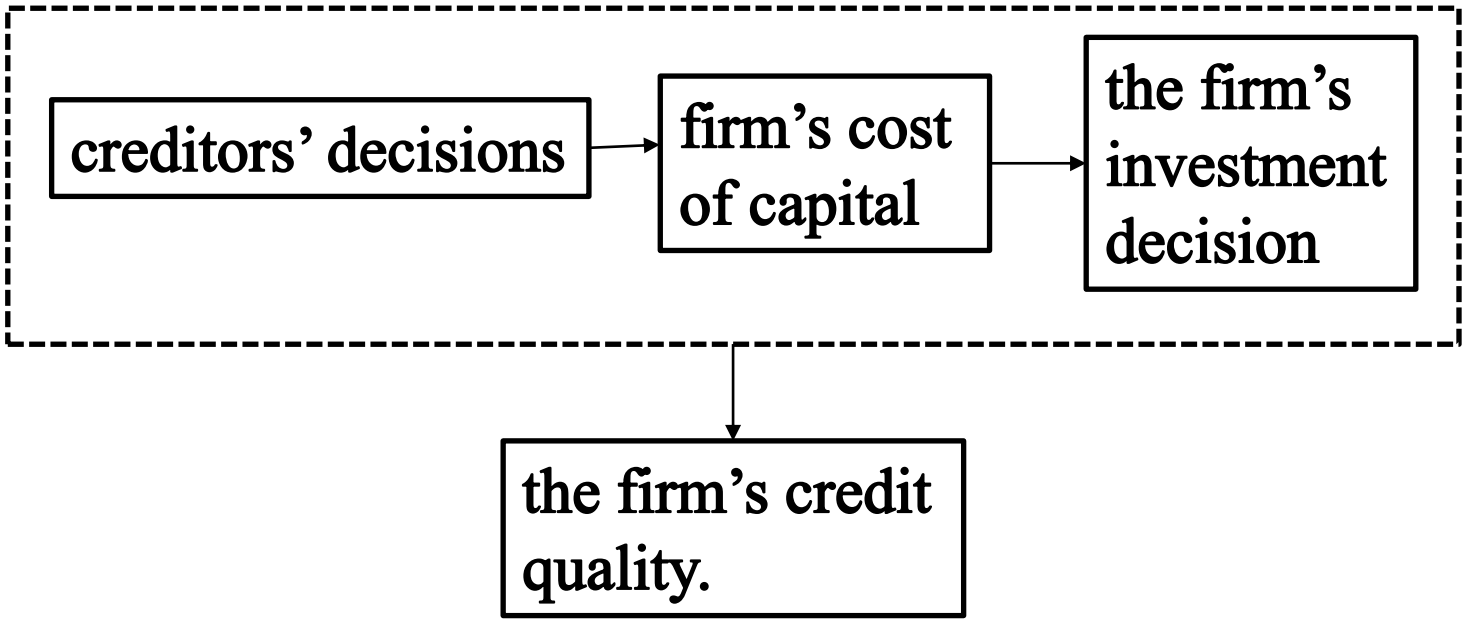
- **partial verifiability constraint.**

  A CRA that, by assigning a higher rating, earns higher revenue but incurs a higher cost if the firm fails.

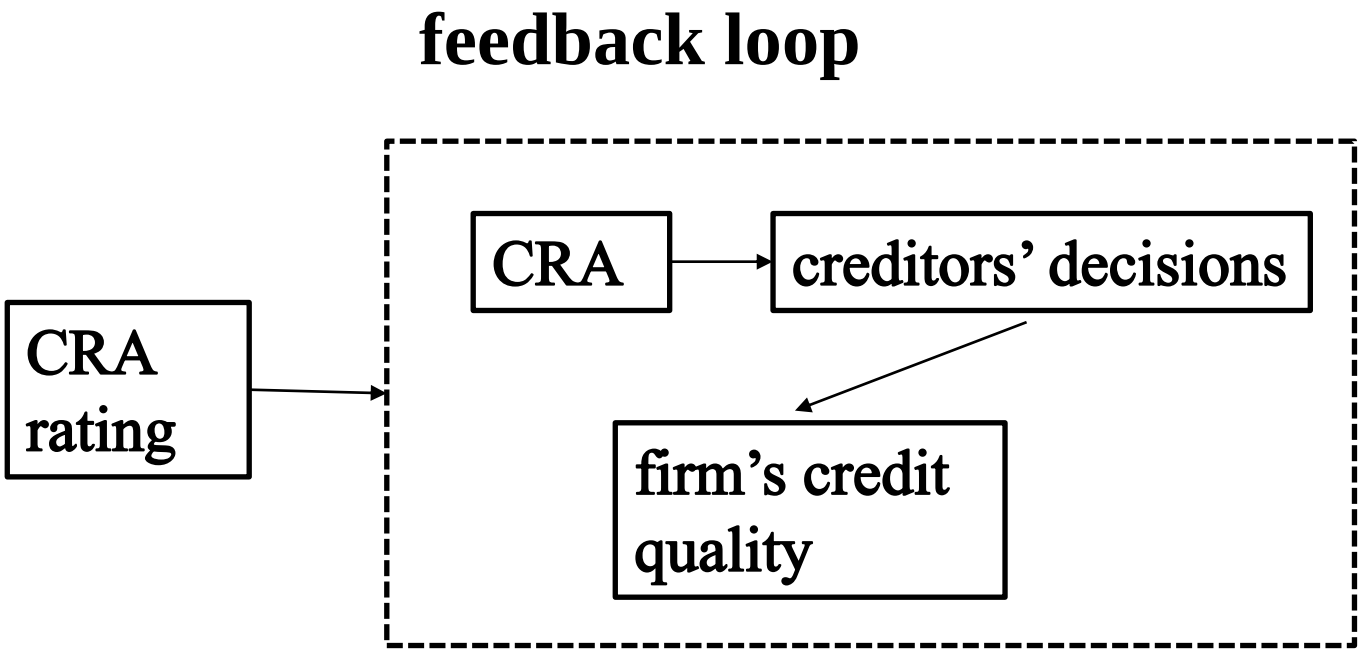
  If the CRA assigns a high rating to a firm that has extremely bad economic fundamentals and that will default immediately despite the high rating, the CRA will incur an extremely high cost.

- CRA, the firm, **rational creditors(dispersed beliefs about a firm's economic fundamentals and decide whether to buy bonds issued by the firm based on their private information and the CRA's credit rating.)**

1.3 基本假设


creditors' decisions
firm's cost of capital
the firm's investment decision
the firm's credit quality.

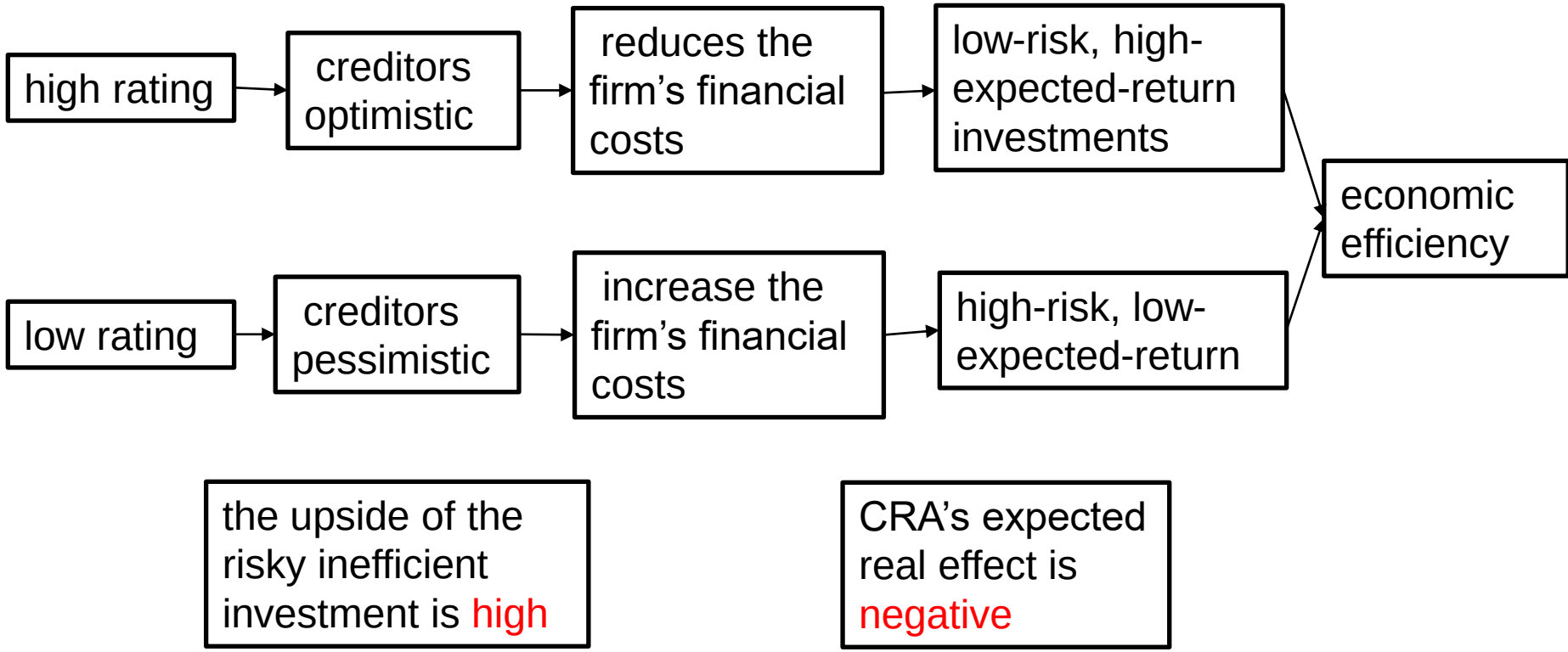
1.3 基本假设



CRAs claim that their ratings are forward-looking, emphasizing that they are based on the potential impact of foreseeable future events, which include the effects of the ratings themselves.

1.4 内容简述及主要结论

∵ **partial verifiability constraint**



1.4 内容简述及主要结论

we decompose the CRA's ex ante real effects into two components, namely, an informational effect and a strategic effect.

informational effect :does not incorporate the effect of its rating on the firm's investment and credit quality.

strategic effect :taking into account the effect of its ratings on creditors' and the firm's decisions.

1.4 内容简述及主要结论

the informational effect always increases economic efficiency.

The negative implications for economic efficiency thus come purely from the strategic effect.

1.5 意义

empirical implications：

- lax rating standards and rating inflation are two distinct endogenous terms that do not necessarily move in the same direction.
- a decrease in firm transparency has an ambiguous effect on rating inflation, an increase in the upside returns of risky projects will lead to higher rating inflation, and an increase in market liquidity will lead to lower rating inflation.

policy implications.

- A rating agency's equilibrium rating strategy depends on the ratio of its incremental revenue to incremental potential cost due to a rating upgrade
- a policymaker should target a ratio of the incremental revenue to the incremental cost due to a rating upgrade such that it falls within a particular range.

1.6 创新

- Our research question, in contrast, centers on the positive and negative real effects of a CRA with an inflation motive.
- Our model differs from these papers in that credit ratings are endogenously determined and the CRA has incentives to inflate ratings.
- our model has a unique equilibrium because the CRA's incentives to inflate credit ratings generate new dominant regions of not investing.
- the CRA in our model discloses information about endogenous firm credit quality, which is affected in turn by its disclosure.

2. A Model of Corporate Credit Ratings

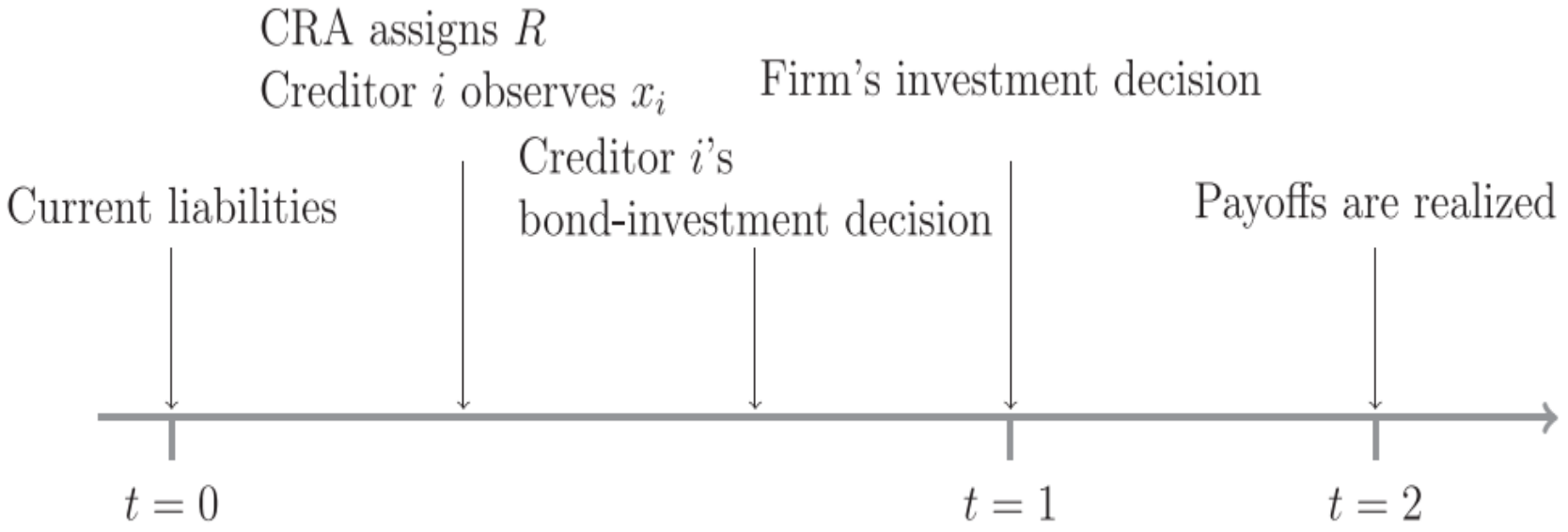


Figure 1. Timing.

山西大学
shanxi university

2. A Model of Corporate Credit Ratings

t=0

资金需求：the firm needs to make a payment of $1 for current liabilities such as unpaid wages.

两种融资方式：the firm can issue bonds at relatively low cost or borrow through an alternative financing channel at relatively high cost.

评级：the CRA assigns a credit rating to the firm.

债券投资决策：crditors' bond-investing decision

t=1

投资或违约：based on the financial cost and its private knowledge about its economic fundamentals, the firm chooses whether to default or to continue investing.

t=2

还钱：the cash flow is realized

A. Firm Investment

- a low-risk “viable” project (VP) or a high-risk project (HR) at date 1. VP generates a cash flow of $V > 0$ with probability $p \in (0, 1)$ but fails with probability $1 - p$. Similarly, HR generates a cash flow of $H > V$ with probability $q \in (0, p)$ but fails with probability $1 - q$.(the firm’s investment choice between VP and HR is unobservable and unverifiable.)
- the firm will not withdraw from its credit line and its liquidation value is $L \in (0, 1)$
- We assume that the expected cash flow generated by VP is greater than one,but HR is unlikely to generate a positive cash flow (q is sufficiently small).Specifically, we assume that

$$pV > 1 > L > qH. \qquad (1)$$

B. Financing

- There is a continuum of creditors with measure $1-\gamma$ in the bond market,each having \$1. captures the liquidity of the bond market, with a larger γ indicating a lower liquidity level. We assume that $\gamma \in (L, 1)$(when the firm defaults at date 1,the largest possible amount of funds available is $1-\gamma+L$, which is less than \$1)
- assume that the bond face value, F, is exogenously given.$pF > 1$, $qF < 1$,thus if any creditor i knows that the firm will invest in VP, he will buy the firm's bonds. the probability that HR is successful is so low ($qF < 1$) that creditor i will not buy the bonds if he knows that the firm will surely invest in HR.
- We denote by $a_i \in \{0, 1\}$ creditor i's bond-investment decision
- The firm can withdraw up to \$1 from the credit line at the constant marginal cost $M > F$, $M < \frac{pV-qH}{p-q}$.
- W:the measure of creditors who buy the bonds.
- $WF + (1-W)M$:The firm's financial cost
- f(θ):The operation cost of a new investment. $\lim_{\theta\to-\infty} f(\theta) = +\infty.$ $\lim_{\theta\to+\infty} f(\theta) = 0$
- if the firm decides to invest in either VP or HR, its total cost at date 2 is

$$K(\theta) = f(\theta) + WF + (1-W)M. \qquad (2)$$

C. Firm's Payoff

$$U = \begin{cases} 0, & \text{if the firm defaults at date 1,} \\ p\left[V - \left(f(\theta) + WF + (1-W)M\right)\right], & \text{if the firm invests in VP,} \\ q\left[H - \left(f(\theta) + WF + (1-W)M\right)\right], & \text{if the firm invests in HR.} \end{cases} \quad (3)$$

D. Information Structure

Before deciding whether to buy a bond, each creditor i observes a private signal $x_i = \theta + \xi_i$, $\xi_i \sim N(0, \beta^{-1})$, is independent of θ and independent across all creditors.

E. Credit Rating Agency

- we restrict the space of ratings to {0, q, p}, because these are

the only possible credit qualities of the firm: early default at date 1 means that the firm will certainly default and thus the firm's credit quality is zero, the firm investing in HR has credit quality q, and the firm investing in VP has credit quality p.

- We denote by V^R the CRA's rating revenue and by C^R its potential rating cost when it assigns a rating, R. The CRA's expected payoff by assigning the rating R is thus

$$V^R - \mathbb{E}(C^R). \qquad (4)$$

F. Economic Effects

- economic efficiency, effects that are captured by the **difference between the sums of all agents' ex ante payoffs(except the CRA) with and without the CRA.**
- the ex ante payoffs to the firm, creditors, the bank, and employees are

firm	$q[H-(f(\theta)+WF+(1-W)M)]$
creditors	$(1-W)+WqF$
bank	$(1-W)qM-(1-W)$
employees	$qf(\theta)$

if the firm invests in **VP, the economic efficiency is pV**; if the firm invests in **HR, the economic efficiency is qH**; and **if the firm defaults at date 1, the economic efficiency is L**.

G . Equilibrium

- The CRA's rating strategy , denoted by R, maps the firm's fundamentals to the rating space {0, q, p};
- creditors' strategies map their own private signals and the CRA's rating to their bond-investment decisions;
- the firm's strategy maps its fundamentals, the CRA's rating, and the measure of creditors investing in the bonds to project choices.

G . Equilibrium

DEFINITION 1: The CRA's rating strategy, the firm's investment strategy, and creditors' bond-investment strategies constitute an equilibrium if:

(1) Given the firm's investment strategy and creditors' bond-investment strategies, the **CRA** chooses the rating R to maximize its rating profits $V^R - E(C^R)$ for all $\theta \in$ R,

(2) Given the total repayment at date 2 in equation (2), the **firm**'s investment strategy maximizes the firm's expected profits,

(3) Given the CRA's rating strategy, the firm's investment strategy, and other creditors' strategies, any **creditor** i's strategy is monotonic in his private signal xi and maximizes his expected payoff,

(4) Creditors use Bayes' rule to update their beliefs.

3. The Benchmark: No CRA

- We first set up a benchmark that excludes the CRA. In such a benchmark, when deciding whether to buy the firm's bonds, creditors' decisions are based solely on their own private information.
- We first analyze the firm's behavior in this benchmark model. any θ-firm's total repayment at date 2 is deterministic:

$$K(\theta) = f(\theta) + W(\theta)F + \left(1 - W(\theta)\right)M. \tag{5}$$

Since H > V, the θ-firm will default early if and only if

$$K(\theta) > H. \tag{6}$$

3. The Benchmark: No CRA

- Conditional on the θ-firm deciding to continue investing, it invests in VP rather than HR if and only if

$$p\left[V-K(\theta)\right] \geq q\left[H-K(\theta)\right]$$

$$\Rightarrow K(\theta) \leq \frac{pV-qH}{p-q}. \tag{7}$$

- As a result, given creditors' strategies, the θ-firm's optimal investment strategy is

$$\begin{cases} \text{early default}, & \text{if} \quad K(\theta) > H, \\ \text{HR}, & \text{if} \quad K(\theta) \in \left(\frac{pV-qH}{p-q}, H\right], \\ \text{VP}, & \text{if} \quad K(\theta) \leq \frac{pV-qH}{p-q}. \end{cases} \tag{8}$$

山西大学 shanxi university

3. The Benchmark: No CRA

- This establishes a dominant region of investing for all creditors: When a creditor receives a very positive private signal, he will believe that the firm is going to invest in VP and hence will buy the firm's bonds even if all other creditors refrain from doing so.
- This establishes a dominant region of not investing: When a creditor receives a very negative private signal, he will believe that the firm will default at date 1 and hence will not buy the bonds even if all other creditors choose to buy.
- Therefore, as in other global game models, in a monotone equilibrium, any creditor employs a cutoff strategy with the threshold $\tilde{x}$, such that he invests in the bonds if and only if $x_i \geq \tilde{x}$
- Given θ and creditors' cutoff strategy, the measure of creditors who invest is

$$W(\theta) = (1-\gamma)\Pr(x \geq \tilde{x}|\theta) = (1-\gamma)\left\{1 - \Phi\left[\sqrt{\beta}(\tilde{x}-\theta)\right]\right\},$$

山西大学 shanxi university

3. The Benchmark: No CRA

- The θ-firm's total repayment at date 2 is thus

$$K(\theta) = f(\theta) + (1-\gamma)\left\{1 - \Phi\left[\sqrt{\beta}(\tilde{x} - \theta)\right]\right\} F$$
$$+ \left[\gamma + (1-\gamma)\Phi[\sqrt{\beta}(\tilde{x} - \theta)]\right] M$$
$$= f(\theta) + \left[(1-\gamma)F + \gamma M\right] + (1-\gamma)\Phi\left[\sqrt{\beta}(\tilde{x} - \theta)\right](M - F). \qquad (9)$$

- the first term is the operation cost of the θ-firm, the second term is the financial cost resulting from insufficient liquidity in the bond market, and the third term is the endogenous financial cost resulting from creditors' strategic uncertainty.
- as the firm's fundamentals improve (i.e., as θ increases), its operation cost decreases (since f(θ) is strictly decreasing); also, more creditors receive private signals above the threshold $\tilde{x}$ and thus choose to buy the bonds, leading to a lower financial cost.
- The monotonicity of K(θ)

3. The Benchmark: No CRA

- First, given creditors' strategies, the firm will choose to default early if and only if $\theta < \tilde{\theta}_1$. This implies that

$$K(\tilde{\theta}_1) = f(\tilde{\theta}_1) + \left[(1-\gamma)F + \gamma M\right] + (1-\gamma)\Phi\left[\sqrt{\beta}(\tilde{x} - \tilde{\theta}_1)\right](M - F) = H. \quad (10)$$

- Because $K(\theta)$ is strictly decreasing, for any $\theta < \tilde{\theta}_1$, the firm's total repayment at date 2 will be greater than H, the upside cash flow of HR.
- When $\theta \geq \tilde{\theta}_1$, the firm needs to choose between VP and HR. From equation (8) and the fact that $K(\theta)$ is strictly decreasing in θ, there must be a $\tilde{\theta}_2 > \tilde{\theta}_1$ such that the firm will choose VP if and only if $\theta \geq \tilde{\theta}_2$.

$$K(\tilde{\theta}_2) = f(\tilde{\theta}_2) + \left[(1-\gamma)F + \gamma M\right] + (1-\gamma)\Phi\left[\sqrt{\beta}(\tilde{x} - \tilde{\theta}_2)\right](M - F) = \frac{pV - qH}{p - q}. \quad (11)$$

3. The Benchmark: No CRA

- the firm will default early if $\theta < \tilde{\theta}_1$, invest in HR if $\theta \in [\tilde{\theta}_1, \tilde{\theta}_2)$, and invest in VP if $\theta \geq \tilde{\theta}_2$.
- Any creditor i receiving a private signal xi about θ first updates his belief about θ according to Bayes' rule:

$$\theta | x_i \sim \mathcal{N}\left(x_i, \frac{1}{\beta}\right).$$

- Given the firm's strategy described above, creditor i then calculates his return from investing in the bonds:

$$\left\{\Phi\left[\sqrt{\beta}(\tilde{\theta}_2 - x_i)\right] - \Phi\left[\sqrt{\beta}(\tilde{\theta}_1 - x_i)\right]\right\} qF + \left\{1 - \Phi\left[\sqrt{\beta}(\tilde{\theta}_2 - x_i)\right]\right\} pF.$$

3. The Benchmark: No CRA

- any creditor will receive the payoff 1 if he does not invest, and his expected payoff from investing is strictly increasing in his private signal, the marginal creditor must have the private signal $\tilde{x}$ that makes his indifference condition hold:

$$\left\{\Phi\left[\sqrt{\beta}(\tilde{\theta}_2-\tilde{x})\right]-\Phi\left[\sqrt{\beta}(\tilde{\theta}_1-\tilde{x})\right]\right\}qF+\left\{1-\Phi\left[\sqrt{\beta}(\tilde{\theta}_2-\tilde{x})\right]\right\}pF=1. \quad (12)$$

3. The Benchmark: No CRA

- PROPOSITION 1 (The Unique Equilibrium in the Benchmark Model): There exists a $\tilde{\beta} > 0$ such that for all $\beta > \tilde{\beta}$, the benchmark model without a CRA has a unique equilibrium described by ($\tilde{\theta}_1$, $\tilde{\theta}_2$, $\tilde{x}$), where$\tilde{\theta}_1 < \tilde{\theta}_2$. In particular:
- (1) The firm's investment strategy is

$$\begin{cases} VP, & if\ \theta \geq \tilde{\theta}_2, \\ HR, & if\ \theta \in \left[\tilde{\theta}_1, \tilde{\theta}_2\right), \\ early\ default, & if\ \theta < \tilde{\theta}_1. \end{cases}$$

- (2) Any creditor i buys the firm's bonds if and only if xi $\geq \tilde{x}$.

4. Credit Ratings

- the CRA strategically chooses its optimal rating strategy.

A. Equilibrium Rating Strategies

- "issuer-pays" we assume that the CRA receives more revenue by assigning the firm a higher credit rating. Hence, $V^p > V^q > V^0 = 0$, where we normalize the revenue from assigning the rating R = 0 to zero.
- The CRA incurs a rating cost, C^R, which may be viewed as a legal or reputation cost, when the firm defaults.
- if a firm with rating R > 0 defaults endogenously at date 1, theCRA incurs a cost of C^D.We therefore assume that

$$C^D > V^p. \tag{13}$$

- We refer to this assumption as the partial verifiability constraint imposed on credit ratings.

4. Credit Ratings

A. Equilibrium Rating Strategies

- if a firm with rating R > 0 defaults at date 2 after making an investment, the CRA incurs a cost of C^R (R = p, q). we assume that

$$V^p > V^q > C^p > C^q > 0.$$

- We further assume that the CRA's reputation cost is exogenous.
- Initially the CRA's reputation cost is high, but when its reputation is sufficiently high, its reputation cost is lower.

- the CRA will assign the rating R = 0 if it foresees that the firm will default at date 1 .if the firm does not default at date 1, the CRA will assign the rating p or q. In such a case, the CRA will issue the rating p if and only if $V^p - E(C^p) \geq V^q - E(C^q)$.

4. Credit Ratings

A. Equilibrium Rating Strategies

- LEMMA 1: The CRA's equilibrium rating strategy depends on the ratio $(V^p - V^q)/(C^p - C^q)$. There are three cases:

(1) *If* $\frac{V^p - V^q}{C^p - C^q} \geq 1 - q$, *the equilibrium rating strategy takes the form*

$$\mathcal{R}(\theta) = \begin{cases} p, & if\ \theta \geq \theta^I, \\ 0, & if\ \theta < \theta^I. \end{cases} \tag{14}$$

(2) *If* $\frac{V^p - V^q}{C^p - C^q} \leq 1 - p$, *the equilibrium rating strategy takes the form*

$$\mathcal{R}(\theta) = \begin{cases} q, & if\ \theta \geq \theta^D, \\ 0, & if\ \theta < \theta^D. \end{cases} \tag{15}$$

(3) *If* $\frac{V^p - V^q}{C^p - C^q} \in (1 - p, 1 - q)$, *the equilibrium rating strategy takes the form*

$$\mathcal{R}(\theta) = \begin{cases} p, & if\ \theta \geq \theta^p, \\ q, & if\ \theta \in [\theta^q, \theta^p), \\ 0, & if\ \theta < \theta^q, \end{cases} \tag{16}$$

where $\theta^q \leq \theta^p$.

4. Credit Ratings

A. Equilibrium Rating Strategies

- Lemma 1 shows that the CRA's equilibrium rating strategy depends on the ratio of the incremental revenue to the incremental cost of upgrading the rating from q to p.

- Part 1 of Lemma 1 shows that if the benefit of upgrading the rating from q to p is high enough (relative to the increase in reputation cost), the CRA will "inflate" the ratings assigned to firms that invest in HR.
- The condition $(V^p - V^q)/(C^p - C^q) \geq 1 - q$ therefore implies that upgrading the θ-firm to the p rating group will be a profitable deviation, and hence the CRA will not assign the rating R = q in equilibrium.

4. Credit Ratings

A. Equilibrium Rating Strategies

- Part 2 of Lemma 1 shows that when the revenue of upgrading the rating from q to p is sufficiently small (relative to the increase in the reputation cost),the CRA will "deflate" the ratings assigned to firms. In this case, only ratings R = 0 and R = q will be assigned in equilibrium.
- The CRA's effects on economic efficiency are therefore identical in these two cases.
- Part 3 of Lemma 1 presents a very different case. When the ratio of the revenue increment of upgrading to the cost increment is in a medium range , the CRA may assign all three possible ratings in equilibrium. Importantly , in this case, in equilibrium the rating coincides with the firm's credit quality, that is, the CRA conveys accurate information about the firm's credit quality. We refer to such a CRA as a self-disciplined CRA.

4. Credit Ratings

A. Equilibrium Rating Strategies

- Therefore, $\frac{V^p - V^q}{C^p - C^q} \in (1-p, 1-q)$. if a θ-firm chooses VP (no matter whether it is assigned the rating p or the rating q), the CRA will assign the rating p. Similarly, if the θ-firm chooses HR (no matter whether it is assigned the rating p or the rating q), the CRA will assign the rating q.
- a self-disciplined CRA will eliminate information asymmetry between the firm and creditors. It is then intuitive that the self-disciplined CRA will lead to a level of economic efficiency that is at least as high as in the case without a CRA, strictly promoting economic efficiency for some firm fundamentals

4. Credit Ratings

B. Rating Inflation and Rating Informativeness

- we focus on the case of the "inflating" CRA in the rest of the paper

$$\frac{V^P - V^q}{C^p - C^q} \geq 1 - q. \tag{17}$$

- Under such an assumption, Lemma 1 implies that the CRA's equilibrium rating strategy is

$$\mathcal{R}(\theta) = \begin{cases} p, & \text{if } \theta \geq \theta_1^*, \\ 0, & \text{if } \theta < \theta_1^*. \end{cases} \tag{18}$$

- Therefore, the CRA's equilibrium rating strategy can be characterized by $\theta_1^* \in$ R, with R(θ) = p when $\theta \geq \theta_1^*$ and R(θ) = 0 when $\theta < \theta_1^*$.

B. Rating Inflation and Rating Informativeness

- When θ_1^* decreases, the CRA assigns more firms with the high rating p. So for rating strategies $R_1$with threshold θ_1^* and R_2 with threshold θ_2^*, we say that the rating strategy R_2 is laxer than the rating strategy R_1 if and only if $\theta_2^* < \theta_1^*$.
- However, the laxer rating strategy R_2 may not lead to higher credit rating inflation, which arises when the nominal rating is strictly higher than the real credit quality.

- DEFINITION 2: A credit rating assigned to a θ-firm is inflated if, in equilibrium, the θ-firm chooses HR and thus has credit quality q but the CRA assigns the rating p. In addition, a rating strategy is inflated if credit ratings assigned according to the rating strategy are inflated for a nonnegligible subset of fundamentals, and a credit rating strategy is more inflated if, for a larger measure of fundamentals, credit ratings assigned according to the rating strategy are inflated.

B. Rating Inflation and Rating Informativeness

- LEMMA 2: There is no monotone equilibrium in which all θ-firms that receive a rating R = p invest in VP.
- The CRA's equilibrium rating strategy (equation (18)) implies that if R=p, all creditors know that $\theta \geq \theta_1^*$. So the rating p guarantees creditors that the firm's fundamentals are not extremely bad.

- COROLLARY 1: Following the credit rating R=p, regardless of his private signal x_i, the support of any creditor i's interim belief about θ is truncated from below by θ_1^*.

C. Equilibrium under Rating Inflation

- In this subsection, we characterize the unique equilibrium under rating inflation.

$$\frac{V^P - V^q}{C^p - C^q} \geq 1 - q. \tag{17}$$

$$\mathcal{R}(\theta) = \begin{cases} p, & \text{if } \theta \geq \theta_1^*, \\ 0, & \text{if } \theta < \theta_1^*. \end{cases} \tag{18}$$

- Since the rating strategy assigns the rating R = 0 to the firm if and only if $\theta < \theta_1^*$, we must have that $K(\theta) = f(\theta) + M > H$, $\forall \theta < \theta_1^*$. Then, by the continuity of f(·), we have the first equilibrium condition:

$$f(\theta_1^*) \geq H - M. \tag{19}$$

C. Equilibrium under Rating Inflation

- We now focus on the case following the rating R = p. Since given creditors' strategies, the firm's total repayment at date 2 is strictly decreasing with its fundamentals, there must be a threshold $\theta_2^* > \theta_1^*$ such that the θ-firm invests in VP if $\theta \geq \theta_2^*$ but in HR if $\theta \in [\theta_1^*, \theta_2^*)$. Note that Lemma 2 implies that θ_2^* must be strictly greater than θ_1^*, because some firms with the rating R = p will invest in HR.

- Corollary 1 implies that given the CRA's rating strategy, after observing the rating p, all creditors believe that the firm's true fundamentals are above θ_1^*.
- Hence, any creditor i will buy the bonds if and only if his private signal lands above a threshold $x* \in R$. We refer to the creditor with private signal $x*$ the marginal creditor.

C. Equilibrium under Rating Inflation

- the CRA chooses θ_1^* to maximize its expected rating profit. Since it will assign R = p to the firm if and only if the firm will not default at date 1 with such a rating, θ_1^* must be chosen so that the firm is indifferent between early default and HR.
- The above arguments lead to the indifference conditions of the firm, the marginal creditor, and the CRA, which are characterized by equations (20),(21), and (22), respectively:

$$f(\theta_2) + (1-\gamma)\left[1 - \Phi\left(\sqrt{\beta}(x-\theta_2)\right)\right]F + \left[\gamma + (1-\gamma)\Phi\left(\sqrt{\beta}(x-\theta_2)\right)\right]M = \frac{pV - qH}{p-q}, \tag{20}$$

$$\frac{\Phi[\sqrt{\beta}(\theta_2^* - x^*)] - \Phi[\sqrt{\beta}(\theta_1^* - x^*)]}{1 - \Phi[\sqrt{\beta}(\theta_1^* - x^*)]} qF + \frac{1 - \Phi[\sqrt{\beta}(\theta_2^* - x^*)]}{1 - \Phi[\sqrt{\beta}(\theta_1^* - x^*)]} pF = 1, \tag{21}$$

山西大学 shanxi university

C. Equilibrium under Rating Inflation

$$f(\theta_1^*) + (1-\gamma)\left[1 - \Phi(\sqrt{\beta}(x^* - \theta_1^*))\right]F + \left[\gamma + (1-\gamma)\Phi(\sqrt{\beta}(x^* - \theta_1^*))\right]M = H. \quad (22)$$

- PROPOSITION 2: Given equation (17), there is a $\beta* > 0$ such that when $\beta > \beta*$, the model has a unique equilibrium. The equilibrium is characterized by $(\theta_1^*, \theta_2^*, x*)$, where $\theta_2^* > \theta_1^*$, such that:
- (1) The CRA will assign the rating R = p if the firm's fundamentals θ belong to $[\theta_1^*, +\infty)$, and the rating R = 0 otherwise.
- (2) If R = 0, no creditor buys the bonds, and the firm defaults at date 1.
- (3) If R = p, a creditor invests in the bonds if and only if his private signal lands above $x*$, and the firm will choose HR if $\theta \in [\theta_1^*, \theta_2^*)$ and VP if $\theta \in [\theta_2^*, +\infty)$.
- (4) The triple $(\theta_1^*, \theta_2^*, x*)$ solves equations (20), (21), and (22).

山西大学 shanxi university

C. Equilibrium under Rating Inflation

- Proposition 2 shows that under the assumption of rating inflation (equation(17)), the model has a unique equilibrium in which the CRA's rating, the firm's investment decision, and creditors' bond-investment decisions interact with one another.(4) The triple $(\theta_1^*, \theta_2^*, x*)$ solves equations (20), (21), and (22).
- Proposition 2 provides a clear measure of equilibrium rating inflation. When $\theta<\theta_1^*$, the CRA will assign the rating R = 0 to the firm. Since the firm will default early, the credit rating accurately reflects the firm's credit quality. When $\theta\geq\theta_2^*$, the firm's fundamentals are sufficiently good that it will invest in VP. In this case, the credit rating R=p also indicates the firm's actual credit quality.
- However, when $\theta\in[\theta_1^*,\theta_2^*)$, the firm invests in HR and thus has credit quality q, but it receives the high rating p. The credit ratings assigned to such firms are inflated. Hence, rating inflation can be captured by $\theta_2^* - \theta_1^*$.

5. The CRA's Real Effects under Rating Inflation

- We are now able to analyze the CRA's real effects. For a given θ-firm, if the assigned credit rating changes its investment decision (compared to its investment in the benchmark model without a CRA), the CRA affects economic efficiency. In this case we say that the CRA has real effects on the θ-firm.
- Such effects are positive if the CRA leads to higher economic efficiency and negative if the CRA leads to lower economic efficiency.
- We capture the CRA's ex ante real effects using the average change in economic efficiency.

5. The CRA's Real Effects under Rating Inflation

- LEMMA 3: Comparing the equilibrium of the model with a CRA (described in Proposition 2) to that of the benchmark model without a CRA (described in Proposition 1), we have $\theta_1^* < \tilde{\theta}_1$, $\theta_2^* < \tilde{\theta}_2$, and $x^* < \tilde{x}$. However, the sign of $\theta_2^* - \tilde{\theta}_1$ is undetermined.

- Lemma 3 shows that, with the CRA, both the early default threshold and the VP investment threshold are lower than those in the benchmark model without a CRA.

5. The CRA's Real Effects under Rating Inflation

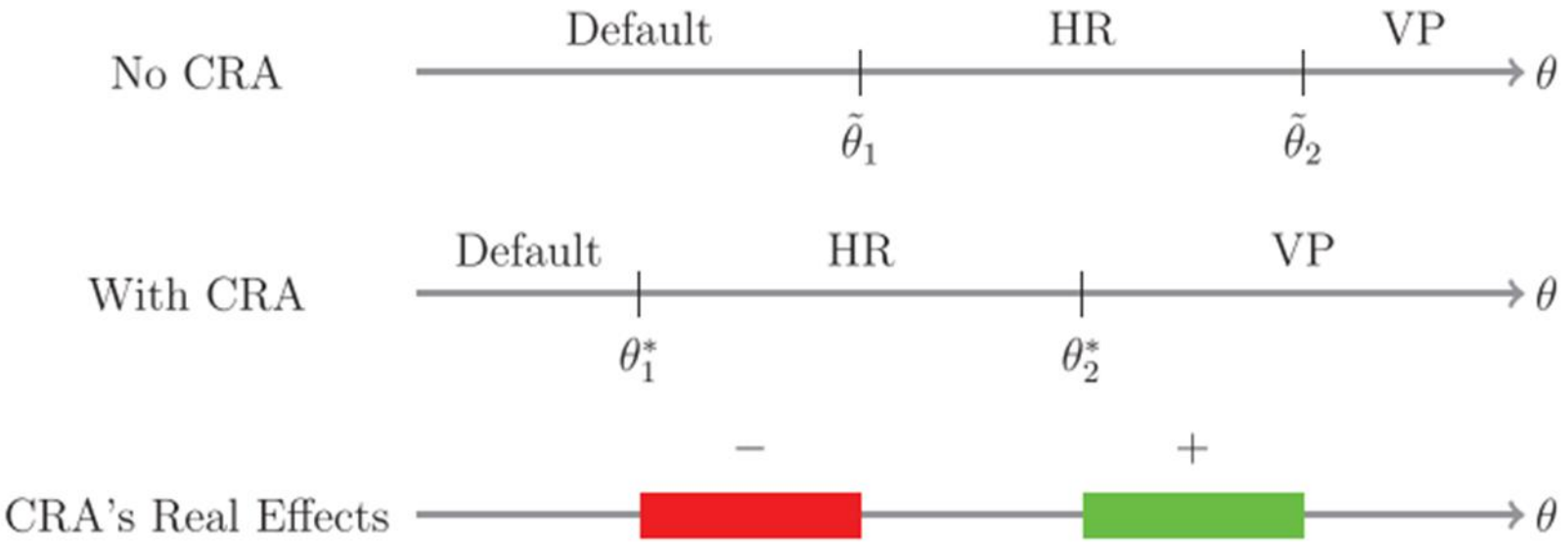


Figure 2. CRA's real effects when $\theta_2^* > \tilde{\theta}_1$. (Color figure can be viewed at wileyonlinelibrary.com)

- Figure 2 illustrates the CRA's real effects in the case in which $\theta_2^* > \tilde{\theta}_1$.
- When $\theta_2^* > \tilde{\theta}_1$, there are two cases.
- When $\theta_2^* \leq \tilde{\theta}_1$, the CRA's real effects are similar, except that the range for negative real effects is different.

5. The CRA's Real Effects under Rating Inflation

- PROPOSITION 3: Under the assumption of equation (17), the CRA's real effects are summarized by two cases:
- (1) If $\theta_2^* > \tilde{\theta}_1$, the CRA has positive real effects when $\theta \in [\theta_2^*, \tilde{\theta}_2)$ and negative real effects when $\theta \in [\theta_1^*, \tilde{\theta}_1)$, and hence the CRA's ex ante real effects are

$$(\tilde{\theta}_2 - \theta_2^*)(pV - qH) + (\tilde{\theta}_1 - \theta_1^*)(qH - L).$$

- (2) If $\theta_2^* \leq \tilde{\theta}_1$, the CRA has positive real effects when $\theta \in [\theta_2^*, \tilde{\theta}_2)$ and negative real effects when $\theta \in [\theta_1^*, \theta_2^*)$, and hence the CRA's ex ante real effects are

$$(\tilde{\theta}_2 - \tilde{\theta}_1)(pV - qH) + (\tilde{\theta}_1 - \theta_2^*)(pV - L) + (\theta_2^* - \theta_1^*)(qH - L).$$

- Importantly, Proposition 3 shows that the CRA that employs an inflated rating strategy may have positive or negative real effects, depending on the firm's fundamentals. The CRA's ex ante real effects then depend on model parameters.

5. The CRA's Real Effects under Rating Inflation

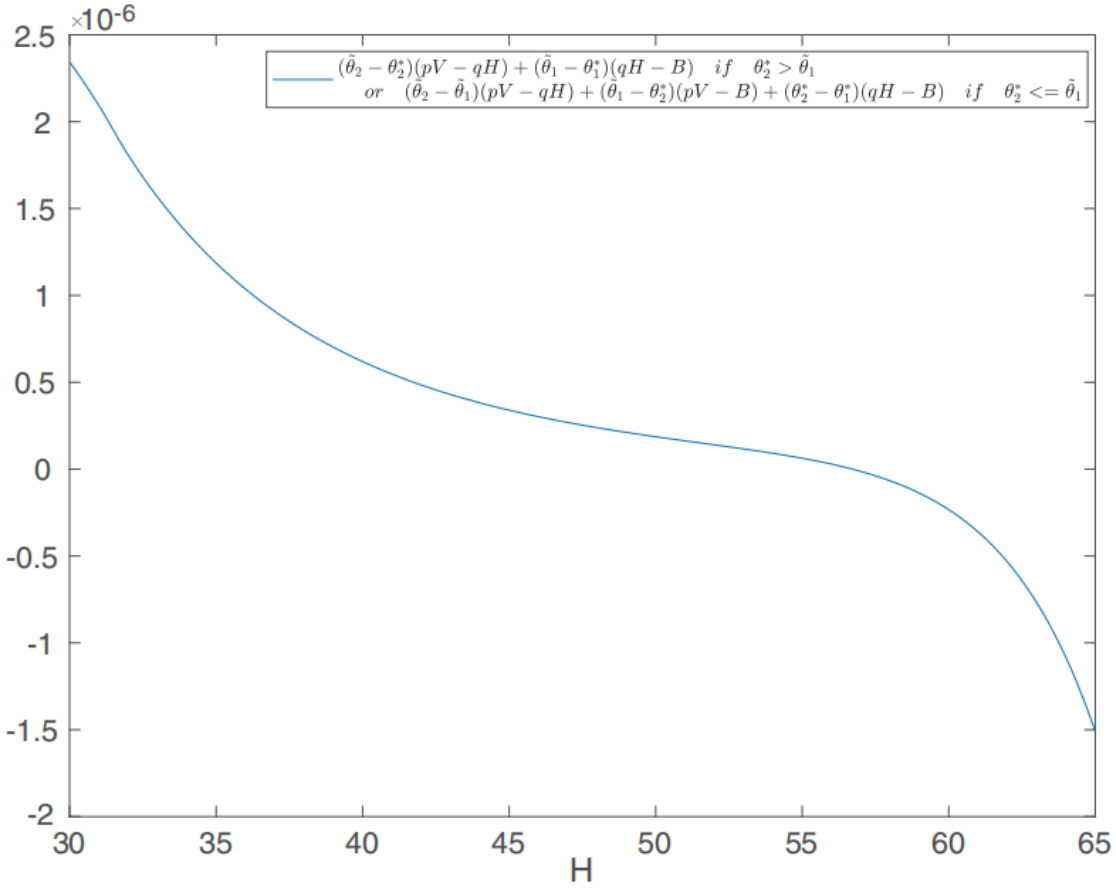


Figure 3. The CRA's real effects as a function of H. The parameters used in this figure are $F = 1.2, M = 1.5, V = 3, p = 0.9, q = 0.005, \gamma = 0.7, L = 0.7, \beta = 0.8$, and $f(\theta) = e^{-\theta}$. (Color figure can be viewed at wileyonlinelibrary.com)

山西大学 shanxi university

5. The CRA's Real Effects under Rating Inflation

- In Figure 3, we depict the CRA's ex ante real effects as a function of the upside return of the risky project, H.
- The figure shows that when the upside return of the risky project is relatively high, the CRA's ex ante real effects are negative. This is because when H is large, the firm has stronger incentives to take risks by investing in HR and thus is less likely to default at date 1 efficiently.
- The CRA will therefore assign more firms the high rating R = p, which allows those firms to gamble for resurrection and in turn have negative ex ante real effects.
- When H is relatively small, the CRA encourages more firms to switch from HR to VP and thus has positive ex ante real effects.

5. The CRA's Real Effects under Rating Inflation

- **A. Informational Effects and Strategic Effects**

- Proposition 2 suggests that the CRA affects a firm's investment decision through two interacting channels.
- On the one hand, by assigning the rating R=p, the CRA separates firms with fundamentals above a threshold from those with fundamentals below the threshold. Hence, the rating R=p provides creditors with new information about the firm's fundamentals.
- This new information affects creditors' bond-investment decisions, and thus the firm's financial costs and investment choice. We refer to such effects as the CRA's informational effects.

5. The CRA's Real Effects under Rating Inflation

- **A. Informational Effects and Strategic Effects**

- On the other hand, the CRA strategically chooses θ_1^* to pool the firms that invest in HR with those that invest in VP.
- Hence, the set of firm types that invest in HR or VP may differ in cases with and without a CRA.
- This also affects firm investment decisions. We refer to such effects as the CRA's strategic effects, since the CRA, when choosing θ_1^*, takes into account creditors' and the firm's best responses to the ratings.
- In this subsection, we examine how these two effects interact to determine the CRA's real effects.

5. The CRA's Real Effects under Rating Inflation

- **A. Informational Effects and Strategic Effects**

- We first analyze the CRA's informational effects. Consider the case in which the CRA commits to the following rating strategy

$$\mathcal{R}(\theta) = \begin{cases} 0, \text{ if } \theta < \widehat{\theta}_1 \equiv \tilde{\theta}_1; \\ p, \text{ if } \theta \geq \widehat{\theta}_1. \end{cases} \tag{23}$$

- Here, $\tilde{\theta}_1$, which is characterized in Proposition 1, is the early-default threshold of the firm when there is no CRA.
- The committed rating strategy characterized in equation (23) simply reflects the firm's investment decision in the benchmark model without a CRA.
- such a CRA as a reflecting CRA
- CRA analyzed in Section III as a strategic CRA

山西大学 shanxi university

5. The CRA's Real Effects under Rating Inflation

- **A. Informational Effects and Strategic Effects**

- Importantly, a reflecting CRA does not have strategic effects, because it does not strategically account for its effects on the firm's investment decision when committing to its rating strategy, although such a rating strategy may still be inflated.
- Therefore, the real effects of the reflecting CRA are just the informational effects of the strategic CRA.
- By comparing the strategic CRA's real effects with the reflecting CRA's real effects, we can identify the strategic CRA's strategic effects.

5. The CRA's Real Effects under Rating Inflation

- **A. Informational Effects and Strategic Effects**

- PROPOSITION 4: Given the committed rating strategy in equation (23), the resulting credit ratings lead to two continuation plays:
- (1) Following R = 0, there is a unique equilibrium play in which the firm defaults at date 1.
- (2) Following R = p, in any equilibrium, the θ-firm invests in VP if $\theta \geq \hat{\theta}_2$ and in HR if $\theta \in [\hat{\theta}_1, \hat{\theta}_2)$. Furthermore, if $\theta_2^* > \tilde{\theta}_1$, we have $\hat{\theta}_2 < \theta_2^*$.
- Proposition 4 characterizes the firm's equilibrium investment decision in the case with the reflecting CRA.

山西大学 shanxi university

5. The CRA's Real Effects under Rating Inflation

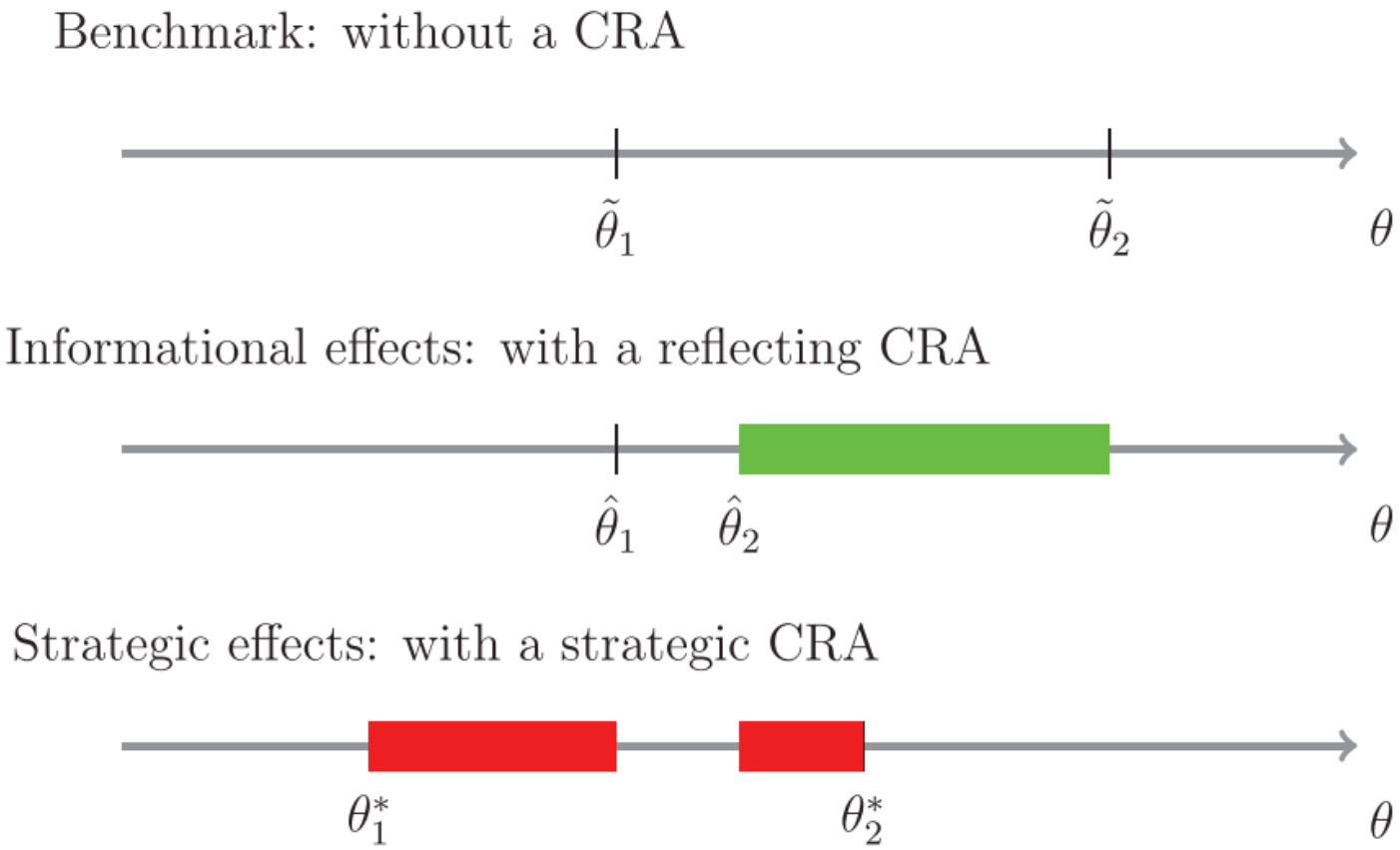


Figure 4. CRA's strategic effects when $\theta_2^* > \tilde{\theta}_1$. (Color figure can be viewed at wileyonlinelibrary.com)

5. The CRA's Real Effects under Rating Inflation

- **A. Informational Effects and Strategic Effects**

- PROPOSITION 5: The CRA's real effects can be decomposed into its informational effects and its strategic effects. The informational effects, which are captured by $(\tilde{\theta}_2-\hat{\theta}_2)(pV-qH)$, are always positive. When the parameters are such that $\theta_2^* \geq \hat{\theta}_1$, the strategic effects are captured by

$$(\tilde{\theta}_1 - \theta_1^*)(qH - L) + (\theta_2^* - \hat{\theta}_2)(qH - pV),$$

- which is negative, but when $\theta_2^* < \hat{\theta}_1$, the strategic effects are captured by

$$(\theta_2^* - \theta_1^*)(qH - L) + (\hat{\theta}_1 - \theta_2^*)(pV - L) + (\hat{\theta}_2 - \hat{\theta}_1)(pV - qH),$$

- the sign of which is undetermined.

5. The CRA's Real Effects under Rating Inflation

- **A. Informational Effects and Strategic Effects**

- Proposition 5 implies that credit rating inflation itself does not necessarily lead to negative ex ante real effects.
- Because inflated ratings are informative signals, they do increase market efficiency and have positive real effects.
- Negative real effects, however, can arise from the CRA's strategic effects. Because the CRA knows that the rating will reduce the firm's financial costs and default likelihood, it will issue the high rating to more firms, providing them with opportunities to gamble for resurrection.

6. Empirical Predictions

- PROPOSITION 6: When β is sufficiently large, a decrease in β, an increase in H, and a decrease in γ will lead to a decrease in θ_1^*. However, a decrease in β has an ambiguous effect on $\theta_2^*-\theta_1^*$, an increase in H increases $\theta_2^*-\theta_1^*$, and a decrease in γ decreases $\theta_2^*-\theta_1^*$.
- Proposition 6 shows that for more opaque firms , the CRA employs laxer rating strategies.
- By the properties of a truncated normal random variable's mean, when creditors' private signals become less precise, they infer that the firm is more likely to invest in VP. As a result, more creditors invest in the bonds and the firm's financial costs decrease, which allows the CRA to employ a laxer rating strategy.

6. Empirical Predictions

- an increase in H decreases the firm's incentives to default early, because the firm has limited liability
- for fixed creditors' strategies, when H increases, the CRA's rating strategy will be laxer and the firm is more likely to invest in HR than VP, resulting in higher credit rating inflation.
- a decrease in γ will lead more creditors to buy the firm's bonds.
- the firm's VP-investment threshold will decrease, implying that fewer firms will invest in HR given the CRA's credit rating strategy

7. The Role of Dispersed Beliefs

- Since a continuum of creditors with a homogeneous belief is informationally equivalent to a single large creditor.

- when all creditors share an accurate common belief, the CRA has little real effect—creditors will ignore the information extracted from credit ratings.

8. Conclusion

- We study CRAs' effects on firm investment.
- high ratings make creditors more optimistic, which reduces the firm's financial costs and changes its investment decisions.
- inflated ratings have significant real effects.
- Such real effects, however, could be positive or negative.
- With high ratings , some firms take risky projects rather than default efficiently, implying that CRAs have adverse real effects.
- other firms switch from risky inefficient investments to safe efficient investments, implying that CRAs have positive real effects.
- CRAs' overall ex ante real effects thus depend on the economic environment. Specifically, when the upside return of a risky project is high, CRAs' overall ex ante real effects are negative.
- To better understand why the CRA may have negative ex ante real effects, ,we decompose its real effects into its informational effects and its strategic effects.

8. Conclusion

- credit ratings that act as new informative signals positively affect firms' investment efficiency
- the CRA's negative real effects arise solely from its strategic effects.

THANKS !