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The Analysis of Competition in the Credit Rating Industry from the Perspective of Auction Theory

경매이론의 관점에서 본 신용평가 산업의 경쟁분석

2021년 1월

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이 논문을 경제학석사 학위논문으로 제출함

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박상준의 석사 학위논문을 인준함

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Abstract

The Analysis of Competition in the Credit Rating Industry from the Perspective of Auction Theory

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We build a model including the aspect of ratings shopping, ratings catering, and resulting rating inflation. Especially, we adopt the setting of first price auction to show the effects of competition among credit rating agencies to rating inflation. The analysis of benchmark model reveals that there is uniform rating inflation if issuers can provide high enough reward to the winning credit rating agency. In addition, rating inflation worsens when there are more competing credit rating agencies. After analyzing the benchmark model, we explore implication of adopting stricter disclosure requirement and 'investor pays' model. Both proposals have similar advantage that the cost of issuers' inducing uniform rating inflation becomes expensive. Yet, these policies also share the same weakness that the issuers with sufficient financial resource are not affected. Nonetheless, there is a chance of recovering investors' loss in the case of investor pays model by giving more information to them. However, if investor pays model results overly pessimistic view on average financial products, securities with high success probability can be crowded out from the market. Lastly, we study hypothetical circumstance where legal penalty is given to winning credit rating agency which reported untruthfully, and figure out the range of penalty that can guarantee strategy-proofness.

keywords : ratings shopping, ratings catering, rating inflation, stricter disclosure requirement, investor pays model, legal responsibility

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Chapter 1 Introduction

Section 1 Motivation

Credit rating agencies are exerting tremendous influence on today's financial market. For example, the regulation of many countries concerning financial commodity directly cites the rating given by credit rating agencies. Especially, in the U.S., The Securities and Exchange Commission (SEC) made a category called "nationally recognized statistical rating organization" (NRSRO) and is using the NRSRO's rating as a reference for setting safety requirements for the commercial paper (short-term debt) held by money market mutual funds (White, 2010). As a result, credit rating agenceis (or NRSROs) have de facto regulation power to control financial market.

Yet, there are growing doubt and controversy arguing that credit rating agencies do not deserve their current regulatory status. In particular, the criticism based on credit rating agencies' conflict of interest started to receive attention after the Enron bankruptcy and 2008 Subprime Mortgage Crisis. This conflict of interest comes from the fact that issuers who ask credit rating agencies to rate their securities of structured finance product are the ones paying the agencies for their work. Since rating business is a major revenue source of credit rating agencies, the agencies are pressured to offer favorable ratings to security issuers. (known as "ratings catering")[1]

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1) According to Chu and Rysman (2019), '*Ratings Catering* refers to when ratings agencies boost ratings in order to appeal to issuers, presumably at the cost of the agencies reputations' with investors and regulators, to the extent that ratings prove

As mentioned by Becker and Milbourn (2011), this tendency gets stronger when there are more available competitors who can potentially fight for the same customers, which is one of the reasons why just encouraging competition may not necessarily be a solution to – or even exaggerate – the ratings inflation problems.

What makes things worse is that the security issuers has an ability to select which rating to get published. That is, even if one credit rating agency reports truthful and accurate appraisal of a security, the issuer can just choose not to publish the rating and hire another credit rating agency to get more optimistic reporting. The practice called ratings shopping, together with ratings catering, induces universal rating inflation at the cost of investors and financial market stability. Indeed, Bolton, Freixas, and Shapiro (2012) quote the chief operating officer of Moody's, "There is a lot of rating shopping that goes on."

Ironically, ratings shopping and ratings catering both results from the competition in credit rating market. In other words, peculiar characteristics of this market lead to the consequence that the competition between the firms harms the consumers (in this case, investors) by dropping the quality of the commodity (i.e. ratings). A lot of theoretical models have been introduced to explain and analyze this phenomenon. However, the existing research mainly focus on the topic such as moral hazard or errors in rating accuracy, and the model concerning competition between credit rating agencies, rating shopping, and ratings catering all together is still scarce in number. To capture the effect due to the competition among rating agencies, the current paper adopts an auction theoretical model. The ongoing ratings shopping and ratings catering process is somewhat similar to

misleading.'

the argument found in auction theory. The credit rating agencies (bidders) compete with each other by offering favorable rating to issuer who then awards a prize to the agency who offers the highest rating. While doing so, the winning credit rating agency will bear the reputation or regulatory cost which limits the bid (rating) up to some point. All these aspects resemble the features of first price auction.

Accordingly, this paper designs a simple first-price auction model that analyze the competition in credit rating industry and rating inflation caused by ratings shopping and catering. The result shows that if the issuer can give a prize up to some point, then every credit rating agency will report the rating higher than their signal, which we will call uniform rating inflation. Also, the inflation gets serious when there are more competitors, the finding which many empirical researches share. After constructing the benchmark model, we will extend the analysis to consider some of the frequently mentioned proposals for solving the current rating inflation problem: stricter disclosure requirement, 'investor pays' model, and legal responsibility. We will adopt the model of all-pay auction for stricter disclosure requirement to reflect the aspect that reputation of every credit rating agency is affected as disclosure requirement becomes stronger. The result is that this measure can drive up the cost of the issuer to incentivize uniform rating inflation, but the efficacy of the proposal can be limited if the securitizers have enough financial ability. What is worse is that social welfare loss can be bigger than in the benchmark setting if the issuer succeeds in neutralizing the effectiveness of stricter disclosure requirement to control rating inflation. On the other hand, we will give alternative chance of trade with investors to losing credit rating agency to reflect the idea of 'investor pays' model. That is, the losing agency have an option to sell its information to investors. While this approach gives similar result to that of stricter disclosure requirement setting, the investors' loss of welfare may be reduced due to the fact that more information is available for them. The investors will not be deceived by rating inflation even when the security receives extremely optimistic appraisal. However, the unique disadvantage of 'investor pays' model is that investors sometimes can have too pessimistic view and that the issuers with relatively safe security are crowded out from the market as a consequence. Finally, we will introduce legal penalty in the cost function to analyze the situation where credit rating agencies have legal responsibility for their issued ratings. If legal penalty is above the certain point, then it is possible to make every credit rating agencies to report their signal truthfully. Yet, there are some practical limitations to adopt this policy.

The remainder of the paper goes as follows. First, we will review some important empirical and theoretical literature regarding the topic. Then, Chapter 2 introduces a benchmark model with one issuer and two credit rating agencies, and analyze when the uniform rating inflation happens and the result of it with respect to social welfare. Chapter 3 extends the model to study the effects of applying stricter disclosure requirement, 'investor pays' model, and legal responsibility for credit rating agency. Chapter 4 summarizes and concludes.

Section 2 Literature Review

Although there had been a number of papers studying credit rating agency's conflicts of interest, rating inflation caused by competition between credit rating agencies started to be studied clearly by Becker and Milbourn (2011). Becker and Milbourn (2011) reveal that the entry of a third rating agency (Fitch) led to the increase in average rating given by two incumbents, Moody's and Standard & Poor's. While Becker and Milbourn (2011) focus on the ratings of corporate bonds, Griffin and Tang (2012) study similar competitive effects on collateralized debt obligations, and Efing and Hau (2015) research residential mortgage and other asset-backed securities. Griffin and Tang (2012) calculate imputed ratings and compare it with observed ratings to figure out discrepancies. On the other hand, Efing and Hau (2015) find correlation between the degree of rating inflation and the prospect of doing future business with the issuer firm. When analyzing the benchmark model in Chapter 2, we will find similar result that the increase of the number of credit rating agencies participating in competition can induce rating inflation.

Sangiorgi, Sokobin, and Spatt (2009) and Skreta and Veldkamp (2009) are connected to this paper in that both are using auction theory approach and study the effect of ratings shopping. Sangiorgi, Sokobin, and Spatt (2009) liken the consequence of rating shopping to the winner's curse in the auction. In addition, they provide dynamic sequential model of ratings shopping and illustrate some numerical solutions to show qualitative aspects of ratings shopping. In contrast, Skreta and Veldkamp (2009) adopt uniform price auction when investors are buying the asset. They show that an increase in the complexity of securities could create a rating inflation even when the credit rating agencies report their estimate truthfully. This phenomenon gets worse with the presence of ratings shopping and increasing competition. The difference is that our model analyzes static first price auction where credit rating agencies compete for the prize given by security issuers.

On the other hand, there are some literature dealing with ratings catering. Bolton, Freixas, and Shapiro (2012) argue that competition leads to ratings catering and reduces efficiency, and this tendency is more likely to be worse when investors are more trusting. Moreover, Mathis, McAndrews, and Rochet (2009) assert that credit rating agency has an incentive to cater even under monopoly situation if the issuer can choose not to have their security be rated. In our paper, the assumption of naïve investor will be introduced following the model of Bolton, Freixas, and Shapiro (2012), and we will observe analogous ratings catering behavior and welfare loss. However, we will not concern monopoly situation since we are using the argument from auction theory. To cope with ratings shopping and ratings catering, Farhi, Lerner and Tirole (2013) suggest that every credit rating agency has to reveal their ratings. The similar extension will be tried in this paper. However, unlike Farhi, Lerner and Tirole (2013), our result shows that mandatory disclosure requirement sometimes have adverse effect to social welfare if security issuers can offer enough reward to persuade credit rating agencies to report overrated value.

The most similar approach with this paper can be found in Chu and Rysman (2019). Despite being empirical work, their literature is on the same line with ours in terms of taking auction perspective. Chu and Rysman (2019) construct empirical model based on auction literature and characterize the incentives of credit rating agencies to distort ratings in favor of issuers. Also, they conduct several counterfactual experiments using the past data and the model. Following their approach, this paper will also build theoretical model adapted from auction theory and study implications of three policy proposals. The data of Chu and Rysman (2019) mainly focuses on commercial mortgage backed securities (CMBS). The other literature that studies CMBS market is Cohen and Manuszak (2013). Cohen and Manuszak (2013) find correlation between the percentage of AAA rated CMBS deal and the intensity of competition among credit rating agencies for the deal. Also, Flynn and Ghent (2018) show that the entry of new competitors in CMBS ratings sector induces current incumbents to respond with more favorable ratings, which is highly analogous result with Becker and Milbourn (2011).

Apart from the above, there are several theoretical papers concerning reputation issues. Frenkel (2015) concentrates on double reputation issue facing credit rating agencies. They have an incentive to maintain public reputation while also have a desire to build reputation for favorable raters among issuers. Similarly, Mariano (2012) assumes that credit rating agency simultaneously wants to maximize reputation and protect market power. Balancing among two objectives, credit rating agencies take different strategies under monopoly and competition. Bouvard and Levy (2017) studies more general setting where privately informed seller resort to certification to overcome adverse selection. They find that the profit of a monopolistic certifier and his reputation for accuracy shows inverted U-shaped functions. Unlike these papers, here we will just focus on reputation cost coming from the investors′ side.

Chapter 2 Benchmark Model

This section will provide simple benchmark model that explains rating inflation caused by the competition between credit rating agencies. Simultaneously, we will observe that such an inflation induces social welfare loss.

Section 1 Model

Suppose that an issuer issues a structured finance product. This product pays V with probability p and 0 with probability $1-p$. Assume the issuer knows the true value of p.

The issuer is considering of getting his product rated. Suppose the issuer hires 2 credit rating agencies (CRAs) simultaneously.[2] To be specific, each CRA has to pay the cost ϵ to get a private information about the probability of the products' not going default. When the issuer hires the CRA, he will pay upfront fee ϵ to CRA. After each CRA observes their private information, they will report their ratings, i.e. probability of the product's making positive payment, to the issuer privately. The issuer will pay χ to the CRA who offered the most favorable rating to publish the rating while the other CRA gets nothing. Hence, the rating shopping process is similar to the first-price sealed-bid auction.

When CRA enters into investigation process, they observe identically and independently distributed θ which is uniformly distributed over $[0,1]$. CRAs do not know the true value of p and each of their signal θ is independent of p. Plus, let's assume that the winning CRA who bids b pays the cost $c(b)=a(b-\theta)$ where $a>0$. We can interpret this cost assumption in this way. Due to the disclosure requirement, the private information of the winning CRA, θ, will become publicly observable in some time. This will result

2) This setting corresponds to the fact that Moody's and Standard & Poor's dominate 80% of credit rating industry.

reputation cost or regulatory punishment to CRA, so the cost function $c(b)$ reflects future damage to the CRA in simple way.[3)]

The above cost assumption implies that credit rating agency who reported below their signal is rewarded. In other words, they can build good reputation of having strict assessment criteria. For example, the investors may believe that the CRA with very high signal θ reports comparatively low b because they are applying some conservative assessment to their signal, and hence conclude that the CRA seems more reliable.[4)] However, we can also imagine possible contrasting scenario in which a CRA which reports below its signal loses its reputation for accuracy. In this case, we will need cost function such as $c(b) = a|b - \theta|$. Yet, the problem is that it is impossible to derive symmetric increasing bidding equilibrium under this assumption, which gives highly complex setting to get equilibrium bidding strategy for CRAs. Therefore, this paper will stick to the original cost function assumption, $c(b) = a(b - \theta)$ for simplicity. Also, we will focus on the situation in which every CRA has an incentive to bid greater than or equal to their signal by properly setting the value of χ, which we will call uniform rating inflation from now on. This kind of approach can help us avoid the circumstance in which CRAs strategically report values lower than their true signal to get reputational reward.

Back to the topic, solving the benchmark model gives the below

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3) Later, when we are discussing legal responsibility in Chapter 3, we will strictly divide the cost function into reputation cost part (i.e. $b - \theta$) and fixed legal penalty part.

4) Interestingly, according to White (2010), there had been a period when CRAs were very tough on their ratings and underreport frequently. This tendency was reversed and credit rating agencies started to participate in rating inflation when new derivative product markets in which there are less customers for CRAs became popular.

result.

Proposition 1. *Given that* $0 < \chi < \frac{a}{2}$*, CRA's symmetric equilibrium bidding strategy is* $\frac{\chi}{a} + \frac{1}{2}\theta$*. If* $\frac{a}{2} \le \chi \le a$*, then CRA's symmetric equilibrium bidding strategy becomes*

$$\overline{\beta}(\theta) = \begin{cases} \frac{\chi}{a} + \frac{1}{2}\theta, \theta \le \frac{a-\chi}{\chi} \\ 1, \qquad \theta > \frac{a-\chi}{\chi} \end{cases}$$

When $\chi > a$*, all CRAs report the probability of* 1*. Note that when* $\chi \ge \frac{a}{2}$*, every CRA has an incentive to report the probability greater than or equal to their signal, i.e. uniform rating inflation occurs.*

Proof. For a moment, ignore the condition that CRA cannot report their bid above 1. Suppose there exists symmetric, increasing, and continuous equilibrium bidding strategy β. Then, the maximization problem of CRA becomes

$$\beta(\theta) = \underset{b \in [0,1]}{\arg max}(\chi - a(b-\theta))F(\beta^{-1}(b))$$

which is equivalent to

$$\theta_i = \underset{\theta \in [0,1]}{\arg max}(\chi - a(\beta(\theta) - \theta_i))F(\theta)$$

where subscript $i = 1,2$ names each credit rating agency. Let $U_i(\theta_i)$ denote the equilibrium payoff that results from the maximization problem above. By the envelope theorem, we obtain

$$U_i'(\theta_i) = \frac{\partial}{\partial \theta_i}[(\chi - a(\beta(\theta) - \theta_i))F(\theta)]|_{\theta = \theta_i} = F(\theta_i)$$

and thus

$$U_i(\theta_i) = U(0) + \int_0^{\theta_i} F(s)ds = \int_0^{\theta_i} F(s)ds \ .$$

By definition of $U_i(\theta_i)$, it must be true that

$$(\chi - a(\beta(\theta_i) - \theta_i))F(\theta_i) = U_i(\theta_i) = \int_0^{\theta_i} F(s)ds \ ,$$

which can be rearranged to yield

$$\beta(\theta_i) = \frac{\chi}{a} + \theta_i - \frac{\int_0^{\theta_i} F(s)ds}{F(\theta_i)} = \frac{\chi}{a} + \theta_i - \frac{\int_0^{\theta_i} sds}{\theta_i} = \frac{\chi}{a} + \theta_i - \frac{1}{2}\theta_i = \frac{\chi}{a} + \frac{1}{2}\theta_i.$$

We can see that this strategy is truly symmetric, increasing, and continuous. Also, by substituting the β into the maximization problem, it can be easily checked that $\theta = \theta_i$ achieves global maximum.

Observe that if $\chi \geq \frac{a}{2}$, then $\frac{\chi}{a} + \frac{1}{2}\theta \geq \theta$ for any $\theta \in [0,1]$. Also, note that $\frac{\chi}{a} + \frac{1}{2}\theta \geq 1$ is equivalent to $\theta \geq 2 - \frac{2\chi}{a}$. Hence, when $\chi \geq \frac{a}{2}$, some CRAs with signal θ cannot bid according to β because probability reporting should be 1 at the maximum. In other words, these types of CRAs are having budget constraint problem from the perspective of auction theory. This kind of problem has the symmetric equilibrium bidding strategy such that for signal below some cutoff point $\hat{\theta}$, following $\beta(\theta)$ is optimal while it is good to report 1 with signal above the cutoff point. The $\hat{\theta}$ should satisfy

$$[\chi - a(\frac{\chi}{a} + \frac{1}{2}\hat{\theta} - \hat{\theta})]\hat{\theta} = [\chi - a(1 - \hat{\theta})][\sum_{k=0}^{1} \frac{1}{k+1}\binom{1}{k}(1-\hat{\theta})^k \hat{\theta}^{1-k}],$$

which means the CRA with signal $\hat{\theta}$ is indifferent from bidding $\beta(\hat{\theta})$ and 1. Solving the above equation gives $\hat{\theta} = \frac{a - \chi}{\chi}$. □

Remark If $\chi \geq \frac{a}{2}$, then the symmetric equilibrium bidding strategy in Proposition 1 can also be a symmetric equilibrium bidding strategy for the model with cost function assumption $c(b) = a|b-\theta|$. This is an obvious consequence because uniform rating inflation implies that CRA with any signal does not have incentive to report the probability lower than its true signal. Hence, the symmetric equilibrium still holds for the model where the reward for underreporting is removed.

Proposition 1 implies that the issuer can provide an incentive for CRA to report overrated value by setting χ properly. Also, note that when there are I number of CRAs, the equilibrium bidding strategy will become $\beta(\theta) = \chi + \frac{I-1}{I}\theta$ given that the bid does not exceed 1 and $a = 1$.[5] Since bidding function β is increasing with respect to I, it follows that rating inflation becomes serious when there are more CRAs to compete for the prize. This implication corresponds to the findings by Becker and Milbourn (2011).

Section 2 Rating Inflation and Welfare

The expected ratings that the issuer receives corresponds to the expected revenue of seller from traditional auction theory. Since the signal of each CRA is independently distributed, the expected ratings is

5) From now on, we will set $a = 1$ for arguments below to make things simple.

$$\int_0^{\frac{1-\chi}{\chi}} (\chi+\frac{\theta}{2})2\theta d\theta + \int_{\frac{1-\chi}{\chi}}^1 2\theta d\theta = \chi - \frac{7}{3} + \frac{4}{\chi} - \frac{2}{\chi^2} + \frac{1}{3\chi^3}.$$

The above value is increasing when $\frac{1}{2} \le \chi \le 1$. If $\chi = \frac{1}{2}$, then the expected rating is $\frac{5}{6}$, which implies that quite large fraction of the issuers can get more optimistic ratings than the true underlying value of p. Moreover, when $\chi = 1$, the expected ratings becomes 1, which is consistent with the past observation that every CRA will report probability 1 given that the issuer rewards $\chi = 1$ to winning bidder. This corresponds to the argument found in other researches that rating shopping and catering results inflated ratings. The rating inflation will worsen if the prize χ gets bigger.

Now, let us assume that investors are in the competitive market and they are naïve in the sense of trusting nature defined by Bolton, Freixas, and Shapiro (2012) (i.e. the investors believe that CRA reported truthfully). In this case, the price of the structured product will be $(\chi - \frac{7}{3} + \frac{4}{\chi} - \frac{2}{\chi^2} + \frac{1}{3\chi^3})V \equiv RV$. Therefore, the issuer is willing to get the product rated rather than revealing the true type of product without getting rating if $RV - 2\epsilon - \chi \ge pV$. If so, the investors overexpended the money for the product by $(R-p)V$. As a result, calculating the expected social welfare gives

$$[RV - 2\epsilon - \chi] + [pV - RV] + [\chi + \epsilon - \epsilon - \int_0^{\frac{1-\chi}{\chi}} \int_0^{\theta_1} (\chi + \frac{1}{2}\theta_1 - \theta_1) d\theta_2 d\theta_1$$

$$- \int_{\frac{1-\chi}{\chi}}^1 \int_0^{\frac{1-\chi}{\chi}} (1-\theta_1) d\theta_2 d\theta_1 - \frac{1}{2} \int_{\frac{1-\chi}{\chi}}^1 \int_{\frac{1-\chi}{\chi}}^1 (1-\theta_1) d\theta_2 d\theta_1$$

which is equivalent to $pV - 2\epsilon - \frac{\chi}{2} + \frac{5}{6} - \frac{1}{\chi} + \frac{1}{2\chi^2} - \frac{1}{12\chi^3}$. The first bracket in the above equation is the issuer's profit, the second is investor's loss, and the third is winning CRA's payoff. Note that, if the quality of the structured product were publicly observable without getting rating, then the social welfare would be pV. Hence, when $pV-2\epsilon-\frac{\chi}{2}+\frac{5}{6}-\frac{1}{\chi}+\frac{1}{2\chi^2}-\frac{1}{12\chi^3}<pV$, the imperfect information and the existence of ratings deteriorates the social welfare compared to the perfect information economy. Observe that $-\frac{\chi}{2}+\frac{5}{6}-\frac{1}{\chi}+\frac{1}{2\chi^2}-\frac{1}{12\chi^3}$ is decreasing and between $-\frac{1}{4}$ and $-\frac{1}{12}$. Thus, with $\epsilon>0$, the proposition follows.

Proposition 2. *The cost paid to CRAs by the issuer and the resulting inflated ratings is one source of a loss of social welfare compared to perfect information state. The welfare loss becomes worse if χ and ϵ gets bigger.*

Chapter 3 Extensions

In this chapter, we will look into effects of three policy proposals to cope with ratings shopping and ratings catering.

Section 1 Stricter Disclosure Requirement

Suppose that stronger disclosure requirement is applied and now even the CRA who did not succeeded to get ratings published is demanded to disclose their signal. For simplicity, we will still maintain the assumption that disclosure requirement does not affect the market right away but imposes the reputation cost to CRAs in the future. Now, even the losing CRA has an incentive to care about their reputation cost (or benefits). This situation is very similar to the all-pay auction in which every bidder has to pay their bid regardless of winning. Indeed, using the framework of all-pay auction, we can derive the following proposition.

Proposition 3. *When the stricter disclosure requirement is applied, all CRAs have an incentive to report inflated ratings if* $\chi \geq 1$*. When* $1 \leq \chi \leq 2$*, the symmetric equilibrium bidding strategy is*

$$\bar{\gamma}(\theta) = \begin{cases} \chi\theta, \theta \leq \dfrac{2-\chi}{\chi} \\ 1, \quad \theta > \dfrac{2-\chi}{\chi} \end{cases}$$

If $\chi > 2$*, then every CRA's bidding value is* 1*.*

Proof. Again, we will first ignore the range condition. Suppose there exists symmetric, increasing, and continuous equilibrium bidding strategy γ. The CRA has to solve

$$\gamma(\theta) = \underset{b \in [0,1]}{\arg\max}\, \chi F(\gamma^{-1}(b)) - (b - \theta)$$

which is equivalent to

$$\theta_i = \underset{\theta \in [0,1]}{\arg\max}\, \chi F(\theta) - (\gamma(\theta) - \theta_i).$$

Using the envelope theorem, it follows that

$$U_i'(\theta_i) = \frac{\partial}{\partial \theta_i}[\chi F(\theta) - (\gamma(\theta) - \theta_i)]|_{\theta = \theta_i} = 1$$

and

$$U_i(\theta_i) = \theta_i.$$

By definition of $U_i(\theta_i)$, we get

$$\chi F(\theta_i) - (\gamma(\theta_i) - \theta_i) = U_i(\theta_i) = \theta_i,$$

which gives

$$\gamma(\theta_i) = \chi\theta_i.$$

This equilibrium strategy is indeed symmetric, increasing, and continuous.

To make $\chi\theta \geq \theta$ hold for any $\theta \in [0,1]$, χ has to be greater than or equal to 1. Let's solve the budget constraint all-pay auction problem under this condition. In this case, the cutoff point should satisfy

$$\chi\tilde{\theta} - (\chi\tilde{\theta} - \tilde{\theta}) = \chi(\tilde{\theta} + \frac{1-\tilde{\theta}}{2}) - (1-\tilde{\theta}).$$

It follows that $\tilde{\theta} = \frac{2-\chi}{\chi}$ and the desired result is confirmed. □

Notice that CRAs have to pay more money than in the benchmark model to assure that every CRA participates in rating inflation. In particular, when $\chi = 1$, every CRA is truth-telling under the strict disclosure requirement while all CRAs report probability 1 in the previous model. Moreover, the CRA needs to pay $\chi = 2$ to guarantee that almost every CRA reports probability 1. Thus, compared to the benchmark model, the application of mandatory disclosure requirement for all CRAs can increase the cost of the issuer for inducing rating inflation. Also, the rating inflation corresponding to the increase in CRA's reward grows relatively slower than the original model.

Calculating the expected ratings gives

$$\int_0^{\frac{2-\chi}{\chi}} (\chi\theta) 2\theta d\theta + \int_{\frac{2-\chi}{\chi}}^1 2\theta d\theta = -\frac{2}{3}\chi + 4 - \frac{4}{\chi} + \frac{4}{3\chi^2}.$$

Thus, the issuer will prefer getting the product rated to selling the product with true type revealed if $DV-2\epsilon-\chi \geq pV$ where D is the expected ratings. When it comes to social welfare under this condition, the total expected welfare is

$$[DV-2\epsilon-\chi]+[pV-DV]+[\chi+\epsilon-\epsilon-\int_0^{\frac{2-\chi}{\chi}}(\chi\theta-\theta)d\theta-\int_{\frac{2-\chi}{\chi}}^1(1-\theta)d\theta]$$

$$+[\epsilon-\epsilon-\int_0^{\frac{2-\chi}{\chi}}(\chi\theta-\theta)d\theta-\int_{\frac{2-\chi}{\chi}}^1(1-\theta)d\theta],$$

which is equivalent to $pV-2\epsilon-\chi+1$. Each of the brackets means the issuer's profit, the investor's loss, the winning CRA's payoff, and the losing CRA's payoff in order. Note that when $1 \leq \chi \leq 2$, we have $-1 \leq -\chi+1 \leq 0$. Hence, although strict disclosure requirement can improve the social welfare with some chances, there can be more welfare loss under the worst situation where the rating inflation is very universal.

Proposition 4. *The strict disclosure requirement can enhance social welfare compared to the benchmark model by increasing the cost of the issuer for the rating inflation. However, if the issuer has enough financial power to induce uniform rating inflation and can provide sufficiently large reward to the winning CRA, the policy would bring worse result with respect to the social welfare.*

Section 2 Investor Pays

In this section, we assume that the losing CRA can approach to investor and reveal their signal after the bidding competition. The losing CRA will get $r \leq \chi$ from investor as a reward. This setting is slightly different from reality because a typical credit rating agency adopts either 'issuer pays' structure or 'investor pays' structure but not both.[6] That is, the situation in this model where the CRA with 'issuer pays' structure converts to 'investor pays' structure and seeks alternative trade opportunity after losing the bidding competition usually does not happen. Yet, since we are dealing with the model with 2 credit rating agencies, this kind of setting will be useful for making the model tractable when we want to consider the competitive pressure coming from the existence of CRA with 'investor pays' structure.

Under the circumstance mentioned above, the resulting symmetric equilibrium bidding strategy is like the following proposition.

Proposition 5. *When the losing CRA can trade with the investor, the issuer has to pay* $\chi = \frac{1}{2} + r$ *to induce uniform rating inflation. If* $\frac{1}{2} + r \le \chi \le 1 + r$, *the symmetric equilibrium bidding strategy is*

$$\bar{\delta}(\theta) = \begin{cases} \chi + \frac{1}{2}\theta - r, & \theta \le \frac{1-(\chi - r)}{\chi - r} \\ 1, & \theta > \frac{1-(\chi - r)}{\chi - r} \end{cases}$$

6) Before the early 1970s, credit rating agencies' revenues were based on 'investor pays' model. However, credit rating agencies started to switched to 'issuer pays' model from 'investor pays' model in the early 1970s. The supposed reasons are that photocopy technology was developing so fast that it was not able to prevent free-riding, and that regulatory status of ratings from credit rating agencies became very important from the perspectives of firms and so on. The shift in payment model is regarded as the main culprit of conflicts of interest. Yet, according to White (2010), it was until the structured nance product was widely produced in 2000s that the rating inflation became real problem. Today, a few small credit rating agencies such as Egan-Jones are maintaining 'investor pays' model.

Proof. The proof is almost similar to that of proposition 1. The difference is that now a CRA with signal 0 gets outside payoff r and hence $U(0)=r$. Considering this and solving the problem, it follows that the equilibrium bidding strategy is a parallel shift of the strategy in proposition 1. □

Like the result of strict disclosure requirement, the possibility of the investors' buying rating imposes more cost to the issuer to incentivize rating inflation. However, the demerit is also the same one. If the issuer can pay enough reward compared to the investor, the result will have no difference with that of benchmark model. Moreover, when $\frac{1}{2}+r \le \chi \le 1+r$, the social welfare is also same as in Chapter 2.

Nonetheless, the intrinsic advantage of this model is that the investors can reduce or avoid their loss because they can have more information to exploit. Suppose the rating of CRA 1 is published and CRA 2 decides to sell the information of their signal to the investors. Hence, the investors are now able to observe two ratings, $\chi+\frac{1}{2}\theta_1-r$ and θ_2. There are three cases to consider to calculate the expected rating values.

1. $\int_0^{\frac{1-(\chi-r)}{\chi-r}}\int_0^{\theta_1}\frac{\chi-r}{2}+\frac{1}{4}\theta_1+\frac{1}{2}\theta_2 d\theta_2 d\theta_1$ for $0\le\theta_2\le\theta_1\le\frac{1-(\chi-r)}{\chi-r}$

2. $\int_{\frac{1-(\chi-r)}{\chi-r}}^{1}\int_0^{\frac{1-(\chi-r)}{\chi-r}}\frac{1}{2}+\frac{\theta_2}{2}d\theta_2 d\theta_1$ for $0\le\theta_2\le\frac{1-(\chi-r)}{\chi-r}<\theta_1$

3. $\frac{1}{2}\int_{\frac{1-(\chi-r)}{\chi-r}}^{1}\int_{\frac{1-(\chi-r)}{\chi-r}}^{1}\frac{1}{2}+\frac{\theta_2}{2}d\theta_2 d\theta_1$ for $\frac{1-(\chi-r)}{\chi-r}<\theta_1,\theta_2\le 1$

Summing up the above three values gives the expected rating between $\frac{7}{24}$ and $\frac{3}{8}$ if $\frac{1}{2}+r \leq \chi \leq 1+r$. Observe that these values are much lower than the expected rating values in the benchmark model. In particular, even when every CRA bids probability 1, the investor has expected value of $\frac{3}{8}$, which means that they are not deceived by completely inflated ratings. However, the problem is that expected ratings can become so low that the issuers with relatively safe structured products may not be willing to get ratings for their products. Depending on the investors′ inference of success probability based on available ratings, there can sometimes be massive crowding out of sound financial products.

Proposition 6. *Under the situation where the alternative trade between investor and CRA is possible, the burden of the issuer inducing uniform rating inflation increases. Although the new information for investors cannot make change to the total social welfare, the investors can reduce or avoid the original loss caused in the benchmark model. However, there is a chance that the issuers with strong products are crowded out from financial market because of low expected success probability inferred by investors.*

Section 3 Legal Responsibility

Currently, in the U.S., credit rating agencies are protected by the First Amendment′s free speech because their ratings are treated as ‘opinions’. This is the reason why credit rating agencies are not legally punished when they fail to give accurate evaluation. In other words, CRAs are not legally liable for ratings they give. It is highly controversial that whether credit rating agencies deserve this kind of protection. The Dodd-Frank Act demands the SEC to adopt regulation making credit rating agencies legally responsible for their ratings, but this has never been into practice. (Chu & Rysman, 2019)

This section will consider alternative situation when credit rating agencies can be exposed to legal punishment when it is revealed that they gave ratings not corresponding to their signals. Again, an issuer wants to sell a structured finance product with success probability p and gives winning CRA the payoff χ. However, in this case, legal authority executes inspection to the winning CRA if the rated structured product defaults. When the authority finds out that the CRA did not truthfully report, the CRA has to pay legal penalty K. Hence, the cost function becomes $c(b) = b - \theta + (1-p) I_{b \neq \theta} K$, where I denotes indicator function.

Proposition 7. *Suppose there is a legal penalty for untruthful reporting. If* $(1-p)K \geq \max\{\chi, (1-\sqrt{\chi})^2\}$, *then every CRA always reports true signal value regardless of* θ*.*

Proof. Suppose one CRA knows that the other will take truth-telling strategy. For a moment, ignore the range of θ. If the CRA with signal θ reports $b \neq \theta$, then its expected payoff is

$$\Pi(b,\theta) = \int_0^b \chi + \theta - b - (1-p)K ds.$$

First order condition gives

$$\frac{\partial \Pi}{\partial b} = \chi + \theta - b - (1-p)K - b = 0,$$

which implies that it is optimal to bid $b = \dfrac{\chi + \theta - (1-p)K}{2}$. Note that since $(1-p)K \geq \chi$ the CRA with private signal $\theta \leq (1-p)K-\chi$ cannot follow optimal strategy and bids 0. Hence the CRA with type $\theta \leq (1-p)K-\chi$ gets expected payoff 0 because it can never win the auction. However, truth-telling approach can increase its expected payoff by $\chi\theta$. On the other hand, when $\theta > (1-p)K-\chi$ and the CRA bids $\frac{\chi+\theta-(1-p)K}{2}$, its expected payoff is

$$\frac{(\chi+\theta-(1-p)K)^2}{4}.$$

By comparing this payoff with expected payoff from truth-telling strategy, we can find out that the condition in which the CRA does not deviate from truth-telling strategy is

$$\chi\theta \geq \frac{(\chi+\theta-(1-p)K)^2}{4},$$

which is equivalent to

$$\theta^2 - 2\{\chi+(1-p)K\}\theta + \{\chi-(1-p)K\}^2 \leq 0.$$

Solving the above equation gives

$$\chi+(1-p)K-2\sqrt{\chi(1-p)K} \leq \theta \leq \chi+(1-p)K+2\sqrt{\chi(1-p)K}.$$

Observe that $(1-p)K-\chi \geq \chi+(1-p)K-2\sqrt{\chi(1-p)K}$ because $\chi \leq (1-p)K$. Also, $\chi+(1-p)K+2\sqrt{\chi(1-p)K} = (\sqrt{\chi}+\sqrt{(1-p)K})^2 \geq 1$ if $(1-p)K \geq (1-\sqrt{\chi})^2$. Therefore, deviating from truth-telling strategy worsens the expected payoff. □

Implication of the above proposition is quite intuitive. If legal penalty is sufficiently big enough to offset the financial reward given by the issuer to CRAs, then false reporting will disappear. Each of two values in maximum operator of the previous proposition serves a role of preventing overreporting and underreporting. If $\chi > (1-p)K$, then CRAs with low θ can also bid as $\frac{\chi+\theta-(1-p)K}{2}$. Note that

$\theta \geq \frac{\chi+\theta-(1-p)K}{2}$ if and only if $\theta \geq \chi-(1-p)K$. Also, observe that $\chi+(1-p)K-2\sqrt{\chi(1-p)K}$ in the previous proof can exceed 0 when $\chi > (1-p)K$. Thus, we can deduce that a CRA having terribly bad private signal will overreport to beat the truth-telling CRA unless expected legal penalty is bigger than the reward gained from competition. On the other hand, $(1-p)K < (1-\sqrt{\chi})^2$ implies $\chi+(1-p)K+2\sqrt{\chi(1-p)K} < 1$. In this case, some CRAs with sufficiently optimistic signal can underreport the bidding value to enjoy reputation benefit. That is, CRAs having good private signal may bid the value smaller than true signal despite the existence of legal penalty because the term $b-\theta$ in the cost function implies underreporting is rewarded for adopting conservative evaluation approach. The condition of $(1-p)K \geq (1-\sqrt{\chi})^2$ blocks this situation.

Although making credit rating agencies legally responsible for their ratings seems ideal because of its strategy-proofness, inherent difficulty of adopting the measure is that legal institution should have capability to figure out what was the original signal CRAs had. While our model assumes that untruthful reporting of winning CRA becomes publicly observable because of disclosure requirement, it is actually highly difficult to understand how certain ratings came out in reality because credit rating agencies do not reveal their standards of assessing financial commodities. Sometimes the legal authority may have to evaluate financial products independently by themselves to make given proposal work. In addition, the legal authority has to guess true success probability of structured product p, which is private information of issuers, sufficiently well to set proper legal penalty.

Chapter 4 Conclusion

In this paper, we constructed the model of rating inflation based on auction theory. The benchmark model shows that when the issuer can provide credit rating agencies with enough reward, every credit rating agency has an incentive to report overrated assessment and uniform rating inflation follows. If the prize for winning credit rating agency goes beyond some point, all credit rating agencies will give the highest rating to the securities. This phenomenon worsens fast if there are more credit rating agencies competing. As a result, the trusting investors will get loss and social welfare decrease. Then, we analyzed implications of three policy proposals for coping with rating inflation. In case of stricter disclosure requirement, although the policy can restrict rating inflation by raising the cost of inducing it, disclosure requirement will not be effective if the issuers have sufficient financial power to overcome it. On the other hand, while investor pays model shares similar weakness with stricter disclosure requirement, the model can contribute to reducing investors' loss by giving them more information. Yet, there can be crowding out of safe asset if the resulting expectation of investors are too pessimistic. When it comes to introduction of legal liability of credit rating agencies, sufficient legal penalty can make strategy-proofness possible but there are hurdles to implement it practically.

Though our research succeeded to show some results consistent with the reality and other literatures, there are several limitations that need to be overcome. For example, the real credit rating is given as ranking order, not like detailed probability in our model. Further studies have to be done to build models containing discrete rating system and pooling as a consequence. Also, considering that credit rating has regulatory power, getting good ratings can lead to securities' becoming safer by reducing capital cost. This is a kind of self-realization effect and the reason why many firms are willing to pay higher fees to credit rating agencies when ratings of the securities or structured products are expected to be near a border line of investment grade. Hence, future models should include feedback effect of credit rating. Finally, we assumed that the investors are trusting ratings given by credit rating agency. Although, many personal investors truly do not have ability to find out how much rating inflation exists, the institutional investors may have some ability to do so. Therefore, the models with rational investors are also available. Future study could be done in a way analyzing equilibrium given the proportion of rational and naïve investors.

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국문초록

본 논문에서는 신용등급 쇼핑, 신용등급 케이터링, 신용등급 인플레이션을 모두 포함하는 모델을 설계한다. 특히 최고가격경매의 모델을 통해 신용평가사들 간의 경쟁이 신용등급 인플레이션에 미치는 영향을 분석할 것이다. 기본 모델의 분석은 채권발행자들이 신용평가사에 충분히 높은 보상을 제공할 수만 있다면 균일한 신용등급 인플레이션을 유도할 수 있다는 것을 보여준다. 또한 이러한 신용등급 인플레이션은 경쟁하고 있는 신용평가사들의 수가 많을수록 심해지는 경향이 있다. 기본 모델의 분석에 이어서 본 논문에서는 강력한 의무공개 조항과 투자자 지급 모형의 도입이 가지는 함의에 대해 알아볼 것이다. 두 정책 모두 채권발행자가 균일한 신용등급 인플레이션을 유도하는 비용을 높여준다는 장점이 있다. 그러나 동시에 채권발행자가 충분한 자본력을 가지고 있으면 정책이 무력화된다는 약점도 공유한다. 그럼에도 불구하고 투자자 지급 모형의 경우 투자자들에게 더 많은 정보를 제공함으로써 투자자의 손실을 줄여줄 가능성이 있다. 그러나 한편으로 이 과정에서 투자자들이 지나치게 비관적인 전망을 가지게 될 경우, 금융시장에서 건전한 상품들이 구축되는 결과가 나올 위험도 있다. 끝으로 본 논문에서는 거짓된 신용등급을 보고한 신용평가사에 법적 처벌이 주어지는 가상적인 환경을 연구함으로써 대전략성이 보장되는 법적 처벌 정도의 범위를 도출한다.

주요어 : 신용등급 쇼핑, 신용등급 케이터링, 신용등급 인플레이션, 강력한 의무공개 조항, 투자자 지급 모형, 법적 책임
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