Received: 18 January 2020 | Revised: 12 September 2020 | Accepted: 16 September 2020
DOI: 10.1002/ijfe.2303

RESEARCH ARTICLE

WILEY

Credit rating and competition

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Funding information
Fundação para a Ciência e a Tecnologia, Grant/Award Number: PTDC/IIM-FIN/2977/2014

Abstract

We analyze the effect of competition between credit rating agencies (RA) which trade-off reputation (future income) and rating inflation (current income). We find that relative to monopoly, RA are more likely to inflate ratings under duopoly. Moreover, competition reduces welfare (the net income of the projects that are rated good) if the new entrant has low reputation and increases it if the new entrant has high reputation. Therefore, our results suggest that lowering barriers to entry (thus, allowing low-reputation credit RA to enter the market) might increase the level of rating inflation and reduce welfare.

KEYWORDS

competition, financial regulation, rating agencies, reputation

JEL CLASSIFICATION

D43; D82; G24; L14

1 | INTRODUCTION

Rating agencies (RA) are often cited as one of the main culprits of the recent subprime crisis, as they were too lax when awarding too high ratings for many securities, in particular structured finance products. By stripping them as soon as the crisis was crystallized, they helped to destabilize the financial system, as the downgradings had direct impacts on the issuers' cost of capital.[1] Although in principle rating, agencies should act as unbiased opinion providers of the credit quality of the issuer, the aforementioned evidence suggests they have been inflating ratings. Some argue that the lack of competition in the ratings' market is behind the rating inflation.

Even in a monopolist market, reputation is perhaps the most important deterrent of rating inflation, as the informativeness of the rating goes in line with the reputation of the rating provider.[2] When choosing between inflating ratings or not, the rating agency is making an intertemporal decision whether it wants more profits today (rating inflation) or tomorrow (more reputation).

How is the trade-off between ratings inflation and reputation mentioned above altered by competition? It is often suggested that introducing more competition between RA may help alleviate the conflict of interest problem. In fact, the European Union approved a law requiring companies to rotate agencies, and in turn encourage new ratings competitors to enter the market.[3] In 1997, the Korean government launched a series of financial restructuring measures to help the country recover from a severe financial crisis. Among them, the "Enforcement Rule of the Use and Protection of Credit Information Act" lowered entry barriers in the credit rating agency industry, which led to an increase in the level of competition between agencies, as empirically shown by Oh (2014). Bolton, Freixas, and Shapiro (2012) build a model in which competition is welfare-reducing, as it facilitates ratings shopping (in which issuers look for many RA and request only the highest rating they can find) by issuers.[4] However, ratings shopping might not be the only mechanism behind this result. In fact, Benmelech and Dlugosz (2010) document that 80% of all structured finance securities' tranches were rated by either two or three agencies and were less prone to ratings shopping.

We have a novel result that contributes to the existing literature: if the new entrant rating agency has low reputation, the incumbent will inflate more its ratings and welfare is going to be reduced. This is a result of the channel provided by this paper, which prescinds ratings shoppings and studies how competition alters the trade-off between reputation and rating inflation. On one hand, more competition could deteriorate the quality of ratings as it decreases the RA's future profits, if the market size of ratings is fixed. We call this mechanism the *market-sharing effect*. On the other hand, there is a *disciplining effect* at work: if the new entrant has a higher reputation than the incumbent, the latter has an extra incentive to become more disciplined, as the market leader collects more rents.

We develop a model that takes into account the two countervailing effects explained above, the *market-sharing* and the *disciplining effects*, and assesses how competition between RA affects their reputational concerns and the level of rating inflation. The *disciplining effect* is the incentive that a rating agency has to be the market leader and grab all the fees from projects that need a good rating (GR) from a rating agency with a minimum enough reputation. This is the mechanism that is in general emphasized by policy makers when proposing competition as a means of alleviating the conflicts of interest surrounding RA. In order to improve their reputation, they need to be more truthful and thus, throughout the *disciplining effect*, competition decreases rating inflation. In contrast, the *market-sharing effect* is the fact that competition reduces the reward from maintaining reputation as the market is shared between a larger number of RA. Hence, they prefer to cash in today, by giving GRs to bad projects at the expense of future income through a higher reputation. The *market-sharing effect* increases rating inflation. We study the impact of competition on the behaviour of RA by exploring the interaction between these two opposite effects.[5]

We find that: (i) relative to monopoly, RA are more likely to inflate ratings under duopoly; (ii) the duopoly setting has a lower welfare (the net income of the projects with GR) if the new entrant has low reputation and a higher welfare if the new entrant has high reputation. Those results suggest that allowing more RA to operate might not lead into more accurate ratings and welfare is only improved if the new entrant's reputation is higher than the incumbent's. On balance the *market-sharing effect* dominates and higher competition results in greater rating inflation.

Given the structure of the market—with S&P's and Moody's having 80% of market share, we model competition among the RA in a duopolistic setting.[6] In our model, issuers need a GR to finance their projects. RA, which can be of two types—*honest* or *strategic*, perfectly observe the quality of the project and can either give the issuer a GR or refuse rating.[7] An honest rating agency always gives GRs to good projects and no rating (NR) to bad projects, while a strategic rating agency acts to maximize its expected profits. Neither investors nor issuers know for sure if a rating agency is honest and they Bayesian update on the reputation of the RA, that is, the probability that a rating agency is honest. The market share of the rating agency is modelled such that RA with higher reputation attract more projects. An issuer only requests a rating from a rating agency if its reputation is high enough such that a GR renders the project a positive expected profit. If both RA are above the minimum reputation threshold for the project, the issuer flips a coin.[8] Hence, the RA face a trade-off between current income and reputation, which determines their future market share and income.

We compare the behaviour of RA between the duopolistic case and the monopolistic case.[9] We first derive closed-form solutions in a three-period model and show that the lax behaviour of a rating agency increases with the reputation of its competitor, that is, competition leads to more lax behaviour and the *market-sharing effect* dominates. We then compute numerical solutions under an infinite-period setting, which enables us to relax parameter restrictions and extend the horizon of RA, thereby making reputation more important for them.

Our results show that the *market-sharing effect* tends to dominate the *disciplining effect* when the degree of competition is sufficiently high, that is, the reputation of the competitor is high. Moreover, we find that expected welfare is higher in the monopoly case than in the duopoly case as long as the reputation of the entrant rating agency (the competitor) is not greater than that of the incumbent rating agency. In our model, expected welfare rises only when the new entrant has a higher reputation *vis-à-vis* the incumbent. We verify that the results are robust to different parameter specifications and on balance, our results suggest that increasing competition is likely to result in more rating inflation.

This paper belongs to the literature on how competition alter the conflicts of interests between financial intermediaries and investors. Allen (1990) provides a rationale for the existence of financial intermediaries as information sellers cannot obtain the full value of his information due to a reliability problem. Hauswald and Marquez (2006) study how banks strategically acquire information on borrowers in order to soften competition and gain market share. Boot, Milbourn, and Schmeits (2006) provide a model in which credit RA serve as a *focal point* between firms and investors that face multiple equilibria. Lizzeri (1999) shows that the optimal disclosure policy of a monopolist rating agency that can assess the quality of the issuer perfectly at zero cost is to pool all issuers into one rate class. Building on it, Doherty, Kartasheva, and Phillips (2012) study how the entrance of a new competitor in a previously monopolistic credit rating agency industry affects the information content of the ratings. It shows that the new entrant applies stricter standards to apply a rating similar to the one assigned by the monopolist. Our paper differs from theirs, as in our study the new entrant might have a lower or higher reputation than the incumbent. Moreover, while in their study issuers can be rated by more than one rating agency, we rely on a competition mechanism in which an issuer can only be rated by one single rating agency. Manso (2013) develops a model in which RA consider the effects of their ratings on the solvency of the issuers when rating. Relying on a different channel than ours, he also shows that increased competition might lead to a lower welfare equilibrium.

Our theory builds on Mathis, McAndrews, and Rochet (2009), who demonstrate that reputational concerns are not enough to solve the conflict of interest problem. In equilibrium, RA are likely to behave laxly, that is, rate bad projects as good and are prone to reputation cycles. Our model innovates by introducing competition through an endogenous market share function and studying how competition affects the behaviour of RA.

Our results are related to the literature on the importance of regulation of financial intermediaries, as we show that the suggestion brought by American and European regulators that inducing competition might alleviate the conflicts of interest surrounding RA would only work if the new entrants have high reputation. Opp, Opp, and Harris (2013) model a monopolist issuer-pay credit rating agency industry in the presence of regulatory requirement for ratings in a rational framework in which issuers take into account the strategic behaviour of RA due to the regulatory requirements and their incentives to inflate ratings. Bongaerts, Martijn Cremers, and Goetzmann (2012) provide evidence that the existence of multiple ratings is mainly due to regulatory reasons rather than information production or ratings shopping. Bongaerts (2014) offers a rationale for the resilience of the issuer-pay model *vis-à-vis* alternative business models for the rating agency industry, such as the investor-paid one. He shows that although the alternative models reduce rating inflation, their scope for welfare enhancement *vis-à-vis* the issuer-pay model are very limited and hard to realize in practice. Fulghieri, Strobl, and Xia (2014) study the effects of unsolicited ratings on the RA's strategies and find that it leads to an improved reputation and, in equilibrium, that unsolicited ratings are lower than solicited ones. While our paper explores how competition interacts with reputation, Lee and Oh (2019) model how the reputational concerns of a monopolistic CRA interact with liquidity crises. They show that the probability of liquidity crises is not monotonic on the accuracy of the CRA's private signal, leading a CRA with inaccurate signal to place more weight on the common prior. This is an interesting channel different from ours on how reputation can alter CRA's behaviour. While in our paper, CRAs have a perfect signal and trade-off how competition will alter their current and future profits, Lee and Oh (2019) show how the CRA's precision of its noisy signal might affect liquidity crises and ultimately make it conform to the common prior.

A number of empirical papers find that the conflicts of interest problem play an important role in RA's decisions. In particular, Becker and Milbourn (2011) lend support to our results by providing an empirical test of the impact of competition on RA. They measure competition using the growth of Fitch's market share and find that S&P and Moody's ratings became more "friendly." Their findings are consistent with our results that competition will tend to lower the quality of ratings in the market. Cohen and Manuszak (2013)'s results highlight our *market-sharing* channel: they show that S&P and Moody's accept lower subordination levels in order to give GRs to commercial mortgage-backed securities when Fitch's market rate was on the rise and thus perceived as a more serious competitor. Griffin and Tang (2011) compare the CDO assumptions made by the ratings department and by the surveillance department within the same rating agency, and find the former uses more favourable assumptions, which in turn increases rating inflation. In contrast, Xia (2014) finds a significant improvement in the quality of S&P's ratings following the entry of a new investor-paid rating agency. This result however is compatible with our model since an investor paid rating agency in our setting would be perfectly honest and our results suggest that in cases in which the incumbent RA has lower reputation than the entrant RA, welfare improvement is possible. Morkoetter, Stebler, and Westerfeld (2017) is another work that empirically shows benefits from increasing the level of competition in the credit rating agency industry. The authors investigate the effects of multiple ratings in the US residential mortgage-backed securities in the issuance and monitoring stages and find that RA put more effort for tranches with multiple ratings. In particular, RA produce more and better information in the post-issuance stage with multiple ratings and predict better default risk. Their results suggest that issuers can have a lower refinancing cost if they engage in ratings shopping, a mechanism not explored in our paper.

There is a literature that studies the incentives of RA to inflate ratings in the presence of asset complexity, other than Skreta and Veldkamp (2009) and Bolton et al. (2012). Pagano and Volpin (2012) provide evidence that issuers of structured products favour sophisticated investors by releasing opaque information about the issue, which enhances liquidity at the primary market at the expense of reducing liquidity at the secondary market. Damiano, Hao, and Suen (2008) compare rating inflation among centralized (all firms are rated together) and decentralized (firms are rated separately) rating schemes. When the quality of projects is weakly correlated, centralized rating dominates because decentralized rating leads to lower rating inflation. Sangiorgi, Sokobin, and Chester (2009) study how the correlation between RA's models influence ratings shopping and bias and show that a higher cost of obtaining indicative ratings lead to inflation in published ratings, as they are obtained less frequently. Bar-Isaac and Shapiro (2011) explore how the labour market for analysts and their incentives influence ratings accuracy and find that the latter increases with monitoring and also with investment bank profitability.

Some other studies also study competition through reputation in other contexts. For example, Horner (2002) shows that the incentive to maintain good reputation and stay in the market can induce good firms to exert higher effort and try to distinguish themselves from the bad ones. The adverse effects of competition on the building and maintenance of reputation has been studied by Klein and Leffler (1981). They argue that when faced with a choice between supplying high quality products or low quality ones, firms would be induced to supply high quality products only when the expected value of future income given a high reputation outweighs the short-run gain of lying. Bar-Isaac (2005) points out that the overall effect of competition on reputational incentives is ambiguous and may be non-monotonic, since increased competition can reduce the discounted value of maintaining a high reputation on one hand, but can also lead to a more severe punishment for low reputation on the other. This intuition is very close to ours, except that we use a framework in the context of credit RA.

A few papers look into reputation and competition in a RA framework. Bouvard and Levy (2009) examine the trade-off between reputation and profits of RA in a competitive setting and find that the threat of entry attenuates reputational effects. Hirth (2014) uses Evolutionary Game Theory to study the dynamics of competition between many RA in a market with sophisticated and trusting investors and find that a unique equilibrium can be reached only if trusting investors dominate. Mariano (2012) models how reputational concerns change RA incentives to reveal private information. In a setting in which RA have access to private and public information, her results provide a mechanism in which competition between RA might inflate the ratings even in the absence of conflicts of interest.

The rest of the paper is organized as follows. We outline the basic features of our model in Section 2. Section 3 describes the equilibrium in our model and Section 4 solves the model solution in a three-period setting. In Section 5, we solve the model numerically in an infinite horizon. We go on to compare the behaviour of RA under monopoly and duopoly and discuss the expected welfare consequences of enhanced competition. Section 6 concludes. The proofs and additional robustness checks are presented in the Appendix.

2 | MODEL SETUP

We consider a discrete time setting with three types of agents—the issuers, the RA and the investors. Each period, we have a *new issuer* with a project that requires financing.[10] We assume that issuers do not have funds of their own and need to obtain outside financing. The investors have funds and are willing to invest in the project provided they are convinced that it is profitable to do so. The role of the RA in this setting is to issue ratings that convince investors to provide financing.

More formally, each period we have one issuer that has a project which lasts for one period. All projects have a fixed pay-off ϕ if successful and 0 otherwise and require an investment of X. This required investment X is uniformly distributed over (a,b) and its realization is observed by all agents before investors make their financing decisions. Projects that require low investment have high return and vice versa. We can get similar results if we assume fixed investment with uncertain pay-off. The project is *good* with probability λ and *bad* with probability $1-\lambda$, and λ is independent of X. Good projects succeed with probability p_G and fail with probability $(1-p_G)$. Bad projects always fail.

We assume that a-priori projects are not worth financing without rating, that is, $\lambda p_G \phi \leq a$. Further, the RAs can perfectly observe the type of project at no cost. After observing the type, the RA can either issue a GR or NR. Note that, we do not distinguish between bad rating and NR and abstract away from a ratings scale. In our setup, a GR is one that allows the issuer to borrow from investors. It does not matter if this rating is AAA or A or BBB or even C. As long as the rating allows the firm to get financing, we consider it to be a GR. A bad rating in this setting will be a rating which does not enable a project to get financing. This is the same outcome as a NR and thus, a bad rating and NR are equivalent in our model.

The rating agency receives fixed income $I < p_G\phi(1-\lambda)$ if it issues GR, and 0 otherwise.[11,12] This assumption arises from the conflict of interest in the ratings industry. Given the *non-transparent* nature of the market and the widespread use of *negotiated ratings*, issuers and RAs routinely have negotiations and consultations before an official rating is issued. RAs, as part of their day-to-day operations, give their clients "creative suggestions" on how to repackage their portfolios or projects in order to get better ratings. To quote former chief of Moody's, Tom McGuire[13]:

> "The banks pay only if [the rating agency] delivers the desired rating... If Moody's and a client bank don't see eye-to-eye, the bank can either tweak the numbers or try its luck with a competitor..."

We assume that there are two types of RAs—*honest* and *strategic*. An honest RA always issues a GR to a good project and NR to a bad project, while a strategic RA behaves strategically to maximize its expected future profits. The strategic RA faces the following trade-off:

1. (**Truthful**) It can either be truthful and maintain its reputation, thus ensuring profits in the future
2. (**Lie**) It can inflate ratings (give a GR to a bad project) and get fees now, at the cost of future profits

We consider a duopolistic setting of RA.[14] The type of the RA is chosen *ex ante* by nature and is known only to the rating agency itself. The *reputation* of the rating agency is defined as the probability that it is honest, denoted by q_i, $i \in \{1, 2\}$. The reputation evolves over time depending on the ratings and outcome of the projects. The *strategy* of the RA is x_i, the probability the RA issues a GR to a bad project.[15]

The investors (and issuers) have some priors about the types of the RAs and they update their beliefs in a Bayesian fashion. Firstly, investors and issuers take into account the rating and update the reputation of the RA, before observing the outcome of the project. Given prior reputation q_t,

$$\text{If RA issues GR, } q_t^{GR} = \frac{\lambda q_t}{\lambda + (1-q_t)(1-\lambda)x} < q_t \tag{1}$$

$$\text{If not rated, } q_{t+1}^{N} = \frac{q_t}{1-x(1-q_t)} > q_t \tag{2}$$

If the project is issued a GR by the RA, the investors update their beliefs after observing the outcome of the project.

$$\text{If the project succeeds, } q_{t+1}^{S} = \frac{\lambda p_G q_t}{\lambda p_G q_t + \lambda p_G(1-q_t)} = q_t \tag{3}$$

$$\text{If the project fails, } q_{t+1}^{F} = \frac{\lambda(1-p_G)q_t}{\lambda(1-p_G)q_t + [\lambda(1-p_G)+(1-\lambda)x](1-q_t)} < q_t \tag{4}$$

We make the simplifying assumption that each issuer can only approach one RA for rating. Therefore, our model considers ratings shopping only to the extent that the issuer and the rating agency have negotiations before an official rating is issued. We do not explicitly study multiple ratings and herd behaviour of the RAs. While these are important issues that merit attention, they are not the focus of this paper. Here, we look at the competition for market share among RA and show that rating inflation increases with competition.

Investors observe the rating decision and decide whether to invest. If they observe a GR from a RA with reputation q, their subjective belief that the project will succeed (using Equation (1)) is given by

$$\begin{aligned} s(q,x) &= q^{GR}p_G + (1-q^{GR})\frac{\lambda p_G}{\lambda+(1-\lambda)x} \\ &= \frac{\lambda q}{\lambda+(1-q)(1-\lambda)x}p_G \\ &\quad + \left(1-\frac{\lambda q}{\lambda+(1-q)(1-\lambda)x}\right)\frac{\lambda p_G}{\lambda+(1-\lambda)x} \\ &= \frac{\lambda p_G}{\lambda+(1-q)(1-\lambda)x} \end{aligned} \tag{5}$$

Given the required investment level X, investors are willing to finance the project *if and only if* $X \le s(q, x)\phi$, that is, if the initial investment required for the project is no greater than its expected pay-off. Without loss of generality, assume $s(q_1, x_1) > s(q_2, x_2)$. We have three cases:

1. If X is such that a GR from either RA is enough, that is, $X \le s(q, x)\phi$ for both q_1 and q_2, the firm can approach either RA.[16] We assume that in this case the firm will randomly choose one of the RAs, that is, the project goes to both RAs with equal probability.[17]
2. If $s(q_2, x_2)\phi < X < s(q_1, x_1)\phi$, that is, only the high reputation RA can issue ratings that can convince the investors to provide financing, hence the firm will go to RA1 and not RA2.
3. If $X > s(q_1, x_1)\phi$, the project does not get financed.

Thus, we get the following result as illustrated in Figure 1.

$$\text{Probability that a project comes to RA1} = \frac{(s_1 - s_2) + \frac{1}{2}\left(s_2 - \frac{a}{\phi}\right)}{\frac{b}{\phi} - \frac{a}{\phi}}$$

$$\text{Probability that a project comes to RA2} = \frac{\frac{1}{2}\left(s_2 - \frac{a}{\phi}\right)}{\frac{b}{\phi} - \frac{a}{\phi}}$$

We set $(a, b) = (\lambda p_G \phi, p_G \phi)$, because any project with $X < \lambda p_G \phi$ does not need a rating to be financed, and any project with $X > p_G \phi$ is never worth financing *ex-ante*.

$$\text{The probability that a project comes to RA1} = \frac{s_1 - \frac{1}{2}(s_2 + \lambda p_G)}{p_G(1-\lambda)} \tag{6}$$

$$\text{The probability that a project comes to RA2} = \frac{\frac{1}{2}(s_2 - \lambda p_G)}{p_G(1-\lambda)} \tag{7}$$

Reputation plays a critical role in our model. The market share of the RAs depends on s, and thus on reputation q. Since the income from giving a GR is constant (denoted by I), the future profits of the RA will solely depend on its market share. Moreover, the RA with a higher reputation enjoys additional benefits of being the market leader, because it owns entirely the proportion of the market that cannot be rated by its competitor but can be rated by itself; whereas, its competitor can only share its market with the leader. This creates incentives for RAs to maintain or gain the market leader position and hence disciplines the RAs through competition.

We can now see that competition (modelled through market share) has two effects on lax behaviour: the market-sharing effect and the disciplining effect. The market-sharing effect refers to the fact that the RA finds lying and receiving income today more attractive as its expected future income is shared with another RA, and the disciplining effect refers to the fact that the RA finds lying less attractive in order to maintain/gain the advantages of being a market leader. We will show later that the market-sharing effect tends to dominate the disciplining effect and hence competition aggravates the lax behaviour of RAs in general.

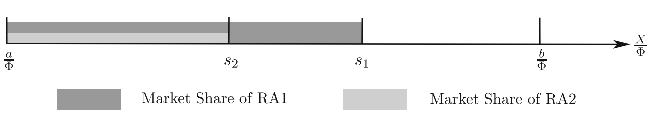


FIGURE 1 The market for ratings

3 | EQUILIBRIUM

Definition 1 *The equilibrium in our model is a Markov Perfect Equilibrium such that, at each period t, the strategic RA always.*

(i) Gives a GR to a good project.
(ii) Gives a GR to a bad project with probability x_t, where $0 \le x_t \le 1$.

We look for a Markov Perfect Equilibrium in the sense that the equilibrium is "memoryless," that is, the strategy of the strategic RA only depends on the current reputation of its opponent and itself. The equilibrium is also "symmetric," as the strategy function of both RAs (if they are both strategic) is the same. However, the RAs do not take actions simultaneously.

Let RA1 be a strategic RA and let $V_t(q_1, q_2)$ denote its discounted future profits, given its reputation q_1 and its competitor's reputation q_2, and let δ be the discount rate. The RA's new reputation after it gives NR and the failure of a project following a GR are denoted by q_1^N and q_1^F, respectively. A successful project with a GR leaves the RA's reputation unchanged. Note that q_1^F and q_1^N are functions of the strategy of the RA and its current reputation level. For notational simplicity, we suppress the time subscript of these reputation-updating functions.

Figure 2 shows the decision tree of RA1. Suppose it is approached for rating. If the project is good, RA1 gives it a GR and gets income I (see Proposition 2). On the other hand, if the project is bad, RA1 strategically decides whether to give a GR and get fees I or refuse rating. In case

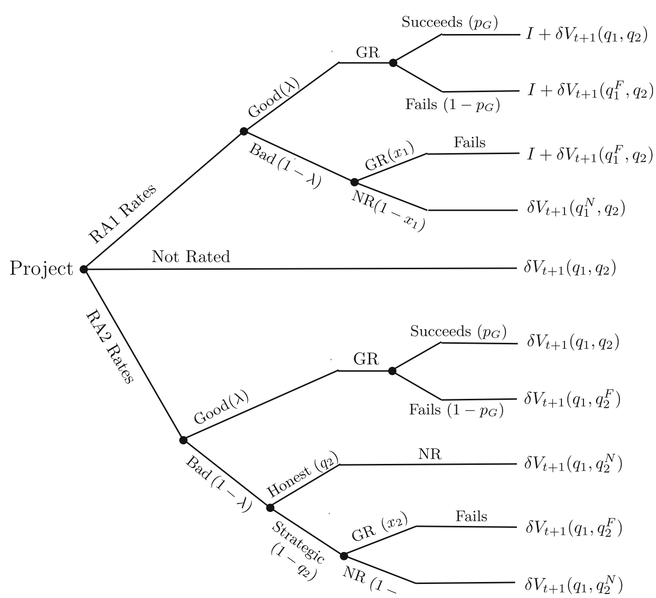


FIGURE 2 Decision-tree for strategic RA1

of NR, RA1's reputation rises as it gets a larger market share in the future. In case of a GR, RA1's reputation falls if the project fails and remains the same if it succeeds. This in turn determines the RA1's expected future income. A similar analysis applies if RA2 is approached for rating. In this case, the fees go to RA2 and RA1 is only indirectly affected through a change in RA2's reputation. Note that, since RA1 does not know the type of RA2, it has to take into account the possibility that RA2 is either honest or strategic.

$$\begin{aligned} V_t(q_1,q_2) &= P(RA1rates) \\ &\{P(Good)[I+p_G\delta V_{t+1}(q_1,q_2)+(1-p_G)\delta V_{t+1}(q_1^F,q_2)] \\ &\quad +P(Bad)[x_1(q_1,q_2)(I+\delta V_{t+1}(q_1^F,q_2)) \\ &+(1-x_1(q_1,q_2))\delta V_{t+1}(q_1^N,q_2)]\} \\ &+P(RA2rates)\{P(Good)[p_G\delta V_{t+1}(q_1,q_2) \\ &+(1-p_G)\delta V_{t+1}(q_1,q_2^F)] \\ &+P(Bad)[(1-q_2)x_2(q_1,q_2)\delta V_{t+1}(q_1,q_2^F) \\ &+[q_2+(1-q_2)(1-x_2(q_1,q_2))]\delta V_{t+1}(q_1,q_2^N)]\} \\ &+P(NotRated)\delta V_{t+1}(q_1,q_2) \end{aligned} \tag{8}$$

The objective function of RA1 is to maximize $V_t(q_1, q_2)$, the strategy being x_1. Note that, RA1's strategy is only effectual when it rates a bad project. In all other cases, RA1's strategy is inconsequential.

Proposition 1 *There exists a unique x_1, where $0 \le x_1 \le 1$, given that $V_t(q_1, q_2)$ is an increasing function in q_1.*

Proof See Appendix A.1.

Intuitively, it is easy to see from Equation (8) that $V_t(q_1, q_2)$ is linear in x_1. This ensures that RA1's maximization problem has a unique solution.

Proposition 2 *A strategic RA does not have incentives to give NR to a good project.*

Proof See Appendix A.2.

Proposition 2 implies that a strategic RA always gives GR to a good project. This is because it gets a lower pay-off if it deviates from this strategy and gives a NR to a good project. The proposition follows directly from the pay-off structure of the RAs and the beliefs.

Proposition 3 *There exists a unique equilibrium as described in Definition 1.*

Proof Follows from Propositions 1 and 2.

Corollary 1 *Assume $p_G < 1$. Then the equilibrium strategy of the strategic RA is always positive, that is, it inflates ratings with positive probability.*

Proof See Appendix A.3.

Corollary 2 *Suppose the model ends in period T. Then the equilibrium strategy of the strategic RA is $x = 1$ at $t = T - 1, T$.*

Proof See Appendix A.4.

We now present an analytical solution in a finite period setting. We solve the model numerically in infinite horizon in Section 5.

4 | FINITE HORIZON SOLUTION

We assume the model lasts for three periods, $t = 1,2,3$, and the RAs maximize their expected total income over the three periods. We compute the equilibrium strategy of the RAs using backward induction. We already know that the strategic RA will always lie in the last two periods, as shown in Corollary 2.

We solve for the equilibrium strategy at $t = 1$. Again, let us look at the decision of RA1. Since RA1 will always lie at $t = 2$, 3, the expected pay-off of RA1 at $t = 1$ is

$$\begin{aligned} \Psi(lie) &= I+\delta V_2\left(q_1^F,q_2\right) = I+\delta f\left(q_1^F,1,q_21\right)I \\ &+\delta^2 I\{f(q_1^F,1,q_2,1)[\lambda p_G f(q_1^F,1,q_2,1) \\ &+((1-p_G)\lambda+(1-\lambda))f(q_1^{FF},1,q_2,1)] \\ &+f\left(q_2,1,q_1^F,1\right)[\lambda p_G f\left(q_1^F,1,q_2,1\right) \\ &+(\lambda(1-p_G)+(1-\lambda)(1-q_2))f\left(q_1^F,1,q_2^F,1\right) \\ &+(1-\lambda)q_2 f(q_1^F,1,q_2^N,1)]\} \end{aligned} \tag{9}$$

if it lies, and

$$\begin{aligned} \Psi(honest) &= \delta V_2\left(q_1^N,q_2\right) = \delta f\left(q_1^N,1,q_2,1\right)I \\ &+\delta^2 I\{f\left(q_1^N,1,q_2,1\right)[\lambda p_G f\left(q_1^N 1 q_2 1\right) \\ &+((1-p_G)\lambda+(1-\lambda))f(q_1^{NF} 1 q_2 1)] \\ &+f\left(q_2,1,q_1^N,1\right)[\lambda p_G f\left(q_1^N,1,q_2,1\right) \\ &+(\lambda(1-p_G)+(1-\lambda)(1-q_2))f\left(q_1^N,1,q_2^F,1\right) \\ &+(1-\lambda)q_2 f(q_1^N,1,q_2^N,1)]\} \end{aligned} \tag{10}$$

if it is honest, where $f(q_1, x_1, q_2, x_2)$ is the probability that the project comes to RA1 next period, given its reputation q_1, its strategy x_1, its competitor's reputation q_2 and its competitor's strategy x_2.

As described in Section 3, we look for an equilibrium of the game by examining the trade-off facing RA1, that is, the difference between expressions (9) and (10). If the pay-off from lying is greater then $x_1 = 1$, and we have a pure-strategy equilibrium in which RA1 always lies; if the pay-off from not lying is greater then $x_1 = 0$ and we have a pure-strategy equilibrium in which RA1 never lies; otherwise, we have a mixed-strategy equilibrium in which RA1 is indifferent between lying and not lying, given some prior beliefs about its strategy, that is, $0 < x_1 < 1$.

To derive an analytical solution to this game, we make a simplifying assumption that $p_G = 1$ and $\delta = 1$. This assumption implies that the reputation of the strategic RA goes to zero if it gives a GR to a bad project since now every good project succeeds and every bad project fails. This simplifies expressions (9) and (10) and allows us to derive the equilibrium strategy of RA1. This assumption is relaxed in Section 5.

The expression of market share of RA1 depends on whether RA1 has a higher probability of success than its competitor. Given that the strategy of the strategic RA in the last two periods is to always lie, the RA with a higher reputation will have a higher market share in any single period. Hence, we compute the strategy of RA1 in different ranges of the reputation of RA2.

Proposition 4 *The equilibrium strategy at* $t = 1$ x_1 *is*

$$x_1 = \begin{cases} 0 & \text{if } A \le \dfrac{\lambda q_1}{2(\lambda q_1 + (1-q_1))} \\ 1 - \dfrac{(1-2A)\lambda q_1}{2A(1-q_1)} & \text{if } \dfrac{\lambda q_1}{2(\lambda q_1 + (1-q_1))} < A < \dfrac{1}{2} \\ 1 & \text{if } A \ge \dfrac{1}{2} \end{cases}$$

where A is the solution to the equation

$$\Psi(lie) - \Psi(honest) = I - \delta(2A - \min\{A,B\})$$
$$I - \delta^2(\lambda(2A - \min\{A,B\})^2 + (2B - \min\{A,B\})$$
$$[\lambda(2A - \min\{A,B\}) + 2(1-\lambda)(1-q_2)A + (1-\lambda)q_2 A])I = 0$$

and $B = \frac{\frac{1}{2}(s(q_2,1) - \lambda p_G)}{p_G(1-\lambda)}$.

Proof See Appendix A.5.

Corollary 3 *In equilibrium,* x_1 *is decreasing in* q_1. *Moreover,* x_1 *is increasing in* q_2.

Proof See Appendix A.5.

Proposition 4 implies that the strategy of RA1 depends on its own and its competitor's reputation. When A is large, RA1 always gives a GR to a bad project. Conversely, when A is small RA1 behaves honestly and gives NR to bad projects. In the intermediate range, RA1 has a mixed strategy, with $0 < x_1 < 1$. Note that the lower threshold for A is increasing with RA1's reputation.

The results imply that RA1 tends to lie less as its reputation increases (Corollary 3). The intuition behind this result is straightforward. Since we assumed $p_G = 1$, the reputation of RA1 goes to zero immediately after a project fails. This means that the cost of lying increases with RA1's reputation while the benefit of lying stays constant. Hence, it is not surprising that RA1 prefers to lie less as its reputation increases.[18]

Moreover, according to Corollary 3, RA1's strategy tends to increase with RA2's reputation. As explained before, competition has two opposite effects on the behaviour of RA1: the disciplining effect and the market-sharing effect. When the reputation of its opponent increases, RA1 will find it less attractive to increase its own reputation given a smaller expected future market share, and hence will behave more laxly. On the other hand, RA1 may have incentives to behave honestly when RA2's reputation increases in order to maintain its market leader position. Our analysis shows that the market-sharing effect tends to dominate the disciplining effect. One potential explanation is that the market share of a rating agency is determined not only by its reputation relative to that of its competitor, but also by the absolute level of its reputation. That is, even a monopolistic RA cannot behave totally laxly, because otherwise its reputation would become too low to credibly rate most projects. Therefore, the incentives of a RA to maintain good reputation, even in absence of competition, render the disciplining effect of competition weaker. We believe this is reasonable because in reality, given rational investors, a monopolistic RA would not have unbounded market powers.

However, the results above are based on a three-period model with the assumption that $p_G = 1$, that is, the strategic RA is caught immediately after the project fails. The results may be driven by the fact that the RAs only live for three periods, and hence have limited potential gains associated with higher reputation. In order to capture the long-term benefits of reputation under a more general setting, we move on to the next section, where we relax parameter assumptions and compute numerical solutions in an infinite-horizon case.

5 | INFINITE-HORIZON SETUP

We now present the numerical solution of the model in infinite horizon. The numerical solution is once again computed using backward induction, that is, we first solve the model in the finite period case, and then increase the number of periods so that the equilibrium strategy converges to the infinite-horizon solution.

In an infinite period setting, V_t by itself is independent of t. Hence, we suppress the time subscript for notational simplicity. However, the reputations evolve over time as investors (and issuers) update their beliefs. Let RA1 be the rating agency that behaves strategically. Then, RA1's value function takes the following form:

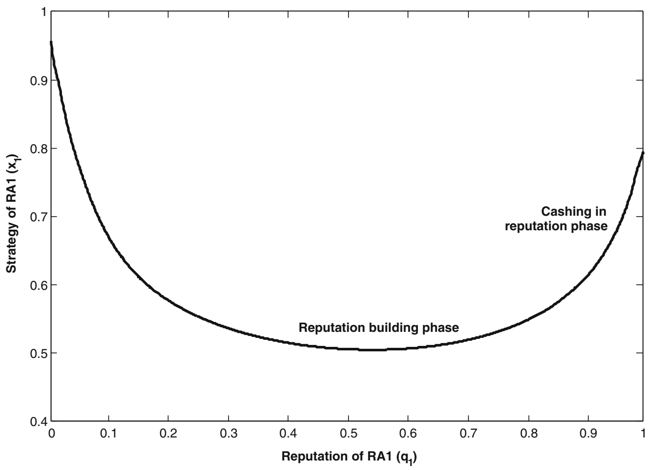
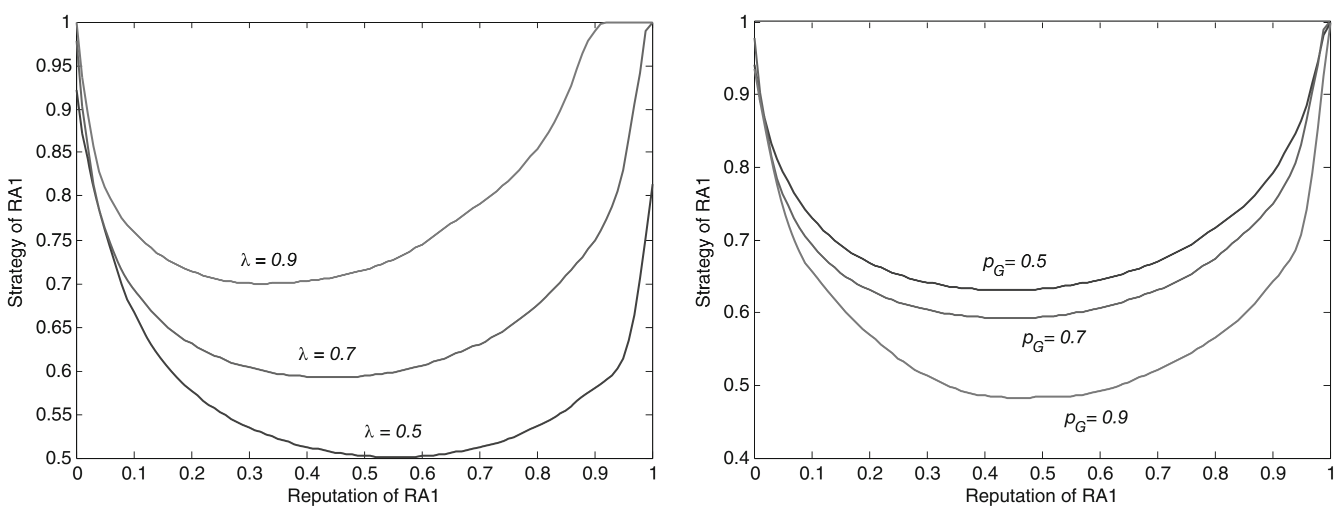


FIGURE 3 Strategy versus reputation, monopolistic RA (λ, p_G, δ, q_2) = (0.5, 0.7, 0.9, 0)

$$
\begin{aligned}
V(q_1,q_2) = {} & \frac{\frac{1}{2}(s_1-\lambda p_G)}{(1-\lambda)p_G} \\
& \{\lambda[I+p_G\delta V(q_1,q_2)+(1-p_G)\delta V(q_1^F,q_2)]+ \\
& (1-\lambda)[x_1(q_1,q_2)(I+\delta V(q_1^F,q_2))+(1-x_1(q_1,q_2))\delta V(q_1^N,q_2)]\} \\
& +\frac{s_2-\frac{1}{2}(s_1+\lambda p_G)}{(1-\lambda)p_G}\{\lambda[p_G\delta V(q_1,q_2)+(1-p_G)\delta V(q_1,q_2^F)]+ \\
& (1-\lambda)[(1-q_2)x_2(q_1,q_2)\delta V(q_1,q_2^F) \\
& +[q_2+(1-q_2)(1-x_2(q_1,q_2))]\delta V(q_1,q_2^N)]\} \\
& +\frac{p_G-s_2}{(1-\lambda)p_G}\delta V(q_1,q_2)
\end{aligned}
\tag{11}
$$

where $\frac{\frac{1}{2}(s_1-\lambda p_G)}{(1-\lambda)p_G}$ is the probability that the issuer approaches RA1 for rating, $\frac{s_2-\frac{1}{2}(s_1+\lambda p_G)}{(1-\lambda)p_G}$ is the probability that the issuer approaches RA2 and $\frac{p_G-s_2}{(1-\lambda)p_G}$ is the probability that the project is not rated by either RA.

We assume that the model ends at period T and solve the model backwards. We know that the strategic RA will always lie at period T and $T-1$, according to Corollary 2. For all $t < T-1$, the strategy of the RA depends on its own and its competitors' reputation. We solve for the equilibrium strategy of the RA described in Section 3. We look at the pay-offs from lying and being honest and determine the strategy. As long as $I+V_t(q_1^F,q_2) > V_t(q_1^N,q_2)$ for $x_t = 1$, RA1 will always choose to lie. Conversely, if $I+V_t(q_1^F,q_2) < V_t(q_1^N,q_2)$ for $x_t = 0$, RA1 will always tell the truth. In all other intermediate cases, there exists a unique x_t states that $I+V_t(q_1^F,q_2) = V_t(q_1^N,q_2)$ at which RA1 is indifferent between lying or not. Hence, we deduce inductively the equilibrium strategies of RA1. As T goes to infinity, we



(a) Strategy of RA1 for different values of λ (pG= 0.7)

(b) Strategy of RA1 for different values of pG (λ= 0.7)

FIGURE 4 Strategy versus reputation for different values of λ and p_G ($\delta = 0.9$)

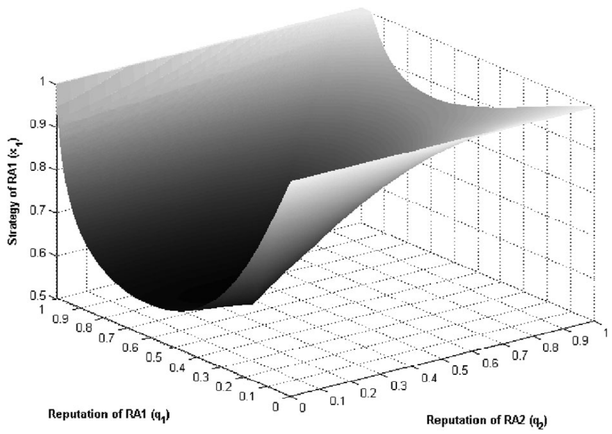


FIGURE 5 Strategy versus reputation, $(\lambda, p_G, \delta) = (0.5, 0.7, 0.9)$

approach the infinite horizon solution. Since $\delta < 1$, the Blackwell conditions are satisfied.

Using this procedure, we solve the model for various parameter values. At the first instance, we solve the model for a monopolistic RA. Next, we introduce competition in the form of RA2 and show that the additional competitive element is not sufficient to discipline the RAs. Furthermore, our results show that competition will in fact increase rating inflation.

5.1 | Monopolistic RA

First, we consider the case where there is only one RA in the market. In order to make RA1 a monopolist, we set the reputation of RA2 to 0.

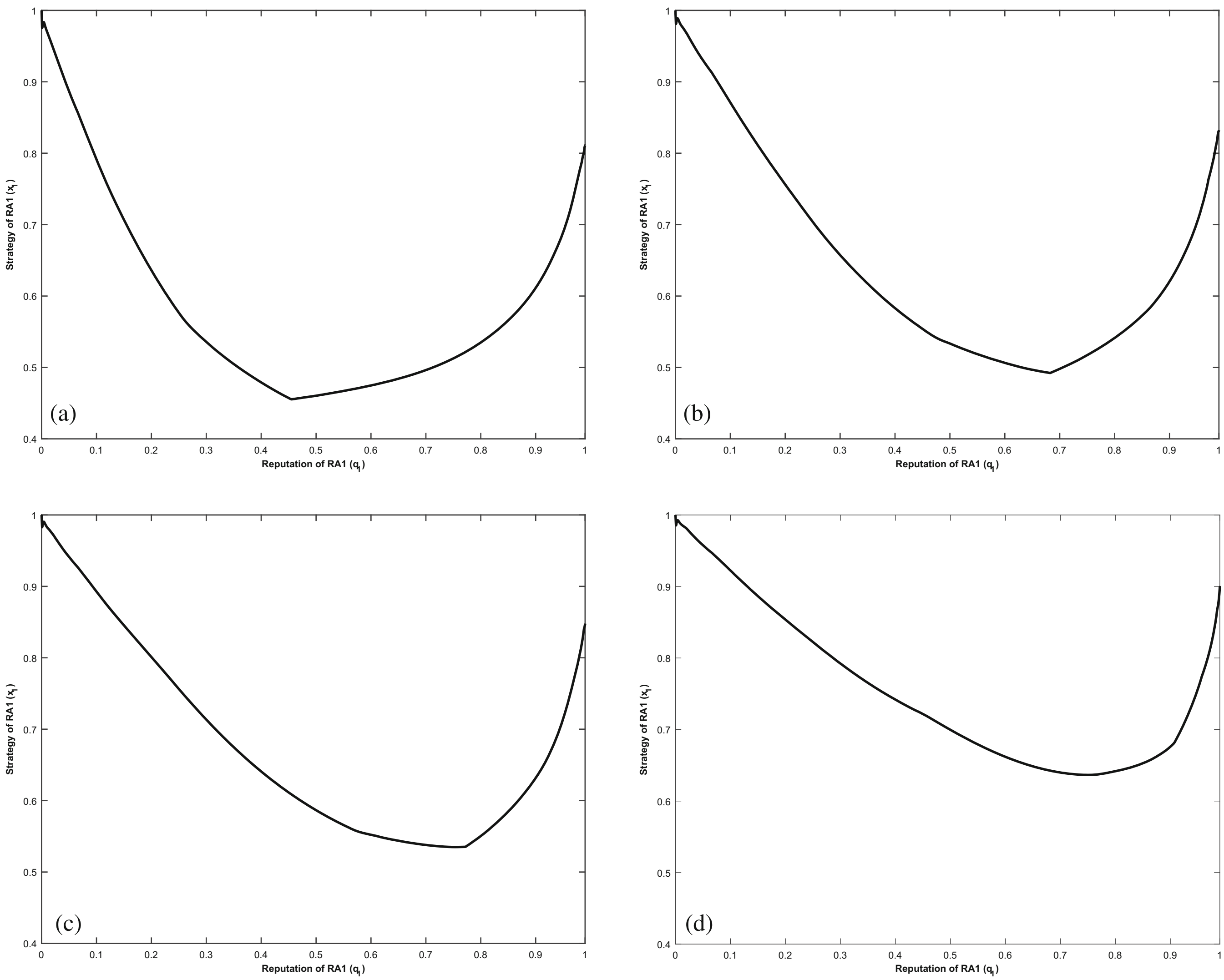


FIGURE 6 Strategy versus reputation, $(\lambda, p_G, \delta) = (0.5, 0.7, 0.9)$, different values of q_2

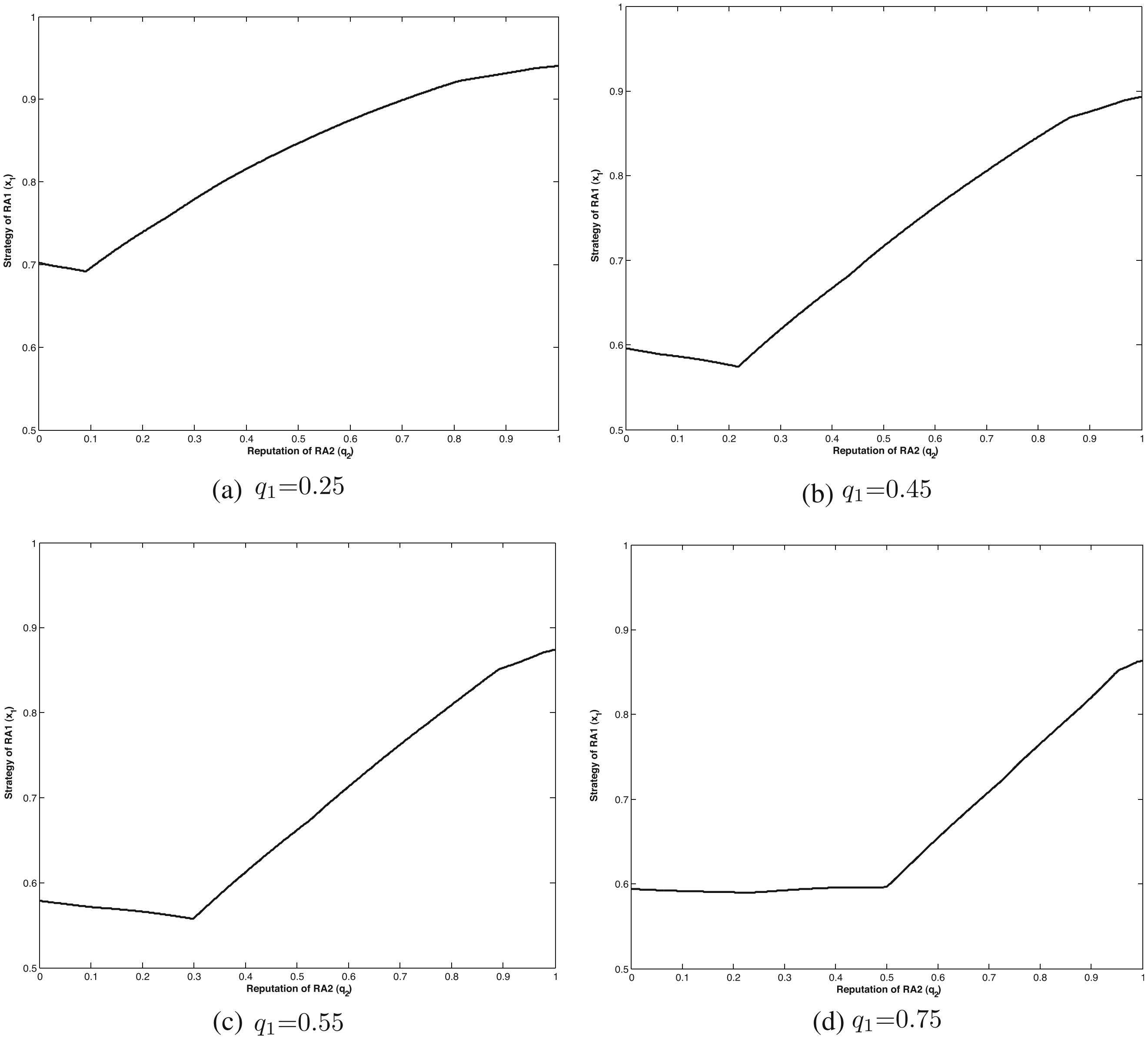
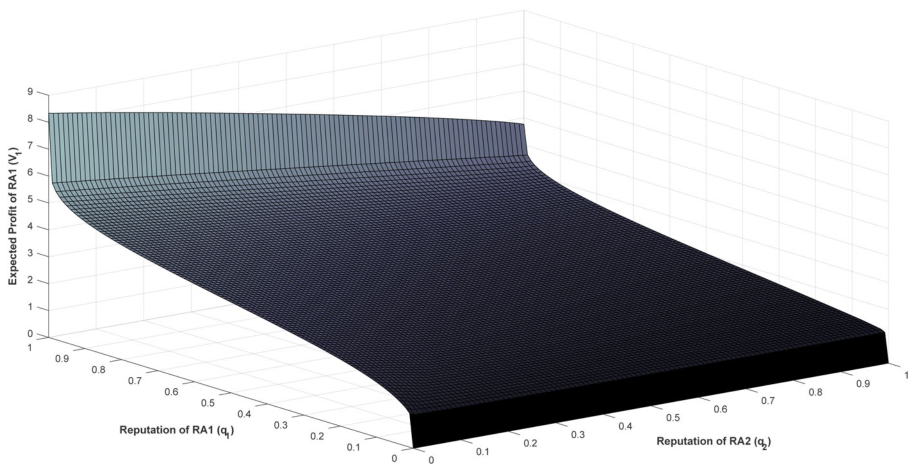


FIGURE 7 Strategy versus reputation, different values of q_1, $(\lambda, p_G, \delta) = (0.5, 0.7, 0.9)$

FIGURE 8 Expected profits versus reputation, $(\lambda, p_G, \delta) = (0.5, 0.7, 0.9)$ [Colour figure can be viewed at wileyonlinelibrary.com]



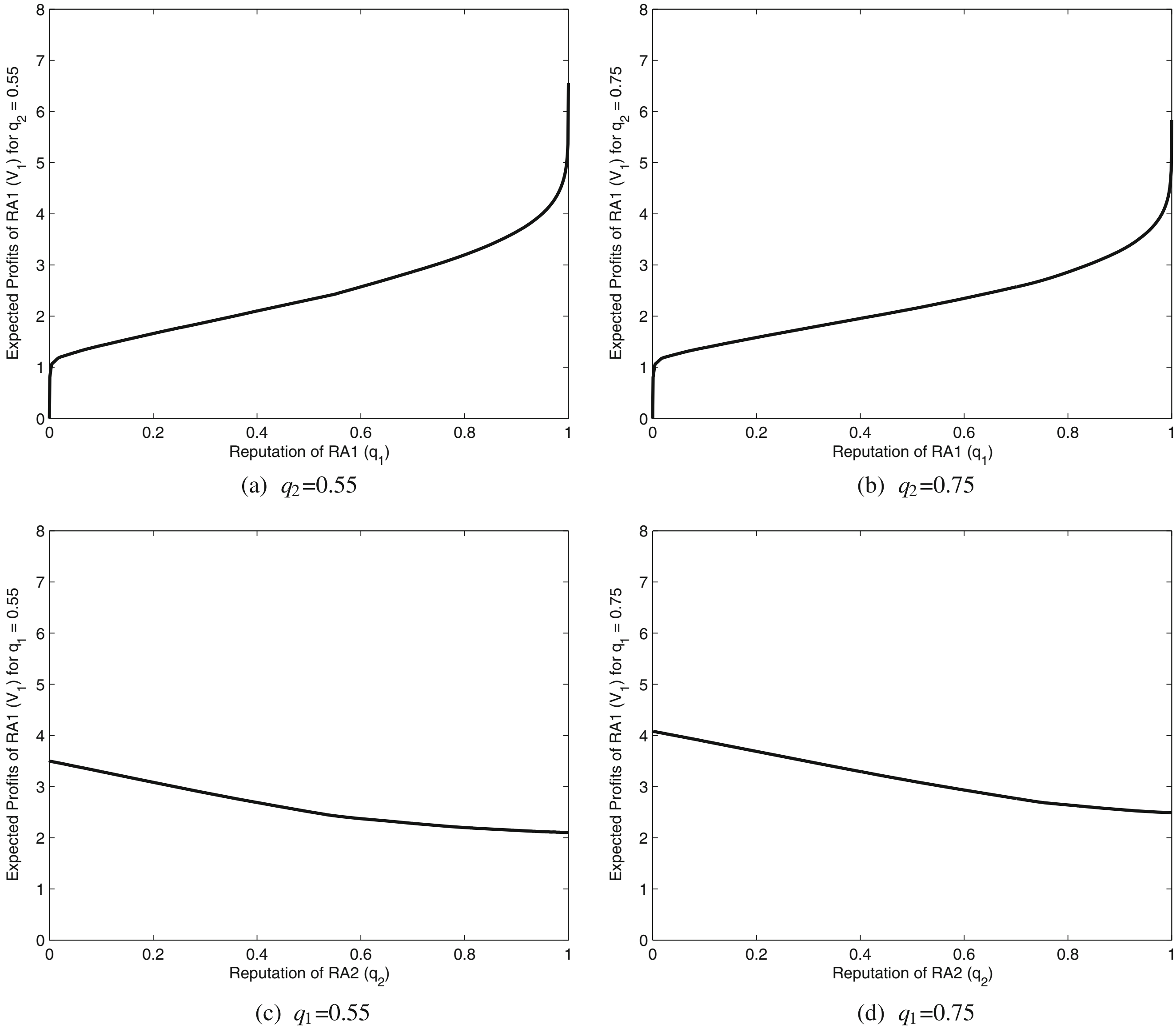


FIGURE 9 Expected profits versus reputation, different values of q_1 and q_2, $(\lambda, p_G, \delta) = (0.5, 0.7, 0.9)$

Figure 3 plots the strategy of the monopolistic RA for parameters $(\lambda, p_G, \delta) = (0.5, 0.7, 0.9)$.[19] We can clearly see the strategy of RA1 is "u-shaped" in its reputation. Intuitively, the RA's strategy is determined by the trade-off between current fees and expected future income. When its reputation is very low, the RA's expected future income is very small compared to current fees, hence it has little incentive to behave honestly. When its reputation increases, the RA's future income becomes larger while current fees stay the same, the RA tends to lie less. However, when the RA's reputation is very high, the penalty for lying decreases, and the RA starts to lie more. The reason that the penalty for lying decreases with reputation is that investors attribute project failures

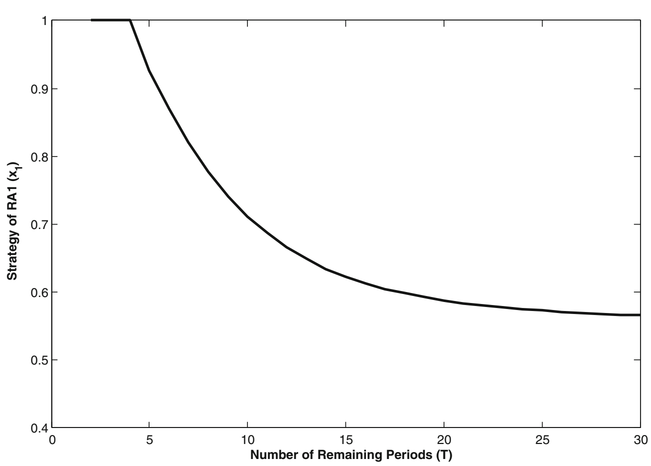
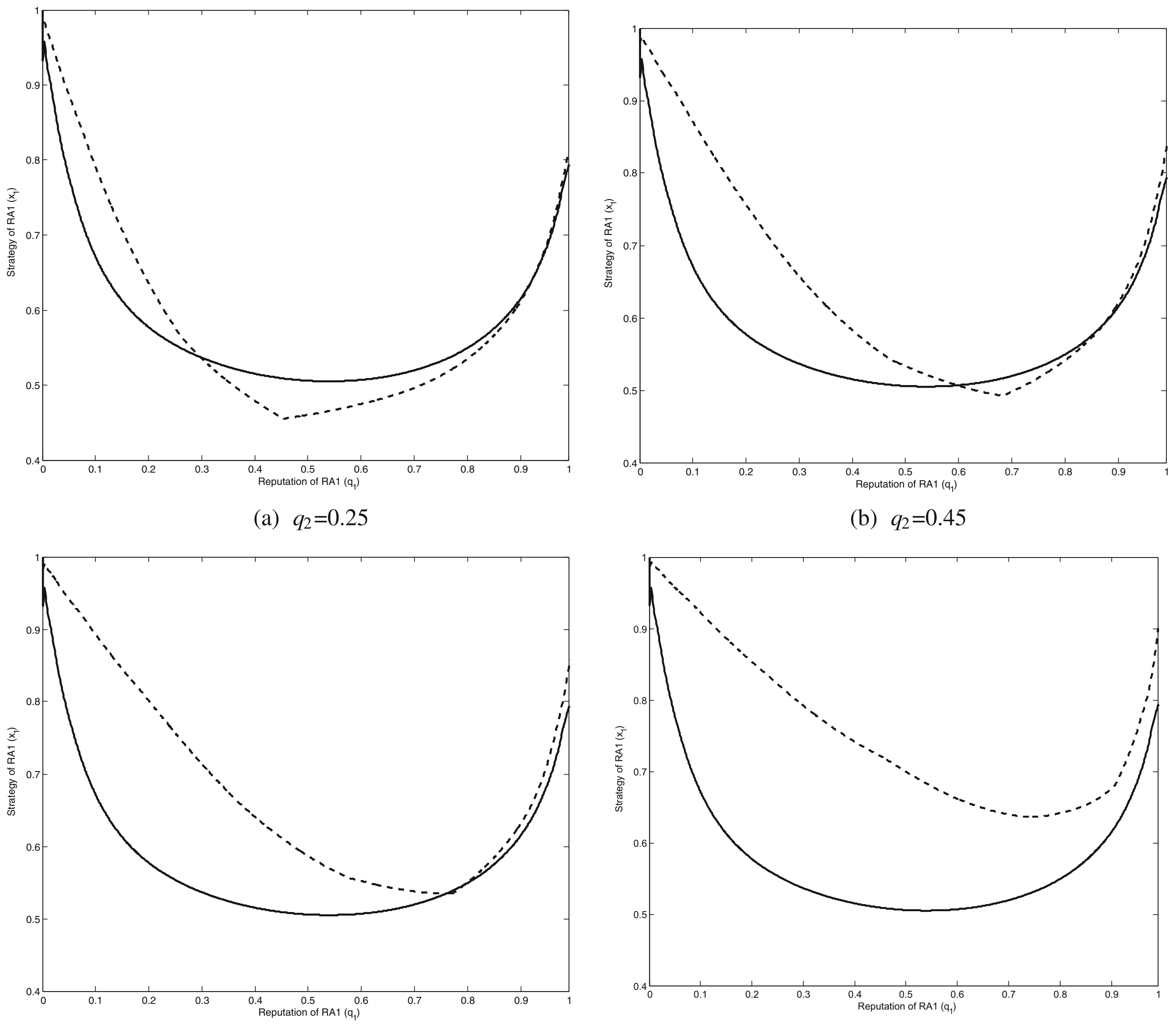


FIGURE 10 Convergence dynamics of RA1



(a) q_2=0.25

(b) q_2=0.45

(c) q_2=0.55

(d) q_2=0.75

FIGURE 11 Comparing monopolistic and competitive RA, (λ, p_G, δ) = (0.5, 0.7, 0.9). Solid line represents monopolistic RA, while dashed line represents competitive RA with different values of q_2

to bad luck rather than lax behaviour when they believe that the RA is very likely to be of the honest type.

Moreover, we can see from Figure 4 that the strategy of RA1 is increasing in λ but decreasing in p_G.[20] The intuition is that, the reputational penalty of lying depends on how the investors update their beliefs. If projects are more likely to be good (higher λ) or if good projects are more likely to fail (lower p_G), then a failure is more likely to be attributed to bad luck rather than lying. Anticipating this smaller cost of lying on reputation, the RA would choose to lie more when λ increases or p_G decreases.

5.2 | Competitive RA

We now look at the impact of competition on the behaviour of RA by introducing a second RA (RA2). Figure 5 plots the strategy of RA1 for parameter values (λ, p_G, δ) = (0.5, 0.7, 0.9). Figures 6 and 7 show cross sections of this figure, for different values of q_2 and q_1, respectively.

Figure 6 shows the relationship between the reputation and strategy of RA1 for different values of the competing RA2's reputation. As we can see, the relationship between the reputation and strategy of RA1 remains "u-shaped" as in the monopolistic case. Moreover, as the reputation of RA2 increases, the reputation at which RA1 has minimum x_1, that is, is least likely to lie, also increases. This is not surprising as the disciplining effect is greatest when the reputation of the competing RA (RA2) is close to the reputation of RA1. This is because when the RAs' reputations are close, it is more likely that the market leadership will change, resulting in more disciplined behaviour. Conversely, if the two RAs have very different reputations, the disciplining effect is relatively weaker.

Moreover, as Figure 7 shows, the strategy of RA1 is initially decreasing with or flat in RA2's reputation, and then increasing. This effect of competition is a combination of the disciplining effect and the market-sharing effect. The disciplining effect is strongest when the two RA's reputations are close, and weakest when the two RA's reputations are far apart, which implies that the probability of a change of market leader is very small. On the other hand, the market-sharing effect is always increasing in the competing RA's reputation. When the reputation of RA2 is low, the market-sharing effect is very small as RA2 can only take away a tiny fraction of market share. As RA2's reputation starts to increase, RA1 tends to lie less as the disciplining effect dominates the market-sharing effect. However, when RA2's reputation goes beyond a certain level, the market-sharing effect dominates as RA2's reputation becomes much higher than RA1's. Hence, RA1 will lie more for high values of RA2's reputation, due to the dominance of the market-sharing effect.

Figures 8 and 9 show the expected profits of RA1 as a function of RA1 and RA2's reputation. We can clearly see that the expected profits of RA1 are increasing in its own reputation, and decreasing in its competitor's reputation, illustrating the market-sharing effect.

Finally, Figure 10 shows the convergence dynamics. It plots the change in RA1's strategy as the number of periods remaining increases. Reputation becomes less and less important as the number of periods remaining declines since there are fewer periods to reap the benefits of higher reputation. Thus, rating inflation increases. Note that, as the number of periods remaining increases, the strategy converges, implying that we approach a long (infinite) horizon equilibrium.

In summary, our results show that introducing competition in the form of a second RA is not sufficient to discipline the RAs which always lie with positive probability in equilibrium. We now show that competition will actually increase the lax behaviour of RAs and reduce expected welfare.

5.3 | Comparing monopolistic and competitive RA

It is often suggested that introducing more competition in the ratings industry can alleviate the problem of improper incentives and rating inflation. However, our results show that competition is likely to worsen this situation and lead to more rating inflation.

Figure 11 compares the strategic behaviour of RA1 under no competition, that is, monopolistic RA ($q_2 = 0$), and under a competitive setting with different values of q_2. We observe that in most cases, RA1 is prone to greater rating inflation relative to the monopolistic RA.

As described before, the implication of competition can be divided into the market-sharing effect and the disciplining effect. We can see that the market-sharing effect dominates the disciplining effect (i.e., competition aggravates lax behaviour) in most cases. The only case where competition may actually alleviate the lax

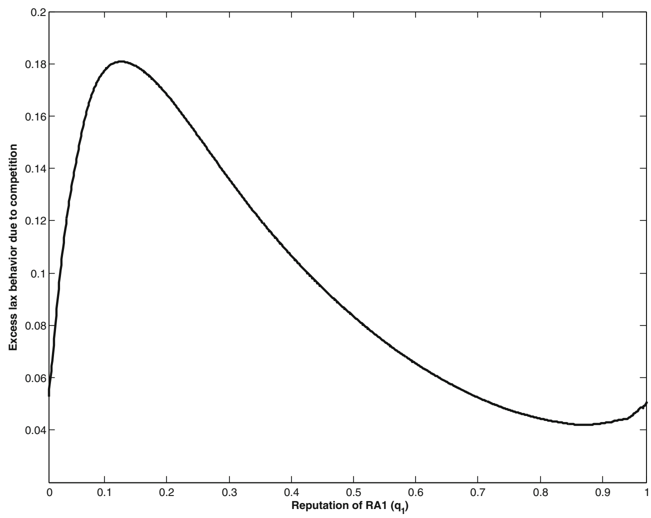


FIGURE 12 Excess lax behaviour of RA1 due to competition, $(\lambda, p_G, \delta) = (0.5, 0.7, 0.9)$

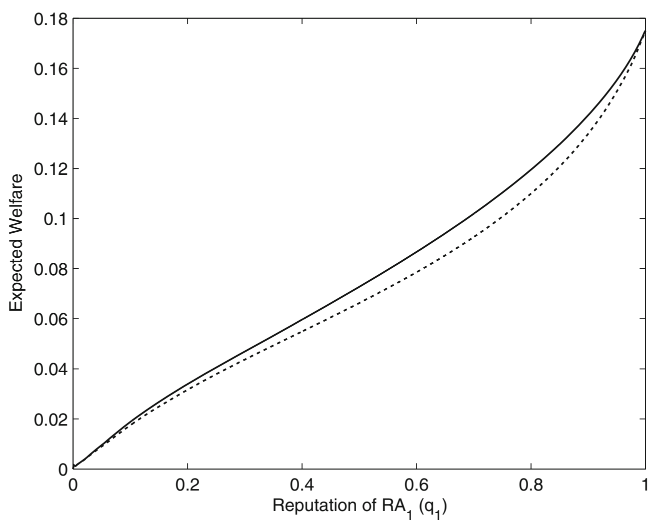


FIGURE 13 Variable fees, expected welfare—competitor has same reputation. Solid line represents monopoly, while dashed line represents duopoly with $q_1 = q_2$

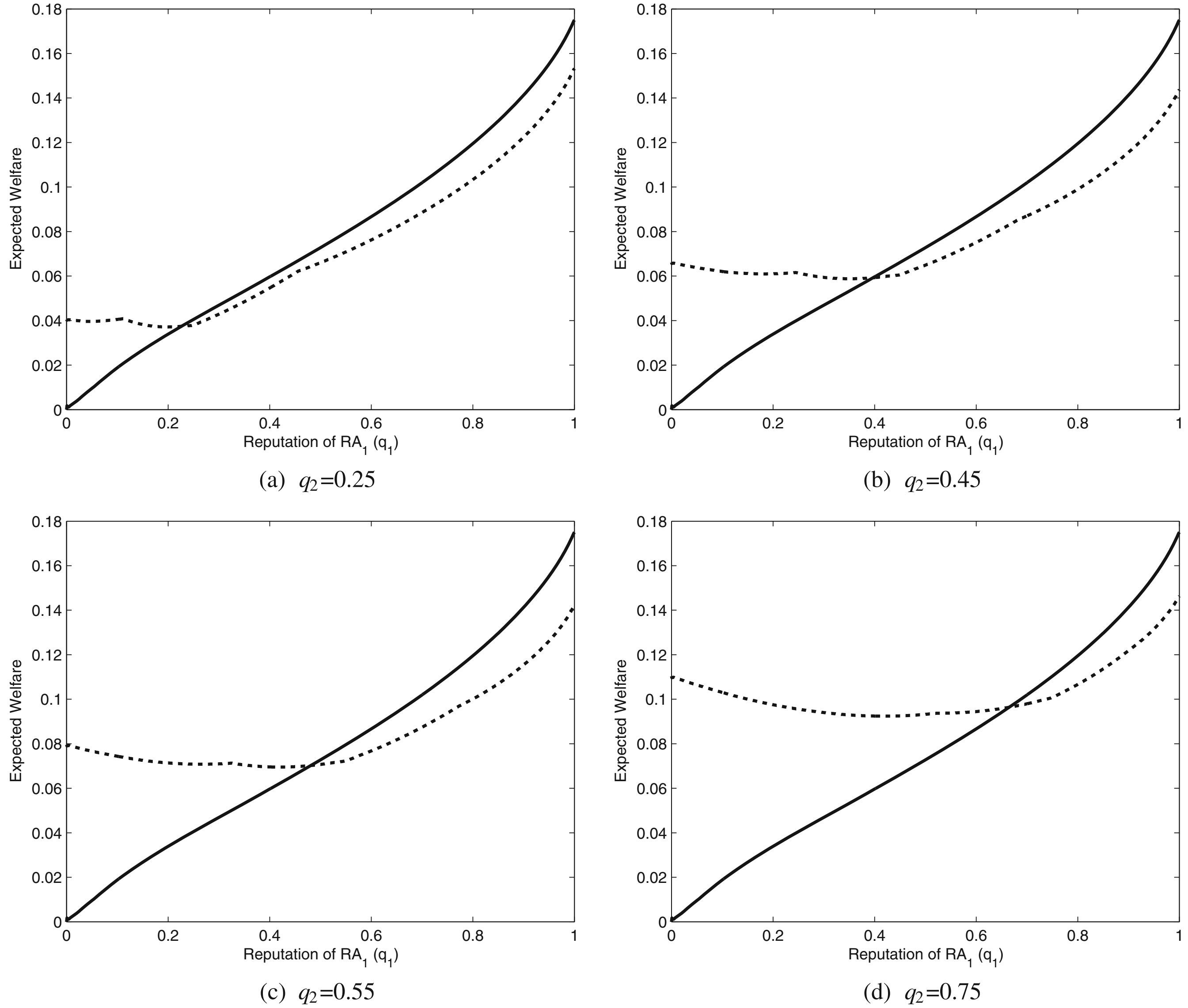


FIGURE 14 Variable fees, expected welfare—competitor has different reputations. Solid line represents monopoly, while dashed line represents duopoly for different values of q_2 $(\lambda, p_G, \delta) = (0.5, 0.7, 0.9)$

behaviour of RA1 is when q_2 is very low (as shown in Figure 10). This is because the market-sharing effect is weakest relative to the disciplining effect for low values of q_2. Intuitively, the disciplining effect only depends on the difference between q_1 and q_2; whereas, the market-sharing effect increases with the absolute level of q_2. Hence, the market-sharing effect tends to dominate the disciplining effect except for low values of q_2.

In order to assess the overall impact of competition, we compute the expected increase in lax behaviour of RA1 given its own reputation, assuming that the reputation of RA2 is uniformly distributed on [0, 1]. A positive value of this measure means the overall effect of enhanced competition on RA1 is to lie more (i.e., inflate ratings more).

$$\text{Excess Lax behavior of RA1} = \int_{q_2 \in [0,1]} x_1(q_1, q_2)\, dq_2 - x_1(q_1, 0) \tag{12}$$

As shown in Figure 12, the expected increase in lax behaviour of RA1 is always positive, indicating that competition will, in general, aggravate rating inflation. This is because a smaller market share will tend to reduce the reputational concerns of the RAs, and this market-sharing effect outweighs the disciplining effect brought by competition. Moreover, we can see that the expected increase in lax behaviour is increasing for low values of RA1's own reputation and decreasing for high values of RA1's reputation. The intuition is that, when the reputation of RA1 is low, the market share of RA1 is going to

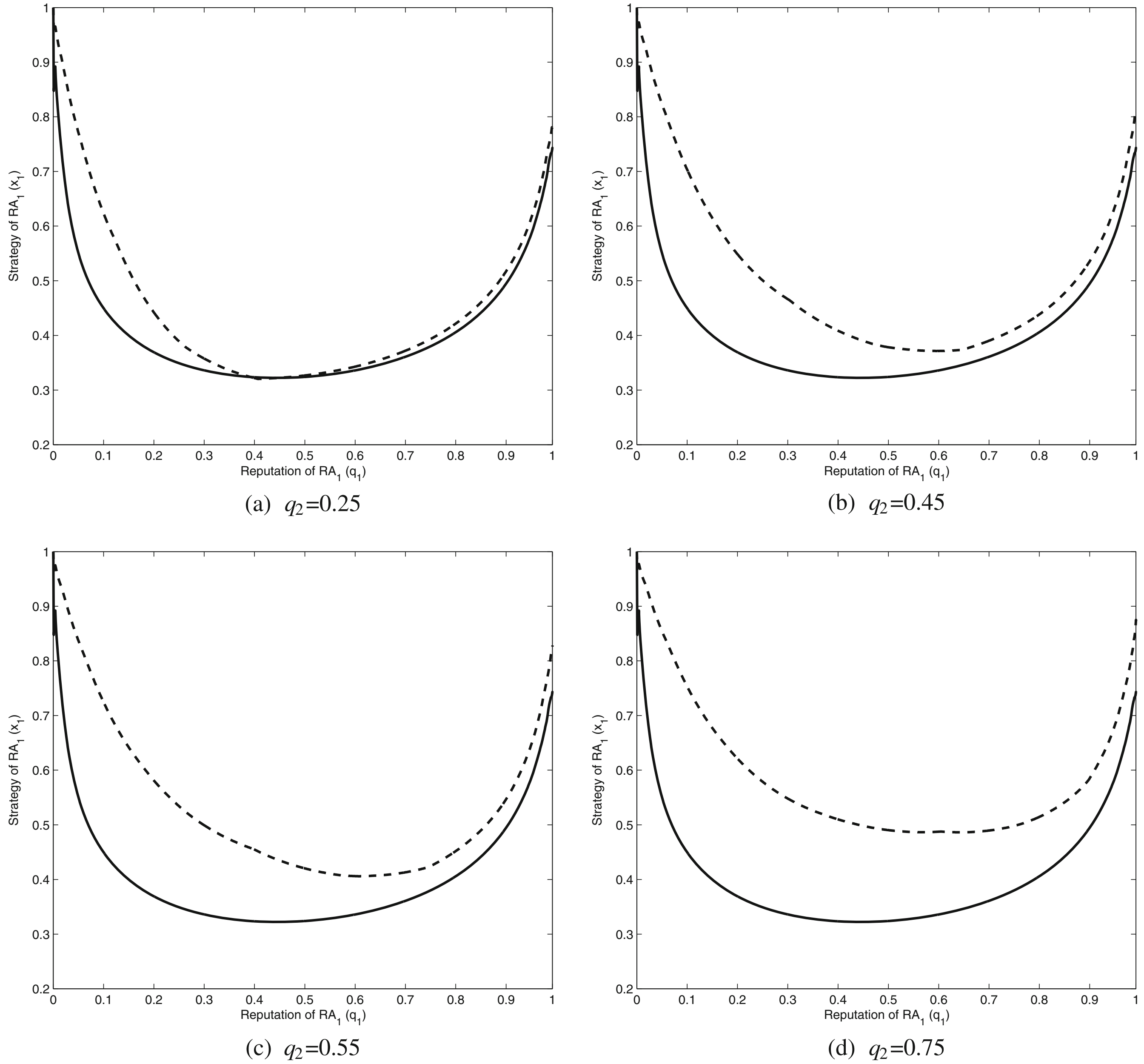


FIGURE 15 Variable fees, comparing monopolistic and competitive RA, $(\lambda, p_G, \delta) = (0.5, 0.7, 0.9)$. Solid line represents monopolistic RA, while dashed line represents competitive RA with different values of q_2

shrink significantly after introducing RA2 and the market-sharing effect of competition is strongest. However, when the reputation of RA1 is high, the impact of introducing RA2 on RA1's market share is small, hence the market-sharing effect becomes weaker and RA1 will lie relatively less. We verify that the excess lax behaviour, as defined above, is always positive for other values of λ and p_G in Appendix B.1, Figures 17 and 18.

In addition, we measure the expected total welfare in both monopolistic and duopolistic settings as defined below.

$$\begin{aligned}\text{Expected Total Welfare} &= E(\text{Project Payoff}) - E(\text{Financing Cost})\\ &= P(\text{RA1 rates})(\lambda p_G \phi - E(X)(\lambda + (1-\lambda)(1-q_1)x_1))\\ &\quad + P(\text{RA2 ates})(\lambda p_G \phi - E(X)(\lambda + (1-\lambda)(1-q_2)x_2))\end{aligned}$$

Figure 13 compares the total welfare between the monopolistic case and the duopolistic case where both RAs have the same reputation.[21] We can see that if a new RA is introduced with the same reputation as the incumbent RA, then the total welfare will always decrease, due to the fact that both RAs are more likely to inflate ratings.

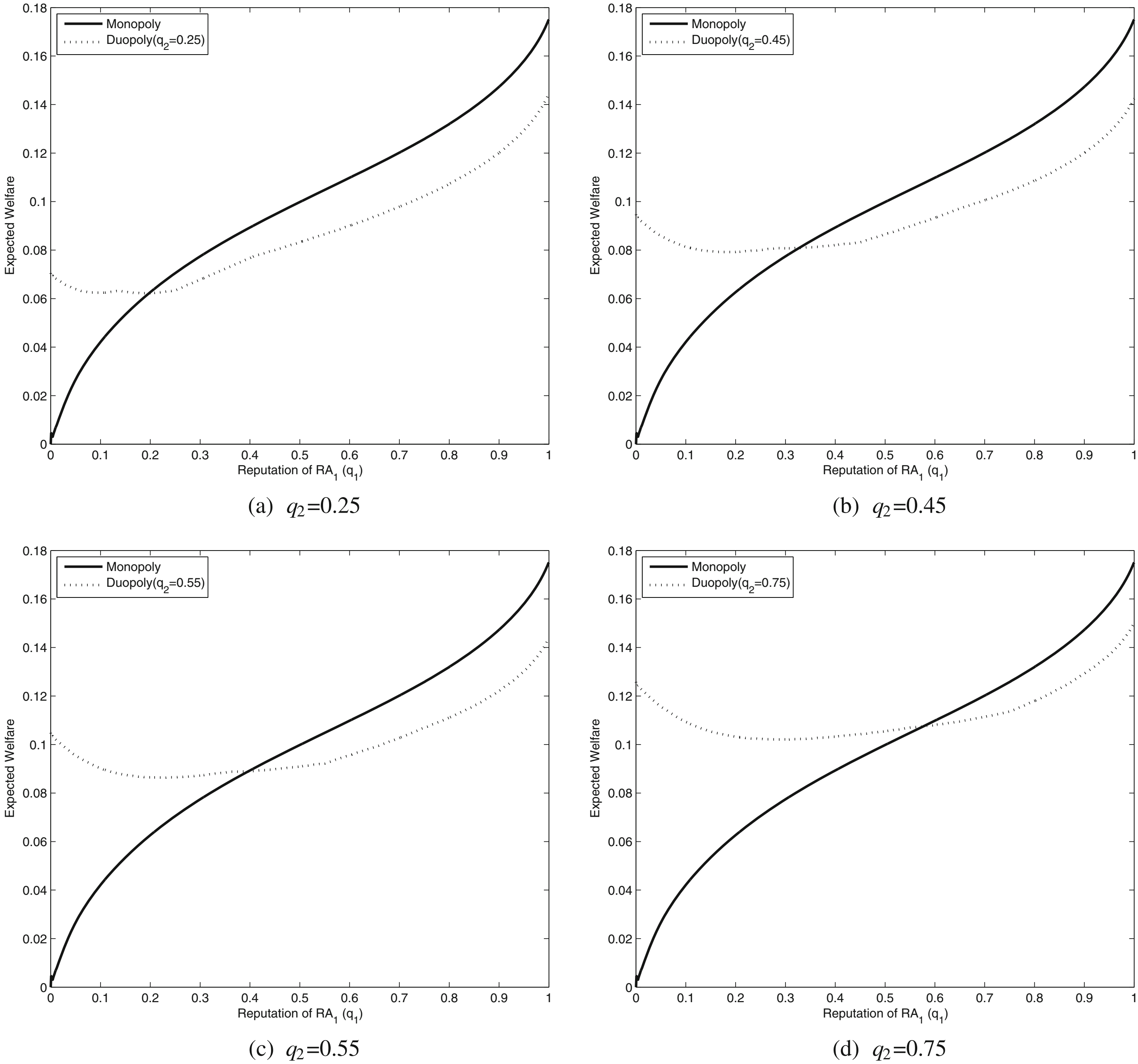


FIGURE 16 Variable fees, expected welfare—competitor has different reputations. Solid line represents monopoly, while dashed line represents duopoly for different values of q_2 ($\lambda = 0.5$, $p_G = 0.7$, $\delta = 0.9$)

Moreover, when we compare in Figure 14, the expected total welfare between the monopolistic case and the duopolistic case with fixed values of reputations of RA2, we can see that introducing competition will always lead to lower total welfare as long as the reputation of RA2 is lower than the reputation of RA1. However, total welfare may increase if the entrant RA has a higher reputation than the incumbent. Overall, this implies that competition is likely to adversely impact total welfare, unless we can introduce a new RA with much higher reputation than the incumbent. We check the robustness of this result for different values of λ and p_G in Appendix B.2.

5.4 | Variable fees

Instead of fixed fees $I(q) = I < p_G(1-\lambda)\phi$, we assume that (i) $\phi > \frac{1}{p_G(1-\lambda)}$ and that (ii) fees are linearly increasing in reputation as in[22]

$$I(q) = \frac{1}{2} + \frac{1}{2} \cdot q$$

The effect of allowing for variable fees is not obvious *ex-ante*: on one hand, rating inflation should decrease as reputation has more value than in the fixed fees case; on the other hand, a low reputation rating agency earns less than in the fixed fees case which in turn decreases the cost of inflating ratings.

We re-run all the numerical solutions previously implemented for the fixed fees case and we find that the two effects explained above seem to balance each other and that our results are mainly robust to introducing variable fees, as we can see in the plots below.[23]

The only slight difference we see by comparing Figures 11 and 15 is that the introduction of variable fees renders the disciplining effect of competition weaker: if in the fixed fees case, there are some pair of reputations (q_1, q_2) for which rating inflation decreases with competition, this is almost not the case in the variable fees case.

On the other hand, the welfare measure of net expected profit of projects that get financing, as seen in Figures 14 and 16, is largely robust to the introduction of variable fees: we can only see an increase in the expected welfare due to competition if the new entrant has a higher reputation than the incumbent.

6 | CONCLUSION

In this paper, we show that competition can amplify rating inflation and the lax behaviour of RA, reducing total welfare. This result has important policy implications since it suggests that the most often cited solution to rating inflation—enhanced competition in the ratings industry—might render the situation worse. While we acknowledge that in order to focus on the implications of competition in the credit ratings industry, we have abstracted from other important issues such as herd behaviour, multiple ratings and the quality of the models used by RA, we believe that our results can serve as a baseline for evaluating the reform proposals currently being discussed.

One of the key thrusts of recent regulatory action in the credit ratings space has been to relax barriers to entry and enhance competition. In the United States, the Securities and Exchange Commission has relaxed some barriers to entry and allowed several new CRAs in the US to obtain the Nationally Recognized Statistical Rating Organization (NRSRO) status. The European Union (EU) has gone further and has introduced new requirements as part of the proposed amendments to the EU Regulation on credit RA, the so called "CRA-III." The new legislation seeks to place a cap on the market share of each rating agency and requires issuers to rotate credit RA periodically (see European Commission (2011) for details).

In the context of our model, the cap on the market share of RA is likely to incentivize RAs to inflate ratings when their market share is close to the cap since they would no longer benefit from higher reputation. Furthermore, proposals to rotate RAs would mean that RAs would be assured of a market share, irrespective of their reputation. This would break the link between reputation and future income, thereby increasing rating inflation. More broadly, proposals aimed at artificially enhancing competition are likely to exacerbate the market sharing effect, while doing little to increase the discipling effect.

One of the key findings in our model is that unless the new entrant RA has a higher reputation than the incumbent, increased competition is likely to adversely impact total welfare. However, it is unlikely that a new entrant would have sufficiently high reputation (and hence market share) to challenge the incumbents. It is more plausible to believe that the new entrants would start off as marginal players. Moreover, it is likely that under the current issuer pay model, they will continue to remain marginal players as their low reputation (and associated-market share) would incentivize them to inflate ratings more than the established RAs. Interestingly, Kisgen and Strahan (2010) show evidence that ratings issued by Dominion Bond Rating Service (DBRS), a relatively new player in the European market, are significantly more lenient than those issued by the more established players.

In conjunction with related work on multiple ratings and herd behaviour in the credit ratings industry, our results suggest that a fundamental reorganization of the industry may be required to align the incentives. The conflict of interest highlighted in our paper is fundamental to the issuer-pay model and any meaningful attempt to resolve the conflict would require a fundamental shift in the way RA are compensated. Empirical work by Xia and Strobl (2012) suggests that investor paid RAs can be a solution as they are unlikely to be affected by the conflict of interest highlighted in this paper and can have a discipling effect on the incumbent RAs. However, while an investor pay RAs can be a solution, free riding on the part of investors could result in insufficient revenues for such RAs, making it difficult for them to compete with the incumbents. Deb and Murphy (2009) argue that although free riding is a problem, the increasing use of ratings by institutions, coupled with the rise in the speed of information diffusion in the markets over the last few decades could, with proper regulatory encouragement, ensure that there are investors willing to subscribe to ratings issued by investor pay RAs.

DATA AVAILABILITY STATEMENT
Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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ENDNOTES

[1] According to Benmelech and Dlugosz (2010), one-third of the tranches of structured finance products downgraded by Moody's in 2007 and 2008 bore the maximum AAA rating. For a model in which rating agencies understate risk in structured products, see Black and Gervais (2009).

[2] See He, Qian, and Strahan (2011), Covitz and Harrison (2003) and Cantor and Packer (1995).

[3] See "New York Times: Finance Ministers Clear Way for Credit Rating Competition in Europe," in http://www.nytimes.com/2012/04/01/business/european-finance-ministers-clear-way-for-credit-rating-competition.html?_r=0.

[4] See also Skreta and Veldkamp (2009) for a model of ratings shopping with asset complexity.

[5] Bar-Isaac and Shapiro (2013) also consider competition as a robustness check to their model that analyzes labour-market conditions, but ours is more general than theirs: while they use a grimmer-trigger strategy equilibrium in which a rating agency that gives a good rating to a project that subsequently defaults is out of the market, in our paper such a situation would have a lesser impact of a reputation loss and the rating agency would not shut its doors as a consequence to a single mistake.

[6] The figure stands at 95% if we include the third major player, Fitch.

[7] Issuers cannot deceive rating agencies. For a model in which issuers misreport the quality of the project, see Cohn, Rajan, and Strobl (2013).

[8] As we assume that issuers are paid only if projects succeed, they are indifferent between rating agencies with different but high enough reputation.

[9] Although we only focus on competition in a duopolistic setting, our results intuitively extend to situations with higher degrees of competition.

[10] *New Issuer* implies that it is a one shot game for the issuer and we rule out the possibility that issuers try to maximize profits over multiple periods. This assumption also ensures that issuers have the same belief as the investors about the reputation of the RAs. If we allow the same issuers to approach the rating agencies in subsequent periods, then issuers will have more information than investors.

[11] This is a standard simplifying assumption in the literature. We generalize for variable fees later in the paper.

[12] In order to guarantee that the issuer would not approach the rating agency unless its good rating is necessary for financing, we need that the unconditional payoff $\lambda p_G \phi - X$ be lower than the expected ex-ante payoff conditional on the project being good $\lambda(p_G \phi - X - I)$, which is equivalent to $I < a\frac{1-\lambda}{\lambda} = p_G \phi(1-\lambda)$, if we consider that $a = \lambda p_G \phi$ is the lower bound for X.

[13] New York Times Magazine, Triple-A-Failure, April 27, 2008.

[14] Given the structure of the market, with Moody's and S&P controlling nearly 80% of the market, we believe that this is a reasonable approximation of reality.

[15] Note that in equilibrium the strategic RA will always issue GR to a good project (see Section 3).

[16] We assume that the issuers are only paid when projects succeed. This implies that the issuers will be indifferent between RAs (with different reputation) given that both can guarantee financing.

[17] Note that this is one of infinite many possible equilibria. Since the issuers are indifferent, we have an equilibrium for all probabilities ($\alpha \in (0, 1)$) of approaching a specific RA. We focus on the case where $\alpha = \frac{1}{2}$. Our qualitative results do not depend on the choice of α.

[18] Our results in Section 5 show that this is no longer true if $p_G < 1$. The penalty on reputation will be smaller as the reputation of RA increases, that is, the cost of rating inflation can decrease with reputation, resulting in a "u-shaped" relationship between strategy and reputation.

[19] Note that, we have chosen this set of parameters $(\lambda, p_G, \delta) = (0.5, 0.7, 0.9)$ for the purpose of illustration only, and verified that our results are robust to other parameter specifications, the plot of which are available upon request. In particular, robustness checks of the main results (Section 5.3) are presented in Appendix B.

[20] We have also verified that this result holds in the case of competitive RAs, the plots of which are available upon request.

[21] We are computing the welfare in one period only because it does not depend on time.

[22] In order to still guarantee that the issuer would not approach the rating agency unless its good rating is necessary for financing, we still need that $I < p_G(1-\lambda)\phi$ or that $I(1) < p_G(1-\lambda)\phi$ for an increasing linear function, which is equivalent to $I(1) = 1 < p_G(1-\lambda)\phi$.

[23] Other plots for the variable fees case are available on request.

[24] That is, A is real and less than B.

[25] That is, A is real and greater than B.

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How to cite this article: Camanho N, Deb P, Liu Z. Credit rating and competition. *Int J Fin Econ*. 2022;27:2873–2897. https://doi.org/10.1002/ijfe.2303

APPENDIX A: Proofs

Proof of Proposition 1

There exists a unique x_1, where $0 \leq x_1 \leq 1$, given that $V_t(q_1, q_2)$ is an increasing function in q_1.

Proof When the strategic RA (RA1) gets a bad project, it will get pay-off $\Psi(lie) = I + \delta V_t\left(q_1^F, q_2\right)$ if it gives the project a GR, and $\Psi(honest) = \delta V_t\left(q_1^N, q_2\right)$ if it refuses rating. Note that $q_1^F = \frac{\lambda(1-p_G)q_t}{\lambda(1-p_G)+(1-\lambda)(1-q_1)x_1}$ and $q_1^N = \frac{q_t}{1-x_1(1-q_t)}$, that is, q_1^F is decreasing in x_1 and q_1^N is increasing in x_1. Given that $V_t(q_1, q_2)$ is increasing in q_1, it is easy to see that $\Psi(lie)$ is decreasing in x_1 and that $\Psi(honest)$ is increasing in x_1. Thus, if we define x_1 such that

- $x_1 = 1$ if $\Psi(lie) \geq \Psi(honest)$

- $x_1 = 0$ if $\Psi(lie) \le \Psi(honest)$ for
- $x_1 = x_1^*$ such that $0 < x_1^* < 1$ if $\Psi(lie) = \Psi(honest)$

it follows that x_1 is well-defined and unique.

Proof of Proposition 2
The strategic RA does not have incentives to give NR to a good project.

Proof Suppose that the strategic RA (RA1) gets a good project and that its strategy is x_1. Let us examine whether RA1 wants to deviate:

- if $x_1 = 1$, we have $\Psi(lie) \ge \Psi(honest)$, or $I + \delta V_t(q_1^F, q_2) \ge \delta V_t(q_1^N, q_2)$. If the RA1 gives NR to the good project, it will get $\delta V_t(q_1^N, q_2)$ and $I + p_G \delta V_t(q_1, q_2) + (1-p_G)\delta V_t(q_1^F, q_2)$ otherwise. Since $I + p_G \delta V_t(q_1, q_2) + (1-p_G)\delta V_t(q_1^F, q_2) \ge I + \delta V_t(q_1^F, q_2) \ge \delta V_t(q_1^N, q_2)$, RA1 does not want to deviate.
- if $x_1 = 0$, $q_1^N = q_1^F = q_1$, hence reputation becomes irrelevant and the RA does not have an incentive to give NR to the good project.
- if $0 < x_1 < 1$, we have $\Psi(lie) = \Psi(honest)$, so $I + p_G \delta V_t(q_1, q_2) + (1-p_G)\delta V_t(q_1^F, q_2) \ge I + \delta V_t(q_1^F, q_2) = \delta V_t(q_1^N, q_2)$, and hence RA1 does not want to deviate.

Therefore, RA1 does not have incentives to give NR to a good project.

Proof of Corollary 1
Assume $p_G < 1$. Then the equilibrium strategy of the strategic RA is always positive.

Proof Suppose that the equilibrium strategy is $x_1 = 0$. Then $q_1^N = q_1^F = q_1$ and we must have $I + \delta V_t(q_1, q_2) \le \delta V_t(q_1, q_2)$. This is impossible as long as $I > 0$. Hence, $x_1 = 0$ cannot be an equilibrium strategy.

Proof of Corollary 2
Suppose the model ends in period T. Then the equilibrium strategy of the strategic RA is $x_t = 1$ at $t = T-1, T$.

Proof At $t = T$, the strategic RA does not have any reputational concerns. This implies that the strategy of strategic RA will be to always give GR if the project is bad, that is, $x_T = 1$.

Similarly, at $t = T-1$, the strategic RA will always lie. Suppose that a bad project comes to strategic RA, say RA1. The expected pay-off of RA1 is

$$I + \delta V_{T-1}(q_1^F, q_2) = I + f(q_1^F, 1, q_2, 1)\delta I \tag{13}$$

if it lies, that is, gives a GR, and

$$\delta V_{T-1}(q_1^N, q_2) = f(q_1^N, 1, q_2, 1)\delta I \tag{14}$$

if it does not lie, that is, gives NR, where $f(q_1, x_1, q_2, x_2)$ is the probability that the project comes to RA1 in the next period. Using Equations (5)–(7), we have

$$f(q_1, x_1, q_2, x_2) = \frac{\frac{1}{2}(s(q_1, x_1) - \lambda p_G)}{p_G(1-\lambda)} \text{ if } s(q_1, x_1) \le s(q_2, x_2)$$

$$f(q_1, x_1, q_2, x_2) = \frac{s(q_1, x_1) - \frac{1}{2}(s(q_2, x_2) + \lambda p_G)}{p_G(1-\lambda)} \text{ otherwise}$$

where $s(q, x) = \frac{\lambda p_G}{\lambda + (1-q)(1-\lambda)x}$.

Although in this case RA1 does have reputational concerns, these are not sufficient to prevent RA1 from being lax and not giving GR to bad projects. Since by being honest RA1 is giving up I today, in exchange for having a higher chance of getting I in the next period, it is not optimal for RA1 to be honest, given that RA1 is impatient (i.e., $\delta < 1$). Hence, the optimal strategy of RA1 is to always lie, that is, $x_{T-1} = 1$.

Proof of Proposition 4
The equilibrium strategy at $t = 1$ assuming $p_G = 1$ and $\delta = 1$ is

$$x_1 = \begin{cases} 0 & \text{if } A \le \dfrac{\lambda q_1}{2(\lambda q_1 + (1-q_1))} \\ 1 - \dfrac{(1-2A)\lambda q_1}{2A(1-q_1)} & \text{if } \dfrac{\lambda q_1}{2(\lambda q_1 + (1-q_1))} < A < \dfrac{1}{2} \\ 1 & \text{if } A \ge \dfrac{1}{2} \end{cases}$$

where A is the solution to the equation

$$\Psi(lie)-\Psi(honest)=I-\delta(2A-\min\{A,B\})$$
$$I-\delta^2\left(\lambda(2A-\min\{A,B\})^2+\right.$$
$$((2B-\min\{A,B\})$$
$$[\lambda(2A-\min\{A,B\})+2(1-\lambda)(1-q_2)A+(1-\lambda)q_2A])I=0$$

and $B=\frac{\frac{1}{2}(s(q_2,1)-\lambda p_G)}{p_G(1-\lambda)}$.

In addition, x_1 *is decreasing in* q_1. *Moreover,* x_1 *is increasing in* q_2.

Proof Since $p_G=1$, the reputation of RA1 (i.e., the strategic RA) will go to zero if it gives a GR to a bad project since now every good project succeeds and every bad project fails. So the expected pay-off from giving a GR to a bad project is I. This simplifies expressions (9) and (10) and allows us to derive RA1's equilibrium strategy.

The expected pay-off from being honest is

$$\Psi(honest)=\delta f\left(q_1^N,1,q_2,1\right)I+\delta^2\left(f\left(q_1^N,1,q_2,1\right)\lambda f(q_1^N,1,q_2,1)+f\left(q_2,1,q_1^N,1\right),\right.$$

$$[,\lambda f,(,q_1^N,1,q_2,1)+(1-\lambda)(1-q_2)f(q_1^N,1,q_2^F,1)$$

$$+(1-\lambda)q_2 f(q_1^N,1,q_2^N,1)])I$$

Using Equations (6) and (7) and noting that RA1 will always lie in periods t = 2, 3, this can be rewritten as

$$\Psi(honest)=\delta(2A-\min\{A,B\})I+\delta^2\left(\lambda(2A-\min\{A,B\})^2+(2B-\min\{A,B\})[\lambda(2A-\min\{A,B\})+2(1-\lambda)(1-q_2)A\right.$$

$$+(1-\lambda)q_2A])I$$

where $A=\frac{\frac{1}{2}\left(s\left(q_1^N,1\right)-\lambda p_G\right)}{p_G(1-\lambda)}$ and $B=\frac{\frac{1}{2}(s(q_2,1)-\lambda p_G)}{p_G(1-\lambda)}$.

The expected pay-off from lying is I, since the RA's reputation goes to zero

$$\Psi(lie)=I$$

We look for an equilibrium of the game by examining RA1's trade-off between lying and not lying. If the pay-off from lying is greater when $x_1=1$, we have a pure-strategy equilibrium in which RA1 always lies; if the pay-off from not lying is greater when $x_1=0$, we have a pure-strategy equilibrium in which RA1 never lies; otherwise we have a mixed-strategy equilibrium in which RA1 is indifferent between lying or not given some prior beliefs about its strategy, that is, $0<x_1<1$.

We now solve the equation $\Psi(lie)-\Psi(honest)=0$. We do this in two stages. In the first stage, we solve the equation in terms of A and then using the expression for A, we solve for the equilibrium value of x_1.

For $A<B$ we have

$$\Psi(lie)-\Psi(honest)=\delta^2(1-\lambda)(2-q_2)A^2-\left(\delta+2B\delta^2\lambda+2B\delta^2(1-\lambda)(2-q_2)\right)A+1$$

Assuming $\delta=1$, the solution is

$$A=B+\frac{1+2B\lambda-\sqrt{(1+2B\lambda)^2+(1-\lambda)(2-q_2)\rho}}{2(1-\lambda)(2-q_2)}$$

which is valid as long as $\rho=B^2(2-(1-\lambda)q_2)+B-1>0$.[24]

Note that B can be simplified to

$$B=\frac{\lambda q_2}{2(1-q_2(1-\lambda))}$$

We can see that B is bounded above by $\frac{1}{2}$. Therefore, $\rho\le 0$ and we can rule out the case above.

Now for $A\ge B$, we have

$$\Psi(lie)-\Psi(honest)=-4\delta^2\lambda A^2-\left(2\delta-2B\delta^2\lambda+B\delta^2(1-\lambda)(2-q_2)\right)A+\delta B+1$$

Assuming $\delta=1$, the solution is

$$A=B+\frac{\sqrt{(2+6\lambda B+B(1-\lambda)(2-q_2))^2-16\lambda\rho}-(2+6\lambda B+B(1-\lambda)(2-q_2))}{8\lambda}$$

which is valid given $\rho = B^2(2-(1-\lambda)q_2) + B - 1 \leq 0$.[25]

Note that A can also be expressed as

$$A = \frac{\sqrt{(2-2\lambda B + B(1-\lambda)(2-q_2))^2 + 16\lambda(B+1)} - (2-2\lambda B + B(1-\lambda)(2-q_2))}{8\lambda}$$

It can be shown that

$$\frac{d}{dx}\left(\sqrt{f(x)^2+g(x)}-f(x)\right)>0$$

provided that

$$f'(x)<0$$

and

$$g'(x)>0.$$

Therefore, we have

$$\frac{dA}{dq_2}>0$$

given that

$$\frac{dB}{dq_2}>0$$

and

$$\lambda>\frac{1}{2}$$

and thus

$$\frac{d}{dq_2}(2-2\lambda B+B(1-\lambda)(2-q_2))<0.$$

Therefore, A is increasing in q_2.

Now, we have shown that there always exists a solution which depends on the parameter ρ. Since A always has a solution, we can use it to find the equilibrium strategy x_1 in terms of A, that is, we will look for the value of x_1 such that $\frac{\frac{1}{2}\left(s\left(q_1^N,1\right)-\lambda p_G\right)}{p_G(1-\lambda)}=A$.

Note that assuming $p_G = 1$ implies $\lambda p_G = \lambda$. Using this and Equation (5), the above expression can be rewritten as $\frac{\lambda q_1^N}{\lambda q_1^N+1-q_1^N}=2A$, where $q_1^N = \frac{q_1}{1-(1-q_1)x_1}$.

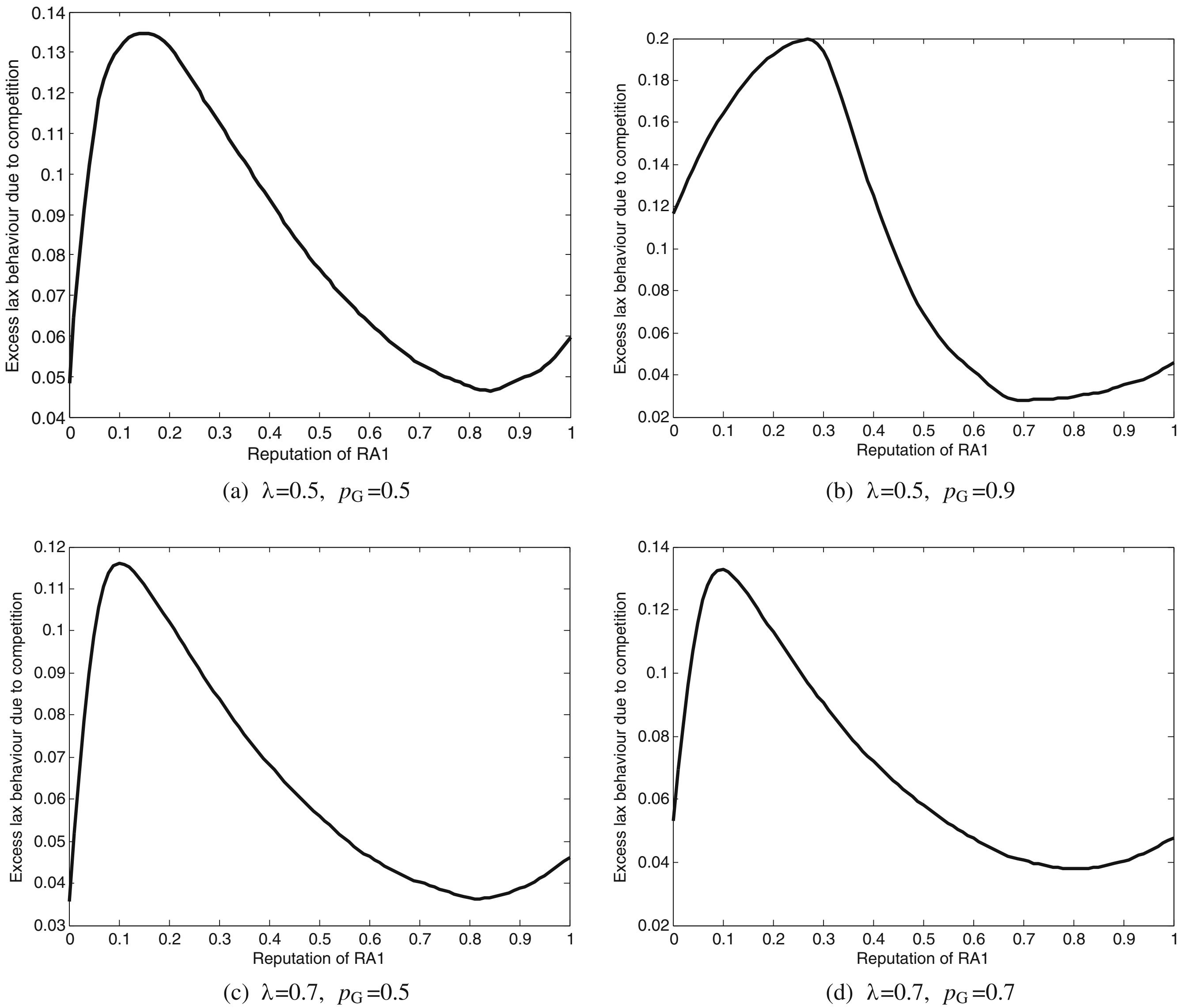
Solving, we obtain

$$x_1 = 1-\frac{(1-2A)\lambda q_1}{2A(1-q_1)}$$

for $0 < x_1 < 1$. This holds when $\frac{\lambda q_1}{2(\lambda q_1+(1-q_1))}<A<\frac{1}{2}$. Clearly, we have x_1 increasing in A and decreasing in q_1.

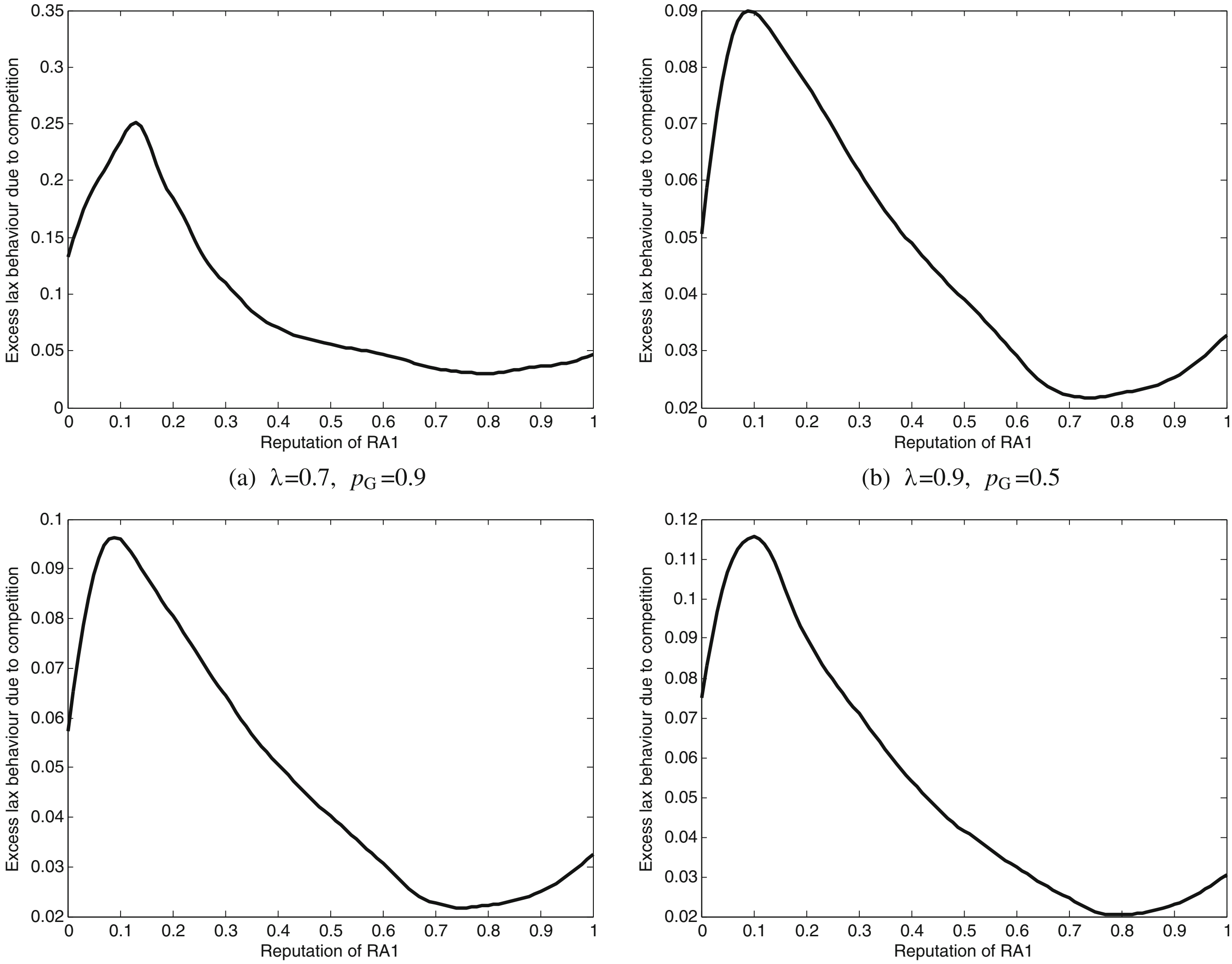
APPENDIX B.: Robustness check

B.1 Excess lax behaviour



(a) λ=0.5, p_G=0.5 (b) λ=0.5, p_G=0.9 (c) λ=0.7, p_G=0.5 (d) λ=0.7, p_G=0.7

FIGURE 17 Excess lax behaviour for different values of λ and p_G ($\delta = 0.9$)



(a) λ=0.7, p_G=0.9

(b) λ=0.9, p_G=0.5

(c) λ=0.9, p_G=0.7

(d) λ=0.9, p_G=0.9

FIGURE 18 Excess lax behaviour for different values of λ and p_G (continued)

B.2 Expected total welfare

The reputation of RA1 (q_1) above which the expected total welfare is always greater in the monopoly case than in the duopoly case, for different values of q_2 ($\delta = 0.9$)

Parameter values	$q_2 = 0.25$	$q_2 = 0.45$	$q_2 = 0.55$	$q_2 = 0.75$
$\lambda = 0.5$, $p_G = 0.5$	$q_1 = 0.23$	$q_1 = 0.45$	$q_1 = 0.52$	$q_1 = 0.69$
$\lambda = 0.5$, $p_G = 0.7$	$q_1 = 0.23$	$q_1 = 0.45$	$q_1 = 0.52$	$q_1 = 0.69$
$\lambda = 0.5$, $p_G = 0.9$	$q_1 = 0.23$	$q_1 = 0.45$	$q_1 = 0.52$	$q_1 = 0.69$
$\lambda = 0.7$, $p_G = 0.5$	$q_1 = 0.15$	$q_1 = 0.45$	$q_1 = 0.51$	$q_1 = 0.67$
$\lambda = 0.7$, $p_G = 0.7$	$q_1 = 0.15$	$q_1 = 0.45$	$q_1 = 0.51$	$q_1 = 0.67$
$\lambda = 0.7$, $p_G = 0.9$	$q_1 = 0.15$	$q_1 = 0.45$	$q_1 = 0.51$	$q_1 = 0.67$
$\lambda = 0.9$, $p_G = 0.5$	$q_1 = 0.13$	$q_1 = 0.45$	$q_1 = 0.51$	$q_1 = 0.66$
$\lambda = 0.9$, $p_G = 0.7$	$q_1 = 0.13$	$q_1 = 0.45$	$q_1 = 0.51$	$q_1 = 0.66$
$\lambda = 0.9$, $p_G = 0.9$	$q_1 = 0.13$	$q_1 = 0.45$	$q_1 = 0.51$	$q_1 = 0.66$