Does competition improve ratings?

Neil A. Doherty[*] Anastasia Kartasheva[†] Richard D. Phillips[‡]

September 13, 2007

Abstract

The paper analyzes how entry of a new rating agency changes the information content of ratings. In the first part of the paper we build a model to analyze the optimal disclosure policy of a monopoly rating agency depending on the value of information to the buyers, and then describe the potential market and the strategy of the entrant. Also we study how the entry affects the rating system of the incumbent and the overall amount of information disclosed to the market. In the second part of the paper we empirically test the qualitative predictions of the model. Standard and Poor's entry to the insurance market that was previously covered by a monopoly agency, A.M. Best, is used as a natural experiment to study the impact of competition on the information content of ratings.

Keywords: rating agency, precision and disclosure of information, rating system, competition.

JEL Codes: D8, G22, G28, L1, L43

[*]Insurance and Risk Management Department, Wharton School of the University of Pennsylavania, doherty@wharton.upenn.edu

[†]*Corresponding author.* Insurance and Risk Management Department, Wharton School of the University of Pennsylavania, karta@wharton.upenn.edu

[‡]Department of Risk Management and Insurance, Robinson College of Business, Georgia State University. rphillips@gsu.edu.

1 Introduction

Financial regulation has made increasing use of external credit ratings in recent years. In the United States, Securities and Exchange Commission (SEC) uses the term "Nationally Recognized Statistical Rating Organization" (NRSRO) to determine the agencies whose investment grade ratings allow for favorable regulatory treatment. However, the NRSROs themselves are not subject to substantive monitoring and there is little guidance on the designation of the NRSRO status.

Most agree that the barriers to building a successful rating agency that rates a large number of issues and is widely relied upon by market participants are substantial, and the industry has distinct natural monopoly features. However, the current (absence of) designation process further increases the barriers to entry. Recently the U.S. House of Representatives discussed the "Credit Rating Agency Duopoly Relief Act of 2006" that aimed to substantially simplify the process of obtaining a NRSRO status[1]. One of the reasons why this bill never became a law is that there was no agreement about the impact of competition on the quality of information provided by credit raters.

Although there exists vast literature on competition policy in product markets, rating industry has a number of specific features that raises questions about the impact of competition on the quality of information produced by rating agencies. The current paper analyzes how entry of a new rating agency changes the information content of ratings. In the first part of the paper we build a model to analyze the optimal disclosure policy of a monopoly rating agency depending on the value of information to the buyers, and then describe the potential market and the strategy of the entrant. Also we study how the entry affects the rating system of the incumbent and the overall amount of information disclosed to the market. In the second part of the paper we empirically test the qualitative predictions of the model. Standard and Poor's entry to the insurance market that was previously covered by a monopoly agency, A.M. Best, provides a unique natural experiment to study the impact of competition on the information content of ratings.

We build a model in which a monopoly rating agency decides how the information about the firm's financial quality is aggregated into ratings. Lizzeri (1999) establishes an important result of information intermediation literature: A monopoly rating agency's optimal policy is to disclose no information. However, this result hinges on the assumption that the buyers do not value the precision of information contained in the rating. In our model we assume that

[1] Credit Rating Agency Duopoly Relief Act of 2006 (H.R. 2990 [109th]) proposed to remove the SEC's designation process, and in its place give rating agencies who have issued ratings for 3 years the option of registering as NRSROs. This bill never became law.

precision of information has value to buyers. In this case, the no disclosure result no longer holds. Since purchasing a rating is voluntary to a company, the rating agency has to maximize its coverage of the market. As a result, the optimal rating system of the agency is designed to trade-off the ability of high quality companies to signal their quality by purchasing a rating and the benefits for the low quality companies to be pooled with better companies. This trade off determines how the rating agency aggregates signals about companies into rating categories. We study how the market coverage, precision and information aggregation depend on the value of information to buyers.

We apply the basic model to study the impact of competition on both agencies' rating systems. First we analyze the entry strategy of a new rating agency. We show that a new agency can enter either by targeting high quality companies that derive substantial benefits from purchasing a second rating, or companies that benefit from finer information disclosure. We also study how the incumbent agency adjusts its rating system as a reaction to entry.

The empirical part of the paper uses the qualitative predictions of the model to study the data on the US insurance market. The insurance ratings market was originally dominated by A.M. Best that has been covering nearly all insurers operating in the U.S. marketplace – over 1700 insurers were rated in 1992. Standard and Poor's entered the insurance ratings market in the early 1990's and produced only 385 ratings in 1992. By year 2004, S&P is the second largest insurance rating agency and now rates almost 800 companies which represent in excess of 90 percent of the industry's assets.

Our empirical objective is to investigate the strategies employed as the new entrant came into the insurance ratings business and also to document how A.M. Best changed its own standard following the introduction of competition. A fundamental component of our analysis is to determine an objective measure of the probability of default for each insurer in the data set and then map how the rating standards and the accuracy of the implementation of those standards changed over time for each agency. We apply the reduced form models to estimate the bankruptcy probabilities of the firms in our data using an approach similar to the discrete-time hazard rate model suggested by Shumway (2001).

We show that S&P entered the market by providing ratings on only high quality insurers and assigning their ratings in more stringent manner than was A.M. Best. In addition, we find evidence the S&P rating methodology more accurately classified insurers into rating categories. We also find evidence A.M. Best significantly adjusted their rating methodology as S&P's presence in the market grew.

2 Literature Review

The paper belongs to the growing literature on the role of information intermediaries and their incentives to disclose information to uninformed parties. In an important paper, Lizzeri (1999) obtains a striking result: The unique equilibrium outcome of a monopoly rating agency involves no information revelation and the intermediary extracting all the information surplus in the market. The logic of this result is the following. Since the intermediary can be bypassed by the seller, it has to design a disclosure rule that maximizes the demand for its services. If good types go to the intermediary, going to the intermediary is a good signal about seller's quality. Under no disclosure all types prefer to go to the intermediary instead of being perceived as the worse type. Then an intermediary can extract the surplus by charging a price equal to the expected quality of the sellers.

The reason why no disclosure is optimal in Lizzeri's model is that buyers are risk-neutral. Risk-neutrality implies that the price that buyers are willing to pay does not depend on the precision of information disclosed by the intermediary. In the current paper, we also study the incentives of the intermediary (the rating agency in our case) to aggregate information. In contrast to Lizzeri (1999), we assume that information has value to buyers. Then aggregation has a cost because it decreases the benefits of certification to sellers, and ultimately the fee that can be charged by the intermediary. We study how the optimal disclosure rule of the intermediary depends on the value of information.

There are also papers that discuss other reasons for information manipulation. Reputation concerns may lead to misreporting of information. Scharfstein and Stein (2000) and Ottaviani and Sorensen (2006a, 2006b, 2006c) study the impact of reputation concerns on the reports of analysts. These papers consider cheap talk models in which intermediaries are concerned with establishing a reputation of being well informed. In order to signal its ability to provide information with high precision, the intermediary biases its private observation in favor of prior belief. Mariano (2006) addresses a similar issue in the context of rating agencies.

Manipulation can also occur due to collusion between the intermediary and the seller. Strausz (2003) and Peyrache and Quesada (2005) study the incentives of intermediaries to collude with sellers demanding certification. Strausz shows that honest certification is a natural monopoly. Peyrache and Quesada argue that mandatory certification makes intermediaries more prone to collusion by increasing participation of poor types.

In spite the fact that information intermediaries function in oligopolistic markets, there is no much research that analyzes the impact of competition on the disclosure of information. Lizzeri (1999) obtains that competition leads to full disclosure and zero fees for certification.

3 The model

We consider the following model of information intermediation. There are three groups of agents: Insurance companies, rating agencies, and buyers of insurance policies[2]. A unit mass of insurance companies are indexed by their financial strength, or quality, $v \in [0,1]$, which is private information of a company. Higher v corresponds to higher quality. Rating agencies and buyers share a common prior about the financial strength of a company. For simplicity, we assume that v is distributed uniformly on $[0,1]$.

There is a unit mass of identical buyers. Each buyer purchases one insurance policy. Buyer's willingness to pay for the policy depends on financial quality of a company and the accuracy of information about quality. We model risk aversion by assuming that buyers have mean-variance preferences. Given information I, buyers valuation of the policy is equal to

$$u(I) \equiv E[v|\, I] - aVar[v|\, I],$$

where $E[v|\, I]$ is the expected quality of the company, and $Var[v|\, I]$ is the variance of quality. $a > 0$ measures the value of information accuracy to buyers. $u(I)$ is the maximum price that buyers are ready to pay for the policy given information I. Under the prior distribution of quality, buyers valuation is equal to

$$u_0 = \frac{1}{2} - \frac{1}{12}a.$$

If the value of information is low, $0 < a < 6$, the reservation price u_0 is positive. In this case providing new information is not essential for functioning of the market. When $a > 6$, a buyer would not purchase a policy unless it has some additional information about a company.[3]

We assume that an insurance company cannot credibly communicate its financial strength to buyers. In order to exchange information, the company and the buyer need services of a rating agency. A rating agency has an information technology and the reputation to provide information about financial strength of insurance companies. It offers an evaluation service for a flat fee t paid by the insurance company. An agency observes a perfect signal r about the quality of a company.

A disclosure policy of the agency defines how the estimates of the quality r are communicated to buyers. One particular case is full disclosure, where a rating agency communicates the signal r without aggregation. In general, a disclosure policy is a measurable function from the set

[2] In order to be coherent with the empirical part of the paper, we frame the model within the insurance industry. However, our analysis of the incentives of the information intermediary to disclose information and the impact of competition on disclosure apply to other markets as well.

[3] An alternative role of information intermediaries as gatekeepers is considered in .... The application include drug certification, doctors certification, etc.

of signals $[0,1]$ into the set of Borel probability distributions on real numbers. For the model analyzed in the paper we will show that the optimal disclosure policy is a rating system where an agency partitions the set of realization of r in K subintervals, and discloses that its estimate of quality belongs to a subinterval. This disclosure policy is very similar to the discrete system of ratings employed by the major rating agencies.

Obtaining ratings is voluntary to insurance companies. Thus an insurance company purchases a rating only if it increases the expected reservation price of the buyers. Denote δ the demand for ratings. Then the payoff of the rating agency is equal to

$$V = \delta t.$$

We assume that the fee is universal for all companies purchasing the rating, and the rating agency cannot screen companies by demanding higher fee for better rating[4].

The company's decision to obtain a rating is based on the cost of rating and its impact on the reservation price. The information content of the rating depends on the rating system employed by the agency and on participation decisions of the other companies. The expected payoff of the insurance company v is equal to

$$\begin{array}{l} u_R(v) - t, \text{ if a company is rated,} \\ u_N(v), \text{ if a company is not rated,} \end{array}$$

where $u_R(v)$ and $u_N(v)$ are the expected payoffs of type v with and without a rating, respectively. This specification of the profit function implicitly relies on the assumption that the insurance company does not have an option to withhold the rating if it is not satisfied with the results of the rating agency[5].

The game consists of four stages.

1. Insurance companies observe their types v.
2. The rating agency designs its disclosure policy.
3. The companies decide whether to purchase a rating. The participating companies are evaluated, and the results are disclosed to buyers according to the disclosure policy of the agency.
4. The buyers use the rating to update their beliefs about a company's quality, and pay the reservation price for the contract.

[4] Faure-Guimaud, Peyrache and Quesada (2005) show that if the decision to obtain the rating is not observable by the market and the firms seeking ratings are sufficiently uncertain about their quality, firms may have incentives to hide their ratings.

[5] Faure-Grimaud, Peyrache and Quesada

We study sequential equilibria of the game. The strategy of an insurance company is its decision to obtain a rating. The strategy of the rating agency is the disclosure rule. Buyers' strategy is the decision to purchase a policy. Buyers pay the reservation price conditional on all available information. Strategies of all players must be optimal given the beliefs about other players information. Beliefs must be consistent with the Bayes rule whenever possible.

4 Preliminary analysis: Full disclosure

This section describes the demand for ratings and the profits of the rating agency under full disclosure. Though this system is not optimal for the rating agency, the analysis can be useful to highlight the rating agency's gains from aggregating information. Lizzeri (1999) establishes a similar result in the case of risk neutral buyers.

Proposition 1 *Suppose that a monopoly rating agency commits to full disclosure, and the fee for the rating services is such that* $t < \frac{1}{2} + \frac{1}{12}a$*. Then the unique sequential equilibrium of the subgame has a threshold structure: There is a type* $\underline{v} \in [0,1]$ *such that all types above* $\underline{v}$ *purchase a rating, and no type below* $\underline{v}$ *is rated.*

Proof. Let's consider some type $v \in [0,1]$ and assume that all types above v and no types below v are rated. If v is rated, the reservation price of this type is

$$u_R(v) \equiv v.$$

If type v is not rated, it is pooled with types $[0, v]$. The reservation price of non-rated companies is then equal to

$$u_N(v) \equiv \frac{1}{2}v - \frac{1}{12}av^2.$$

The best estimate of company's quality is the expected quality of non-rated types $[0, v]$, that is, $\frac{1}{2}v$. The variance of the uninformative signal is equal to $\frac{1}{12}v^2$. If this price is negative, the non-rated companies do not trade.

A necessary condition that type v purchases a rating is that it increases its reservation price net of the rating fee,

$$u_R(v) - t \geq \max\{u_N(v), 0\}. \tag{1}$$

Note that as v increases, the difference between the two prices increases,

$$\frac{d}{dv}(u_R(v) - u_N(v)) = \frac{1}{2} + \frac{1}{6}av > 0. \tag{2}$$

Then comparing the two limit cases, $v = 0$ and $v = 1$,

$$\begin{aligned} u_R(0) - u_N(0) &= 0, \\ u_R(1) - u_N(1) &= \frac{1}{2} + \frac{1}{12}a > 0, \end{aligned}$$

suggests that if the fee t is below $\frac{1}{2}+\frac{1}{12}a$, then there is a type $\underline{v} \in (0,1)$ for which the participation constraint (1) is binding. (2) implies that all types above $\underline{v}$ prefer to obtain a rating, and no type below $\underline{v}$ obtains a rating. The buyers' beliefs that the company's quality is above $\underline{v}$ if it is rated and below $\underline{v}$ if it is not rated are consistent with the equilibrium. The proof of the uniqueness is devoted to the Appendix. ■

Under full disclosure the fee charged by the rating agency is $t = u_R(\underline{v}) - \max\{u_N(\underline{v}), 0\}$. It is equal to the amount that the lowest quality company is willing to pay for the rating. The demand for ratings is $\delta = 1 - \underline{v}$. So the profit of the rating agency writes

$$\max_{\underline{v}} (1-\underline{v})(u_R(\underline{v}) - \max\{u_N(\underline{v}), 0\}).$$

Since increasing the fee reduces the demand for ratings, the optimal fee and the resulting coverage of the market, $1 - \underline{v}$, are derived from the trade off between the size of the fee and the demand for ratings.

In the next proposition we describe how the optimal coverage of the market and the profit of the rating agency depend on the value of information a.

Proposition 2 *The optimal market coverage, $1 - \underline{v}^{FD}$, with*

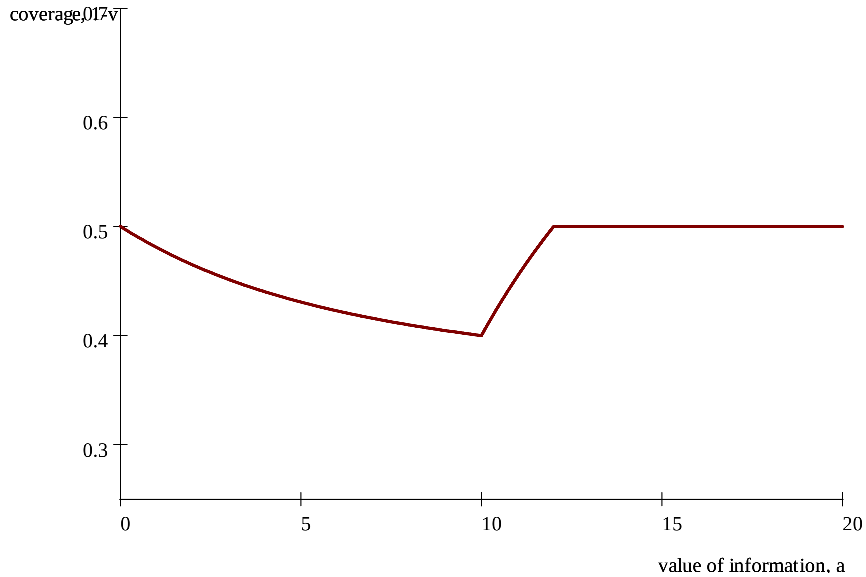
$$\underline{v}^{FD} = \begin{cases} \frac{a-6+\sqrt{a^2+6a+36}}{3a}, & a \leq 10, \\ \frac{6}{a}, & 10 \leq a \leq 12, \\ \frac{1}{2}, & a \geq 12. \end{cases}$$

is decreasing in the value of information for $a < 10$ and increasing for $a > 10$. The profit of the rating agency is

$$\pi^{FD} = \begin{cases} \frac{(a+12)(a+3)(a-6)+(6a+a^2+36)^{\frac{3}{2}}}{162a^2}, & a \leq 10, \\ \frac{6(a-6)}{a^2}, & 10 \leq a \leq 12, \\ \frac{1}{4}, & a \geq 12. \end{cases}$$

It is increasing in the value of information a.

The optimal market coverage $1 - \underline{v}^{FD}$ is given on Figure 4.



Optimal coverage under full disclosure

The non-monotone relation between the value of information and the market coverage relies on the ability of non-rated companies to charge a positive price. When the value of information is relatively low, non-rated companies can sell their policies at a positive price. In this case higher value of information reduces the price that can be charged by a non-rated company, and results in higher willingness to pay for the rating. When the value of information is high enough do that a company cannot sell its policy without purchasing a rating, the optimal coverage is decreasing in a. In this case higher value of information increases the price that can be charged to a rated company company, and effect the size effect dominated the coverage effect.

The profit of the rating agency is weakly increasing in the value of information because it increases the benefits of obtaining the rating by type $\underline{v}$.

Under full disclosure, the fee for the rating is equal to the willingness to pay of the marginal type $\underline{v}$. If instead of disclosing all information about this type the rating agency aggregates information by assigning the same rating to types $v \in [\underline{v}, \overline{v}]$, type $\underline{v}$ is pooled with better types, and its willingness to pay may increase. If the amount of information disclosed by the rating agency has no impact on the reservation price, this intuition leads to Lizzeri's (1999) no disclosure result where all types are aggregated in one rating. In our setup aggregation of signal has some cost because it leads to more coarse information about the quality of the company that is contained in the rating.

5 Monopoly rating system

In this section we analyze the optimal disclosure policy of the monopoly rating agency. Let's consider a rating system where the agency assigns two ratings, A and B. We will show below that this disclosure policy is optimal in our model. Denote $\underline{v}$ the lowest type that purchases a rating. If the rating agency receives a signal $r \in [\underline{v}, \underline{v} + b]$, the company is rated B. If the signal is $r \in [\underline{v} + b, 1]$, the company is rated A. The prices charged by rated companies are

$$\begin{aligned} u_A &= \frac{1}{2}(1 + \underline{v} + b) - \frac{1}{12}a(1 - \underline{v} - b)^2, \\ u_B &= \underline{v} + \frac{1}{2}b - \frac{1}{12}ab^2, \end{aligned}$$

for ratings A and B, respectively. The price charged by a non-rated company is

$$u_N = \frac{1}{2}\underline{v} - \frac{1}{12}a\underline{v}^2.$$

The disclosure policy must be compatible with incentives of companies to obtain ratings. It implies that rated companies must be better off by purchasing a rating,

$$u_A - t \geq \max\{u_N, 0\} \tag{3}$$

$$u_B - t \geq \max\{u_N, 0\}. \tag{4}$$

The right hand side of these constraints is the reservation price of a company if it does not purchase a rating. It is determined endogenously depending on whether a non-rated company is able to charge a positive price.

Also the non-rated companies must be better off without a rating. If a company $v \in [0, \underline{v}]$ deviates and purchases a rating, the rating agency discovers that the type of this company is below $\underline{v}$. We assume that in this case the rating agency announces that the company's financial strength is from the interval $[\underline{v}, 1]$. Then deviating and purchasing a rating cannot increase the reservation price charged by these companies.

The optimal rating system of the rating agency solves

$$\max_{(\underline{v}, b)} (1 - \underline{v})(u_B - \max\{u_N, 0\}).$$

If a company is able to sell at a positive price without purchasing a rating, $u_N > 0$, the value of the rating is the difference in price due to being rated. Since companies with better financial quality expect to obtain a higher rating, $u_A > u_B$, it implies that the fee charged by the rating agency is equal to the difference between the prices u_B and u_N. As the value of information increases, obtaining a rating becomes vital for selling the policy. In this case the fee that can be charged by the rating agency becomes equal to the price of the lowest rated company, u_B.

In the next proposition we characterize the optimal rating system of a monopoly rating agency.

Proposition 3 *The monopoly rating system is summarized in the following table.*

a	A	B	$profit\ of\ RA$	u_N
$2 \leq a \leq 6$	$[\frac{3}{4} - \frac{1}{2a}, 1]$	$[\frac{3}{4} - \frac{1}{2a}, 1]$	$\frac{(a+2)(a+10)}{96a}$	$\frac{(a-\frac{2}{3})(\frac{26}{3}-a)}{192a}$
$6 \leq a \leq \frac{21}{2}$	$[\frac{2}{3} + \frac{2}{a}, 1]$	$[\frac{2}{3} - \frac{1}{a}, \frac{2}{3} + \frac{2}{a}]$	$\frac{(a+3)^3}{81a^2}$	$\frac{(a-\frac{3}{2})(\frac{21}{2}-a)}{108a}$
$\frac{21}{2} \leq a \leq \frac{51}{4}$	$[\frac{9}{a}, 1]$	$[\frac{6}{a}, \frac{9}{a}]$	$\frac{27(a-6)}{4a^2}$	0
$a \geq \frac{51}{4}$	$[\frac{1}{2} + \frac{21}{8a}, 1]$	$[\frac{1}{2} - \frac{3}{8a}, \frac{1}{2} + \frac{21}{8a}]$	$\frac{(4a+3)^2}{64a^2}$	0

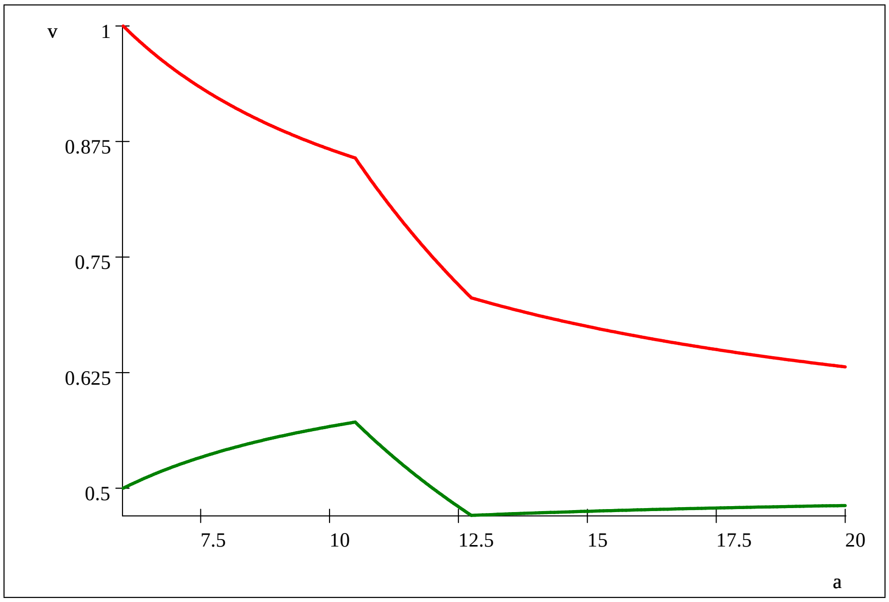
When the value of information is relatively low, $2 \leq a \leq 6$, all rated firms $v \in [\frac{3}{4} - \frac{1}{2a}, 1]$ are assigned the same rating. For higher values of information, $a \geq 6$, the rating agency assigns two ratings. The market coverage $1 - \underline{v}$ is non-monotone in the value of information. When the value of information is so low that the non-rated companies can sell at a positive price, the market coverage is decreasing in a; it is increasing for higher values of a.

The value of information has the major effect on the design of the optimal rating system. When a is relatively low, the optimal disclosure policy of the rating agency is to announce that the company's quality is above a minimum standard. In this case the price charged by the rated companies is equal to the expected valuation of companies in $[\underline{v}, 1]$. Recall that the valuation by customers is composed of two components, the expected quality and the variance of quality. Since the value of accuracy of information is relatively low, rating is not necessary for selling at a positive price. The rating system of the agency is a trade-off between the higher coverage of the market and the higher expected valuation of the contract.

As the value of information increases, the positive effect of disclosing information dominates the effect of the higher expected quality of pooled companies. As a result, the price that can be charged by the company rated B becomes higher than the price charged by the pool of rated companies under no disclosure, even though the expected quality of this pool is higher then that of B rated companies.

The profit of the rating agency is non-monotone in the value of information. For relatively low values, the rating agency can benefit from its unique ability to screen the companies and selectively disclose the results. However, as the value of information increases, the optimal rating system requires finer information disclosure, and reduces the fee that can be charged for the rating.

Finally, the boundaries for ratings A and B are shown on Figure 5. Interestingly, the lower boundary for rating B is increasing for low information values.



Ratings of the monopoly rating agency

In the next proposition we compare the rating system with two ratings results and a system of full disclosure.

Proposition 4 *A rating system with two ratings provides higher profit to the rating agency than full disclosure rating system.*

6 Demand for a Second Rating

Suppose that a new rating agency decides to enter the market served by the incumbent. A rated company may be willing to obtain a second rating only if it increases the price that can be charged to customers. The reservation price of the company can be increased either when the second rating allows to signal higher quality, or when it improves the information of the buyers.

In this section we take the rating system and the demand for ratings of the incumbent as given, and analyze the entry strategy of a new agency. We assume that the entrant has the same information technology as the incumbent, and denote t_e the entrant's fee for the rating.

In the next proposition we show that the demand for the second rating comes from the companies with the highest financial strength.

Proposition 5 *An entrant can always design a rating system that attracts the best companies.*

A limit example of such rating system is the one where the entrant attracts only the hghest type $v = 1$. This system anambigously creates some positive surplus for the insurance company, and all the extra surplus can be extracted by the new rating agency.

When designing its rating system, an entrant faces two types of participation constraints. Ex-ante, a company with two rating must be valued higher than a company with a single rating. Ex-post, the net payoff of a company with two ratings must be higher than a post-entry payoff of companes that do not demand a second rating.

Consider an example of entry strategy where an entrant discloses all information. We will show that, like the incumbent, the entrant will have incentives to aggregate its information. Consider a set of companies that demand a second rating, $[\underline{v}^e, 1]$. The ex-ante participation constraint states that the maximum price that a company $v \in [\underline{v}_e, 1]$ is ready to pay for the rating is equal to the marginal benefit of the second rating, $t_e = u_{RR_e} - u_R$. R denotes the rating assinged by the incumbent, R_e is the rating assigned by the entrant and u_{RR_e} is the reservation price of a company rated by the two agencies. The ex-post participation constraint requires that the rated company obtian a net payoff $u_{RR_e} - t_e$ not lower than the payoff that it can obtain by not requesting the second rating. Denote this payoff u_R^0. These two participation constraints imply that the maximum fee that can be charged by the entrant equals $u_{RR_e} - \max\{u_R, u_R^0\}$. Then the objective of the rating agency is to design a system that maximizes its revenues,

$$(1 - \underline{v}_e)(u_{RR_e} - \max\{u_R, u_R^0\}).$$

In general, the entry strategy of a new agency depends on the value of information to customers. In the next proposition we characterize the optimal entry strategy in a general case.

The rating system of the incumbent aims to maximize the market coverage but is constrained by the fact that the fee that can be charged to firms on the bottom of the distribution is limited. Compared to this system the optimal strategy of the entrant is to target the firms on the top of the distribution.

7 Duopoly

In this section we analyze how the incumbent rating agency adjusts its rating system when a new agency enters the market. We assume that the incumbent rating agency is a Stackelberg leader in setting its rating system. A company first decides whether to obtain a rating from the incumbent agency, and then may purchase a second rating from the other agency.

Presence of the second agency changes the design of the incumbent's rating system in the following way. Since obtaining a new rating adds more value to high quality companies, it decreases the price that these companies are willing to pay for the first rating. As a result the incumbent agency adjusts its system to make it more attractive to the companies that have intermediate quality. Our preliminary results show that the optimal rating systems result in more pooling for the intermediate quality companies. At the same time there is more information disclosure for the highest quality companies.

8 Empirical Analysis

In this section we empirically investigate the stringency of the ratings assigned by two of the largest agencies that follow the property-liability insurance industry: the A.M. Best Company and Standard & Poor's. A.M. Best has covered the insurance industry for close to one hundred years. The company publishes ratings on virtually all insurers and, prior to the mid-1980's, they were the only agency doing so. The monopoly position A.M. Best enjoyed, however, began to change in the mid-1980's as new agencies began assigning ratings to insurers. The most aggressive firm to enter the market was Standard & Poor's. S&P began publishing ratings on property-liability insurers in 1983, expanded their coverage to 100 firms in 1987, and then significantly expanded coverage again in 1991. Today, S&P provides ratings on insurers that represent in excess of 80 percent of the assets of the industry.

In this study we obtained data on all ratings assigned to property-liability insurers by A.M. Best from 1989-2000 and by Standard & Poor's from 1992-2000. We use this information to investigate two primary research questions. First, we are interested to empirically compare the stringency of the ratings assigned by the incumbent firm (A.M. Best) and by the new entrant into this market (S&P). How do S&P ratings compare to A.M. Best ratings? Are they more stringent or less stringent? The second objective we have is to investigate how the stringency of Best's ratings changed over time in response to the increased competition they faced from S&P and other new entrants.

The benchmark we use to investigate these questions is the probability of default for each firm in our data set. The one-year probability of default is a reasonable benchmark since both agencies state the primary objective of their rating systems is to provide an opinion about the insurer's ability to meet its contractual obligations to policyholders. We use these probabilities to estimate the stringency of the rating system by looking at either the median or mean probability of default for a given rating class. Presumably companies with lower probabilities of default should, on average, expect to receive higher ratings from each agency. More stringent ratings standards are said to exist when the average probability of default for insurers in a particular rating class is lower for one agency than the other.

8.1 Estimating Default Probabilities

8.1.1 Methodology and Data

Methodology. A variety of methods can be used to forecast the likelihood of bankruptcy for an insurance company[6]. In this study we use the discrete-time hazard model suggested by Shumway (2001) take advantage of our panel data. The hazard model approach has at least two primary advantages over the more traditional static models. First, hazard model allow for time-varying covariates that explicitly recognize the financial health of some firms may deteriorate over time even though the firm does not declare bankruptcy. Static models, on the other hand, only make comparisons between firms that are classified as healthy or not healthy at just one point in time and they therefore ignore firms that are at risk of bankruptcy even though they do not become bankrupt. Shumway shows that ignoring this information creates a selection bias which leads to biased and inconsistent parameter estimates. Intuitively, hazard models correct this problem by allowing to extract useful information from the times series data on each individual firm. In addition, it can be shown that the parameter estimates from hazard models are unbiased and consistent.

The second reason the hazard model may be preferred to static models is that they allow to exploit all available information about the firm rather than just the last year's observations. Thus, the hazard model is more efficient and it yields more reliable parameter estimates and better out-of-sample forecasting results.

Implementing the discrete-time hazard model is rather straightforward since it can be shown that the likelihood function of a discrete time hazard model is identical to the likelihood function for a multiperiod logit model. Thus, estimating the hazard model is equivalent to estimating the traditional static logistic model except the coding of the dependent variable is slightly different. The dependent variable for the hazard model, y_{it}, is a binary indicator set equal to 1 if firm i is declared bankrupt in year $t+1$ and equals 0 otherwise. Thus, the dependent variable equals 0 for each year the firm does not exit the system. Otherwise, each bankrupt firm contributes only one failure observation, i.e., $y_{it} = 1$, in the last year the firm has data. Firms which survive the entire data period never receive a value of 1 and firms that become bankrupt no longer have observations after their last year of operation. Time varying covariates are easily incorporated by using each firm's annual data.

[6] U.S. regulatory authorities use three univariate models to forecast bankruptcy. The Insurance Regulatory Information System (IRIS) employs twelve audit ratios based upon financial statement data filed with the regulators. The newer Financial Analysis and Surveillance Tracking (FAST) system uses an expanded set of approximately thirty audit ratios where each ratio is given a corresponding score. The risk-based capital (RBC) system introduced in 1994 defines a minimum amount of capital insurers must hold where the individual capital charges are a function of the riskiness of the assets and the businesses in which the insurer participates.

Data. The data to estimate the hazard model comes from the annual regulatory statements of all property-liability insurers maintained in electronic form by the National Association of Insurance Commissioners (NAIC). We include all firms that meet our data requirements (discussed below) over the years 1989-2000. As previously discussed, the dependent variable for the model, y_{it}, is a binary indicator set equal to 1 if firm i is declared bankrupt in year $t+1$ and equals 0 otherwise. Consistent with the literature, we define the year of insolvency as the year that the first formal regulatory action is taken against a troubled insurer. We identify the year of first regulatory against insurers through a variety of sources including the NAIC's Report on Receiverships and the Status of Single-State and Multi-State Insolvencies for various years. We also obtained the list of insolvent insurers provided in a report by A.M. Best Company (A.M. Best, 2002), which lists all property-liability insurers that failed from 1969-2001. From these sources we identified 300 property-liability insurers that failed between 1990 and 2001.

The explanatory variables we use to estimate the hazard model are nineteen of the balance sheet and income statement ratios that make up the NAIC's Financial Analysis and Surveillance Tracking (FAST) solvency tracking system. As suggested by Grace, Harrington and Klein (1995), there are diminishing marginal returns to incorporating additional balance sheet and income statement ratios not already included in the FAST system plus the two control variables for firm size and organizational form.

The variable we use to control for firm size equals the natural logarithm of the real assets of the firm where the price deflator we use is the Consumer Price Index. The organization form control variable is an indicator set equal to 1 if the insurer either belongs to a mutual or reciprocal group of insurers or is a single insurer that is either a mutual or a reciprocal. Otherwise the indicator variable is set equal to zero.

As discussed above, we estimate the hazard models using all insurers for which we have data to calculate the FAST ratios. Thus, we include insurers rated by A.M. Best and/or Standard & Poor's and also insurers that do not receive ratings from either of these two agencies. The only insurers we delete from the analysis are those with insufficient data needed to calculate the nineteen FAST variables or those who do not have data available in the year prior to their first event year. In an effort to include as many insolvent observations in the analysis, we also include insurers who report data two years prior to their first event year but who do not report in the year prior to their first event year. We delete any bankrupt firms for which we were unable to locate data within 2 years of their first event year. The final data set contains 24,062 solvent firm-year observations and 214 insolvent firm-year observations.

8.1.2 Summary Statistics and Regression Results

Summary statistics for the solvent and insolvent company observations are shown in Figure 1. Not surprisingly tests between the means of the solvent and insolvent samples suggest the two groups of insurers differ significantly across a number of dimensions. The results of the discrete-time hazard model (Table 2) reinforce this observation. Overall the explanatory power of the model is reasonable as the pseudo R^2 statistic is 26 percent. The results are consistent with the summary statistics shown in Figure 1. The estimated beta coefficients suggest that insurers that carry higher leverage ratios, namely the Kenney ratio and the reserves to policyholder surplus ratio, rapidly growing firms, and firms that rely more heavily upon reinsurance to increase policyholder surplus are associated with higher failure rates. Larger firms and insurers that are part of mutual organizations are relatively safe. Finally, firms that have high cash outflows relative to inflows or who experience adverse reserve development are more likely to fail.

Looking at the estimated probabilities of default is another way to judge the results of the estimated hazard model. Summary statistics of the estimated one-year probabilities of default are shown in Figure 3. The average/median probability of default for the healthy firms is 0.8/0.2 percent while the average/median statistics for the firms in the year before they become bankrupt is 9.4/4.5 percent. Thus, the average probability of default for bankrupt firms is over 10 times larger than the average probability for healthy firms. Clearly the model provides reasonable results by assigning high default probabilities to firms that ultimately fail and low probabilities to healthy firms.

8.2 Stringency Tests: A.M. Best vs. Standard & Poor's

In this section we present statistics on the distribution of the ratings assigned by A.M. Best and S&P over the time period of this study. After presenting the general trends, we compare the stringency of the two rating agencies.

In order to compare Best's rating systems with S&P's we need to define a mapping between the different symbols used by the two agencies. For this study we reviewed the verbal descriptions each agency ascribes to the individual ratings and decided to use the five rating categories shown in Figure 4. Numerical values are assigned to each rating category to facilitate comparisons across agencies and over time.

Market coverage. Figures 5 and 6 are designed to demonstrate the extent of the coverage each agency provided of the property-liability insurance industry over the time of this study. The total number of insurance companies in the NAIC data base ranged from a low of 1897 firms in year 1990 to a high of 2100 firms in year 1996. The total assets of the industry grew from $534 billion in 1989 to almost $940 billion by the end of 2000. Of these companies, the A.M. Best Co. assigned ratings to approximately 70 – 80% of the firms. These firms held approximately 93% of the assets of the industry. Obviously during the period of the 1990's, A.M. Best was providing almost complete coverage of the property-liability insurance industry. By comparison, S&P provided ratings on only 18% of the firms in the industry in 1992 - 360 insurers - and the number only grew to 590 insurers by the end of 2000. Based upon assets, S&P does appear to provide greater coverage as they are rating firms that represent almost 70 percent of the assets of the industry by the end of the 2000 up from a low of 24 percent in 1993.

Figure 7 displays the average rating each agency assigned to the firms it oversaw. The difference across the two firms is dramatic. The average rating assigned to firms in the industry by A.M. Best was slightly declining over the time period and ranged from a high of 2.8 in 1989 and declined to 2.4 by the end of the time period. S&P stands in stark contrast in two ways. First, unlike Best, there was a monotonic increase in the average rating assigned by S&P over the time period 1992 – 2000. In 1992, the average rating assigned by S&P was only 0.6 and it more than tripled to 2.1 by 2000. Second, S&P appears dramatically more pessimistic about the financial health of the property-liability insurance industry over this time period than does A.M. Best – especially during the early part of the 1990's.

One possible explanation for the difference of opinion regarding the average health of the industry across the agencies could be because the firms that A.M. Best tracked were, on average, of higher financial quality than the firms tracked by S&P. To consider this possibility, we calculated the average and median probability of default using the results from the hazard model for insurers tracked by A.M. Best and by S&P over the time period of this study. The results are shown in Table 8. Contrary to the hypothesis, the average and median probability of default statistics are always lower for S&P than they are for A.M. Best suggesting the firms tracked by S&P are typically of higher financial quality firms – not lower. The non-parametric Wilcoxon-Mann-Whitney test rejects the null hypothesis of equal medians for all nine years and the parametric t-test rejects the null hypothesis of equal means in seven out of nine years.

Since the financial quality of firms rated by S&P appears, on average, to be better than Bests, another possible explanation for the difference in opinion may be because S&P entered this market by employing higher standards. Before we can investigate this possibility, however, we first need to review how S&P entered this market.

Prior to 1991, S&P provided coverage to only a small number of property-liability insurers (approximately 100). However, in 1991, S&P dramatically expanded their coverage by introducing a new rating service they called "Insurance Solvency Review." The primary enhancement in the new service was that S&P increased the number of firms it covered by offering a "qualified ratings" in addition to their traditional ratings. The methodology used to determine a qualified rating for an insurer differed in at least three important ways from the traditional manner. First, qualified ratings were solely based upon publicly available data. Thus, unlike the traditional method, S&P analysts did not interview or speak to the management of an insurer prior to issuing the qualified rating. Second, individual insurers were not required to request the rating or to a pay a fee to receive the qualified rating. Finally, the third important difference was that S&P had a policy that no insurer could receive above a BBB rating using the qualified method – regardless of the characteristics of the company. S&P ultimately relaxed this position following significant criticism from the industry and began to issue qualified ratings above BBB in 1994. This behavior can be explained by the intention of S&P to increase its visibility on the market. Also it increases the value of obtaining a high rating from S&P, and provides additional incentives for the solvent insurers to pay for a second rating.

Figure 9 shows summary statistics regarding the types of ratings, qualified versus unqualified, given by S&P over this time period. In 1992, S&P issued 360 ratings of which 337, or 94%, were determined using the qualified rating system. Only 23 firms received a full rating in 1992. Over time, however, more firms agreed to be obtain a full rating and by 2000 over 300 property-liability insurers paid to receive an unqualified rating. Similar to Best's, the average full rating declined slightly over time from a high of 3.2 in 1992 to 2.8 by the end of the time period. The average qualified rating increased over time from a low of 0.5 in 1992 to 1.2 by year 2000. However, even after 1994 when S&P removed the restriction that firms could not receive a rating above BBB on a qualified basis, the average qualified rating is always significantly less than the average rating given using the traditional methodology.

We know from Figure 9 the average ratings issued by S&P differ significantly across the two rating methodologies. But do the firms differ? In addition, how did the standards S&P used to assign ratings differ from A.M. Best? To answer these questions consider Table 10 which shows summary statistics regarding the default probabilities of firms rated by A.M. Best's and those rated by S&P's on a qualified and unqualified basis.

First, consider the stringency of the standards employed across the three rating technologies. There is clearly a natural ordering within each rating technology: firms that received higher ratings had, on average, lower probabilities of default. For example, the average probability of default for firms rated by A.M. Best increases monotonically by rating category from a low of 0.25 percent for firms rated "Extremely Strong" to a high of 3.11 percent for firms that received the lowest rating "Marginal." A similar pattern can be seen for S&P firms that received either a full or qualified rating. The results suggest that at least on average each of the three technologies required firms to be less likely to default in order to receive a higher rating.

Now consider the stringency across rating technologies. Table 11 graphically displays the average probability of default of the firms over the time period of this study by rating category across each of the three rating technologies (the data can be seen in Table 10). It is easy to see the stringency employed by A.M. Best and S&P are almost identical when S&P issued a full unqualified rating. This is particularly true in the higher rating categories (Extremely Strong, Strong, and Good) where the average probability of default for firms in the categories was almost identical. In stark contrast, however, is the case when S&P issued an unqualified rating. In this case we find the average probability of default was substantially lower in each rating category relative to Bests and S&P's own full rating standards. For example, firms that received an adequate rating (BBB) from S&P on a qualified basis had an average probability of default equal to 0.22 percent. A firm with a default probability of 0.22 percent likely would have received either an Extremely Strong (AAA) or a Strong (AA) rating if S&P was using their full rating standards.

It is also interesting to consider the accuracy of the assignment of ratings across rating categories. Table 12 displays the difference between the 90th and 10th percentile of the probability of default for firms in each rating category (the data can be seen in Table 10). The comparison across rating technologies is very similar to the conclusions that were drawn regarding stringency. S&P's full rating system and A.M Best's methodology had almost the same amount of noise in each rating category. The only exception to this general conclusion is the Marginal rating category where Best appears to have a wider range of default probabilities for firms in that category. This seems reasonable since Best rated many more insurers than did S&P and many of these are small insurers with lower financial quality (see Figure 2 where the average probability of default for insurers rated marginal by Best is also significantly higher than the average for insurers rated marginal by S&P). S&P's qualified rating system, however, had significantly less noise than Bests or S&P's full rating system.

There are two possible explanations for the results shown in Table 10. Clearly one possibility is that the standards S&P employed when they issued qualified ratings were much more stringent than those they used when the insurer paid a fee to receive a full rating. In addition, it suggests S&P very carefully choose insurers to issue a qualified rating to and then carefully placed those insurers in rating categories lower than what they would have received had they agreed to pay for a full rating methodology. Then, when the insurer agreed to pay a fee to receive a full rating, S&P would move some insurers into a more appropriate rating category or, in the language of our theoretical model, would misclassify some insurers which showed up as an increased amount of noise in the full rating system.

A second explanation for the results we show in Figures 11 and 12 is that it is possible, if not probable, that our econometric model does not fully capture all information that would be useful to determine the default probability of each insurer. More specifically, when a firm agrees to pay for a full rating, S&P analysts presumably learn private information about the firm which is then factored into the ultimate ratings. Therefore, all we may be picking up is that we have an omitted variable problem since we only include publicly available information in our hazard model. Unfortunately, it is difficult to control for the information that S&P learns when they engage in conversations with the management of insurers when they decide to receive a full rating. Private information is, by its very nature, private.

One way to differentiate between the two explanations is to see how often S&P and A.M Best agree on the financial quality of firms they both review. In this case, the average financial quality of the firms included in the analysis is constant which allows us to avoid having to use the predicted probabilities from hazard model. In addition, in one case A.M. Best and S&P both gain private information and, in the other, only A.M Best has the private information.

Tables 13 and 14 show two frequency matrices where each matrix compares the ratings assigned to the firm when the firm is rated by both agencies. The cells of each matrix c_{ij} display the number of firm-year observations that received rating i from A.M Best and rating j from S&P where i, j e {Extremely Strong, Strong, Good, Adequate, and Marginal}. For example, over the time period 1992 – 2000, there were 281 firm-year observations where both agencies, A.M. Best and S&P using there full rating methodology, issued an Extremely Strong rating to the firm (see Panel A). Cells along the main diagonal of the matrices display cases where A.M Best and S&P issued the exact same rating. Cells along the two off-diagonals next to the main diagonal, coded in orange, are cases where A.M Best and S&P disagree slightly about the financial quality of the firm. For example, in the diagonal just below the main diagonal, A.M. Best was slightly more optimistic about the fortunes of the firm than was S&P as these firms received an A.M Best rating that is one category better than the rating they received from S&P. Cells coded in coded in green(blue), located in the lower(upper) triangles of each matrix represent cases where the S&P rating differed substantially from the A.M. Best rating. Cells in the lower(upper) triangle represent cases where S&P issued a rating that was significantly below(above) the rating issued by A.M Best.

Table 13 compares the rating given by Best with the rating S&P issued when they used their full rating methodology. The results suggest A.M Best and S&P tended to agree in most cases about the financial health of the insurers they both oversaw over the time period. In 37 percent of the cases, Best and S&P agreed completely regarding the financial prospects of the insurers and they agreed to disagree only slightly on another 58 percent of the observations. It is also interesting to note that when S&P does diverge slightly from A.M. Best, they are more likely to issue a rating one category below the rating Best rather than one category above. There were very few cases, only 4.7 percent of the observations, where S&P and Best's completely disagreed about the financial health of the insurer. These results strengthen our earlier conclusion that, for the most part, A.M Best and S&P employed approximately the same standards when S&P issued a full rating.

Table 14 tells a completely different story. The data in this matrix compares Best's ratings with the rating S&P issued on a qualified basis. The results show S&P issued a rating that was at least two categories lower than A.M. Best in almost 60 percent observations (the comparable number in Table 13 is only 4 percent). In addition, the percentage of cases where A.M. Best and S&P issued the same rating on a firm dropped from 37 percent in Table 13 to just 10.5 percent in Table 14. Clearly the standards S&P used to assign qualified ratings was significantly more stringent than the standards they used in their full rating methodology. In addition, the results lend significant credibility to the conclusion that S&P systematically chose insurers that would receive a qualified rating and then downgraded those insurers relative to what they would have received had they agree to pay to receive for a full unqualified rating.

8.3 A.M. Best's Reaction to S&P's Entry

Did Best react to S&P's entry into this market? It will be difficult to find direct evidence Best reacted to the strategies S&P employed to enter the market for property-liability insurer ratings. However, there is evidence Best did change their standards as competition for ratings increased. Table 15 shows the median probability of default of the firms rated by A.M. Best by rating category over the years 1989-2000. In Table 16 we show the ratio of the median probability of firms by rating category relative to the median probability of default for all insurers rated by A.M. Best in that year. We divide by the median default probability in each year because recent theoretical and empirical work suggests rating agencies have incentives to adjust their standards relative to the location of the distribution of credit quality in the industry/economy. For example, Prakash (2005) uses data on corporate bond ratings and shows there is a direct relationship between the quarterly change in the probability of default for the median firm in the economy and quarterly change in the standards he estimates for a firm from Standard & Poor's. Nayak (2001) argues rating agencies follow standards that are relative to the financial condition of firms in the economy. Specifically, he finds evidence ratings agencies determine ratings not by looking at the characteristics of the firm itself but instead by looking at the firm's audit ratios and position relative to the median firm in that industry. Finally, the theoretical model presented earlier in this paper argues a rating agency will adjust as a function of the distribution of the credit quality of the firms.

The results in Table 15 suggest there was no significant time in the median probability of default for firms assigned to any particular rating category except the lowest rated firms. However, in Table 16 we find evidence of a significant negative relationship between the median probabilities of default for firms in the Good and Strong categories relative to the median probability of default for all rated firms. For example, the average ratio of the median default probability for firms in the Strong category relative to the median for all rated firms over the years 1989-1991 was 1.0. This ratio dropped to be an average 0.75 for the last three years of this study. Thus, for at least the Strong and Good categories, we find evidence consistent with Best increasing stringency for firms to achieve either "Good" and "Strong" ratings - results consistent with earlier reported by Doherty and Phillips (2002).

9 Conclusion

The objective of the paper is to analyze how competition impacts information disclosure choices of rating agency. We developed a model to study how the disclosure of informatio depends on teh value of information to the buyers. We show that the optimal entry strategy for a new rating agency is to target high quality companies. This result is consistent with our empirical results. Also we show that following the entry, the original rating agency adjusts its system to make it more attractive to intermediate companies. As a result the ratings become more opaque about intermediate comapnies. At the same time, entry increses the accuracy of infromation about the top quality companies.

References

[1] Cantor, Richard, and Frank Packer, 1997, "Differences of Opinion and Selection Bias in the Credit Rating Agency," *Journal of Banking and Finance*, 21: 1395-1417.

[2] Cummins, J. David, Martin F. Grace, Richard D. Phillips, 1999, "Regulatory Solvency Prediction in Property-Liability Insurance: Risk-Based Capital, Audit Ratios, and Cash Flow Simulation", *Journal of Risk and Insurance*, 66(3): 417-458.

[3] Green, Jerry R., and Nancy L. Stokey, 2006, "A Two-Person Game of Information Transmission", *Journal of Economic Theory*, forthcoming

[4] Lizzeri, Alessandro, 1999, "Information Revelation and Certification Intermediaries", *RAND Journal of Economics*, 30(2): 214-231.

[5] Merton, Robert C., 1974, "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates," *Journal of Finance* 29: 449-470.

[6] Milgrom, Paul R., 1981, "Good News and Bad News: Representation Theorems and Applications", *Bell Journal of Economics*, 12(2): 380-391.

[7] Ottaviani, Marco and Peter Norman Sorensen, 2006a, "Professional Advice", *Journal of Economic Theory*, 126: 120-142.

[8] Ottaviani, Marco and Peter Norman Sorensen, 2006b, "Reputational Cheap Talk", *RAND Journal of Economics*, 37(1): 155-175.

[9] Ottaviani, Marco and Peter Norman Sorensen, 2006c, "The Strategy of Professional Forecasting", *Journal of Financial Economics*, 81: 441-466.

[10] Peyrache, Eloic and Lucia Quesada, 2005, "Intermediaries, Credibility and Incentives to Collude", working paper, HEC Paris and Universidad Torcuato Di Tella.

[11] Pottier, Stephen W., and David W. Sommer, 1999, "Property-Liability Insurer Financial Strength Ratings: Differences Across Rating Agencies," *Journal of Risk and Insurance* 66(4): 621-642.

[12] Scharfstein, David, and Jeremy Stein, 1990, "Herd Behavior and Investment", *American Economic Review*, 80: 465-479.

[13] Shumway, Tyler, 2001, "Forecasting Bankruptcy More Accurately: A Simple Hazard Model," *Journal of Business* 74(1): 101-124.

[14] Strausz, Roland, 2005, "Honest Certification and the Threat of Capture", *International Journal of Industrial Organization*, 23:45-62.

[15] Trieschmann, James S. and George E. Pinches, 1973, "A Multivariate Model for Predicting Financially Distressed P-L Insurers", *Journal of Risk and Insurance*, 40(3): 327-338.

Appendix A: Proofs

Proof of Proposition 1. The gain of obtaining a rating under full disclosure is equal to

$$G(v) = u_R(v) - u_N(v) = \frac{1}{12}a\beta v^2 + \frac{1}{2}(\beta + \frac{1}{3}a(1-\beta))v + (1-\beta)(\frac{1}{2} - \frac{1}{12}a),$$

and it is positive for all values of v. Indeed, $G(0) = (1-\beta)(\frac{1}{2} - \frac{1}{12}a) > 0$ and $G'(v) = \frac{1}{6}a\beta v + \frac{1}{2}(\beta + \frac{1}{3}a(1-\beta)) > 0$.

Suppose that t is such that $G(0) < t < G(1)$. Then there exists $\underline{v} \in (0,1)$ such that $G(\underline{v}) = t$. Since $G' > 0$, all types above $\underline{v}$ prefer to obtain a rating, and all types below $\underline{v}$ prefer not to be rated. The buyers' beliefs that the company's quality is above $\underline{v}$ if it is rated and below $\underline{v}$ if it is not rated are consistent with this equilibrium.

To prove uniqueness, consider a set of types V_n who do not go to the intermediary. Then the reservation price of these types is

$$E(v|\,V_n) - aVar(v|\,V_n),$$

where

$$E(v|\,V_n) = \frac{1}{|V_n|}\int_{V_n} v dv,$$

$$Var(v|\,V_n) = \frac{1}{|V_n|}\int_{V_n} (v - E(v|\,V_n))^2 dv.$$

If $V_n = [0,1]$, then this reservation price is equal to $\frac{1}{2} - \frac{1}{12}a$. If type $v = 1$ is the only one rated, it is paid a reservation price equal to 1. When $t < 1 - (\frac{1}{2} - \frac{1}{12}a)$, among the non-rated types there are types that prefer to be rated. Denote v_r any of these types. Then all types above v_r prefer to be rated, and there is some type $\underline{v} < v_r$ who is indifferent. ■

Proof of Proposition 2. We distinguish between two cases, $u_N > 0$ and $u_N < 0$. $u_N > 0$ is equivalent to

$$\frac{1}{2} - \frac{1}{12}a\underline{v} > 0. \tag{5}$$

If $u_N > 0$, the agency charges the fee $t = \underline{v} - u_N$, and the problem of the rating agency writes

$$(1-\underline{v})(\frac{1}{2}\underline{v} + \frac{1}{12}a\underline{v}^2)$$
$$\text{subject to (5).}$$

Denote $\lambda \geq 0$ the Lagrange multiplier of (5). Suppose first that $\lambda > 0$. Then $\underline{v} = \frac{6}{a}$, and

$$\lambda = \frac{12}{a}(\frac{3}{2} - \frac{15}{a}),$$

so $\lambda > 0$ when $a > 10$. In this case the profit of the agency is $\frac{6(a-6)}{a^2}$. Now suppose that (5) is not binding, $\lambda \geq 0$. Then $\underline{v} = \frac{a-6+\sqrt{a^2+6a+36}}{3a}$, and (5) is satisfied when $a < 10$. The profit is $\frac{a^3+9a^2-54a-216+(6a+a^2+36)^{\frac{3}{2}}}{162a^2}$.

Consider the case $u_N < 0$. In this case the agency charges the fee $t = \underline{v}$, and the problem of the rating agency writes

$$(1-\underline{v})\underline{v}$$
$$\text{subject to } -\frac{1}{2} + \frac{1}{12}a\underline{v} > 0.$$

Denote $\lambda \geq 0$ the Lagrange multiplier of the constraint. If $\lambda > 0$, then $\underline{v} = \frac{6}{a}$ and $\lambda = \frac{12}{a}(\frac{12}{a} - 1)$, implying $a < 12$. The profit in this case is $\frac{6(a-6)}{a^2}$. Now assume that the constraint is not binding. Then $\underline{v} = \frac{1}{2}$, the profit is $\frac{1}{4}$, and the constraint is satisfied when $a > 12$.

To find the optimal $\underline{v}$, compare the solutions for different values of a. When $a < 10$, the global solution is $\underline{v} = \frac{a-6+\sqrt{a^2+6a+36}}{3a}$, resulting in profit $\frac{(a+12)(a+3)(a-6)+(6a+a^2+36)^{\frac{3}{2}}}{162a^2}$. When $10 < a < 12$, solutions in the two cases are the same, $\underline{v} = \frac{6}{a}$, and the profit is $\frac{6(a-6)}{a^2}$. Finally, when $a > 12$, the global solution is $\underline{v} = \frac{1}{2}$ and the profit is $\frac{1}{4}$. ■

Proof of Proposition (monopoly). Let's consider the optimal rating system when the rating agency assigns two ratings, $A = \{v | \, v \in [\underline{v} + b, 1]\}$ and $B = \{v | \, v \in [\underline{v}, \underline{v} + b]\}$. The prices charged by the companies are

$$\begin{aligned} u_A &= \frac{1}{2}(1 + \underline{v} + b) - \frac{1}{12}a(1 - \underline{v} - b)^2, \\ u_B &= \underline{v} + \frac{1}{2}b - \frac{1}{12}ab^2, \\ u_N &= \frac{1}{2}\underline{v} - \frac{1}{12}a\underline{v}^2. \end{aligned}$$

We distinguish between two cases, $u_N > 0$ and $u_N < 0$.

Consider a rating system with $u_N > 0$. The problem of the rating agency writes

$$\max_{(b,\underline{v})} (1-\underline{v})(u_B - u_N) = (1-\underline{v})(\frac{1}{2}\underline{v} + \frac{1}{12}a\underline{v}^2 + \frac{1}{2}b - \frac{1}{12}ab^2)$$
$$\frac{1}{2} - \frac{1}{12}a\underline{v} \geq 0, \qquad (6)$$
$$1 - b - \underline{v} \geq 0. \qquad (7)$$

Constraint (6) is equivalent to $u_N > 0$, and (7) is a feasibility condition for the disclosure policy with two ratings. Denote $\lambda \geq 0$ and $\mu \geq 0$ the Lagrange multipliers of these constraints. The first order conditions of the problem are

$$\begin{aligned} b: &\quad (1-\underline{v})(\tfrac{1}{2} - \tfrac{1}{6}ab) - \mu = 0, \\ \underline{v}: &\quad -\tfrac{1}{4}a\underline{v}^2 + \tfrac{1}{6}(a-6)\underline{v} + \tfrac{1}{2} - \tfrac{1}{2}b + \tfrac{1}{12}ab^2 - \tfrac{1}{12}a\lambda - \mu = 0. \end{aligned}$$

Suppose that $\lambda > 0$ and $\mu > 0$. Then $\underline{v} = \frac{6}{a}$ and $b = 1 - \frac{6}{a}$. It implies that $\mu = \frac{(a-6)(9-a)}{6a}$ and $\lambda = \frac{3(a-10)}{a}$. $\mu > 0$ when $6 < a < 9$, and $\lambda > 0$ when $a > 10$. A contradiction.

Suppose that $\lambda > 0$ and $\mu = 0$. Then $b = \frac{3}{a}$ and $\underline{v} = \frac{6}{a}$. It implies that $\lambda = \frac{9(2a-21)}{a^2}$, and $\lambda > 0$ when $a > \frac{21}{2}$. $\mu = 0$ implies that (7) must be satisfied, $\frac{6}{a} + \frac{3}{a} < 1$, or $a > 9$. Then this case is possible when $a > \frac{21}{2}$. The profit of the rating agency in this case is $\frac{27(a-6)}{4a^2}$.

Suppose that $\lambda = 0$ and $\mu > 0$. Then $b = 1 - \underline{v}$, and $\mu = (1-\underline{v})(\frac{1}{2} - \frac{1}{6}a(1-\underline{v}))$. The first order condition with respect to $\underline{v}$ writes $\frac{1}{4}a - \frac{1}{3}av - \frac{1}{2} = 0$, and $\underline{v} = \frac{3}{4} - \frac{1}{2a}$. $\underline{v} > 0$ when $a > 2$. $\mu = \frac{36-a^2}{96a}$, and $\mu > 0$ when $a < 6$. $\lambda = 0$ implies that (7) must be satisfied, $\frac{3}{4} - \frac{1}{2a} \leq \frac{6}{a}$, or $a < \frac{26}{3}$. Then this case is possible when $2 < a < 6$. The profit of the rating agency in this case is $\frac{(a+2)(a+10)}{96a}$. If $a < 2$, then $\underline{v} = 0$, and $b = 1$. The profit of the rating agency in this case is $\frac{1}{2} - \frac{1}{12}a$.

Suppose that $\lambda = \mu = 0$. Then $b = \frac{3}{a}$, and the first order condition with respect to $\underline{v}$ writes $-\frac{1}{4}a\underline{v}^2 + \left(\frac{1}{6}a - 1\right)\underline{v} + \frac{1}{2} - \frac{3}{4a} = 0$ implying that $\underline{v} = \frac{2}{3} - \frac{1}{a}$. $\lambda = 0$ implies that $\frac{2}{3} - \frac{1}{a} \leq \frac{6}{a}$, or $a \leq \frac{21}{2}$. $\mu = 0$ implies that $\frac{3}{a} + \frac{2}{3} - \frac{1}{a} \leq 1$, or $a \geq 6$. Then this case is possible when $6 \leq a \leq \frac{21}{2}$. The profit of the agency in this case is $\frac{(a+3)^3}{81a^2}$.

The next table summarizes the case $u_N > 0$.

a	$\underline{v}$	b	$profit$
$2 \leq a \leq 6$	$\frac{3}{4} - \frac{1}{2a}$	$\frac{1}{4} + \frac{1}{2a}$	$\frac{(a+2)(a+10)}{96a}$
$6 \leq a \leq \frac{21}{2}$	$\frac{2}{3} - \frac{1}{a}$	$\frac{3}{a}$	$\frac{(a+3)^3}{81a^2}$
$a \geq \frac{21}{2}$	$\frac{6}{a}$	$\frac{3}{a}$	$\frac{27(a-6)}{4a^2}$

Consider the alternative system with $u_N < 0$. The problem of the rating agency in this case writes

$$\begin{aligned} \max_{(b,\underline{v})} (1-\underline{v})u_B &= (1-\underline{v})(\underline{v} + \frac{1}{2}b - \frac{1}{12}ab^2) \\ -\frac{1}{2} + \frac{1}{12}a\underline{v} &\geq 0 \text{ and (7).} \end{aligned}$$

Again, denote $\lambda \geq 0$ and $\mu \geq 0$ the Lagrange multipliers of the constraints. The first order conditions of this problem write

$$\begin{aligned} b: &\quad (1-\underline{v})(\tfrac{1}{2} - \tfrac{1}{6}ab) - \mu = 0, \\ \underline{v}: &\quad 1 - 2\underline{v} - \tfrac{1}{2}b + \tfrac{1}{12}ab^2 + \tfrac{1}{12}a\lambda - \mu = 0. \end{aligned}$$

Suppose that $\lambda > 0$ and $\mu > 0$. Then $\underline{v} = \frac{6}{a}$ and $b = 1 - \frac{6}{a}$. It implies that $\lambda = -\frac{3(a^2-12a+12)}{a^2}$, and $\lambda > 0$ when $6 - 2\sqrt{6} < a < 6 + 2\sqrt{6}$. $\mu = \frac{(9-a)(a-6)}{6a}$, and $\mu > 0$ when $6 < a < 9$. Then this case is possible when $6 < a < 9$. The profit of the rating agency is $\frac{(a-6)(18-a)}{12a}$.

Suppose that $\lambda > 0$ and $\mu = 0$. Then $\underline{v} = \frac{6}{a}$ and $b = \frac{3}{a}$. It implies that $\lambda = \frac{3(51-4a)}{a^2}$, and $\lambda > 0$ when $a < \frac{51}{4}$. $\mu = 0$ implies that (7) must be satisfied, $\frac{6}{a} + \frac{3}{a} \leq 1$, or $a \geq 9$. So this case is possible when $9 \leq a < \frac{51}{4}$. The profit of the rating agency in this case is $\frac{27(a-6)}{4a^2}$.

Suppose that $\lambda = 0$ and $\mu > 0$. Then $b = 1 - \underline{v}$, and $\mu = (1-\underline{v})(\frac{1}{2} - \frac{1}{6}a(1-\underline{v}))$. The first order condition with respect to $\underline{v}$ becomes $a\underline{v}^2 - 2(a+2)\underline{v} + a = 0$, implying that $\underline{v} = \frac{a+2-2\sqrt{a+1}}{a}$. Then $\mu = \frac{7\sqrt{a+1}-2a-7}{3a}$, and $\mu > 0$ when $4a^2 + 21a + 42 < 0$. A contradiction.

Suppose that $\lambda = \mu = 0$. Then $b = \frac{3}{a}$ and $\underline{v} = \frac{1}{2} - \frac{3}{8a}$. $\lambda = 0$ implies that $\frac{1}{2} - \frac{3}{8a} \geq \frac{6}{a}$ must be satisfied, or $a \geq \frac{51}{4}$. $\mu = 0$ implies that $\frac{1}{2} - \frac{3}{8a} + \frac{3}{a} \leq 1$ must be satisfied, or $a \geq \frac{21}{4}$. So this case is possible when $a \geq \frac{51}{4}$. The profit of the rating agency in this case is $\frac{(4a+3)^2}{64a^2}$.

The next table summarizes the case of $u_N < 0$.

a	$\underline{v}$	b	$profit$
$6 \leq a \leq 9$	$\frac{6}{a}$	$1 - \frac{6}{a}$	$\frac{(a-6)(18-a)}{12a}$
$9 \leq a \leq \frac{51}{4}$	$\frac{6}{a}$	$\frac{3}{a}$	$\frac{27(a-6)}{4a^2}$
$a \geq \frac{51}{4}$	$\frac{1}{2} - \frac{3}{8a}$	$\frac{3}{a}$	$\frac{(4a+3)^2}{64a^2}$

The global solution to the problem can be found by comparing the profit of the rating agency under the two alternative rating systems. The next table summarizes the global solution.

a	$\underline{v}$	b	$profit$
$a \leq 2$	0	1	$\frac{1}{2} - \frac{1}{12}a$
$2 \leq a \leq 6$	$\frac{3}{4} - \frac{1}{2a}$	$\frac{1}{4} + \frac{1}{2a}$	$\frac{(a+2)(a+10)}{96a}$
$6 \leq a \leq \frac{21}{2}$	$\frac{2}{3} - \frac{1}{a}$	$\frac{3}{a}$	$\frac{(a+3)^3}{81a^2}$
$\frac{21}{2} \leq a \leq \frac{51}{4}$	$\frac{6}{a}$	$\frac{3}{a}$	$\frac{27(a-6)}{4a^2}$
$a \geq \frac{51}{4}$	$\frac{1}{2} - \frac{3}{8a}$	$\frac{3}{a}$	$\frac{(4a+3)^2}{64a^2}$

It completes the proof. ■

Proof of Proposition 4. Recall that under full disclosure the fee for the rating is defined by the willingness to pay of the lowest rated type $\underline{v}$. Under discrete rating system, it is the average willingness to pay of the types rated B, $v \in [\underline{v}, \overline{v}]$. Since the gains of the rating are higher for higher types, the second system will provide higher profit to the rating agency. Indeed, let's compare the profit functions of the rating agency under the two systems for any values of $(\underline{v}, \overline{v}, \beta)$. Denote π^F and π^D the profits of the rating agency under these systems.

$$\begin{aligned}
\pi^D - \pi^F &= (1-\underline{v})(u_R(B) - u_R(\underline{v})) \\
&= (1-\underline{v})(\beta(\frac{1}{2}(\underline{v}+\overline{v}) - \frac{1}{12}a(\overline{v}-\underline{v})^2) + (1-\beta)(\frac{1}{2}(1+\underline{v}) - \frac{1}{12}a(1-\underline{v})^2) \\
&\quad -(\beta\underline{v} + \frac{1}{2}(1-\beta)(1+\underline{v}) - \frac{1}{12}a(1-\beta)(1-\underline{v})^2)) \\
&= \beta(1-\underline{v})(\overline{v}-\underline{v})(\frac{1}{2} - \frac{1}{12}a(\overline{v}-\underline{v})) > 0.
\end{aligned}$$

In words, for any values of $(\underline{v}, \overline{v}, \beta)$ the profit under discrete rating system is higher than under full disclosure. Thus it also holds for the optimal points. Denote by $(\underline{v}^i, \overline{v}^i, \beta^i)$, $i = F, D$ the optimal points. Then

$$\pi^F(\underline{v}, \overline{v}, \beta) \leq \pi^D(\underline{v}, \overline{v}, \beta) \leq \pi^D(\underline{v}^D, \overline{v}^D, \beta^D) \text{ for } \forall(\underline{v}, \overline{v}, \beta).$$

In particular, this condition holds for $(\underline{v}^F, \overline{v}^F, \beta^F)$, and therefore $\pi^F(\underline{v}^F, \overline{v}^F, \beta^F) \leq \pi^D(\underline{v}^D, \overline{v}^D, \beta^D)$.
■

Proof of Proposition (entry of the second agency). We characterize the optimal rating system of the entrant for different rating systems of the incumbent depending on a characterized in Proposition (monopoly). Similarly to the incumbent's behavior, in general the entrant will have incentives to aggregate information. We focus on the case of two ratings. Denote v_e the lowest type that demand the 2^{nd} rating and b_e the mass of companies that obtain rating B from the entrant.

A nessesary condition for a company to purchase the 2^{nd} rating is that it increases the price, that is

$$u_2(R, R_e) - t_e \geq u_1(R),$$

where $u_2(R, R_e)$ denotes the price charged by a company rated R by the entrant and R_e by the incumbent, and $u_1(R)$ is the price of a company rated R by a monopoly rating agency. Also a company rated R by the incumebent must be better off with two ratings than with a single rating,

$$u_2(R, R_e) - t_e \geq u_2(R, N),$$

where $u(R, N)$ is the price of a company that is rated R by the incumbent and has no rating from the entrant. These two constraints imply that

$$t_e \leq u_2(R, R_e) - \max\{u_1(R), u_2(R, N)\}. \tag{8}$$

The optimal rating system of the incumbent solves the following program.

$$\max_{\{v_e, b_e\}} (1 - v_e)t_e$$
$$\textit{subject to } (8).$$

In what follows we characterize the solution to this program depending on the rating system of the incumbent discribed in Proposition (monopoly).

Case $a \leq 2$. In this case the incumbent rates all companies $v \in [0, 1]$ and does not disclose anything beyong that the company is rated, $A = B = R$. All insurance companies charge the same price $u_1(R) = \frac{1}{2} - \frac{1}{12}a$. Under full disclosure, the profit of the entrant who rates companies $v \in [v_e, 1]$ writes

$$\max_{v_e} \ (1 - v_e)(v_e - \max\{(\frac{1}{2}v_e - \frac{1}{12}av_e^2), (\frac{1}{2} - \frac{1}{12}a)\}).$$

For all $a \leq 2$,

$$\frac{1}{2} - \frac{1}{12}a - (\frac{1}{2}v_e - \frac{1}{12}av_e^2) = (1 - v_e)(\frac{1}{2} - \frac{1}{12}a(1 + v_e)) > 0,$$

and $\max\{(\frac{1}{2}v_e - \frac{1}{12}av_e^2), (\frac{1}{2} - \frac{1}{12}a)\} = \frac{1}{2} - \frac{1}{12}a$. Thus the profit is maximized at

$$v_e = \frac{3}{4} - \frac{1}{24}a,$$

yielding the profit of

$$\pi_e^{FD} = \left(\frac{1}{4} + \frac{1}{24}a\right)^2$$

Under partial disclosure, consider a system with two ratings. The profit of RA writes

$$\max_{v_e} \ (1 - v_e)(v_e + \frac{1}{2}b_e - \frac{1}{12}ab_e^2 - \max\{(\frac{1}{2}v_e - \frac{1}{12}av_e^2), (\frac{1}{2} - \frac{1}{12}a)\}).$$

The profit is maximized at

$$\begin{aligned} v_e &= \frac{3(a+2) - \sqrt{3(a^2 + 6a + 12)}}{3a} \in (0, 1), \\ b_e &= 1 - v_e. \end{aligned}$$

The resulting profits of the entrant equal to

$$\pi_e^R = \frac{\sqrt{3}(6a + a^2 + 12)^{\frac{3}{2}} - (9a^2 + 54a + 72)}{54a^2} > 0.$$

Also $\pi_e^R > \pi_e^{FD}$.

Case $2 \leq a \leq 6$. In this case the incumbent assigns the same rating to all companies $v \in [\frac{3}{4} - \frac{1}{2a}, 1]$, and

$$\begin{aligned} u_A &= u_B = \frac{164a - a^2 - 52}{192a}, \\ u_N &= \frac{84a - 9a^2 - 52}{192a}. \end{aligned}$$

An entrant designs a rating system with $A_e = [v_e + b_e, 1]$ and $B_e = [v_e, v_e + b_e]$. The profit of the new rating agency in this case writes

$$\max_{v_e} \ (1 - v_e)(v_e + \frac{1}{2}b_e - \frac{1}{12}ab_e^2 - \max\{u_B, \frac{1}{2}(\underline{v} + v_e) - \frac{1}{12}a(v_e - \underline{v})^2\}),$$
$$\text{subject to } 1 - v_e - b_e \geq 0.$$

Denote $\lambda > 0$ the Lagrangean multiplier of the constraint. Assume that $v_e > \underline{v}$ and $\max\{u_B, \frac{1}{2}(\underline{v}+v_e) - \frac{1}{12}a(v_e - \underline{v})^2\} = u_B$. We check ex-post that the constraints are satisfied for the solution.

The first order conditions write

$$\begin{array}{ll} b_e: & (1-v_e)(\frac{1}{2} - \frac{1}{6}ab_e) - \lambda = 0, \\ v_e: & 1 - 2v_e - \frac{1}{2}b_e + \frac{1}{12}ab_e^2 + u_B - \lambda = 0. \end{array}$$

Suppose $\lambda = 0$. Then $b_e = \frac{3}{a}$ and $v_e = \frac{1}{2}(1 - \frac{3}{4a} + u_B)$. $\lambda = 0$ implies $1 - \frac{3}{a} - \frac{1}{2}(1 - \frac{3}{4a} + u_B) \geq 0$, or $\frac{a^2+28a-956}{384a} > 0$, which is not satisfied for $2 \leq a \leq 6$. A contradiction.

Suppose $\lambda > 0$. Then $b_e = 1 - v_e$ and $\lambda = (1-v_e)(\frac{1}{2} - \frac{1}{6}a(1-v_e))$. Solving for v_e and λ yields

$$\begin{aligned} v_e &= \frac{12(a+2) - \sqrt{3(a^2+28a+244)}}{12a}, \\ \lambda &= \frac{28\sqrt{3(a^2+28a+244)} - (a^2+28a+724)}{288a}. \end{aligned}$$

It is straightforward to verify that $0 < v_e < 1$, $v_e < \underline{v}$ and $\lambda > 0$ for $2 \leq a \leq 6$. Also $u_B > \frac{1}{2}(\underline{v} + v_e) - \frac{1}{12}a(v_e - \underline{v})^2$ is equivalent to $\frac{1}{2} - \frac{1}{12}a(1 - \underline{v} + v_e - \underline{v}) > 0$ which is satisfied for $2 \leq a \leq 6$. The profit of the entrant in this case is

$$\pi_e = \frac{\sqrt{3}(a^2+28a+244)^{\frac{3}{2}} - 36(a^2+28a+180)}{3456a^2},$$

and it is decreasing in a.

Case $6 \leq a \leq \frac{21}{2}$. ■

Appendix B: Tables

Variable	Solvent Insurers μ_{sol}	Solvent Insurers σ_{sol}	Insolvent Insurers μ_{ins}	Insolvent Insurers σ_{ins}	Test Statistic $H_0: \mu_{sol} = \mu_{ins}$
Kenney Ratio: NPW to Policyholder Surplus	1.13	0.85	1.87	1.12	9.591
Reserves to Policyholder Surplus	1.03	0.94	1.64	1.25	7.237
1 Yr. Growth in NPW (%)	11.87	41.62	11.69	61.21	0.042
1 Yr. Growth in GPW (%)	11.94	37.63	11.06	52.93	0.244
Surplus Aid to Policyholder Surplus	2.05	4.34	6.07	7.52	7.816
Investment Yield (%)	5.71	1.38	5.41	1.55	2.778
1 Yr. Growth in Policyholder Surplus (%)	8.82	16.30	-8.50	19.87	12.710
Two-year Reserve Development to Policyholder Surplus (%)	-2.73	10.80	4.00	11.62	8.449
Gross Expenses to GPW	0.58	0.76	0.55	0.64	0.843
1 yr. Change in Gross Expenses (%)	0.05	0.47	0.09	0.58	1.006
1 yr. Change in Liquid Assets (%)	1.17	2.66	0.37	1.79	6.518
Investments in Affiliates to Policyholder Surplus	0.58	1.32	0.94	1.74	3.038
Receiv's. from Affiliates to Policyholder Surplus	0.02	0.04	0.04	0.05	5.243
Misc. Recoverables to Policyholder Surplus	0.03	0.05	0.07	0.08	6.691
Non-investment Grade Bonds to Policyholder Surplus	0.65	2.37	0.68	2.49	0.183
Other Invested Assets to Policyholder Surplus	0.01	0.03	0.02	0.04	3.414
Dummy = 1 if insurer has a large single agent	0.12	0.33	0.22	0.42	3.480
Dummy = 1 if insurer has a large single agent they control	0.08	0.28	0.12	0.32	1.502
Losses, Exp's, Div's and Taxes Paid to Premiums Collected	1.29	0.73	1.59	0.84	5.205
Total Assets (000000's in 2000 $)	433.65	2215.43	100.76	519.92	8.691
Indicator = 1 if insurer is part of a mutual group	0.26	0.44	0.08	0.28	8.965

Figure 1: Summary Statistics. Total solvent firm-year observations: 24,062. Total insolvent firm-year observations: 214

Variable	Coefficient Estimate	Standard Error	Chi-Square Statistic	
Intercept	-0.7577	1.1653	0.4228	
Kenney Ratio: NPW to Policyholder Surplus	0.0047	0.0015	10.3304	***
Reserves to Policyholder Surplus	189.3000	121.0000	2.4455	
1 Yr. Growth in NPW (%)	0.0055	0.0026	4.3943	**
1 Yr. Growth in GPW (%)	0.5068	0.2575	3.8733	**
Surplus Aid to Policyholder Surplus	0.0415	0.0128	10.5759	***
Investment Yield (%)	-0.0117	0.0646	0.0328	
1 Yr. Growth in Policyholder Surplus (%)	-0.0390	0.0063	38.6798	***
Two-year Reserve Development to Policyholder Surplus (%)	0.0311	0.0086	13.0963	***
Gross Expenses to GPW	0.2654	0.1796	2.1834	
1 yr. Change in Gross Expenses (%)	-0.1195	0.1961	0.3714	
1 yr. Change in Liquid Assets (%)	-0.0462	0.0517	0.7956	
Investments in Affiliates to Policyholder Surplus	0.0000	0.0000	10.9740	***
Receivs. from Affiliates to Policyholder Surplus	3.3208	1.6962	3.8327	*
Misc. Recoverables to Policyholder Surplus	2.1060	1.2641	2.7755	*
Non-investment Grade Bonds to Policyholder Surplus	0.0556	0.0317	3.0818	*
Other Invested Assets to Policyholder Surplus	6.7624	2.2026	9.4257	***
Dummy = 1 if insurer has a large single agent	0.6341	0.2205	8.2740	***
Dummy = 1 if insurer has a large single agent they control	-0.3205	0.2870	1.2477	
Losses, Exp's, DiVs and Taxes Paid to Premiums Collected	0.6960	0.1589	19.1885	***
Ln(Total Assets in $2000)	-0.4707	0.0665	50.0860	***
Indicator = 1 if insurer is part of a mutual group	-0.8337	0.2709	9.4694	***
Log Likelihood Function Value	-908.617			
Pseudo R^2	25.86%			

*** - significant at the 1 percent level; ** - significant at the 5 percent level; * - significant at the 10 percent level

Figure 2: Regression results.

Firm Type	Num	Ave.	Median	Standard Deviation	1st Percentile	99th Percentile
Solvent	24,062	0.81%	0.20%	2.46%	0.01%	11.08%
Insolvent	214	9.35%	4.46%	12.78%	0.09%	66.45%

Figure 3: Estimated Default Probabilities: Summary Statistics

Insurer Rating Categories: A.M Best vs. Standard & Poor's

Number	Description	A.M. Best	S&P
4	Extremely Strong	A++,A+	AAA
3	Strong	A	AA
2	Good	A-	A
1	Adequate	B++,B+	BBB
0	Marginal	B and below	BB and below

Figure 4: Insurer rating categories

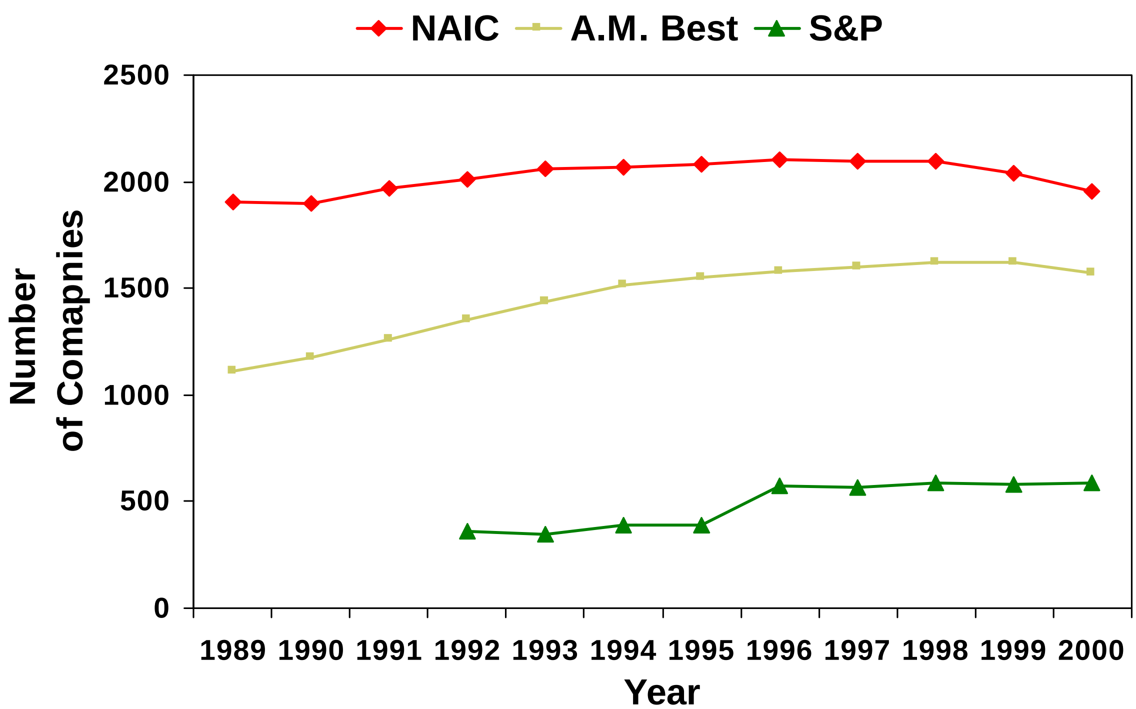


Figure 5: Coverage of the P&L Industry: Number of Companies

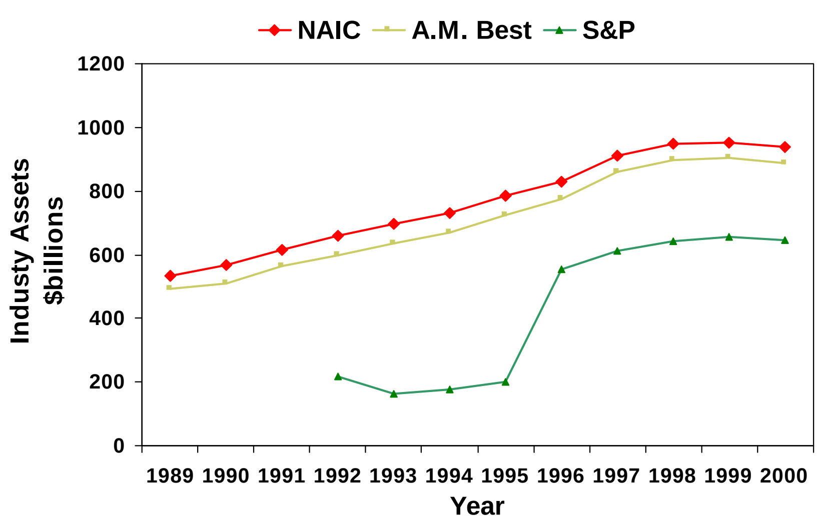


Figure 6: Coverage of the P&L Industry: Assets

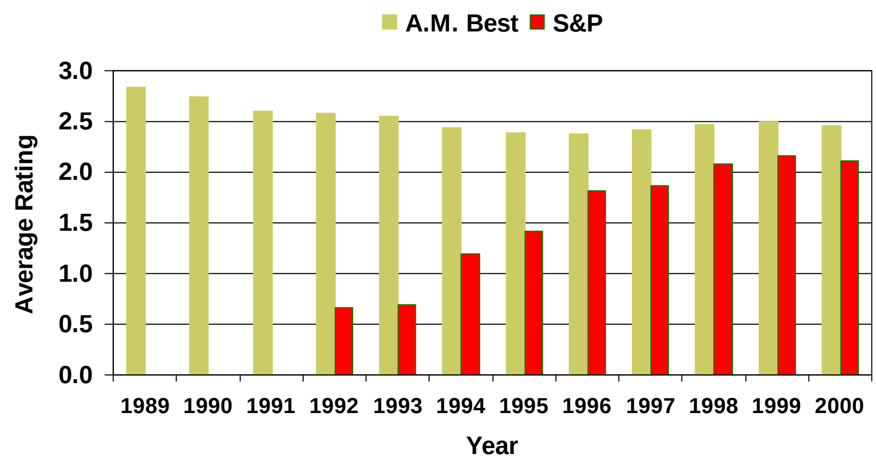


Figure 7: Average ratings 1989-2000

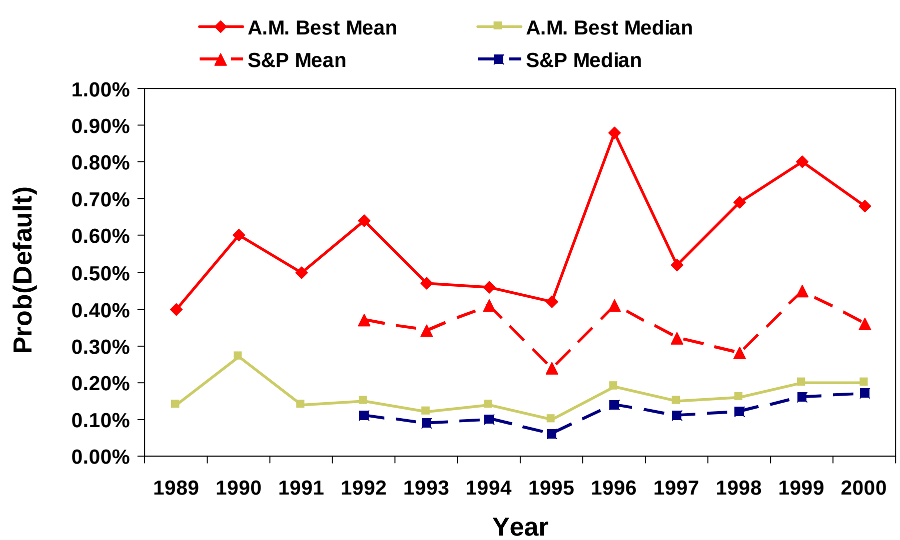


Figure 8: Average Probability of Default

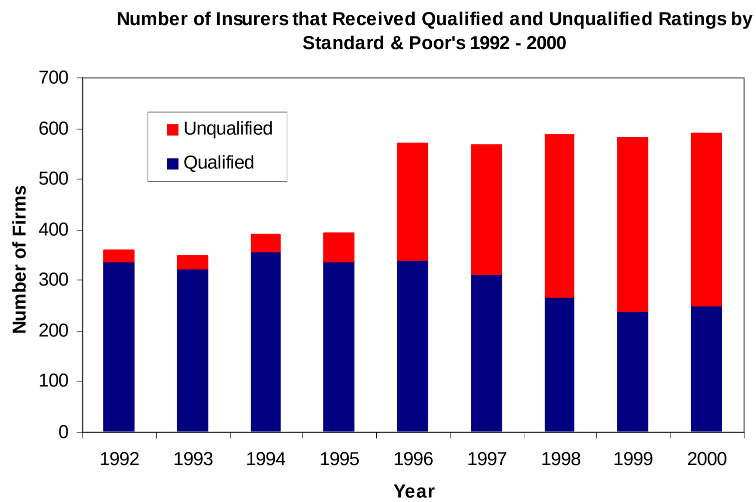


Figure 9: S&P Entry: Qualified versus Unqualified Ratings

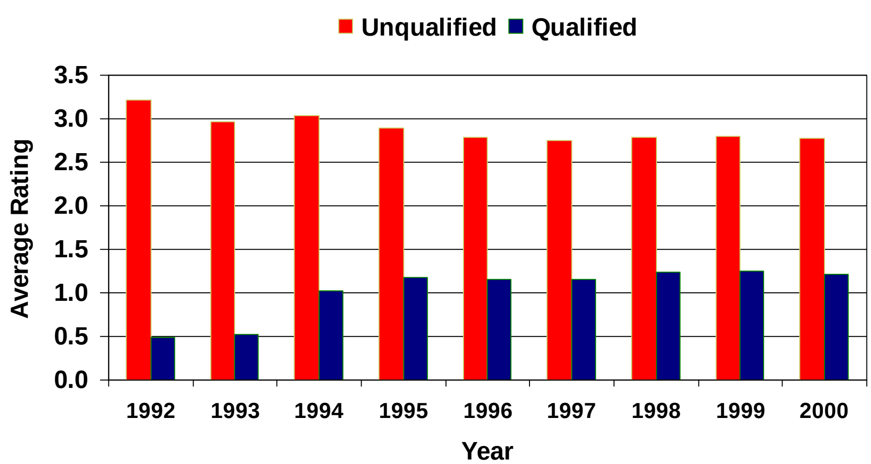


Figure 10: Average S&P Rating: Qualified versus Unqualified

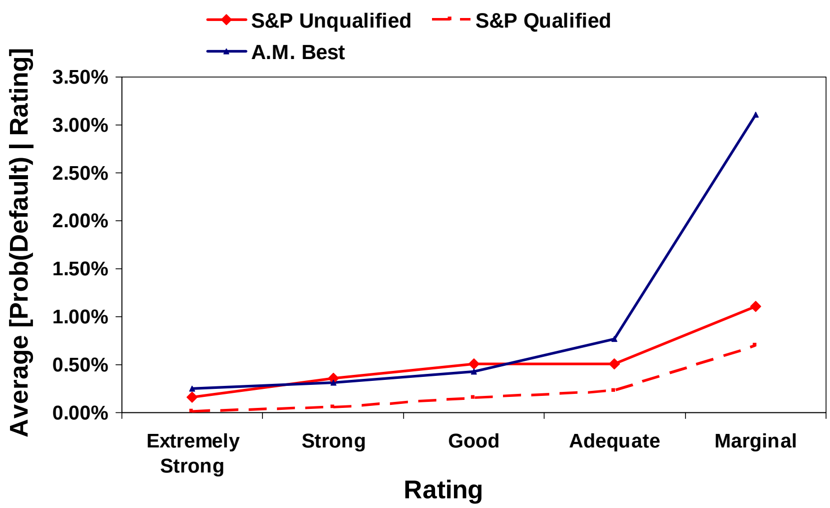


Figure 11: Stringency: Average Default Probabilities by Rating Category

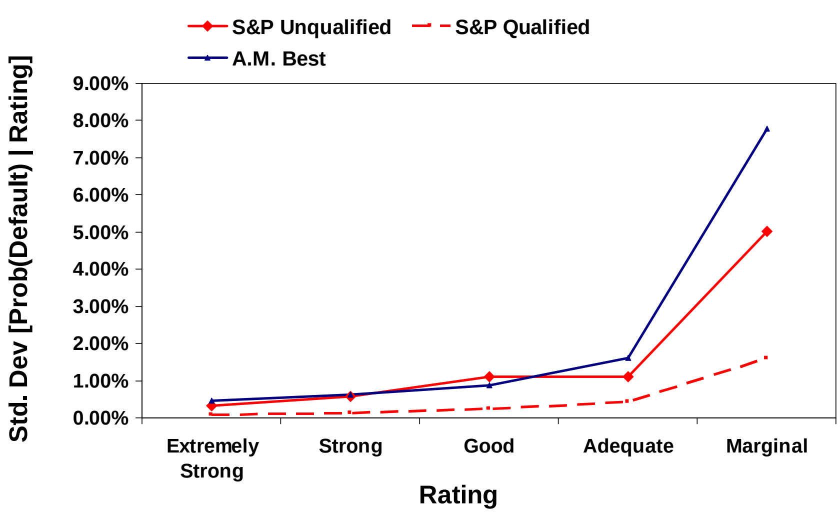


Figure 12: Accuracy: Standard deviation of default probabilities by rating category

Panel A

A.M. Best Rating	S&P Full Rating: Marginal	Adequate	Good	Strong	Extremely Strong
Marginal	1	0	0	0	0
Adequate	3	5	9	4	0
Good	0	51	147	29	6
Strong	0	4	280	118	9
Extremely Strong	0	0	56	490	281

Total number of firm-year observations: 1493

S&P and A.M. Best agree:	36.97%
S&P and A.M. Best almost agree:	58.34%
S&P rates significantly higher than A.M. Best:	0.67%
S&P rates significantly lower than A.M. Best:	4.02%

Figure 13: Ratings on Common Firms: A.M. Best versus S&P Full Rating

Panel B

A.M. Best	S&P Qualified Rating: Marginal	Adequate	Good	Strong	Extremely Strong
Marginal	69	26	0	0	0
Adequate	175	100	11	0	0
Good	154	236	84	2	0
Strong	198	413	291	8	0
Extremely Strong	140	317	265	78	9

Total number of firm-year observations: 2576

S&P and A.M. Best agree:	10.48%
S&P and A.M. Best almost agree:	31.79%
S&P rates significantly higher than A.M. Best:	0.00%
S&P rates significantly lower than A.M. Best:	57.73%

Figure 14: Ratings on common firms: A.M. Best versus S&P qualified ratings

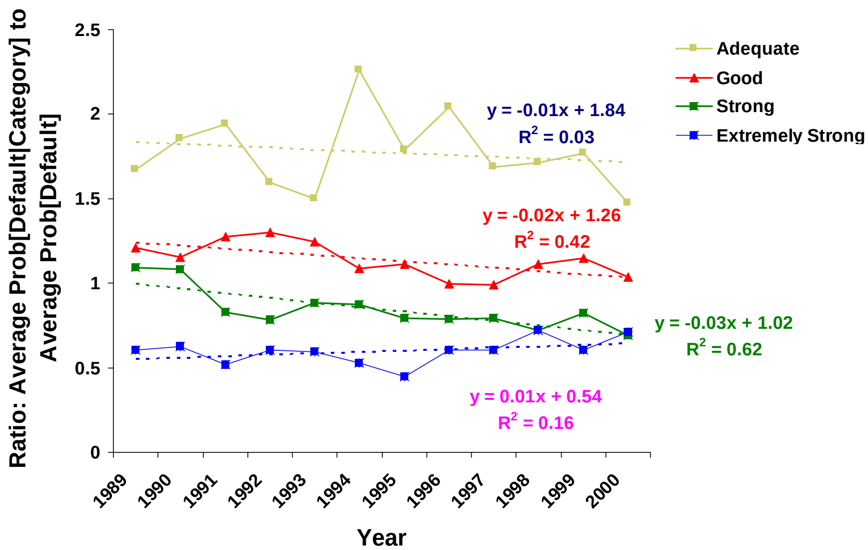


Figure 15: Did A.M. Best Stringency Change?

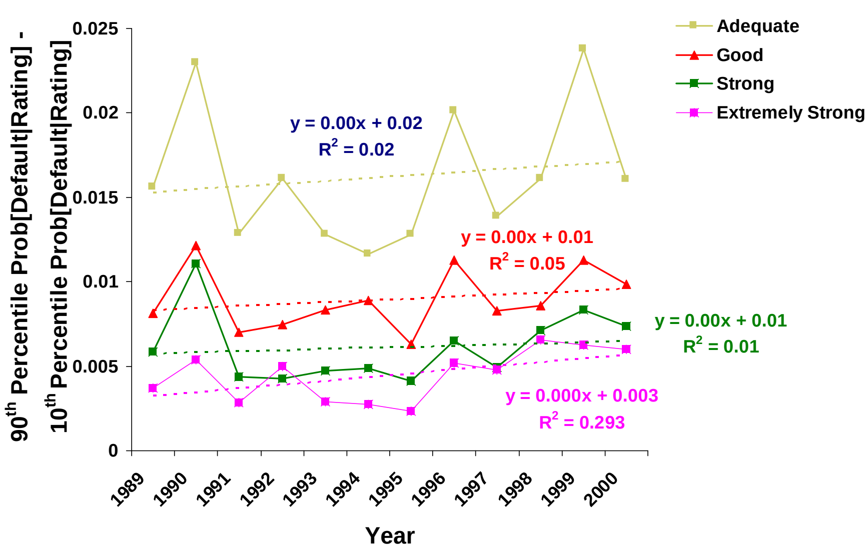


Figure 16: Has A.M. Best accuracy changed?