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CERTIFICATION DISCLOSURE AND INFORMATIONAL EFFICIENCY: A CASE FOR ORDERED RANKING OF LEVELS

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Certification Disclosure and Informational Efficiency: A Case for Ordered Ranking of Levels

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Abstract

This paper shows that a monopolistic certifying party can have incentives to disclose revealing information about the agent he is certifying. Using a three-person game-theoretic model and allowing certificate users (buyers) to have noisy estimates of the quality level of the agent being certified (seller), a disclosure in the form of ordered ranking of levels is predicted. This contrasts with previous results in certification theory stating that monopolistic certifiers disclose a minimum amount of information (with no informational value) about the party being certified, in order to extract all informational rents from the market. The predicted disclosure is consistent with real life observations of certification disclosure as found in debt ratings (notches) and hotels listings (using a discrete system of stars). The model is robust enough to explain the results of previous models. The paper also adds to the existing literature an evaluation of four different strategies of information disclosure that are available to a certifier.

Keywords: Certification, Information Asymmetry, Disclosure Strategies
JEL Classification Numbers: C72, D18, D82, L15, L86

1 Introduction

Certification is an activity whose objective is to dissipate market frictions that impede the direct exchange of information among agents. Asymmetric information is therefore necessary for certification to arise. When a player is better informed than his coplayer in a game, the uniformed player may have an incentive to acquire costly information from a certifier. Certification is sometimes considered an intermediation activity: a company may use a certifier (or a certificate) to convey information about itself that is relevant and unknown to its clients but can be detected by a certifier. It has been described sometimes as if the buyers were purchasing from the certifier, not the seller. However, certification is not necessarily an intermediation activity, in the sense that the agents involved in it (the user and the certified party) may not directly compensate the certifier for his work (this is the case of consumer protection agencies, government bodies and non-profit organizations).

Several market frictions that impede either the certified party from disclosing information directly or the user from accessing this information exist. Examples of these frictions are: doubts that consumers may have in sellers' claims if the sellers have incentives to lie, difficulties in assessing the attributes of a product by a consumer, etc. Certification can therefore help both buyers and sellers in an economy when there is uncertainty about the qualities of suppliers or products (see Akerlof, 1970 and Viscusi, 1978).

Trust problems also can be addressed with the use of a certifier. When a buyer sees a certificate from a known certifying party, stating that supplier X has high quality, or is trustworthy, or complies with certain standards, the buyer no longer depends on trust in his decision to buy or not from the supplier, for she has the information provided by the certifying party. Some may argue that the trust relationship has merely shifted from the seller to the certifying party. This is not necessarily true; as long as the certifier has no incentive to lie, the buyer can be confident that he is revealing truthful information, and there would be no need for trust. A certifying party may have an incentive to lie when he charges the seller for the certificate (as is discussed in Section 3.2). One way to overcome this moral hazard problem is to charge a fixed price for certification regardless of the quality of the party being certified. Still there is a chance of certifier moral hazard if the sellers expect to receive a favourable treatment by simply applying for a certificate. Reputation for the certifying party can help overcome this difficulty.

There are several benefits that certification can bring to an economy. As demonstrated by Akerlof (1970), absence of information can unravel a market so that low quality goods push out high quality goods, causing a market breakdown. As Viscusi (1978) proposed, certification offers an alternative to exit for high quality providers. Informational asymmetries can lead to undesirable monopolistic rather than competitive competition, adverse selection and moral hazard may impede markets from developing, hidden information may skew competition towards observable attributes instead of desirable attributes (e.g. appearance instead of quality), etc. All these problems may be overcome by certification.

The paper is structured as follows. Section 2 reviews the existing certification literature, Section 3 provides an example of certification from the Bond Rating Industry and presents some issues open to a certifier. Section 4 develops a game-theoretic model of certification that establishes that (contrary to current literature) a certifier can disclose useful information about the party being certified. Section 5 presents a linkage between certification theory and other disciplines. Section 6 concludes.

2 Review

This section will describe the literature relevant to certification. Given the limited attention that certification has encountered in the past, this section intends to provide a comprehensive guide to the existing literature, as a result a brief description of each paper is provided

Akerlof's Market for 'Lemons', 1970

This seminal paper demonstrates that asymmetric information about the quality of a product can have unravelling effects on individual behaviour, driving down the average quality of the products offered, and sometimes leading to complete market failure. The basic model considers good cars and bad cars (or 'lemons') (this is a simplification, as Akerlof also distinguishes between new cars and old cars). If only sellers can identify good cars from bad cars, all cars will sell at the same price, however, as good cars are more valuable than lemons, owners of good cars then will not be willing to sell their cars at the average price, and will be driven out of the market, and only lemons will be traded. The model goes on to show that with a continuum of qualities no market will develop. The paper relates this example to the insurance market, the employment of minorities, the cost of dishonesty, and credit markets. It mentions some counteracting institutions such as guarantors, brand names, and licensing. Although the paper fails to mention certification directly (even though there were certification markets in place at the time, such as the debt rating industry), we can consider the work of some of the institutions mentioned as certification of a sort.

Viscusi's 'Lemons' markets with certification, 1978

Viscusi's short paper introduces quality certification as an alternative to leaving the market for high quality producers. The paper models workers in an industry choosing among potentially hazardous jobs, whose individual risks cannot be identified by the workers. The model shows that certification will unravel from the top down: the safest company certifies, lowering the expectation of safety in the remaining companies, forcing the second safest company to certify, and so on until a company's expected profit from certification is lower than the price of the certificate. The model shows that certification has potential distributive effects, as the wage bill for the industry remains the same, but workers in high-risk jobs get a higher wage.

Leland's Quacks, Lemons and Licensing, 1979

This study examines the use of quality standards (licensing) as a solution to the quality deterioration problem in lemons markets. It exemplifies this through the medical profession, in which, without licensing, "doctors" could range from the highly qualified to "quacks". It shows that with asymmetric information the level of quality will be lower than the social optimum. It then proposes quality standards to raise the level of quality, and illustrate that markets with greater sensitivity to quality, lower elasticity of demand, lower marginal cost of quality, and lower valuation of inferior services are the most likely to benefit from quality standards. The study shows that when quality standards are set by the industry or profession (a type of self-certification), they are likely to be set too high (however this is not always the case).

Kim's Market for 'Lemons' reconsidered, 1985

Kim's paper improves Akerlof's model by letting agents choose between being buyers and sellers (this flexibility is valid in the car market, where there are minimal changing costs, but is not necessarily true of insurance and labour markets). It also makes quality an endogenous variable affected by driving habits, maintenance, etc., and allows for different agent's types. It uses a two period model where cars are new in the first period and old in the second, owners can sell their car or keep it, and decide the level of maintenance for the car. With this model Kim's show that it is not necessarily true that the quality of traded cars is lower than the quality of non-traded cars, as some people may value the service level of the car so highly that they provide good maintenance for their cars, and because they value service so highly they sell their old car in period two to buy a new car, selling a high quality car in the used car market.

Shapiro's Occupational Licensing, 1986

This paper treats licensing and certification as inputs into the production of services rather than controls of quality. The example provided is the medical profession: to obtain a license the professional must get those qualifications that are inputs in his profession. This labelling scheme that determines a minimum level of training (that required for a degree, for example) is a form of certification. The model shows that licensing raises the costs of supplying low quality services, and therefore benefits consumers valuing high quality at the expense of those who do not. This means that even thought it increases aggregate consumer surplus, licensing will not be Pareto improving. Another result is that if training levels are observable (by certification) no consumer can be made better off by licensing. A drawback of certification in this model, though, is that it can lead to over-investing as a signalling device, which can be Pareto inferior to licensing or *laissez-fare.*

Faulhaber and Yao's Market for Product Reviews, 1989

The model of certification (or 'Product Review' as this paper calls it) presented in this study introduces an information intermediary. The model assume there are high quality firms that provide products valued at V by consumers and low quality or "fly-by-night" firms that offer products valued at zero by consumers. Consumers cannot identify the type of firm they are facing, but can buy informative and accurate product reviews from a third-party provider. The model establishes that the third-party cannot charge producers and be credible. The model also allows high quality firms to gain reputation in their first period, live for T periods and then disappear (they justify this as a model of fixed-lifetime for doctors, lawyers and consultants). Low quality firms gaining a bad reputation disappear in the next period. The paper finds that decreasing the cost of providing and using information increases the margins of reputable firms, decreases the prices of new entrants, and leads to more high quality firms and fewer "fly-by-night" firms.

De and Nabar's Implications of imperfect quality certificatio n, 1991

De and Nabar consider the case in which certification is imperfect (in the sense that the certificate is not perfectly accurate) but 'efficient' (the probability that a product gets classified correctly in its category is higher than the probability of lower quality products being classified in that category). Their model considers only two quality categories: high and low. Their results show that with imperfect certification there is room for three types of equilibriums: a differentiated pooling in which all sellers certificate when the cost of the certificate is low; a differentiated semi-separating where all high-quality sellers certify and low-quality sellers chose a mixed strategy, when the costs are above the differentiated pooling level, but not so high as to make the certificate too expensive; and a pooling equilibrium where no seller certifies and the certifier is driven out of the market, if the price of the certificate is too high. In the first two equilibria there is a higher expected profit for high quality sellers that for low quality ones, demonstrating the welfare improving function of the certifier. Another result in their study is that higher accuracy results in a lower demand of certification, as all high quality firms keep certifying, while some low quality ones drop out (or certify less often, if they are using a mixed strategy).

Choi's Certification Intermediaries, 1996

This legal mimeo presents an informal analysis of the role that certifiers play in disseminating information and signaling. The paper distinguishes pure certifiers from gatekeepers, the former reporting information to users; the latter precluding misconduct by preventing firms from selling in the market. The study lists various certification intermediaries, as well as channels for signaling, such as issue of certificates (bond rating agencies, voluntary standard bodies) or signaling by association (underwriters).

Coestier's Reputation and Certification, 1998

This is a model of individual reputation with repeated purchase and moral hazard. Coestier considers an agricultural food product in a market with two segments: high and low quality. The quality in the low segment is observable by the buyers (there is a lower bound to the quality that can be supplied and the firms in this segment produce at this level). In the high-quality segment there is asymmetric information, as only the sellers know the exact quality of their products. There is a continuum of buyers, who can choose whether to buy or not, and in which segment. The consumers have the same preferences (at any given price they will prefer high quality to low quality), but have different valuations for quality differences. There is a costly test to get the quality certified, and room for reputation formation. The results of the model are that if the marginal cost of the test is sufficiently low, the price of high quality is greater than marginal cost (but lower than the equilibrium price that would prevail without certification). Voluntary quality certification in this model lessens (but does not solve) the moral hazard problem. It is shown that public financing of certification results in a socially inefficient outcome, while the establishment of a private body (industrial association) charging a fixed affiliation cost and a periodic premium can help improve efficiency.

Franzoni's Imperfect Competition in Certification Markets, 1999

This study provides an analysis of certification market with imperfect competition. Firms must comply with endogenous standards and certifiers act as gatekeepers, being able to stop non-compliant firms. This game-theoretic model assumes profit maximiser certifiers whose efforts are non-observable to third parties. This poses a moral hazard problem as certifiers exert effort only as they risk liability for erroneous certification. Firms have exogenously given compliant costs uniformly distributed in a closed interval. The paper uses a Bayesian-equilibrium analysis and finds that for a certification price below a threshold value all firms enter an activity, but only those with low compliance cost comply with the regulation, above that price value only compliant firms engage in business. The model also asserts that in equilibrium all certifiers exert the same effort. The paper concludes with a policy analysis of the optimal level of certifier's liability and the evaluation of price regulation.

Lizzeri's Certification intermediaries, 1999

The paper addresses the extent to which certification intermediaries have an incentive to reveal information to uninformed parties. It offers an innovative approach by treating information revelation as a strategic decision for the intermediary. There are four agents in the market: one informed seller (S), two uninformed buyers (B), and one certifier (C). S offers an object whose quality is worth t to the buyers. Neither S nor C values the object. S knows t, and both Bs and C have a prior F(t) which is continuous in the interval [a,b], where. 0 ≤

a < b. C can discover t at no cost. S cannot signal t except by paying P to C. The model assumes a five stage process:

1. C sets price P and commits to a disclosure rule D that maximises his profits. (D can take the form of disclosing the value of t, whether t is above certain value, a rank disclosure, etc.)
2. S decides whether to go to C for certification knowing P, D, t
3. If S pays P, C discovers t
4. The Bs observe D, P whether S paid P or not and C's disclosure.
5. The Bs bid independently and simultaneously for the product.

The decisions of the players are: C chooses a strategy of form (P, D), S chooses whether or not to pay P given P, D, t, and Bs choose their bids conditionally on whether S paid P or not, P, D, and C's disclosure if S paid P.

The results of the model show that under full disclosure all equilibria have a threshold strategy for S such that Ss with $t > x$ pay P, and Ss with $t < x$ do not. That is, for continuous values of t there is a threshold under which it is not profitable to pay P, and above such level it is profitable to do so. For example, with a uniform distribution F(t) in [0,1] the optimal price for C will be $P = {}^1/_4$, those Ss with $t < {}^1/_2$ not certifying and those Ss with $t \geq {}^1/_2$ certifying. In this case the expected profit for S without certification was ${}^1/_2$, but after the certification the market unravels so that only those with t above ${}^1/_2$ expect a gain from certifying, and those not certified sell their product at ${}^1/_4$, the expected value of uncertified t. A striking result is that there is an equilibrium in which C sets $P = E(t) - a$ (where a is the lower bound on quality), C discloses no information (other than that the seller is not of the lowest type, of which there is a zero probability since F(t) is continuous), and all types of S certify. What drives this result is that if the Bs expect all Ss to pay P, S pays P to signal that he is not of type a, in order to receive E(t).

Another result from Lizzeri's paper is an equilibrium without certification if the price of the certificate is too high. The model also considers the case of products that can give negative payoffs to the Bs (dangerous or unsafe products, etc.); in this case there are possibilities for the collapse of the market when $E(t)<0$. Certification could alleviate this inefficiency (there are some products in the market with positive quality, therefore if there is no market there is an inefficiency) and the certifier would improve social welfare. The paper also shows that the certifier could have an incentive to restrict the number of sellers in the market in order to capture a larger share of the information surplus. The author concludes that C's power to extract rents comes from its ability to restrict information, rather than from selling something valuable to the seller.

Jougleux's Certification for Quality Improvement, 2000

Jougleux's paper provides two informal analyses of certification: as a quality improvement tool and as a signaling tool. The study uses the example of the French Norm *NF* for its analyses. It differentiates types of certifiers from third parties, associations and private organizations. It describes the functions of certification as a signal, a reference, and a reporting tool. The study discusses three problems of certification: incertitude, differences in appreciation and quality heterogeneity even within certified parties. The paper concludes that certification can provide two non-exclusive functions: a communication device and a quality improvement tool. Most of the discussion of the paper is centered on service certification.

3 Certification

3.1 Bond Rating: An example on Certification Development

This section describes the development of the bond-rating industry, as it illustrates some of the problems inherent in certification and their possible solutions. For a detailed history of the industry see Cantor and Packer (1994).

Bond Rating is a typical certification activity: bond issuers cannot credibly transmit their financial situation / risk profile to investors. The assessment of this profile can be done at a cost by specialized agents. These agents can then transmit this assessment to interested investors. The bond rating business started from mercantile credit agencies such as that of Louis Tappan, established in New York in 1841, in the aftermath of the financial crisis of 1837. Tappan's agency estimated the ability of merchants to fulfil their obligations. John Bradstreet created a similar agency in 1849 and published his first rating book in 1857, while Robert Dun acquired Tappan's in 1859 and published his first rating guide in 1859. Both companies merged in 1933 to form Dun and Bradstreet, which acquired Moody's Investors Services in 1962. John Moody was the first one to rate securities rather than businesses when in

1909 he began rating U.S. railroad bonds. Standard and Poor's (S&P) was formed in 1941 from the merger of Poor's Publishing Company and the Standard Statistics Company, which began rating in 1916 and 1922 respectively. Other companies providing rating services include Fitch Publishing Company and Duff and Phelps, which have covered companies since 1924 and 1932 respectively. These companies initially provided ratings free of charge to the issuer; their revenue came from the publication of rates. There was a public goods problem, however, as the ratings were copied with ease, or transmitted amongst interested parties, without generating revenue to the rating agencies. Agencies tried to charge issuers but faced resistance, until Penn Central defaulted on its commercial paper in 1970 and investors began to refuse to roll over commercial paper of other companies. Issuers then started requesting ratings to comfort scared investors, and rating agencies were able to charge issuers. Agencies do not charge for all ratings, and sometimes they release unsolicited ones. Agencies do not charge a fixed single amount for ratings, as suggested above to avoid moral hazard; their charges vary with the principal and the life of the bond. Rating agencies also have negotiated rates for frequent issuers. This practice has not damaged the reliability of the ratings, as these companies have a reputation to preserve and the value of future business outweighs their possible benefits from improving the ratings of any single client. Most agencies make their ratings public once a company has requested it (however a company has the right to see it in advance and present arguments in favour of changing the rating if needed). Only Duff and Phelps withholds the rating until the client requests that it be made public. Ratings are usually issued as rank-orderings, but sometimes they are used as cut-off measures (as the practice of using BBB or Baa ratings to separate investment grade and non-investment grade bonds). Over time agencies have developed finer definitions of ratings to help distinguish among issuers: Fitch, S&P and Moody's started attaching + and – signs to their ratings in 1973, 1974 and 1982 respectively. Furthermore they have added an outlook, to signal the direction in which they believe the rating is more likely to move in the future.

3.2 Certification Issues

As we saw from the example of the bond ratings industry in the previous section, there are many issues that must be addressed when introducing a certificate in the market:

1. Who should pay for the certificate?
2. Price of the certificate
3. Who should be certified?
4. Depth of the certificate
5. Disclosure of the certificate

This section provides some ways to address these considerations. Please note that the list is not intended to be complete or applicable to all cases, but is provided as a starting point for discussion of the different issues concerning certification.

Who should pay for the certificate?

A certificate is considered a public good, as its use by one agent does not prevent other agents from using it. As Beales, Craswell and Salop (1981) point out, information markets present imperfections due to their natural monopoly features (there is a low marginal cost for distributing information once it has been produced), and their free rider problems (buyers can resell or give away acquired information to others). These problems are alleviated if the party being certified pays for the certificate, as happens in the bond ratings industry. Coestier (1998) proposes a public financing of certification, given its public good characteristics, and that otherwise there could be too small a supply of certificates. The user of the certificate can also be charged, as is the case in the UK with the Automobile Association, which charges the potential buyer for a certificate on used cars, instead of the car owner. Unfortunately there is no easy way to determine who should pay for a certificate; as a matter of fact, sometimes there are no efficient ways to compensate the certifier. For example, if a certificate benefits a consumer more that a supplier, why should the supplier have to pay for it? One could argue that the supplier can pass the cost to the consumer, but what will happen if not all consumers require the certificate? Some consumers would be subsidizing the cost of the certificate for others.

Pricing the Certificate

If the seller pays for the certificate (which, given the public-good nature of a certificate, is the sensible thing to do), choosing a price produces a moral hazard: if the certifier charges a higher price for a better certificate (which in follows from the higher value that a seller attaches to a good certificate), he has an incentive to lie and increase the rating of all his clients to increase revenue. One way to overcome this moral hazard problem is to charge a fixed price for certification regardless of the quality of the party being certified. Still there is a chance of certifier moral hazard if the sellers expect to receive a favourable treatment by simply applying for a certificate. Reputation for the certifying party can help overcome this difficulty as the example of the debt ratings industry showed.

Choosing whom to certify

When there exist several certifiers in a market, sellers may go "shopping" for the best certificate they can obtain and therefore diminishing the public value of the certificate. To avoid this problem all those that can be certified could be subject to certification. This explains the phenomena of unsolicited ratings in the bond rating industry. Unsolicited certification can be a problem in pricing certificates, as some sellers could try to free raid and wait for an unsolicited certificate instead of paying for a certificate. Random assignment of unsolicited certification could assist in this problem. Universal certification can also help to interpret certificates for users: a rating of $A+$, or three stars may not provide enough information to a consumer, but finding known companies in a certain rating group could help in assessing unknown companies. As some companies would rather not certificate themselves at a given price, if this price is greater than the expected benefits of certification, an unsolicited certificate could bring them to these comparison groups for the benefit of the consumer.

Depth of the Certificate

A certificate should cover those characteristics that matter to the user, and provide accurate and useful information. This may seem obvious, but it is not always the case. For example, consider the star rating system for holiday resorts. Even though it is helpful in establishing quality within a market, it is extremely noisy across markets. A 4 star hotel in Paris is quite different from a 4 star hotel in America, and both are very different from a 4 star hotel in Singapore. Section 4 will show that rank-ordering systems develop naturally in a monopolistic certification market. One point to consider is that the partition used by a ranking order is likely to evolve once the users of the certificate become capable of finer discrimination. This is exemplified in the bond rating industry, in which agencies had to append the + and – signs to their ratings, and have added further 'outlooks' to their ratings. Against increasing the depth of the certificate, Faulhaber and Yao (1989) point out the "user cost" of understanding and remembering certificates. They claim that a simple "OK/not OK" rating such as the Good Housekeeping Seal may dominate complex systems.

Disclosure of the Certificate

To avoid noise in the market a certifying party should disclose the result of its enquiry regardless of its result, for otherwise companies with bad certificates would not display them and this would bias certificates upwards. This is because if companies can decide when to disclose a certificate, they will choose to disclose it only when it is valuable for them to do so, which may be when the certificate is either accurate or positively biased (but not necessarily, as a company may want to disclose even a negatively biased certificate if it improves the expectation of the consumers from an uninformed situation). The bias in certificates could induce a revision in its users about the informativeness of the certificates, introducing unnecessary uncertainty to the market.

4 A New Certification Model

This section challenges the result from Lizzeri, 1999, stating that a monopolistic certifier will disclose a minimum amount of information (with no informational value) about the party being certified and all players certify. Trough a three-player model that allows the buyers to have a noisy estimate of the quality type of the seller, the real world observation that certification is given in the form of an Ordered Ranking of Levels (ORL) is supported. The resulting model is robust enough to explain Lizzeri's results.

4.1 Restrictions in Certification Literature

In the certification literature it has been claimed that the optimal choice for a monopolistic certifying party (C) is to reveal the minimum amount of information possible: specifically, to disclose only that the seller is not of the lowest type, which under the assumption of a continuum of quality types is a zero probability event (Lizzieri, 1999). Models of certification have assumed that, when certification exists, it is binary, therefore limiting the amount of information that can be disclosed by C. Product quality has been modelled as binary as well (De & Nabar, 1991; Biglaiser, 1993). Real life examples of certification, however, give more information than the minimum predicted or assumed by the models. Hotel and restaurant ratings, for example, are given in the form of "stars" generally indicating 4 or 5 levels of quality. Bond rating by agencies include up to ten levels of quality with positive and negative qualifiers, resulting in almost 30 certification levels for debt performance. Educational qualifications are expressed in degree classes. If, as is claimed in the literature, it is optimal for the intermediary to reveal only the minimum amount of information possible, why are certifying agencies providing additional information? The answer may lie in the limiting assumptions of current models that make them too unrealistic to address real life situations.

Some of the restrictive assumptions of the models are that the parties seeking certification are completely incapable of sending signals directly to the market, and have no alternative but to go to a certifying authority; also, that are subject to similar constraints as a group, with quality type providing no leverage. These assumptions, however useful for simplifying models, are difficult to support in the certification industry. For example, companies do not always use certification, even when available, which shows that they do have alternatives to certification. In finance, a company can decide whether to issue debt in the financial markets (and apply for a rating from an agency such as Moody's or Standard & Poors) or finance its activities with alternative funds (loans, venture capital, equity, private debt placement).

Another assumption is that customers for the companies seeking certification are unable to distinguish different quality levels without the aid of a certifying party. In real life, however, consumers are capable of discerning some level of quality from the companies they patronise, or they at least form a belief about the trustworthiness of the companies before dealing with them, to help them decide whether to buy or not. For example investors may use a company's financial statements to estimate its quality and calculate its probability of default, if no information from a rating agency is available. Similarly, two restaurants that are not included in the guide Michelin will not necessarily be considered to have the same quality distribution by their clients, who would not rely solely on guides or magazines as sources of information, having access to other sources of information such as word of mouth, advertising, etc.

More realistic assumptions would allow companies to engage in commercial activities without certification, even when certification is available. Certification may help companies seize certain market opportunities, but without certification they can consider alternative projects. For example, an entrepreneur could evaluate the possibility of creating a business. He can launch an e-business, or establish a street store. The advantage of his e-commerce venture over the street store would depend on the possibility of attracting customers. If the absence of adequate certification sways customers away from e-commerce he would rather set up a street store. Similarly, in capital markets, if a corporation wants to issue debt, but the absence of adequate debt-rating systems makes issuing stock more attractive than issuing debt, the company would finance its activities through equity, without applying for a certificate from a debt-rating company.

Another way to improve the models is to allow buyers to have a noisy estimate of a seller's quality. Companies generally engage in signalling activities through advertising, property and equipment acquisition, etc. Our entrepreneur considering e-commerce, for example, could buy physical assets for warehousing, enter into long term contracts with known suppliers, establish customer guaranties with a bank, etc. to help him differentiate himself from other e-business. By allowing these sensible features into a model we could represent a certification decision process more realistically.

Minimum information disclosure is sub-optimal for the Certifier: an example

Imagine a market in which a debt-rating agency discloses the minimal amount of information possible, as predicted by the literature. This agency would disclose whether or not a company is above a "minimal acceptable level of bankruptcy safety" (b). Let's assume that a company at the b level has a spread of x basis points (bps) above the risk-free asset (r_f). There is a continuum of companies, each company i knowing its level of risk r_i, which has associated with it a fair market spread of x_i bps above r_f. A company will be willing to raise debt if the market is offering a cost of debt not greater than x_i, and otherwise it would look for alternative funds (venture capital, equity, bank loans) at a cost of $x_i + e$. If the capital market has no information about the quality of the company other than that given by the rating agency, there would be a unique price of p bps for debt, between 0 and x ($0 < p < x$), as all companies would be rated identically. Those corporations who could access alternative sources of funds for less than p would do so, getting out of the debt market. The market would then take this into account and raise p, which would unravel upward to the level of x, and only those corporations at the b level would issue debt. The certifying party could now increase its revenue by disclosing two risk levels, for example, companies whose level of risk justifies less than $^{x}/_{2}$ bps spread, and companies whose level of risk is in the $^{x}/_{2}$ to x bps notch. With this certification two types of company would certify, those at the x and those at the $^{x}/_{2}$ level. Therefore a certifying party could increase its revenue by issuing a continuum of information, contrary to what traditional certification literature claims. The fact that one does not observe a continuum in the market could be explained in several ways: it would be costly for C to investigate fully a seller to determine its exact place in a continuum but it could find its place in a discrete scale at a lower cost. Additionally the seller may not know its true type exactly, but only with a noise element; the cost of alternative options e for the seller is not infinitesimal, but within a range that makes it optimal to "accept" a certificate that indicates a level of risk slightly above its real level; investors apply a penalty if a company is not certified, making options outside of certification more expensive; investors are unable to distinguish from a continuum of offerings, etc.

Similarly, if a certifier in e-commerce is to disclose a minimum amount of information (above a minimal level or not), and entrepreneurs have the option of establishing regular businesses so that the consumer can evaluate their claims by experience, there would be an incentive for C to disclose more information.

4.2 The Model

This paper presents a model of commerce in which the buyer can be satisfied or not with the transaction. B's satisfaction comes from receiving the good, on time, with the characteristics ordered, etc. If any of these fails then the customer is dissatisfied. The market is competitive in goods; thus the seller makes no profit from their sale, but he can charge a premium for the expectation that his good will comply with the customer's requirements.

By allowing the buyer to have a noisy estimate of the quality of the seller (Judd and Riordan, 1994, use a similar assumption in a different context), the model will show that a certifying party would be forced to disclose more information than according to the usual minimum disclosure proposition.

There are three players in this certification arena: A certifying party (*C*), a Buyer (*B*) and a Seller (*S*).

S sells goods to *B*, and this transaction can be pleasant or unpleasant for *B*. The probability of *S* providing a pleasant transaction depends on *S*'s "quality krypton" (κ) known only to him, where $\kappa \in (0, 1)$. The probability $p(\kappa)$ of *S* providing a high quality good is common knowledge; it is strictly increasing in κ, with $p(0)=0$, $p(1)=1$. *S* is unable to disclose his level of κ to B directly [1].

C chooses a revelation strategy *R*. This revelation strategy defines the form and amount of information regarding κ to be presented to *B*. Specifically, *R* defines whether to reveal the actual value of κ, a range that includes κ, or whether κ is above or below some threshold value. *S* can certify by paying a price *v* to *C*, who will reveal information about *S*'s κ according to *R*. *S* can also sell uncertified, letting *B* noisily assess its quality on the basis of industry gossip, reputation, etc. The price *v* charged by *C* to *S* is the same for all *S*s, regardless of their value κ. This is necessary to avoid a moral hazard problem for *C*, who would have an incentive to increase his estimate of κ to increase profits if he were to charge a higher price for a certificate with a higher κ. If this was the case *B* would not trust a certificate issued by *C*, If *S* opts for certification *C* can test *S* to discover his value κ.

The risk averse *B* can buy a good from *S*, and is willing to pay a premium if she believes *S* is able to provide a positive experience. If *B* knows a seller's true value κ, she would be willing to pay *S* a premium corresponding to this level, namely $\pi(\kappa)$, where π is continuous and concave, i.e.:

[1] I am assuming that *S* is a seller type, representing a seller from a large number of identical sellers. This is necessary to avoid *S* being able to "form a reputation" with *B* by which *B* could estimate *S*'s true value of κ from the repeated interaction.

$$\pi: \kappa \rightarrow (0,1),\ \frac{dp}{dk} > 0,\ \frac{d^2p}{dk^2} \leq 0$$

Without loss of generality we can normalize $\pi(\kappa)$ so that $\pi(0)=0$ and $\pi(1)=1$.

If *B* does not have full information about κ, she estimates κ_e from information she gets from friends, magazines, chat groups, etc. Her estimate is given by $\kappa_e = \kappa + \theta$, $\theta \sim F(0,\sigma)$, F symmetric[2]. *B* is willing to pay a premium $\pi(\kappa_e)$ based on this estimate.

The game is played as follows:

i) Nature assigns a level κ to *S*

ii) *C* chooses a disclosure strategy *R* and a price *v* for the certificate

iii) *S* decides to certify or not given *R* and *v*

iv) If *S* certifies

  a) *C* tests *S* for κ and discovers the real value of κ

  b) *B* observes the disclosure made by *C*

  c) *B* decides whether to buy from *S* or not and pays a premium based on the information provided by *C* and her estimate of *S*'s κ based on public information, $\pi_c(\kappa_e)$

v) If *S* does not certify

  a) *B* decides whether to buy from or not from *S* and pays a premium consistent with her estimation of *S*'s κ, based on public information, $\pi(\kappa_e)$

It should be noted that when *B* estimates κ she is using information from different sources: chat groups, magazines, third party experiences, etc.

Alternatives for C

The available alternatives for disclosure to *C* considered in this analysis are the following:

$R_{minimal}$: *C* discloses whether those certified have $\kappa > 0$ or not.

R_{level}: *C* discloses that those certified have κ above or below a value η[3]

R_{ranked}: *C* defines ranked categories and states in which κ falls.

R_{full}: *C* discloses the value of κ

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[2] Symmetry is not necessary. Non-positive skewness is sufficient in this model.

[3] For R_{level} is irrelevant to say whether κ is above or below a given value, as both of these disclosures are strategically equivalent. Having established this, we will assume that R_{level} discloses whether κ is above η or not.

Payoff analysis

Under complete information, the buyer would be willing to give the *S*s a premium adequate to their κ level, $\pi(\kappa)$. If a buyer is uncertain about a seller's κ level, she estimates this level and pays a premium $\pi(\kappa_e)$ based on this estimated level (see figure 1) [4].

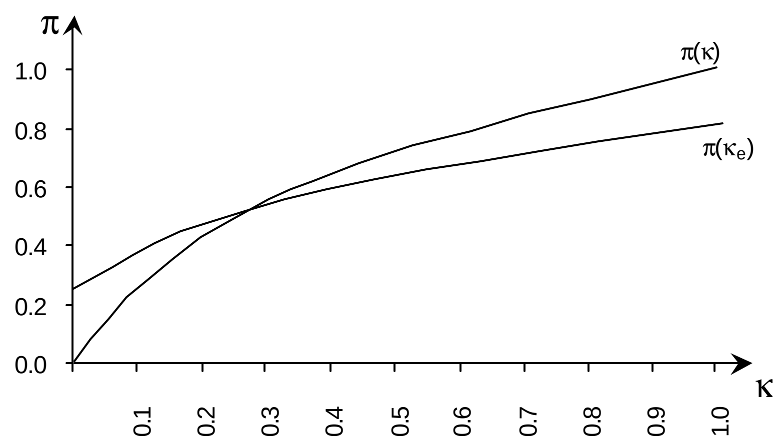

Figure 1
Seller's premium under full information $\pi(\kappa)$,
and under *B*'s estimate of κ, $\pi(\kappa_e)$

It is obvious that, in the regions with full support of the distribution F, $\pi(\kappa)$ is greater than $\pi(\kappa_e)$, given that a buyer estimating $\pi(\kappa_e)$ is in essence averaging the possible values of $\pi(\kappa)$. For each point in the upper half of the distribution centred in κ^*, $\kappa+\varepsilon$, corresponds a point in the lower half of the distribution $\kappa-\varepsilon$ ($\kappa-\xi$; $\xi > \varepsilon$ for negatively skewed distributions) and given the concavity of π, the average of these two points lies below $\pi(\kappa^*)$. In general $\pi(\kappa_e)$ is above $\pi(\kappa)$ for low values of κ, and the reverse is true for large values of κ. This is due to the fact that for low values of κ, when estimating κ_e, *B* knows that κ cannot be lower than zero, so the distribution of the estimate gets truncated, while for large values of κ she knows that κ cannot be greater than one, so she puts more weight on lower values.

[4] The functional form for the illustrations of this chapter assumes the properties mentioned for $\pi(\kappa)$: concave, continuous and increasing in κ.

Theorem 1. $\pi(\kappa_e)$ and $\pi(\kappa)$ cross in at least one point, (and, for continuous, unimodal, non-positively skewed distributions[5] of the estimation noise, this point is unique).

Proof: See appendix.

When *C* uses a disclosure rule R_{level}, of the type "S_i has $\kappa_i \geq \eta$", the payoff from estimation differs according to whether *S* is identified as "type $\kappa \geq \eta$" or "type $\kappa < \eta$". Specifically, for those identified as "type $\kappa < \eta$" the buyer knows for sure that they are below a certain level η, and therefore updates her belief and truncates the right hand side of the estimation distribution, averaging only those values below η. The κ_e of sellers below η is therefore lowered, and consequently their premium under certification, which we write $\pi_c(\kappa_e)$, is smaller than that without certification. Those *S*s identified as "above η" benefit from the certification, as *B* will truncate the left hand side of the noise distribution, when she realizes that the lowest possible value of κ is η and truncates her distribution to $[\eta, 1)$ which will increase her estimate κ_e, resulting in a higher premium under certification, $\pi_c(\kappa_e)$. Note that as κ departs from η, this effect gets dissipated and $\pi_c(\kappa_e) \rightarrow \pi(\kappa_e)$, as κ_i reaches the edge of the support of F. These effects are shown in figure 2 a and 2 b.

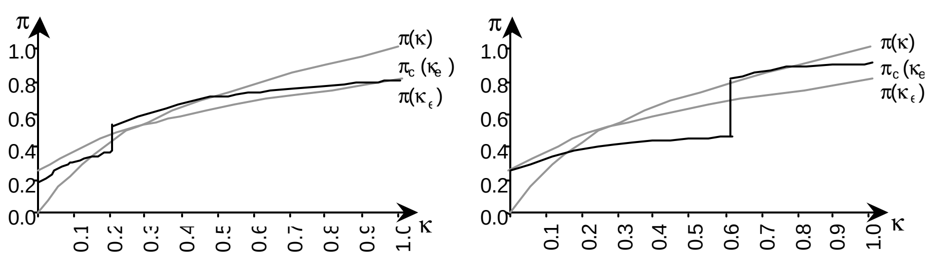

Figure 2
S's premium under certification using a rule R_{level}

a) with η below the crossing point of $\pi(\kappa)$ and $\pi(\kappa_e)$

b) with η above the crossing point of $\pi(\kappa)$ and $\pi(\kappa_e)$

It is intuitively clear that for a disclosure rule R_{level}, $\pi_c(\eta-\varepsilon) < \pi(\kappa_e|\kappa=\eta-\varepsilon)$ and $\pi_c(\eta-\varepsilon) < \pi(\eta-\varepsilon)$, since at $\kappa=\eta$ *B* knows for sure that a certified seller below η is not of type η or above, and so truncates her distribution above η. Furthermore, *B* will be willing to pay at most $\pi(\eta-\varepsilon)$ to a seller certified as

[5] The normal and the uniform distributions satisfy this condition.

below η, as she knows that the best that this S can be is of type $\eta-\varepsilon$, and that he may be of any type lower than that. Similarly, it is easy to see that, under this disclosure rule, $\pi_c(\eta) > \pi(\kappa_e|\kappa=\eta)$ and $\pi_c(\eta) > \pi(\eta)$.

Theorem 2 Under an R_{level} disclosure rule, of the form "$\kappa_i \geq \eta$", a seller of type $\kappa=\eta$, gets a premium $\pi_c(\eta)$, greater than $\pi(\kappa)$ and $\pi(\kappa_e)$, by certifying.

Proof.

a) $\pi_c(\eta) > \pi(\kappa_e)$. By certifying a seller of the type $\kappa=\eta$ is truncating the left hand tail of the distribution F. By knowing that S is certified, B knows for sure that S is not of quality $\kappa<\eta$. Therefore, B's expectation of S has improved and she is willing to give a more generous premium.

b) $\pi_c(\eta) > \pi(\kappa)$. If B had full knowledge of S's κ, she would be willing to pay a premium $\pi(\kappa)$. If S is certified as "κ or above", B knows that her worse case scenario is that S has $\kappa=\eta$, so regardless of her risk aversion, she is willing to give at least as much as she would if she knew for sure that S was of type κ.

Theorem 3 For a disclosure rule R_{level}, of the type "S_i has $\kappa_i \geq \eta$", no seller type $\kappa_i < \eta$ certifies.

Proof.

As this type of seller cannot possibly get a certificate stating that his type is $\kappa_i \geq \eta$, it would rather not certify and save the certification cost, sending the same information to the market as if it was certified as type $\kappa_i < \eta$.

With a disclosure rule $R_{level,}$ sellers above η that are close enough to η for B's distribution before certification to include values of $\kappa<\eta$ in its support would certify, as they face the risk of being confounded with a seller type $\kappa_i < \eta$ if they do not certify. Those sellers who are above the support of F (therefore not facing risk of being confounded) do not certify, as they would be identified as above η for sure.

Inferiority of the disclosure rule $R_{minimal}$

We can see that $R_{minimal}$, the strategy in which C discloses that S_i has $\kappa_i > 0$ and that is predicted in the literature, cannot be an equilibrium. The information that $\kappa_i > 0$ is already known to B. S has no incentive to pay C to give this information. In the literature this minimal disclosure is supported by the assumption that *B* could believe it possible that if *S* did not get a certificate, this was because his type is $\kappa=0$. In the present model, κ cannot be zero, and *B* has access to a noisy estimator of κ, which always yields a value a value of κ above zero. To implement $R_{minimal,}$ *C* would have to offer it for a price $v=0$, and by *Theorem 2* we know that he could charge a strictly positive price by issuing an R_{level} certificate, as he could extract at least the increased premium from the marginal *S*. Therefore, R_{level} will always dominate $R_{minimal}$.

Theorem 4 The maximum price *v* that can be charged for a disclosure rule R_{level}, of the type "$\kappa_i \geq \eta$", implemented with price $v \geq 0$, is given by $\pi(\eta)$ - $\pi(\kappa_e|\kappa=\eta)$, where $\pi(\eta)$ is the premium that a *S* of type η would receive under perfect information, and $\pi(\kappa_e|\kappa=\eta)$ is the premium that this seller could expect if no certification was available.

Proof.

If a price above $\pi(\eta)$ - $\pi(\kappa_e|\kappa=\eta)$ were charged, no *S* would certify. To prove this, let us focus on the seller of type $\kappa=\eta$. This seller is the one who "profits" the most with this disclosure rule, as the distance between $\pi_c(\kappa_e)$ and $\pi(\kappa_e)$ is maximized in him (recall that $\pi_c(\kappa_e)$ is increasing, concave and tends to $\pi(\kappa_e)$, which is also concave and increasing, whence the distance between both is maximised at $\kappa=\eta$ –see figure 2). Clearly, if he is not willing to buy certification at a certain price, no one else would. His benefit from being certified is precisely $\pi_c(\kappa_e)$ - $\pi(\kappa_e)$, so if the price was greater than this benefit he would not certify. Therefore the maximum price *v* is given by $\pi_c(\kappa_e) - \pi(\kappa_e)$.

As demonstrated above $R_{minimal}$, the disclosure rule predicted in the literature, is inferior to other options open to *C*, and therefore it cannot be an equilibrium. Someone could argue that the dismissal of $R_{minimal}$ is due to the restrictive assumption in the present model that does not allow a seller to be of the lowest quality level. To show that this is not the case, the next section demonstrates the inferiority of R_{level}, which does not depend on this assumption. As $R_{minimal}$ is a member of the family of strategies characterized by R_{level}, this demonstration also shows the inferiority $R_{minimal}$.

Inferiority of R_{level}

We will now show that R_{level} cannot be an equilibrium rule, as it is inferior to other alternatives available to *C*. By Theorem 4 we know that there is a maximum price that can be charged for R_{level}. A rise in price has a positive impact in the revenue per *S* that *C* receives, but also reduces the number of *S*s willing to certify, as it makes certification less attractive. There is therefore a revenue maximizing price under R_{level}.

When C charges a price $v>0$ for R_{level} he may sway some *S*s away from certification. For some v within the limit imposed by Theorem 4, it may be the case that some *S* whose type is well above η will prefer $\pi_u(\kappa_e|R_{level})$ to $\pi_c(\kappa_e) - v$ (where π_u denotes the expected profit of selling uncertified given that a certificate is available). In figure 3 those *S*s above κ* will not certify as they can get more from selling uncertified than from selling certified.

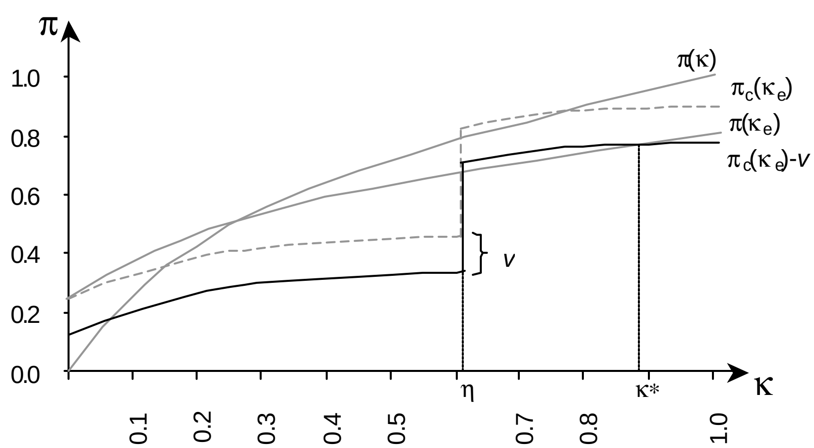

Figure 3

Payoff to sellers of type κ from a certificate R_{level} implemented at a price of v. Note that sellers above κ^* can expect a higher payoff by not certifying: $\pi(\kappa_e) > \pi_c(\kappa_e) - v$

Now let us assume that *C* chooses the price v^* that maximises his revenue under R_{level}. I will show that by simply adding a second certification level at the same price level revenue can be increased. Specifically, by having a rank rule with three levels such as "S is below η-ε", "S is between η-ε and η", and "S is above η" (where ε is arbitrarily small) this revenue is increased. To prove this it is enough to show that someone will buy a certificate stating that 'S is between η-

ε and η”, as all those above η who were certifying before this new level was introduced will continue to do so. The certificate “S is between η-ε and η” will yield a positive benefit to a *S* type $\eta-\varepsilon$, as this would tend to perfect revelation of his type when ε tends to zero and thus would differentiate him from all other types below η. There are two scenarios to consider, when η is above the point defined by Theorem 1 and when it is below it.

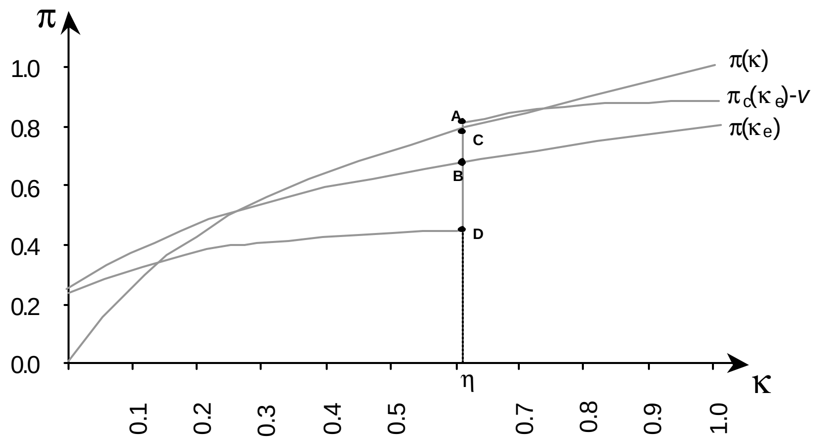

Figure 4

S’s premium under certification using a rule R_{level} with η above the crossing point of $\pi(\kappa)$ and $\pi(\kappa_e)$ implemented at a price of *v*

In the case when η is above the point defined by Theorem 1 we have a situation like that depicted in figure 4. By Theorem 4 we know that the price *v* is at most AB and, as just noted, the benefit from certifying in the “*S* is between η-ε and η” range would yield $\pi(\eta-\varepsilon)$ to a *S* of type $\kappa = \eta-\varepsilon$ (point C in the graph). To demonstrate that a seller of type $\eta-\varepsilon$ has an incentive to buy this certificate, it is enough to show that the additional benefit from this certificate is less than the price of the certificate. Before this new certificate was available this seller type was receiving a premium $\pi_c(\eta-\varepsilon)$ (point D in the figure). We need to show then that AB<CD. These segments have a common part, CB, so it is sufficient to show that AC<BD.

Theorem 5 For a disclosure rule R_{level}, of the type “S_i has $\kappa_i \geq \eta$”, the benefit to the seller type $\kappa=\eta$, compared to the case when no certificate is available, is smaller in magnitude than the detriment to the seller of type $\kappa=\eta-\varepsilon$.

Proof.

The benefit to the seller type $\kappa=\eta$ comes from truncating the distribution of the estimator for values below η. Type η sellers get averaged with types that are above η, while sellers of type $\eta-\varepsilon$ get averaged with types below η. As F is symmetric, the distance from η to κ_e for *S* type $\kappa=\eta$ is the same than the distance from η to κ_e for *S* type $\kappa=\eta-\varepsilon$. However, given that π is increasing and concave, the magnitude $|\pi(\eta)-\pi(\kappa_e|\kappa=\eta-\varepsilon)|$ is greater than $|\pi(\eta)-\pi(\kappa_e|\kappa=\eta)|$. This is, for every point in $\eta+\Delta$ there is a corresponding point in $\eta-\Delta$ such that $|\pi(\eta)-\pi(\eta+\Delta)|<|\pi(\eta)-\pi(\eta-\Delta)|$. To show this lets divide both sides by Δ and take limits when $\Delta \rightarrow 0$. We have

$$\lim_{\Delta\to 0}\frac{p(h+\Delta)-p(h)}{\Delta}<\lim_{\Delta\to 0}\frac{p(h)-p(h-\Delta)}{\Delta}$$, or equivalently

$\pi'(\eta)<\pi'(\eta-\Delta)$ which is true given that π is increasing and concave.

Returning to the relationship between AB and CD, by Theorem 5 we know that AB<BD. Given that AC is a segment of AB, we have that AC<BD. Thus we have proved that R_{level} is inferior to the proposed rule whenever η is above the point defined in Theorem 1.

The case for η below the point defined in Theorem 1 is similar to the one illustrated above. In this case we have a situation as that depicted in figure 5. To show that the proposed rule is superior to R_{level}, it is enough to prove that the distance CD is greater than de distance AB, so that the seller of type $\eta-\varepsilon$ will buy this certificate at a price no greater than AB (as required by Theorem 4).

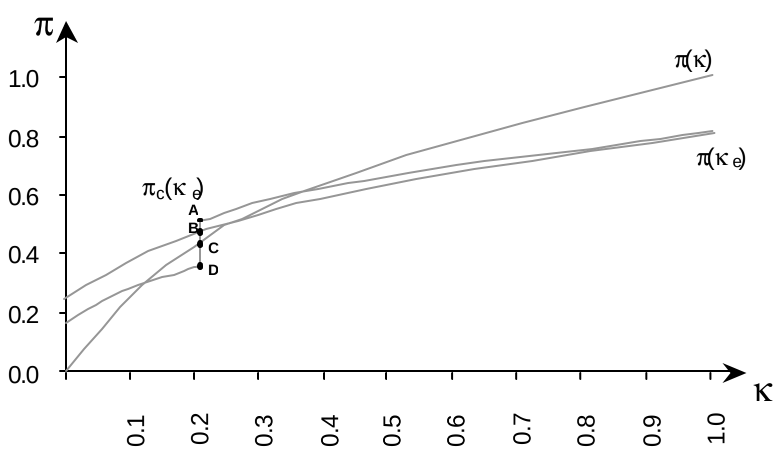

Figure 5
S's premium under certification using a rule R_{level} with η below the crossing point of $\pi(\kappa)$ and $\pi(\kappa_e)$

By Theorem 5 we know that AC is smaller than CD; as AB is a segment of AC, it follows that AB<CD, $\therefore$ Q.E.D.

As has been proved that the proposed disclosure rule is superior to R_{level} in all cases, R_{level} cannot be an equilibrium rule.

Analysis of R_{full}

So far we have demonstrated that neither R_{minimal} nor R_{level} can be equilibrium strategies for C. To conclude this study, let us analyse the strategy R_{full}, and its implications.

R_{full} when implemented at a price v greater than zero gives a payoff such as that described in figure 6 by the curve $\pi(\kappa)$-v. That is, when a seller is certified under R_{full}, his actual κ is disclosed, and his profit is given by the full information premium $\pi(\kappa)$ minus the cost of certification, v.

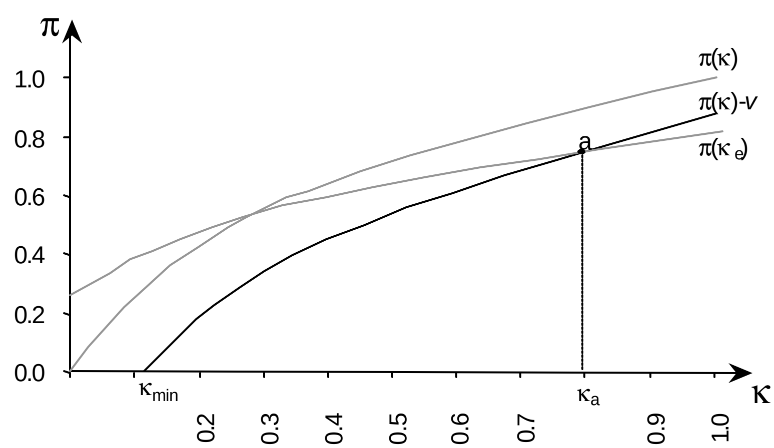

Figure 6
S's premium under certification using
a rule R_{full} with a positive price of v

Two things are evident from the figure: v cannot be greater than the limit of $\pi(\kappa)-\pi(\kappa_e)$ as $\kappa \rightarrow 1$, otherwise every seller would be better off by not certifying, and therefore C would make no profit. As we have seen above, there are strategies that ensure a positive profit for C; so a zero-profit strategy is sub-optimal. Also, there is a κ_{min} under which no seller would certify, as his profit from certifying would be negative. Specifically, those sellers that would receive a value of $\pi(\kappa)$ lower than v would not certify. The question now is, who would certify? Obviously all those above κ_a in figure 6, the value of κ in which $\pi(\kappa_e)$ and $\pi(\kappa)$-v cross would certify, as it is incentive compatible for them, but what about those below κ_a?

Those sellers below κ_a, given that everyone above κ_a certifies, get their estimation revised downwards, as B knows that if S is not certified it is because he is below κ_a. This shifts $\pi(\kappa_e)$ to $\pi(\kappa_e)'$. This shift introduces a new group of Ss for whom it is profitable to certify: those of type $\kappa>\kappa_b$ in figure 7. This moves $\pi(\kappa_e)'$ downwards again to $\pi(\kappa_e)''$, and new Ss are now willing to certify. In this way certification unravels so that everyone above κ_{min} certifies and no one below κ_{min} certifies.

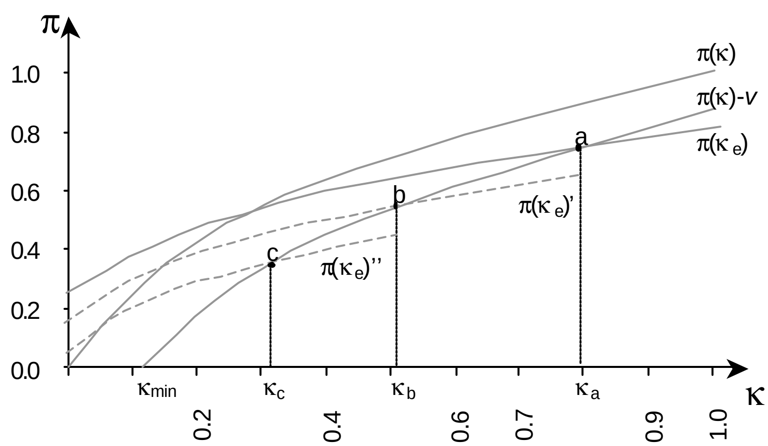

Figure 7
Certification unravelling under rule R_{full}

Inferiority of R_{full}

We know now that with R_{full} there exists a κ_{min} below which no one certifies and above which everyone certifies. Because a rise in price increases revenue per seller for C, but reduces the number of sellers that seek certification, there must exist a price that maximises revenue for C. Let us assume that this price is v^*. It will be proved that it is always possible to construct a strategy R_{ranked} that gives C a higher profit than R_{full} at a price v^*. To construct such a R_{ranked}, let us begin by adding an R_{level} at $\kappa_{min}-\varepsilon$. By Theorem 2 we know that the seller at $\kappa_{min}-\varepsilon$ receives a premium greater than $\pi(\kappa)$, and therefore he is willing to buy the certificate at v^* (as his benefit will be greater than the cost). If we can prove that all sellers above $\kappa_{min}-\varepsilon$ certify we would have proven that this strategy increases the profit for C, and would demonstrate the inferiority of R_{full}.

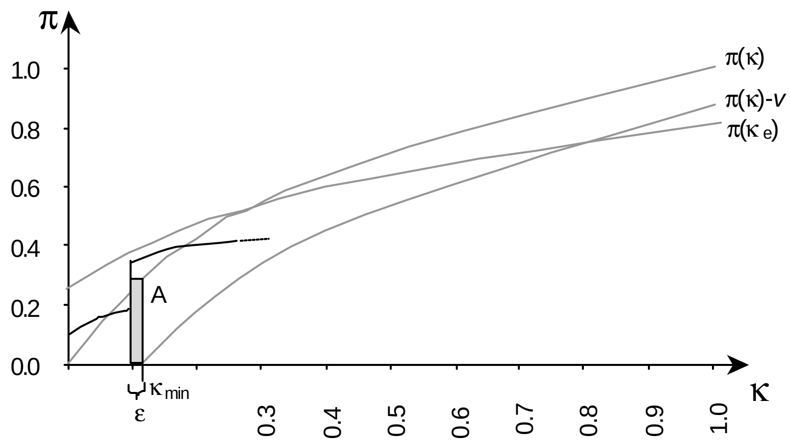

Figure 8

S's premium using a certification rule R_{full} plus an R_{level} at $\kappa_{min}-\varepsilon$.

The introduction of the mentioned R_{level} increases the profit of C. This increment comes from the area A in figure 8, i.e. the additional number of sellers certifying times the price they pay for the certification. Lets assume that we reduce the size of the additional profit from A to $^A/_2$ and we use this reduction to subsidise a reduction in the price v^*. We know that for R_{full} the price of certification cannot be greater than the premium for the highest type seller (κ=1-δ) less the premium that this seller could get from selling uncertified, this is $v^* \leq \pi(\kappa)-\pi(\kappa_e)$. By creating the subsidy we have ensured $v<\pi(\kappa)-\pi(\kappa_e)$, and therefore that $\pi(\kappa)-v>\pi(\kappa_e)$.

Whenever $\pi(\kappa)-v>\pi(\kappa_e)$ it is possible to create an R_{level} in κ=1-δ so that $\pi_c(\kappa_e)-v>\pi(\kappa_e)$. This assures that all S above 1-δ will certify, as they will prefer $\pi_c(\kappa_e)-v$ to $\pi(\kappa_e)$. Once this R_{level} is established, a seller slightly below 1-δ will still prefer to certify, even when $\pi_c(\kappa_e)-v$ is smaller than $\pi(\kappa_e)$ for his type. This is a consequence of the fact that when B sees that an S whose type she has estimated at 1-δ is uncertified, she infers that this is because he is below 1-δ. This belief makes her truncate the distribution of her estimator to account only for values below 1-δ, which brings down her estimate $\pi(\kappa_e)$ for the uncertified seller.

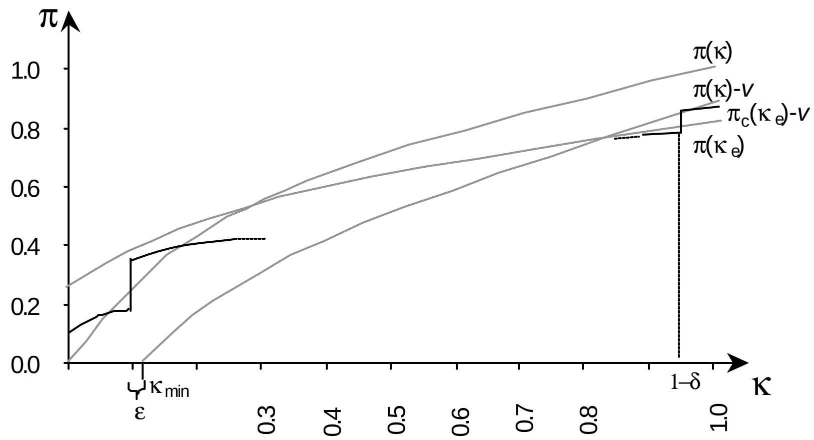

Figure 9
Implementation of an R_{level} at 1–δ

The inclusion of all sellers above 1-δ solves the first part of the problem. Now, how can *C* be sure that a *S* of a type that is below the support of F in 1-δ will certify? *C* can always add a R_{level} at exactly the first such *S* type (call it κ_1), so that this *S* must certificate to avoid being confused with a lower type. In this way *C* can continue to add R_{level}s to ensure that every *S* above κ_{min}-ε certifies.

With this construction *C* is able to improve his profit from his R_{full} optimal, so R_{full} cannot be an equilibrium rule. In figure 10, *C* has constructed a 6-level R_{ranked} (with levels: {(0, κ_{min}-e), [κ_{min}-e, κ_3), [κ_3, κ_2), [κ_2, κ_1), [κ_1,1-δ), (1-δ,1)}), and has improved over R_{full}.

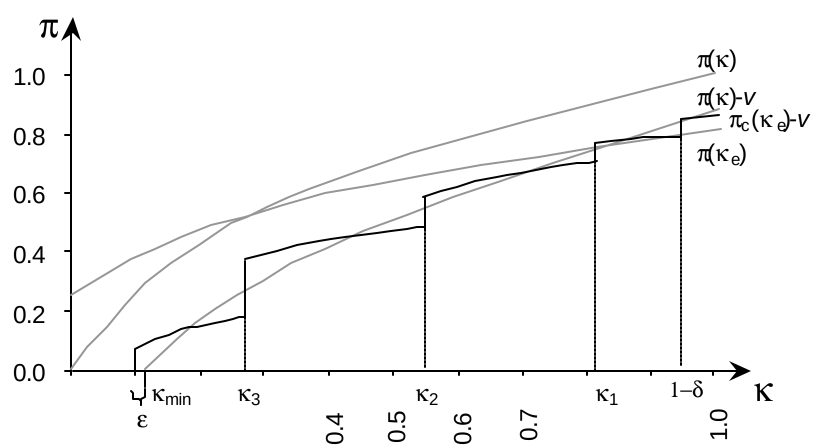

Figure 10
Construction of a rule R_{ranked}

The analysis presented in this section challenges the models that predict or assume a minimal disclosure from certifiers, and proposes an explanation for the occurrence of deeper disclosure in the certification market. The inferiority of R_{minimal} is not dependent on the assumption that a seller cannot be of the lowest type (present in this model); it was demonstrated that R_{level} is sub-optimal for C, and R_{minimal} belongs to the family of rules R_{level}, which is sufficient to prove its inferiority. The results found in the literature can be explained with this model by relaxing the assumption that *B*s have a noisy estimate of a *S*'s κ value, i.e. by making $\pi(\kappa_e) = K$, where K is constant.

5 Certification theory in relation to other disciplines

The results of certification studies can often be extended to other areas of economics and to other disciplines that face asymmetric information problems and use similar structures: the middleman literature in Industrial Organization deals with similar problems such as moral hazard, intermediation, and quality assurance (see for example Biglaiser and Friedman, 1994); signalling models share some characteristics (Spence, 1973); the role of advertising as an information source shares features with certification (Milgrom and Roberts, 1986); the investing, security rating and auditing literature of finance relates to financial intermediaries providing information for investors (see Easterwood and Nutt, 1999; Kish, Hogan and Olson, 1999); law considers the need in arbitration for extracting information from the parties (see Shin, 1998), etc.

6 Conclusion

This paper argued that a monopolistic certifying party would disclose useful information in the form of rank orderings. This type of disclosure is commonly observed in the market, and therefore more realistic than previous results and assumptions from Certification Theory where a minimum amount of information (sometimes with no informational value) was provided by certifiers. While performing the analysis and conducting his research the author found a void in certification research and consequently has included a comprehensive review of the certification literature. This paper presented a three-player game-theoretic model of a certification situation with a buyer, a seller and a certifier. The results of the model support the ordered ranking of levels observed in the market. This result is obtained by allowing the buyer to have a noisy estimate of the quality parameter of the seller, before meeting the certifying party. This approach to certification makes the model more flexible than existing models and produces robust results that can explain the findings of previous models. Four different strategies of information disclosure available to certifiers, a discussion of relevant certification issues and the relation of certification to other disciplines were also included.

Appendix

Proof of Theorem 1

Theorem 1. $\pi(\kappa_e)$ and $\pi(\kappa)$ cross in at least one point, (and, for continuous, unimodal, non-positively skewed distributions of the estimation noise, this point is unique).

Intuitively, given that (as discussed in Section 4) $\pi(\kappa_e) > \pi(\kappa)$ for low values of κ, and $\pi(\kappa_e) < \pi(\kappa)$ for large values of κ, by continuity these curves must cross. Additionally, as discussed in that same section, $\pi(\kappa_e) < \pi(\kappa)$ both in the support of F and when the support of F gets truncated above for large values κ ($\kappa \rightarrow 1$). This means that the crossing point is given by a truncation of the support for low values of κ, when the buyer knows that κ cannot be below 0, and puts more weight on values above the centre of the distribution, making $\pi(\kappa_e) > \pi(\kappa)$ as $\kappa \rightarrow 0$. Furthermore, as this effect gets exacerbated for lowers values of κ, $\pi(\kappa_e) > \pi(\kappa)$ for all values below the crossing point,. And therefore the crossing point is unique. A formal proof is provided below.

We have

i) $\pi : \kappa \rightarrow (0,1),\ \dfrac{dp}{dk} > 0,\ \dfrac{d^2p}{dk^2} \leq 0$

ii) $\kappa_{e} = \kappa + \theta,\ \theta \sim F(0,\sigma)$, F symmetric, or alternatively
$\kappa_{e} = \theta,\ \theta \sim G(\kappa,\sigma)$

We can express $\pi(\kappa_e)$ as :

iii) $$p(k_e) = p(k^*) - \frac{\int_0^{k^*} [p(k^*) - p(x)] g(x) dx}{\int_0^{k^*} g(x) dx} + \frac{\int_{k^*}^{1} [p(x) - p(k^*)] g(x) dx}{\int_{k^*}^{1} g(x) dx}$$

where κ^* is the true value of κ for the seller under estimation.

Let $\kappa^* \to 0$, as $[\pi(\kappa^*) - \pi(x)]g(x) < g(x)$ the numerator of the second term goes to zero faster than the denominator, therefore the second term goes to zero. The third term is positive as $\pi(x) - \pi(\kappa^*)$ is positive for all $x \geq \kappa^*$ (given the concavity of π). Therefore, as $\kappa^* \to 0$ $\pi(\kappa_e) > \pi(\kappa^*)$.

Let $\kappa^* \to 1$. The second term is an average of values that lie between 0 and 1, therefore is positive. The third term goes to zero as $[\pi(x) - \pi(\kappa^*)]g(x) < g(x)$ and its numerator goes to zero faster than its denominator. Therefore as $\kappa^* \to 1$ $\pi(\kappa^*) > \pi(\kappa_e)$.

We have demonstrated that $\pi(\kappa_e) > \pi(\kappa)$ for small values of κ and that $\pi(\kappa_e) < \pi(\kappa)$ for large values of κ. By the continuity of π, $\pi(\kappa_e)$ and $\pi(\kappa^*)$ must cross in at least one point, and by their concavity we know that this point is unique.

In iii), the third term dominates the second term up to the crossing point, beyond which the second term dominates the third term, therefore the crossing point is unique.

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