Two-sided Certification: The market for Rating Agencies

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Abstract
Rating agencies tend to offer certification services to both sides of the market: to firms and investors. Conflicts of interest might arise, since firms have an incentive to "optimize" their rating to attract favorably priced financing. We show in a theoretical model, that a credible rating agency will sell its services to both sides of the market to maximize its own profits. Furthermore we identify markets in which two-sided certification compared to no certification and one-sided certification has a strong welfare increasing effect. Hence, certification services paid by firms does not necessarily indicate distorted certification results.

Keywords: Certification, Rating Agencies, Asymmetric Information in Financial Markets.

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1 Introduction

This paper focuses on the business model of rating agencies in an asymmetric information framework. Financial intermediaries play a key role in the evaluation of creditworthiness of firms and financial products and therewith increase efficiency in capital markets. Demand for certification services arises not only in the financial sector, but also in various other product or services markets, such as the markets for industrial products, second-hand automobiles, food, etc.. The markets for certification services achieved above average growth rates in the last decades and soaring demand can be expected.

We analyze the business model of rating agencies regarding their selling behavior and potential motivations to finance ratings not only by the buyer (investor-pay model), but also by the seller (issuer-pay model). In general, financial ratings are defined as "summary measures of assessment over the probability that a borrower will default" (Fitch, 2002). Their main purpose is the independent evaluation of the quality of an investment or a firm regarding its debt servicing likelihood. Typically ratings are grouped into different rating classes, which comprise a specific default probability.[1]

The importance of credit ratings grew significantly during the last decades, as the number and complexity of financial products increased. Certification providers seek to overcome the unequal distribution of information in markets and thereby increase efficiency. Since the findings on asymmetric information by Akerlof (1970), a broad literature on the reduction of transaction costs of market participants developed. In financial markets generally, the seller of a product possesses private information on the product's quality, which is unobservable by potential buyers, who build expectations on the quality, which might be lower than the actual value. Thus the informed party has an incentive to communicate the true quality to increase profits. The unequal information distribution might be overcome by credibly signalling (Spence, 1973) the private information to the uninformed party by e.g. building up reputation, issuing warranties or using third parties (Grossman, 1981; Albano and Lizzeri, 2001), that credibly certify the information. Marette and Crespi (2003) show that producer collusion might be necessary to signal quality via a third party. A stable cartel may improve welfare even if producers collude to reduce competition.

[1] Cantor (2004) gives a brief overview on recent research on rating agencies, mainly with an empirical focus.

If a third party provides a signal on the quality of a product, the uninformed party builds expectations on the quality of the signal and thereafter values the acquired information. Additionally, the uninformed party tries to differentiate the sellers in the market and screen the investment opportunities to identify superior options (Rothschild and Stiglitz (1976) and Wilson (1977)). Thereby, they seek to reduce the informational costs of finding a suitable investment object and potentially delegate the information acquisition to third parties, which specialized in the evaluation and assessment of available information. Furthermore, they might also possess private information, that cannot be exploited by all investors, as they partially have direct access to private information by the firms.

The 2007 financial turmoil brought up various doubts about the strategies of rating agencies and the quality of their rating assessments (Mason and Rosner, 2007).[2] Especially for innovative financial products a conflict of interest might arise, as rating agencies firstly consult firms and thereafter sell ratings (Ljungqvist, Marston, Starks, Wei and Yan, 2007; Bolton, Freixas and Shapiro, 2009). Rating agencies could therefore maximize their earnings by extending their consulting services and defer their rating if investors naively take ratings at face value or the costs of the loss of reputation is low. Furthermore, Benabou and Laroque (1992) show that access to private information generates both the incentives and the ability to manipulate asset markets, which might be exploited by informed rating agencies. It is not trivial for investors to assess the quality of ratings, if the predicted default probability is not in line with the actual realization, as noise might distort ex ante efficient ratings. Strausz (2005) therefore argues, that one of the main motivations for the high concentration in the rating industry and the attached high profit margins is due to the high costs of deviating from honest certification. Moreover, Skreta and Veldkamp (2009) show that increasing competition in the rating industry will create a systematic bias in published ratings, as only the favourable ratings would be disclosed. In contrast, Lizzeri (1999) shows that with increasing competition the amount of revealed information increases, since monopolistic rating agencies will solely reveal whether the quality of the firm lies above some minimal standard and thereby capture high fractions of the gains from trade. As a consequence of potential market failures Stolper (2009) proposes to implement strong regulations and shows potential approval schemes to fight bribing in a theoretical framework. Boot, Milbourn and Schmeits (2006) stress the role of rating agencies

[2]Often the timeliness of rating changes is criticised e.g. Löffler (2005).

as coordinating mechanism in situations where multiple equilibria exist and therewith play a economically meaningful role. Albano and Lizzeri (2001) explore the impact of the introduction of an intermediary on the quality provision in markets with asymmetric information and find that the intermediary increase market efficiency, even though quality is underprovided compared to full information. Farhi, Lerner, Tirole, Field and des Tabacs (2008) explore further strategic dimensions of the certification market, as e.g. the publicity given to applications of rating services.

It is remarkable, that the rating industry is one of the very few industries where services are sold on both sides of the market, to firms and investors. We contribute to the literature in developing a model describing the business model of rating agencies, that offer their services to both sides of the market. The certification industry literature so far solely focused mainly on one-sided certification. We find that the intermediary maximizes his profits by selling the certificates to both sides of the market. Compared to one sided-certification, the welfare is maximized and more trades are executed, which otherwise would fall victim to the asymmetrically distributed information in the market.

Especially for public finances, the subject is worth considering, as the dependence of many industrial, but also emerging countries on external financing increased significantly during the last years and will keep on soaring in the upcoming years due to the massive recovery programs which are enacted following the current financial and economic crisis, as politicians revive keynesian theories to stimulate the economy. The question arises, how the debt burden will be repaid and how investors might value the public debt issuance. Thereby, the allocative role of efficient credit markets with its sanctioning mechanisms (Stiglitz and Weiss, 1981) are essential to maintain market discipline as proposed by Lance (1993).

This paper is organized as follows: the next section presents three variations of a model describing the market for credit ratings. Thereafter, section 2 discusses the policy implications, section 3 discusses and links the theoretical findings with empirical observations and section 4 concludes.

2 Model

Consider a model with four players: one informed seller, two uninformed buyers and one intermediary. The seller owns a single, indivisible product of quality q which is

not observable by buyers. We assume the quality q to be uniformly distributed on the interval $[0, 1]$. The intermediary has no value for the object while the seller has a reservation utility of αq with $\alpha \in [0, 1]$, which is known to all players. The buyers receive the utility q out of consumption of the product, but only know the distribution of the product's quality and therefore build expectations on the true quality level. The seller has no possibility to communicate the quality of his product q directly and credibly to the buyers. The intermediary owns a perfect evaluation technology, which enables him to determine the true value of q. He can credibly communicate the product's quality.[3] If demand for an evaluation exists, by either the seller or the buyers, the intermediary can determine the quality q at costs normalized to zero. In case the seller demands a rating, the intermediary will communicate the quality q credibly to the market, which is thereafter known to all buyers, hence public information. If one or both buyers demand an evaluation of the product, the information disclosed by the intermediary is private information to the respective buyer.

The game of the model comprises 4 stages.

(1) The intermediary determines prices p_s and p_b for a rating sold to the seller and to each buyer, respectively.

(2) The seller may choose to order a rating from the intermediary for the price p_s. If a rating is sold, the information about the true quality q will immediately become public information.

(3) The buyers decide simultaneously (and independently) whether to order a rating for the product. Buyers, who decide to order a rating, pay price p_b and receive the information on the quality q as their private information.[4]

(4) The product is sold in a first-price (common value) auction. Finally, payoffs are realized.

We assume that the intermediary is honest and applies a perfect information revelation technology. Furthermore, we assume that the intermediary has no competitors and can

[3]Sobel (1985) and Benabou and Laroque (1992) show conditions for which credibility can be assumed.

[4]In our setting the certifier cannot commit to sell exclusively to one buyer. Relaxing this assumption would thwart the monopoly setting of the certification market, as market entry would be likely.

exploit her full monopoly power, which is in line with recent contributions, as e.g. by Strausz (2005), who motivates the high concentration and earnings in the industry. In addition we allow the intermediary to discriminate in prices between sellers and buyers, which is plausible, as different goods are sold to both sides of the market - on seller's side public information is revealed, while on buyer's side private information is traded. The intermediary acts as a profit-maximizing monopolist.

The utility of the seller depends on the consumption or the sale of a single product. Depending on the highest bid in the auction, the seller decides to sell the product or otherwise consume it, which constitutes an outside option in the model.[5] We assume that the seller is the first to decide whether to order a rating. This is an intuitive approach as the seller initially decides whether to produce or sell a product.[6]

All buyers are symmetric ex-ante and no experience or reputation dynamics for selling good or bad quality in the market arise. The buyers bid for the product in a first-price sealed-bid auction, with an a priori unknown reservation price, namely the reservation utility of the seller.[7] It seems a natural way to model the selling stage, as initial public offerings in financial markets follow this structure. Furthermore in all parts of the game the information structure is known to the buyers: in the first-price auction buyers are aware of the opponent's information holdings.[8]

The market is characterized by a single parameter $\alpha \in [0, 1]$ which is known to all market participants. This parameter captures the reservation utility of the seller, which is αq for the quality level q. The buyer's valuation of the product of quality q is q, hence the difference in valuation $(1 - \alpha)q$ generates the possible gains from trade. By applying a market parameter we partly embed a basic adverse selection framework, where ex-ante no trade occurs. As we primarily focus on the market outcomes and the welfare implications, we take an ex-ante viewpoint and study different quality levels of the seller

[5]One could also think of the consumption option as a secondary market.

[6]Simultaneous decisions by buyers and sellers do not alter the general outcomes.

[7]For further types of common value auctions with asymmetric informed bidders, the academic research is quite silent about picking the "right" equilibrium. We follow thereby the findings by Wilson (1967), Weverbergh (1979), Milgrom and Weber (1982), Rob (1985), Hendricks, Porter and Wilson (1994); Kagel and Levin (1999), Campbell and Levin (2000) and Kim (2008). Second-price common value auctions feature multiple equilibria. Sequential bargaining with a stackelberg leader yields similar results. For modelling the first price auction we refer to recent findings by i.a. Larson (2009).

[8]Relaxing this assumption does not fundamentally alter the solution, but reduces the value of private information in the game and diminishes the profit of the privately informed party.

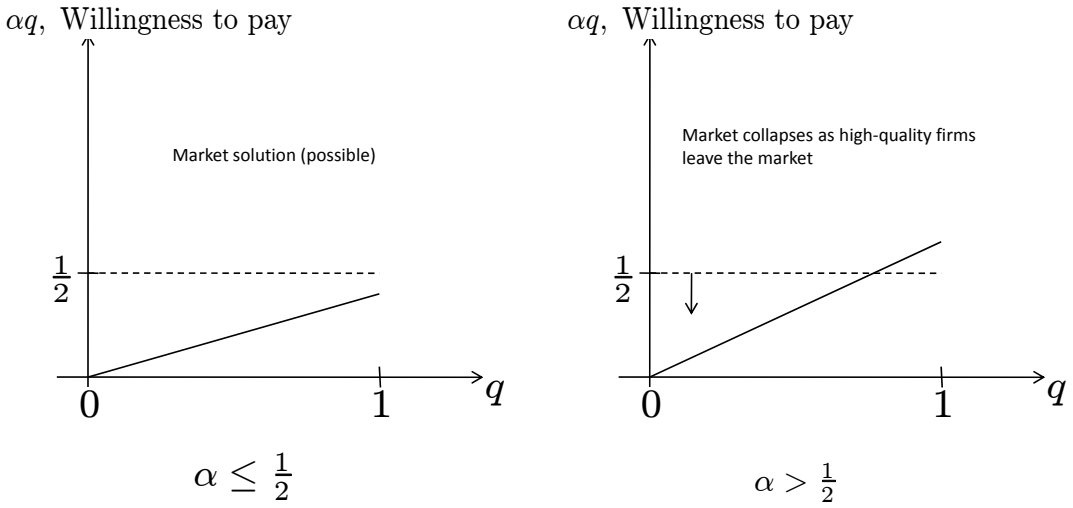
and not if one particular seller likes or dislikes the certification service.[9]

2.1 The market without the certifier

It is known since Akerlof (1970) seminal work on adverse selection, that in specific markets trade may collapse due to asymmetrically distributed information. Sellers cannot be differentiated according to their quality level and buyers are only willing to pay a uniform price reflecting the average quality in the market. Facing the relatively low average price, high-quality sellers do not accept the price, and consequently leave the market. This affects the buyers' beliefs on the average quality offered by the remaining sellers. This dynamics leads to the collapse of the entire market.

In our setting, this kind of market evolves for parameter values of $\alpha > \frac{1}{2}$. In the following we will refer to this market as 'Lemon Market' (Figure 1).

Figure 1: Market outcomes in the Efficient and the Lemon Market.



$\alpha \leq \frac{1}{2}$ $\alpha > \frac{1}{2}$

In the market with $\alpha \leq \frac{1}{2}$, the average price the buyers are willing to pay is higher than the reservation utility of the seller with highest quality. Therefore, a unique equilibrium in a first price sealed bid-auction between buyers exists, with a market clearing price of $\frac{1}{2}$. In this market, the 'Efficient Market', all possible gains of trade are exploited. Proposition 1 summarizes the results for both markets.

[9]This is equivalent to a model where each seller of the quality interval $[0, 1]$ faces two buyers once.

Proposition 1 The Market without the Certification

(a) For $\alpha > \frac{1}{2}$ (Lemon Market) no trades occur.
(b) For $\alpha \leq \frac{1}{2}$ (Efficient Market) all goods are traded for price $q^e = E\{q\} = \frac{1}{2}$. The entire welfare of $W_{max} = \frac{1-\alpha}{2}$ is exploited.

In the Lemon Market, the pair of bidding strategies $(0, 0)$ is the only equilibrium. With a deviating bid of b a buyer wins the auction if the bid exceeds the reservation utility of the seller. The expected quality of such a product is $E[q|\alpha q \leq b]$. As q is uniformly distributed the expected quality is $q^e = \frac{b}{2\alpha}$. Parameter α is greater than $\frac{1}{2}$ and thus $q^e < b$. Consequently, a deviation does not pay off and the equilibrium bids are unique and the market collapses. The applied auction format mirrors exactly the well known asymmetric information dynamics of the Akerlof model, since the reservation price is unknown.

Contrarily, the equilibrium bidding strategy in the Efficient Market is to bid the buyers own valuation in the symmetric first-price sealed-bid auction with common values. With $\alpha \leq \frac{1}{2}$ every seller accepts a bid $b = \frac{1}{2}$ as $\frac{1}{2} \geq \alpha q$ for all $q \in [0, 1]$. All products are traded and the maximum welfare is exploited:

$$W_{max} = \int_0^1 (1 - \alpha) q dq = \frac{1 - \alpha}{2}.$$

The sellers gain the entire welfare, as buyers bid in expectations and compete for the product, and ultimately realize no profits.

2.2 One-sided certification

The information asymmetries might be overcome by an intermediary, who credibly provides the quality level of the seller to the buyers. Thereby, it is important to distinguish between different channels of information provision: on the one hand, the intermediary might announce the rating result publicly. Therewith the intermediary maximizes the amount of potential buyers for the product, which is desirable for the seller, as competition between buyers for the product evolves; in turn seller's profit increases. On the other hand, the information might be privately owned by one or a part of potential buyers. The intermediary chooses to reveal relevant information solely partly, which

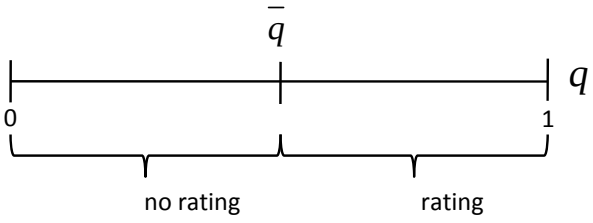
allows the informed buyers to use their informal advantage in the selling process. They will be willing to pay a higher price for the certification service to extract some informational rent. The intermediary will therefore limit the distribution of the information in order to maximize his own profits. The seller will face a limited number of buyers, which shifts the bargaining power partly to the buyers. In our model the intermediary cannot credibly commit to sell solely to one of the buyers, as she will have an incentive to deviate in accepting an offer from the other buyer.

The following section discusses alternatives and equilibrium outcomes of the model with one-sided certification.

2.2.1 One-sided seller-certification

To study the alternative channels, assume at first that an intermediary offers his service exclusively to the seller for a profit maximizing price p_s. To solve the model, we apply backward induction. On the last stage of the game the buyers are symmetrically informed: either both are informed about the quality of the product, or both are uninformed and can solely build quality expectations. In both markets ($\alpha \leq \frac{1}{2}$ and $\alpha > \frac{1}{2}$) a quality threshold $\bar{q} \in [0, 1]$ exists, such that all sellers with a quality above $\bar{q}$ will order a rating. Figure 2 shows the continuum of quality levels and the interval on which sellers will order a rating.

Figure 2: Quality threshold $\bar{q}$



By demanding the intermediary to announce the information on the quality parameter q, the seller assures the product to be traded for the price q, since buyers share a common valuation for the product and therefore compete in prices. The critical quality level $\bar{q}$ is determined by the seller, who is indifferent between receiving $\bar{q}$ and paying p_s or either being traded for the expected quality in the remaining market in the Efficient

Market, which we denote by $q^e_{\bar{q}}$ in equilibrium or receiving her reservation utility $\alpha\bar{q}$ in the Lemon Market. Low quality sellers are still able to pool with superior quality sellers up to $\bar{q}$, since buyers are unable to distinguish between sellers, as the remaining quality is unknown.

Lemma 1 Bidding behavior for the case of Seller-Certification

(a) Lemon Market: Uninformed buyers bid 0 and informed buyers bid q.
(b) Efficient Market: Uninformed buyers bid $q^e_{\bar{q}}$ and informed buyers bid q.

If no rating is demanded by the seller, buyers will be uninformed about the true quality of the product and will not bid in the Lemon Market and will bid their expected valuation $q^e_{\bar{q}}$ in the Efficient Market. For this case, the same intuition holds as in the case of no certification service.

If the seller demands a rating, the only equilibrium in the first price sealed-bid common value auction is to bid the own valuation, which is the publicly announced true quality q. The equilibrium evolves out of pure strategies. The seller has to value the different options in the specific market. He might either order a rating for a given price p_s in order to receive the price for the true valuation, or he excepts the expected average price of the non-rated sellers without paying a certification fee. Therefore, the profit maximizing price of the certifier enables the sellers with the highest quality products to generate an extra rent by ordering a rating.

The certifier maximizes his revenues ($\Pi_C = p_s(1 - \bar{q})$) by either selling to few high-quality sellers or by increasing the number of certificates and simultaneously lowering the respective price p_s. Higher certification prices induce higher $\bar{q}$. A high market parameter α will c.p. increase the threshold value $\bar{q}$ in the Lemon Market, since a higher reservation value decreases the potential gains from trade.

Lemma 2 Induced quality threshold depending on certification price

(a) Lemon Market: $\bar{q} = \frac{p_s}{1-\alpha}$, $p_s \in [0, (1 - \alpha)]$,
(b) Efficient Market: $\bar{q} = 2p_s$, $p_s \in [0, \frac{1}{2}]$.

Proposition 2 states the optimal pricing strategy for the intermediary and the equilibrium results for the relevant market measures; Π_S denotes the expected profits of the

seller, Π_C denotes the expected profits of the certifier and W is the realized welfare in the respective market.

Proposition 2 One-sided seller-certification

(a) Lemon Market: The optimal pricing strategy for the certifier: $p_s = \frac{1-\alpha}{2}$. *In equilibrium:* $\bar{q} = \frac{1}{2}$, $\Pi_C = \frac{1-\alpha}{4}$, $\Pi_S = \frac{1-\alpha}{8}$ *and* $W = \frac{3}{8}(1-\alpha)$.
(b) Efficient Market: The optimal pricing strategy for the certifier: $p_s = \frac{1}{4}$. *In equilibrium:* $\bar{q} = \frac{1}{2}$, $\Pi_C = \frac{1}{8}$, $\Pi_S = W_{max} - \frac{1}{8}$ *and* $W = W_{max}$.

The best half of the sellers order a rating in both markets, the Lemon and the Efficient Market, and pay a price of $\frac{1}{4}$ in the Efficient Market and a smaller price of $\frac{1-\alpha}{2}$ in the Lemon Market. Compared to the profits in the market without certification, sellers gain in the Lemon Market, since the intermediary enables them to trade their products and increases their rents from zero to $\frac{1-\alpha}{4}$. In contrast, the overall gains of all sellers in the Efficient Market are reduced by $\frac{1}{8}$, since the intermediary receives parts of their potential gains from trade. As a result, the introduction of an intermediary increases welfare in the Lemon Market and does not affect welfare in the Efficient Market.

Remarkably, the certification price and the profit of the certifier do not depend on the market parameter α in the Efficient Market. This is rather astonishing, as potential gains from trade differ significantly between varying market settings characterized by the market parameter α. This is due to the fact, that the products are even traded without a certifier and thus, the certifier cannot gain from variations in α. Even though the potential gains from trade increase with lower values of α, the profit of the certifier is capped to $\frac{1}{8}$; as the reservation utility of the seller does not affect the pricing within the market.

2.2.2 One-sided buyer-certification

In contrast to the sale of the certification service merely to the seller, the intermediary might opt to serve solely the other side of the market, namely the buyers, by offering his rating service for the price p_b. Thereby, the objective for information revelation is fundamentally different: in the case of a seller-certification publicly announced ratings are required to verify the quality of the product to differentiate the product from the remainder in the market. In contrast, a buyer can only realize information rents if she

exclusively possesses the information. In our setting, the buyers decide simultaneously and build expectations on the likelihood of being the only consumer of the certification service.

In pure strategies, no symmetric equilibrium exists: if both buyers order a rating, they will accrue losses and a deviation will pay off; if both buyers do not order a rating, it pays off to order a rating as the deviating buyer ends up being exclusively informed. Thus, the only symmetric equilibrium is a mixed-strategy equilibrium in which each buyer decides with a certain probability ω to order a rating. Since buyers are indifferent to order a rating, the expected profit is zero. By assumption buyers are aware of the distribution of the information in the market at the beginning of the first-price auction. The bidding behavior for asymmetrically informed bidders in such a first-price auction results in a unique equilibrium (Weverbergh, 1979).

Lemma 3 Bidding behavior for the case of seller-certification

	informed	*uninformed*
informed	(q, q)	$(\alpha q, 0)$ *if* $\alpha > \frac{1}{2}$ $(\frac{1}{2}q, F(b))$ *if* $\alpha \leq \frac{1}{2}$
uninformed	$(0, \alpha q)$ *if* $\alpha > \frac{1}{2}$ $(F(b), \frac{1}{2}q)$ *if* $\alpha \leq \frac{1}{2}$	$(0, 0)$ *if* $\alpha > \frac{1}{2}$ (q^e, q^e) *if* $\alpha \leq \frac{1}{2}$

The distribution function of bids for a single uniformed buyer is given by $F(b) = 2b$.

Lemma 3 summarizes the bidding behaviour of the buyers. If both buyers are informed, buyers will bid their own valuation, which is q, since they will enter into price competition as in the case of seller-certification. This result holds in both markets. For the remaining information structures, results differ between market structures. In the Lemon Market, the unique equilibrium if both buyers are uninformed is to bid zero, since the asymmetric information feature prevails as in the case of no certification. If one of the buyers is exclusively informed, the bidding strategy is $b = \alpha q$ and the uninformed bids zero. Thereby, the informed buyer extracts the entire information rent, as the seller is indifferent between accepting and rejecting the offer. The uninformed buyer cannot win the auction, if he bids more than zero, since the expected quality in the market is lower than the reservation utility of the seller and the bid of the informed buyer.

In the Efficient Market the results differ significantly. If both buyers did not order a certificate for the given price p_b, the buyers will bid their expected valuation $q^e = \frac{1}{2}$. In

the case of only one exclusively informed buyer, his equilibrium bidding strategy is to bid $b = \frac{1}{2}q$. The uninformed mixes on the interval $[0, \frac{1}{2}]$ according to distribution function $F(b) = 2b$ and generates an expected profit of zero. This is the unique equilibrium in the auction format.

Lemma 4 Expected payoffs of being exclusively informed
(a) Lemon Market: Expected payoff is $V_{ib}^L = \frac{1-\alpha}{2}$.
(b) Efficient Market: Expected payoff is $V_{ib}^E = \frac{1}{6}$.

Lemma 4 shows that the expected payoff is always positive and buyers therefore always favour the alternative of being exclusively informed. In general, the buyer follows a strategy to obtain an information advantage to maximize the expected profit. As the uninformed buyer randomizes over the decision to order a rating using symmetric mixed strategies, the expected profit is zero; the buyer gambles for profits.

From the perspective of the intermediary the most profitable case is to sell her service to both investors, since she can extract a double dividend, as both buyers might pay the price for the certificate p_b. The certifier maximizes his revenues ($\Pi_C = \omega^2 2p_b + 2\omega(1-\omega)p_b$) by either attracting few buyers with a high price and low rating demand or decreasing the price to increase the likelihood ω that a buyer demands a rating. Higher prices induce lower probability ω.

Lemma 5 Induced rating probability depending on certification price
(a) Lemon Market: $\omega = 1 - \frac{2p_b}{1-\alpha}$, $p_b \in [0, V_{ib}^L]$,
(b) Efficient Market: $\omega = 1 - 6p_b$, $p_b \in [0, V_{ib}^E]$.

Intuitively, with a price higher V_{ib}^L respectively V_{ib}^E the demand diminishes to zero, as the expected payoff of being exclusively informed is lower than the rating price p_b. The intermediary will therefore choose a price which is lower. Proposition 3 captures the solution of the game.

Proposition 3 One-sided buyer-certification

(a) Lemon Market: The optimal strategy for the certifier: $p_b = \frac{1-\alpha}{4}$. *In equilibrium:* $\omega = \frac{1}{2}$, $\Pi_C = \frac{1-\alpha}{4}$, $\Pi_S = \frac{1-\alpha}{8}$ *and* $W = \frac{3}{8}(1-\alpha)$.
(b) Efficient Market: The optimal strategy for the certifier: $p_b = \frac{1}{12}$. *In equilibrium:* $\omega = \frac{1}{2}$, $\Pi_C = \frac{1}{12}$, $\Pi_S = W_{max} - \frac{1}{12}$ *and* $W = W_{max}$.

In expectation a buyer will not make any profits, even though he generates profits out of an information advantage in particular auctions. The generated rent diminishes in equilibrium to zero, since buyers accrue losses when both order a rating, which offset the gains of exclusive information. The likelihood of ordering a rating by the buyers is substantial. They seek to maximize their profits by bidding informed in half of the cases. As a result, one exclusively informed bidder evolves in 50 percent of the cases, while respectively in 25 percent investors are either equally informed or uninformed.

Similarly, to the intuition in the case of one-sided seller-certification, the rating price and the profit of the certifier do not depend on the market structure in the Efficient Market. The certifier cannot exploit the additional gains from trade in a market with a low market parameter α. The bidding behavior is independent from the reservation price of the seller in the auction, as the market also clears without a certification service.

2.2.3 Comparison of one-sided certification

Comparing the results with the one-sided seller-certification reveals interesting results. Firstly, the evaluated products in both models differ. With seller-certification, the best half of the products are traded and with buyer-certification it is a random draw from all products that are evaluated and thereafter sold, since the products cannot be differentiated ex-ante. The traded products differ in both market settings, the Lemon and the Efficient Market.

In every market, demand for certification service exists and the intermediary realizes profits by offering the information revelation service. Even in the market where trades occur without a certification service, the players demand a rating to maximize their profits and overall loose parts of their profits in total. The profit of the intermediary is higher in the Efficient Market than in the Lemon Market, even though the intermediary enables trades and therefore contributes more to welfare generation in the Lemon Market. But in the Efficient Market the overall rents are higher and in turn the intermediary can also extract a higher absolute value of the rents at stake. The profit shares are smaller in the Efficient Market, since the information asymmetries are overcome partly by the market itself even without an intermediary and thus the market of the intermediary is smaller.

In the Efficient Market, the certifier will prefer solely to sell the service to the seller-side, since the information value for privately informed buyers is too low, and thus

the certifier generates lower revenues. The uninformed buyer solely bids randomly in the Efficient Market, which reduces the information advantage, whereas he withstands bidding in the Lemon Market. In a Lemon Market the certifier is indifferent on which side to offer his service. The sellers' profits are equal in the Lemon Market under both regimes, but are lower in the Efficient Market with seller sided certification, since the preferences of certifier and seller are reversed in the discussed cases.

The overall welfare is realized in the Efficient Market, but the intermediary increases exploited welfare in the Lemon Market to 75 percent of potential welfare.

Figure 3: Profit shares with one-sided certification sold to sellers.

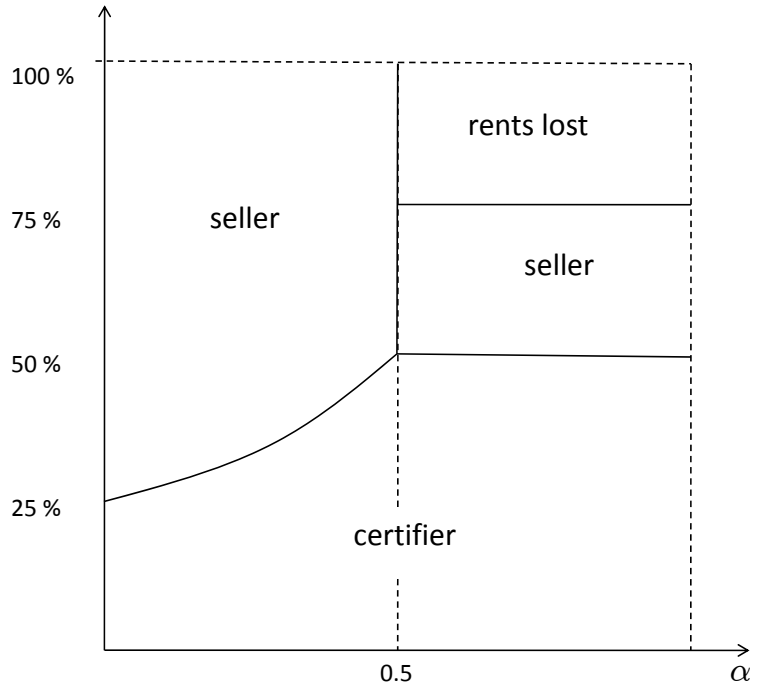


Figure 3 shows the realized potential welfare for all market parameters as well as for the different players. Remarkably, not all rents are realized in the Lemon Market. 25 percent are lost even with the presence of an intermediary.[10]

Corollary 6 summarizes the main results of the previous section on one-sided certification.

[10]Note that the potential welfare varies significantly with the market parameter, as $W_{max} = \frac{1-\alpha}{2}$.

Corollary 6 Summary results of one-sided certification

(a) Lemon Market: Buyers, seller and the certifier are indifferent between one-sided buyer and seller certification.[11] *The welfare equals under both regimes compared to no gains from trade without certification.*

(b) Efficient Market: The certifier prefers to offer her service to the seller side, while the seller prefers (ex ante) the certifier to operate on the buyer side. Welfare is not affected by certification.

[11] The indifference condition is partly due to the uniform distribution of quality q.

2.3 Two-sided certification

The model of two-sided certification combines the previous models of one-sided certification. The different objectives of information revelation are stressed: a high-quality seller tries to disclose his true quality to both buyers by ordering a rating, which is thereafter publicly announced, and the buyers seek to be exclusively informed in order to realize an information rent. To avoid pooling with low-quality sellers, a mid-quality seller hopes to be rated by both buyers, which leads to the same information structure as if the product's quality is disclosed publicly, while the certification costs p_s are shifted towards the buyers. Depending on the market structure a low-quality seller does not hope to be rated by buyers (Efficient Market), as he will then realize the expected price of the remaining pooled products, whereas he favours to be rated in markets where his product is otherwise not traded (Lemon Market).[12]

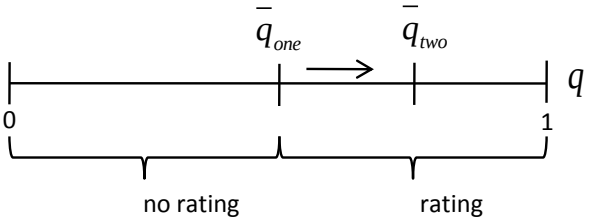
The certifier profits from the fact, that she can sequentially segment the market by discriminatory pricing for public and private information disclosure. Firstly, the seller's willingness to pay is extracted and thereafter, the buyers decide if they are willing to order a rating.

In equilibrium the continuum of sellers is divided into two segments: one containing the high quality sellers, $q \in [\bar{q}, 1]$, where sellers order the rating, which is thereafter publicly announced and traded for the price of the true quality q and a second segment containing the lower-quality sellers, $q \in [0, \bar{q}]$, in which the higher quality part of the sellers do not order a rating, but speculate that either one or both of the buyers order a rating, or trades occur without a certificate. The decision of the seller depends firstly on the quality of his own product and secondly on the endogenous price of the certification service p_s set by the intermediary.

Figure 4 illustrates the change of the quality threshold level between one- and two-sided certification above which the seller will order a rating. Observing some likelihood that the buyers order a rating, fewer sellers are willing to pay the certification price p_s and the threshold value $\bar{q}$ increases. A positive buyer rating probability allows the seller to shift the rating costs to the buyer side, which increases his expected profit without a public rating. Furthermore, the expected quality of the non-rated sellers increases with

[12] Simultaneous decisions of the seller and the buyers lead to the same equilibrium profits and welfare. In this setting, high-quality sellers will also opt to order a rating and thus a quality threshold $\bar{q}$ evolves, which equals the threshold in the standard setting, since no information rent can be extracted from a product with a public rating.

Figure 4: Seller segmentation.



every seller who switches from ordering a rating by himself to hoping to be rated by the buyers, which leads to an even further shift towards a higher quality threshold (q_{two}).

In the second stage, the buyers observe the decision of the seller and condition thereon. It is obvious that a buyer will never demand a certificate if the seller already ordered a rating, as the certification process publicly reveals the true quality, which is observable by all buyers. Therefore, buyers cannot generate an extra rent by exploiting private information. If the seller has not ordered a rating, buyers order with a mixed-strategy probability, as they cannot obverse the ordering decision of their opponent. As in the one-sided buyer-certification three different outcomes might evolve:

1. no buyer orders a rating and the product is traded in the Efficient Market and is not traded in the Lemon Market, or
2. one buyer orders a rating and realizes an information rent, or
3. both buyers order a rating and do not gain by trading the product.

In the Efficient Market there is still a market for uncertified goods in which bidding depends on the quality threshold $\bar{q}$ above which a seller orders a certificate on her own and the probability ω at which the buyers demand a rating, whereas in the Lemon Market trades without a certificate do not occur, as shown in section 2.1.

Lemma 7 Bidding behavior for the case of two-sided certification

	informed	*uninformed*
informed	(q, q)	$(\alpha q, 0)$ *if* $\alpha > \frac{1}{2}$ $(\frac{1}{2}q, F_{\bar{q}}(b))$ *if* $\alpha \leq \frac{1}{2}$
uninformed	$(0, \alpha q)$ *if* $\alpha > \frac{1}{2}$ $(F_{\bar{q}}(b), \frac{1}{2}q)$ *if* $\alpha \leq \frac{1}{2}$	$(0, 0)$ *if* $\alpha > \frac{1}{2}$ $(q^e_{\bar{q}}, q^e_{\bar{q}})$ *if* $\alpha \leq \frac{1}{2}$

The distribution function of bids for a single uniformed buyer is given by $F_{\bar{q}}(b) = \frac{2}{\bar{q}}b$.

The three possible information outcomes in the bidding stage of the buyers in both markets are illustrated in Lemma 7. Hereby, the distribution of the bids in the remaining market $q \in [0, \bar{q}]$ is determined endogenously. If both buyers are informed about the quality q the unique bidding equilibrium is (q, q), which holds in both markets, and exhibits the competition of the buyers for the product. Depending on the market structure, buyers will bid zero in the Lemon Market and $q^e_{\bar{q}}$ in the Efficient Market, which is the expected quality of the products, that have not been rated before. If one investor is exclusively informed about quality q the unique bidding equilibrium requires the informed buyer to bid αq and the uninformed one does not bid at all in the Lemon Market.

In the Efficient Market with one exclusively informed buyer the unique bidding equilibrium requires the informed buyer to bid $\frac{1}{2}q$. The uninformed mixes on the interval $[0, \frac{1}{2}\bar{q}]$ according to the distribution function $F_{\bar{q}}(b) = \frac{2}{\bar{q}}b$.

Lemma 8 Expected payoffs of being exclusively informed
(a) Lemon Market: Expected payoff is $V^L_{ib} = (1 - \alpha)\frac{\bar{q}}{2}$,
(b) Efficient Market: Expected payoff is $V^E_{ib} = \frac{1}{6}\bar{q}$.

Lemma 8 illustrates the expected payoffs of a buyer given he is exclusively informed. The values reflect the information value for the buyer. In the Efficient Market, the information value does not depend on the market parameter α, indicating, that the value of information is capped, as without a certification service trades would also occur. Lemma 9 states the induced quality thresholds and the rating probabilities depending on the certification price set by the intermediary.

Lemma 9 Induced quality threshold and rating probability depending on the certification price

(a) Lemon Market: $\bar{q} = \frac{4p_b^2}{(1-\alpha)(4p_b - p_s)}$ *and* $\omega = \frac{p_s}{2p_b} - 1$ *with* p_s *and* p_b *s.t.* $0 \leq \bar{q}, \omega \leq 1$,
(b) Efficient Market: $\bar{q} = \frac{18p_b^2}{6p_b - p_s}$ *and* $\omega = \frac{p_s}{3p_b} - 1$, *with* p_s *and* p_b *s.t.* $0 \leq \bar{q}, \omega \leq 1$.

For a given p_s, the probability of ordering a rating by the buyers diminishes in p_b, which is intuitive, as the certification service is a normal good. Similarly, the quality threshold $\bar{q}$ increases with higher p_s given p_b. Referring to the considerations of the auction format discussed above, the bidding equilibria are derived from the expected payoffs for the exclusively informed buyer. For a non-certified seller the quality is uniformly distributed on the interval $[0, \bar{q}]$ with the according distribution function $G(q) = \frac{q}{\bar{q}}$. In both cases the expected profit of being uninformed is zero.

The decision of the seller as well as the decision of the buyers to order a rating depends heavily on the rating price set by the certifier. With increasing certification prices, the amount of ratings decreases. Hence, the certifier sets revenue-maximizing prices for his service, that allow him to skim the rents in the market.

Proposition 4 Two-sided certification

(a) Lemon Market: The optimal pricing strategy for the certifier: $p_s = \frac{16}{27}(1-\alpha)$ *and* $p_b = \frac{2}{9}(1-\alpha)$. *In equilibrium:* $\bar{q} = \frac{2}{3}$, $\omega = \frac{1}{3}$, $\Pi_C = \frac{8}{27}(1-\alpha)$, $\Pi_S = (1-\alpha)\frac{17}{162}$ *and* $W = (1-\alpha)\frac{65}{162} \neq W_{max}$.
(b) Efficient Market: The optimal strategy for the certifier: $p_s = \frac{3}{2}(5\sqrt{5} - 11)$ *and* $p_b = \frac{1}{4}(7 - 3\sqrt{5})$. *In equilibrium:* $\bar{q} = \frac{141 - 63\sqrt{5}}{36 - 16\sqrt{5}}$, $\omega = \frac{89\sqrt{5} - 199}{21\sqrt{5} - 47}$, $\Pi_C = \frac{3}{4}(5\sqrt{5} - 11)$, $\Pi_F = \frac{1-\alpha}{2} - \Pi_C$ *and* $W = W_{max}$.

Proposition 4 shows the optimal pricing strategy for the certifier and the equilibrium outcomes of the model of two-sided certification. One third of the sellers order a rating compared to one half in the case of one-sided certification. In either case, the best part of the sellers order a rating and a threshold value $\bar{q}$ evolves. Interestingly, sellers with quality $q \in [\frac{1}{2}, \frac{2}{3}]$ will choose to order a rating if there is solely one-sided certification, but will not order, if there is the option of being rated afterwards by the investors. Two main reasons for this outcome prevail. On the one hand, the intermediary slightly increases the seller price for the rating and thereby reduces the demand and on the other hand, sellers might gamble to be rated by both investors. Therewith, they do not need to pay the certification price and increase their own profits. In total, however, the profit of the seller is lower in the case of two-sided certification.

The probability of being rated by the buyers decreases with two-sided certification compared to one-sided certification, since the available information rents are smaller and for a given price for the certification service the demand diminishes. Furthermore, the amount of sellers is also smaller, since only the non-rated sellers remain in the market and can be rated by the buyers.

The effects on the overall welfare depend on the market structure. In the Lemon Market a certification service increases welfare substantially. It rises from $\frac{3}{8}(1-\alpha)$ to $\frac{65}{162}(1-\alpha)$, as the number of ratings increases and therewith also the number of trades in the market. In contrast, welfare is not affected in the Efficient Market, as even without a certifier, no inefficiencies occur. The market is always cleared. The welfare gains are even higher in the case of two-sided certification as with one-sided certification. As a result one might conclude, that two-sided certification should be promoted to allow for an efficient allocation of resources, if the value of information asymmetries is high.

3 Results and the Rating Market

This section links the theoretical results with empirical observations of the rating industry and discusses the findings. The market for rating agencies is highly concentrated and is estimated to have a volume of $4.5 billions per year. The two biggest rating agencies, Moody's and Standard & Poors, share 80 percent of the market and together with the number three, Fitch Ratings, the market share becomes 95 percent. The operating margins of the leading rating agencies is close to 50 percent and relatively stable over the last years, even in the current turmoil of the financial markets.

Generally, the business model of rating agencies consists of two main pillars. On the one hand, they offer certification services and on the other hand, they offer consultancy, mainly to banks and institutional investors. The combination of the two business areas led to a discussion on conflicts of interest that might evolve, as agencies consult banks on the same products as they evaluate in a later stage. The failure of rating agencies in the current financial crisis underlines this major problem, which is not addressed in this paper, as we do not believe, that it is a sufficient argument for recent rating failures, since long-term rating evaluations concluded that they are rather accurate (Reinhart, Levich and Majoni, 2002) and in the current setting not susceptible to bribing.[13]

[13]Reinhart et al. (2002) compare the historical performance of ratings, as the deviation of estimated

The business model with respect to the sales model of certification services changed significantly over time. Before 1970, ratings were primarily sold to investors, who paid for the certification service (Model 2). A subscription was required to obtain information, which were thereafter private information of subscribers. After 1970, the rating agencies decided to additionally sell their services to the other side of the market, to firms or issuers (Model 3). After the firm received a rating, the information was immediately public and could be observed by all market participants. In addition, a large number of small rating agencies entered the market, which serve the investor's side and sell directly to buyers on a subscription basis (Model 2).

The increasing complexity of financial markets in the last decades caused a massive increase of a reliance on credit ratings by investors, issuers and regulatory bodies. Issuers, such as firms or financial institutions have mainly two incentives to demand a rating: firstly, they expect to receive a lower spread on their financial instruments and secondly, they expect to face a broader investment pool and therewith reduce the liquidity premia in the market. Institutional investors, such as insurers, reinsurers and pension funds require ratings of financial products before the assets can enter into their portfolios. Many of the investors follow long-term strategies and apply portfolio governance rules, consisting of buy and sell restrictions linked to rating changes, to manage their portfolios (Löffler, 2004). Therefore, retaining a strong investment rating in some or even all of their asset classes is essential. Private investors also rely on publicly available ratings to optimize their portfolios and reduce information costs. Most importantly, various government regulators use and permit the use of credit ratings for regulatory purposes. E.g. the Basel II accords (BIS, 2004), partly rely on credit ratings in order to assess the risk exposure of bank portfolios and allow banks to calculate their net capital requirements based on the credit assessments.

A widespread argument for the high concentration and the high profit margins of rating agencies is the rigorous accreditation procedure of rating agencies by the Securities and Exchange Commission in the US. This is only partly true, since currently 10 Nationally Recognized Statistical Rating Organizations exist. Moreover, also in other regions in the world a high concentration is observable, e.g. in Japan two players share most of the market, namely the Japan Credit Rating Agency and Rating and Investment Information Inc.. Worldwide close to 40 rating agencies exist, which offer their services to one or both sides of the market.

from the realized default probability.

Often not only one rating, but up to three ratings are required in the regulatory process. Therefore, a monopolistic market structure of the rating industry can be attributed to the regulatory framework, which also deters entries in the market and establishes major entry barriers. Reputation of the certifiers as a driver for the existing market structure can therefore be only one possible explanation. As a consequence, we model the certification intermediary in our model to be a monopolistic supplier.

We show in a theoretical model, that a credible equilibrium exists, where rating agencies sell their services to both sides of the market to increase their own revenues and maximize their profits. Contrary to Lizzeri's no revelation result (Lizzeri, 1999), we show that strong incentives exist for the rating agency to issue information to both sides. The result objects to the argument, that the rating agencies mainly changed their business model towards the issuer-pay model to be available for bribing by firms or other rated entities.

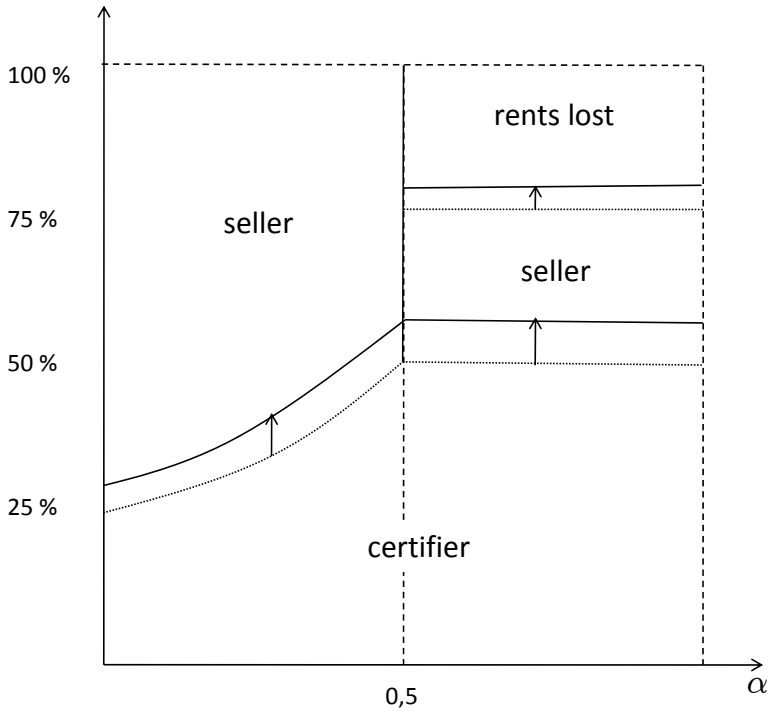
The model reveals some striking results. Without a certification service two market outcomes arise: in one market the costs of asymmetric information does not hinder investors and issuers from exchanging their products. The reservation utility of the best seller is lower than the expected quality of all sellers by the buyers and consequently, all products are traded in the market; an 'Efficient Market' arises. Contrarily, in a market in the sense of Akerlof (1970), the asymmetric information problem leads to the collapse of the entire market. No trades will be observed in this 'Lemon Market'.

In a Lemon Market a financial intermediary can partly overcome the asymmetric information problem, as a high proportion of potential trades is realized. The intermediary in this case receives a high fraction of the rents generated by the market. In the efficient market, the total welfare is not affected by the introduction of the intermediary, as the market mechanism already generates the maximum welfare.

Our results show that a profit-maximizing certifier prefers to operate on the seller's side in an efficient market, if she has to decided to offer the services merely to one side of the market, while she is indifferent in a lemon market. Figure 5 depicts the shares of all parties involved in the market if the certification service is offered to the seller's side and to both sides of the market. In the Lemon Market not the entire welfare can be realized through certification, but a substantial proportion of 75 percent. In both markets, the certifier extracts a high amount of the potential rents, which rise up to 50 percent of potential welfare in the lemon market. Firms gain in the lemon market

by hiring the intermediary, as they extract 25 percent of potential welfare, which could not be realized in an alternative way. In an efficient market the intermediary does not increase welfare and the seller will be unwilling to share the rents with the intermediary in the market (ex-ante).

Figure 5: Profit shares with two-sided certification compared to one-sided.



If the intermediary decides to merely sell to the investor's side, its revenues will shrink by one third. It is important to notice, that the traded products differ between both sales schemes: if the seller orders a rating, the best half of the firms will demand a certificate, whereas if buyers order ratings, they cannot differentiate between good and bad firms and therefore will select randomly.

Comparing the outcomes of one-sided certification with the model in which the intermediary sells its services firstly to the sellers and, if they reject the offer, secondly to the buyers, the welfare in the lemons market increases even further.[14] With two-sided certification, about 70 percent of all products are traded in equilibrium, including the

[14]Relaxing the assumption of a sequential game and allowing sellers and buyers to demand a rating simultaneously does not alter the solutions.

third with highest quality. The welfare loss is down to about 20 percent compared to 100 percent in the case without certification.

The profit for the intermediary is highest in the market with two-sided certification, which is not as intuitive as expected, since the certifier might crowd out demand by sellers in the primary market through the introduction of the evaluation service on the buyer side. By offering the certification service on the secondary market the intermediary faces a negative second-order effect from sellers hoping to be rated by two buyers, which reduces the revenues generated on the seller side for any given price. At the same time, the average quality of non-rated sellers increases, which increases the attractiveness of being exclusively informed for the buyers, which increases demand for investor ratings at any given price. The model shows that the introduction of two-sided certification seem to outweigh the negative effect of being her own competitor.

Appendix 2 gives a summary report on the equilibrium values of the main variables in the model.

The shares of welfare in the one-sided and the two-sided model are depicted in figure 5. The graph shows the slight increase of the intermediaries' share on welfare in the Efficient Market. Compared to the 50% jump in profits from offering ratings to the firm's side instead of operating on investor's side solely, the increase in profits of the intermediary by offering the certification service on both sides in an efficient market is only about 8%.

Table 1: Moody's revenue shares depending on sales scheme

in millions US$	2008	2007	2006
Moody's Analytics (mainly investor-pay model)	550.7	479.1	397.3
Moody's Investors Service (mainly issuer-pay model)	1,268.3	1,835.4	1,685.6
Total revenues	1,755.4	2,259.0	2,037
Investor-pay revenue share	72.3 %	81.2%	82.7%

Source: (Moody's, 2008, p.94).
Notes: Consolidated revenues of business segments in the respective years in millions US$.

Table 1 illustrates exemplarily Moody's revenue shares generated by selling rating ser-

vices to investors and sellers, respectively. In our model the seller contributes two-third of the certifiers' revenues in the lemon market, while the buyers contribute one third. In the efficient market, the seller contributes 86 percent, and the buyers only 14 percent. Hence, the profit shares of the issuer are lower in the lemon market. In the current financial crisis, the efficiency of markets reduced tremendously and at the same time, revenues issuer-generated revenues declined, while investor-generated revenues hiked (Table 1). The findings of the model are therefore in line with recent observations in the credit markets, as they are currently characterized by a higher degree of asymmetrically distributed information.

4 Conclusion

The rating industry is highly concentrated and offers services to both sides of the market. In principle, ratings seek to reduce transaction costs and market inefficiencies which accrue due to information asymmetries between market participants. However, the financing of the intermediaries is under steady criticism, as conflict of interest might arise and the market power could be exploited. The main criticism hereby is the payment scheme of the rating service, being partly an issuer-pay model. Therefore, we analyze the sales mechanism of financial intermediaries to discover the main incentives and determine its influence on welfare generation. Especially in the case of public financing this is relevant, as ratings are related to the financing costs of sovereign entities. The sanction mechanism of high financing costs might be undermined if the asymmetric information problem is not solved by the market.

In the theoretical model, we show that the introduction of a financial intermediary, which offers its services solely to one side of the market, enables trades in a market in the sense of Akerlof. Depending on the sales scheme, either selling the certification service merely to the buyer or to the seller, the profit shares of the parties vary. The certifier can maximize its profit by selling to the sellers side in an efficient market and is indifferent in a lemon market.

Furthermore, we show that the profit maximizing strategy for the rating agencies is to sell to both sides of the market, as it is done since the 1970s. The economic welfare in financial markets increases, as more projects, which are adequately priced, are promoted.

The policy implication of the results of our model is an indirect one. It is not necessarily the case that observing intermediaries being paid by the issuers indicates a cooperation of the two parties or even beautifying the default probability. In a functioning market we expect that intermediaries have a strong tendency to offer their services both sides of the market, with a preference for the seller's side. As a result one might argue, that the presence of intermediaries in inefficient markets, as the lemon market in our model, should be strengthened, as they are able to solve the inefficiency due to asymmetrically distributed information to a certain degree and therewith lead to a massive welfare increase. In an efficient market, the intermediary is not required for the occurrence of trades, but the prices of traded goods vary. With respect to an efficient allocation of resources the true valuation of goods, which is revealed by rating agencies, is substantial and mirrors a reasoning for an intermediary service.

In recent times it seemed to be a straightforward argument that the financial crisis was provoked by unjustified good ratings arising from conflicts of interest between certifiers and firms, who order consultancy services from certifiers. This paper does not claim that this was not the case; it is rather important to determine the incentives in particular markets and the influence of the rating agencies on the valuation in markets.

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A Appendix

A.1 Summary results

Table 2: Comparing equilibrium outcomes of different model settings

	Only sellers	Only buyers	Both sides
$\alpha > \frac{1}{2}$ (lemon market)			
price for seller rating	$\frac{1-\alpha}{2}$	-	$\frac{16}{27}(1-\alpha)$
price for buyer rating	-	$\frac{1-\alpha}{4}$	$\frac{2}{9}(1-\alpha)$
high-quality threshold	$\frac{1}{2}$	-	$\frac{2}{3}$
buyer's rating probability	-	$\frac{1}{2}$	$\frac{1}{3}$
profit certifier	$\frac{1-\alpha}{4}$	$\frac{1-\alpha}{4}$	$\frac{8}{27}(1-\alpha)$
profit seller	$\frac{1-\alpha}{8}$	$\frac{1-\alpha}{8}$	$\frac{17}{162}(1-\alpha)$
welfare	$\frac{3}{8}(1-\alpha)$	$\frac{3}{8}(1-\alpha)$	$\frac{65}{162}(1-\alpha)$
$\alpha < \frac{1}{2}$ (efficient market)			
price for seller rating	$\frac{1}{4}$	-	≈ 0.27
price for buyer rating	-	$\frac{1}{12}$	≈ 0.07
high-quality threshold	$\frac{1-\alpha}{2}$	-	≈ 0.573
buyer's rating probability	-	$\frac{1}{2}$	≈ 0.24
profit certifier	$\frac{1}{8}$	$\frac{1}{12}$	≈ 0.135
profit seller	$\frac{1-\alpha}{2} - \frac{1}{8}$	$\frac{1-\alpha}{2} - \frac{1}{12}$	$\frac{1-\alpha}{2} - 0.135$
welfare	$\frac{1-\alpha}{2}$	$\frac{1-\alpha}{2}$	$\frac{1-\alpha}{2}$

A.2 Proof of Lemma 2

(a) A seller will order a rating if $(1-\alpha)q - p_s \geq 0$. As the left-hand-side is increasing in q the threshold level $\bar{q}$ of being indifferent of ordering a rating is determined by $(1-\alpha)\bar{q} - p_s = 0$ which yields $\bar{q} = \frac{p_s}{1-\alpha}$.

(b) A seller will order a rating if $(1-\alpha)q - p_s \geq \frac{1}{2}\bar{q} - \alpha q$. As the left-hand-side is increasing in q the threshold level $\bar{q}$ of being indifferent of ordering a rating is determined by solving $(1-\alpha)\bar{q} - p_s = \frac{1}{2}\bar{q} - \alpha q$ for $\bar{q}$ which yields $\bar{q} = 2p_s$. q.e.d.

A.3 Proof of Proposition 2

(a) The maximization problem of the certifier is given by:

$$\max_{p_s} \Pi_C(p_s) = (1 - \bar{q}(p_s))p_s. \tag{1}$$

Plugging the result of Lemma 2(a) into the profit function yields the profit Π_C depending solely on p_s as:

$$\Pi_C(p_s) = p_s(1 - \frac{p_s}{1-\alpha}). \tag{2}$$

Maximizing w.r.t. p_s yields $p_s = \frac{1-\alpha}{2}$, and hence, $\bar{q} = \frac{1}{2}$, with a corresponding profit of the certifier of $\Pi_C = \frac{1-\alpha}{4}$. The sellers in the quality interval $[\bar{q}, 1]$ order a rating and subsequently sell their product for price q in the first price sealed bid auction, hence, their profit in this segment is:

$$\Pi_S = \int_{\frac{1}{2}}^{1} (1-\alpha)q dq - \frac{1-\alpha}{4} = \frac{1-\alpha}{8}. \tag{3}$$

As the lower segment is not traded in the Lemon Market overall realized welfare adds up to $W = \frac{3}{8}(1-\alpha)$ and a rent of $W_{max} - W = \frac{1-\alpha}{8}$ is lost due to the asymmetrically distributed information.

(b) The maximization problem of the certifier is given by:

$$\max_{p_s} \Pi(p_s) = (1 - \bar{q}(p_s))p_s. \tag{4}$$

Plugging the result of Lemma 2(b) into the profit function gives the profit Π_C depending

solely on p_s as

$$\Pi_C(p_s) = p_s(1 - 2p_s). \tag{5}$$

Maximizing w.r.t. p_s yields $p_s = \frac{1}{4}$, and hence, $\bar{q} = \frac{1}{2}$ with a corresponding profit $\Pi_C = \frac{1}{8}$. The remainder of the market (quality interval $[0, \bar{q}]$) is traded without a rating at a price of $\frac{\bar{q}}{2} = \frac{1}{4}$ and as all products are traded in this market the profit of the seller is given by:

$$\Pi_S = W_{max} - \Pi_C = \frac{1-\alpha}{2} - \frac{1}{8} \tag{6}$$

. q.e.d.

A.4 Proof of Lemma 4

(a) A single informed buyer in a Lemon Market receives the investment object for a price of αq in the auction with a probability of 1. Hence, the payoff for a product of quality q is $(1 - \alpha)q$. As expected quality in this market is $q^e = \frac{1}{2}$, the ex-ante expectation for the value of being exclusively informed is $V_{ib}^L = (1 - \alpha)q^e = \frac{1-\alpha}{2}$.

(b) As the informed buyer bids $\frac{1}{2}q$ in the auction and the uniformed randomizes the latter sometimes wins. The probability of winning the object for the informed buyer depends on q and is defined as $F(\frac{1}{2}q) = q$. Therefore, the expected payoff (ex-post) for the informed bidder is $F(\frac{1}{2}q)(1 - \frac{1}{2})q = \frac{1}{2}q^2$. Hence, the ex-ante expectation for the value of being exclusively informed is

$$V_{ib}^E = \int_0^1 \frac{1}{2}q^2 dq = \frac{1}{6}. \tag{7}$$

q.e.d.

A.5 Proof of Lemma 5

(a) As the buyers are indifferent between ordering a rating or staying uninformed in the unique mixed-strategy equilibrium the probability ω of ordering a rating is given by:

$$(1 - \omega)V_{ib}^L - p_b = 0. \tag{8}$$

Using Lemma 4(a) we obtain $(1 - \omega)\frac{1-\alpha}{2} - p_b = 0$ and solving for ω gives $\omega = 1 - \frac{2p_b}{1-\alpha}$.

(b) Applying the same logic and using Lemma 4(b)we obtain

$$(1-\omega)V_{ib}^{E} - p_b = 0 \Leftrightarrow (1-\omega)\frac{1}{6} - p_b = 0. \tag{9}$$

Solving for ω yields $\omega(p_b) = 1 - 6p_b$. q.e.d.

A.6 Proof of Proposition 3

(a) The maximization problem of the certifier is given by:

$$\max_{p_b} \Pi_C(p_b) = \omega(p_b)^2 2p_b + 2\omega(p_b)(1-\omega(p_b))p_b. \tag{10}$$

The profit function can be simplified to $\Pi_C(p_b) = 2\omega p_b$. Plugging the result of Lemma 5 (a) into the profit function yields $\Pi_C(p_b) = 2p_b - \frac{4p_b^2}{1-\alpha}$. Maximizing w.r.t. price p_b gives $p_b = \frac{1-\alpha}{4}$. This leads to $\omega = \frac{1}{2}$ and thus, the certifier's profit is $\Pi_C = \frac{1-\alpha}{4}$.

In the Lemon Market sellers only realize gains if the information on their quality is known to both buyers. In $\omega^2 = \frac{1}{4}$ of the cases the expected profit is $\frac{(1-\alpha)}{2}$ and hence the overall seller profit is $\frac{1-\alpha}{8}$. The accumulated welfare adds up to $W = \frac{3}{8}(1-\alpha)$.

(b) The maximization problem of the certifier is given by:

$$\max_{p_b} \Pi_C(p_b) = \omega(p_b)^2 2p_b + 2\omega(p_b)(1-\omega(p_b))p_b. \tag{11}$$

The profit function can be simplified to $\Pi_C(p_b) = 2\omega p_b$. Plugging the result of Lemma 5 (b) into the profit function we obtain $\Pi_C(p_b) = 2p_b - 12p_b^2$. Maximizing w.r.t. p_b yields $p_b = \frac{1}{12}$. This leads to $\omega = \frac{1}{2}$ and thus, the certifier's profit is $\Pi_C = \frac{1}{12}$. As in the Efficient Market all projects are realized it turns out that the profit of the seller is given by $\Pi_S = \frac{1-\alpha}{2} - \frac{1}{12}$ and the realized welfare is $W = W_{max}$. q.e.d.

A.7 Proof of Lemma 8

Let $G_{\bar{q}}(q)$ denote the uniform distribution on the interval $[0, \bar{q}]$ with corresponding density function $g_{\bar{q}}(q) = \frac{1}{\bar{q}}$.

(a) The probability of winning the auction for the informed bidder is 1. The quality remaining un-certified in the market is distributed according to $G_{\bar{q}}(q)$. In expectation

the informed buyer wins an object of quality $\frac{\bar{q}}{2}$ for a bid of $\alpha\frac{\bar{q}}{2}$, and hence realizes an expected profit of $V_{ib}^L = (1-\alpha)\frac{\bar{q}}{2}$.

(b) Let the object in the auction be of a quality q. By bidding $\frac{1}{2}q$ the informed buyer wins with a probability of $F_{\bar{q}}(\frac{1}{2}q) = \frac{q}{\bar{q}}$. If she wins her payoff is $q - \frac{1}{2}q = \frac{1}{2}q$. Thus, expected payoff ex-ante is determined by

$$V_{ib}^E = \int_0^{\bar{q}} \frac{q}{\bar{q}}\frac{1}{2}qdG_{\bar{q}}(q) = \int_0^{\bar{q}} \frac{q}{\bar{q}^2}\frac{1}{2}qdq = \frac{1}{\bar{q}^2}\frac{1}{6}q^3\Big|_0^{\bar{q}} = \frac{1}{6}\bar{q}. \tag{12}$$

q.e.d.

A.8 Proof of Lemma 9

(a) A seller will order a rating if:

$$(1-\alpha)q - p_s \geq \omega^2(1-\alpha)q. \tag{13}$$

As the left-hand-side increases faster in q the threshold level of the seller being indifferent is determined by the given equation with equality

$$(1-\omega^2)(1-\alpha)\bar{q} = p_s \Leftrightarrow (1-\omega)(1-\alpha)\bar{q} = \frac{p_s}{1+\omega}. \tag{14}$$

The buyer's indifference condition is:

$$(1-\omega)V_{ib}^L - p_b = 0. \tag{15}$$

Using Lemma 8(a) we get $(1-\omega)(1-\alpha)\bar{q} = 2p_b$. Plugging this into (14) yields $2p_b = \frac{p_s}{1+\omega}$. Solving this for ω gives $\omega = \frac{p_s}{2p_b} - 1$. To receive a function $\bar{q}(p_s, p_b)$ we calculate $1-\omega^2 = \frac{p_s}{p_b}(1-\frac{p_s}{4p_b})$ and by using (14) we obtain

$$\bar{q} = \frac{p_s}{(1-\alpha)(1-\omega^2)} = \frac{4p_b^2}{(1-\alpha)(4p_b - p_s)}. \tag{16}$$

(b) To determine the seller's indifference condition we need the expected winning bid in case that only one buyer ordered a rating given quality q and upper threshold $\bar{q}$, denoted as $E[b_{win}|q,\bar{q}]$. With a probability of $F_{\bar{q}}(\frac{1}{2}q) = \frac{q}{\bar{q}}$ the informed bidder wins

with a bid of $\frac{1}{2}q$. With a probability of $1 - \frac{q}{\bar{q}}$ the uninformed wins with an expected bid of $\frac{\frac{1}{2}q+\frac{1}{2}\bar{q}}{2} = \frac{1}{4}(q + \bar{q})$. Thus,

$$E[b_{win}|q, \bar{q}] = \frac{q}{\bar{q}} \cdot \frac{1}{2}q + (1 - \frac{q}{\bar{q}}) \cdot \frac{1}{4}(q + \bar{q}) = \frac{1}{4}\bar{q} + \frac{q^2}{4\bar{q}}. \tag{17}$$

A seller will order a rating if:

$$(1 - \alpha)\bar{q} - p_s \geq \omega^2(1 - \alpha)q + 2\omega(1 - \omega)(E[b_{win}|q, \bar{q}] - \alpha q) + (1 - \omega)^2(\frac{1}{2} - \alpha)\bar{q}. \tag{18}$$

Again, the left-hand-side is increasing faster in q. The quality threshold $\bar{q}$ is determined by replacing all q by $\bar{q}$ and thereby replacing $E[b_{win}|q, \bar{q}]$ by $E[b_{win}|\bar{q}, \bar{q}] = \frac{1}{2}\bar{q}$ yielding

$$(1 - \alpha)\bar{q} - p_s = \omega^2(1 - \alpha)q + 2\omega(1 - \omega)(\frac{1}{2} - \alpha)\bar{q} + (1 - \omega)^2(\frac{1}{2} - \alpha)\bar{q}, \tag{19}$$

which can be reformulated as

$$(1 - \omega^2)\frac{\bar{q}}{2} = p_s. \tag{20}$$

The buyer's indifference condition is $(1 - \omega)V_{ib}^E - p_b = 0$. Using Lemma 8(b) we obtain $(1 - \omega)\bar{q} = 6p_b$ or $\omega = 1 - \frac{6p_b}{\bar{q}}$. To receive a function $\bar{q}(p_s, p_b)$ we calculate $1 - \omega^2 = \frac{12p_b}{\bar{q}}(1 - 3p_b)$. Plugging the result into (20) we receive $\bar{q} = \frac{18p_b^2}{6p_b - p_s}$. Finally the probability of ordering a rating is given by $\omega = \frac{p_s}{3p_b} - 1$. q.e.d.

A.9 Proof of Proposition 4

(a) The maximization problem of the certifier is given by:

$$\max_{p_s, p_b} \Pi_C(p_b) = (1 - \bar{q})p_s + \bar{q}[\omega^2 2p_b + 2\omega(1 - \omega)p_b]. \tag{21}$$

The profit function can be simplified to $p_s + \bar{q}[2\omega p_b - p_s]$. By plugging the result of Lemma 9(a) into the profit function of the certifier we obtain a profit function given by

$$\Pi_C(p_s, p_b) = p_s - \frac{8p_b^3}{(1 - \alpha)(4p_b - p_s)}. \tag{22}$$

Maximizing the profit function w.r.t. p_s and p_b we finally obtain $p_s = \frac{16}{27}(1-\alpha)$ and $p_b = \frac{2}{9}(1-\alpha)$. The derived functions for ω and for $\bar{q}$ imply $\bar{q} = \frac{2}{3}$ and $\omega = \frac{1}{3}$. The profit for the certifier is given by $\Pi_C = \frac{8}{27}(1-\alpha)$. In the market segment with a quality parameter below $\bar{q}$ a share of $1 - \left(\frac{2}{3}\right)^2 = \frac{5}{9}$ of all available products is traded. Hence, the overall welfare adds up to:

$$W = \frac{5}{9}\int_0^{\frac{2}{3}}(1-\alpha)qdq + \int_{\frac{2}{3}}^{1}(1-\alpha)qdq = (1-\alpha)\frac{65}{162}. \tag{23}$$

As buyers do not make any profit in equilibrium the seller's profit yields $\Pi_F = W - \Pi_C = (1-\alpha)\frac{17}{162}$.

(b) The maximization problem of the certifier is given by:

$$\max_{p_s,p_b} \Pi(p_s,p_b) = (1-\bar{q})p_s + \bar{q}[\omega^2 2p_b + 2\omega(1-\omega)p_b]. \tag{24}$$

Again, the profit function can be simplified to $p_s + \bar{q}[2\omega p_b - p_s]$. Plugging the results of Lemma 9(b) into the profit function we end up with the following maximization problem:

$$\max_{p_s,p_b} \Pi(p_s,p_b) = p_s - 6p_b^2\frac{6p_b + p_s}{6p_b - p_s} \tag{25}$$

$$\text{s.t.} \leq \omega,\ \bar{q} \leq 1 \tag{26}$$

Hereby, the boundary conditions on ω and $\bar{q}$ need to be fulfilled. Using the expressions for the two parameters derived above, the constraints are equivalent to

$$3p_b \leq p_s \leq 6p_b - 18p_b^2. \tag{27}$$

This maximization problem can be solved analytically and the corresponding solutions are given in the Proposition. q.e.d.