Competition in Certification Markets *

Nima Fazeli †

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Abstract

This paper presents a theoretical model of competition between information intermediaries applied to credit rating industry. Sellers rely on intermediaries to credibly communicate their quality to buyers. Intermediaries are strategic and compete in fees as well as their certification standards i.e. how strict they are in awarding a certification. Choices of fees and certification standards induce a signaling game between buyers and sellers where through their choice of intermediary, sellers can convey information about their quality to buyers. In equilibrium, intermediaries set differentiated certification standards. The leader sets a high standard and the follower sets the minimum standard of certification. This serves to relax price competition and leads to a two-tier market structure where high (low) quality sellers opt for intermediary with high (low) quality standards. Further, I empirically test the predictions of the theoretical model in the credit rating market of European commercial banks. The empirical results confirm the prediction of the theoretical model that the credit rating agencies use differentiated rating standards in this market.

Keywords: Certification, Information Intermediaries, Signaling, Rating Agency

JEL Codes: D43, D82, L13, L15, G14

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†ESSEC Business School and THEMA-Université de Cergy-Pontoise; email: nima.fazeli@essec.edu

1 Introduction

Asymmetric information about the quality of a good or service between sellers and buyers is a source of inefficiency in markets. Under severe asymmetries, trade might not happen at all and markets might collapse due to such "lemons problem" (Akerlof, 1970). To mitigate such inefficiencies, sellers use several mechanisms to credibly convey information about their quality to buyers. Signaling the quality through costly actions (Spence, 1973), warranties and disclosure of verifiable information (Grossman, 1981), or investment in reputation (Klein and Leffler, 1981) are examples of such mechanisms.

In response to the demand for credible transmission of information about quality, another type of market institutions known as *information intermediaries* can emerge. They assume the role of middleman by searching out information about the seller and reveal it to the buyer. Well known examples of information intermediaries include certification agencies who certify whether the production of a good or service meets certain criteria. For example, "Underwriters Labs", certifies whether electric equipments meet certain safety criteria; "bio" certifies whether agricultural products have been produced according to some environmental standards. Auditing firms, similarly, certify whether financial statements of a firm are reliable, etc.

One important example of information intermediaries is a Credit Rating Agency (CRA). As a mechanism of communication of quality of debt issuers to investors, CRAs provide credit rating services to various entities such as corporations or governments who issue bonds or other debt instruments. In order to receive a rating, the issuers pay a fee to the rating agency who in turn investigates the financial standing of the issuer and assigns it a rating. The rating can be seen as an assessment of the issuer's ability in fulfilling its financial obligations. Although the grading systems are slightly different across different agencies, a general institutional rule regarding credit ratings is to classify the ratings in two main categories: *Investment grade* (IG) and *Speculative*. [1] Issues that receive IG rating are deemed to be of higher quality, carry less risk and more creditworthy.

Research question Although mere existence of these intermediaries [2] might suggest their role in reducing asymmetry of information, intermediaries are not passive and can use the tools at their disposal strategically. Two main strategic variables that intermediaries use are

[1] Riskier Speculative grade issues are also called *high-yield* or *junk*.

[2] In the following I use the names Information intermediary, rating agency or certifier interchangeably

their certification fees and quality standards the sellers need to meet in order to be certified. Different institutional settings, such as the market structure in which intermediaries operate as well as legal and regulatory constraints could have strong implications on the outcomes too. This paper focuses on the implications of strategic behavior of intermediaries. In particular, I study the behavior of intermediaries when they can compete not only in the fees they charge for their services but also when they can strategically use the quality standards they require. Through the lens of a theoretical model, I also study the close relationship between certification and signaling, which arises naturally. Moreover, the role of credit rating agencies as important intermediaries is particularly important in the financial markets. Another aim of this paper is to draw implications on the behavior of the credit rating agencies.

In the current research, I provide a theoretical model of competition between information intermediaries in a setting where seller has private information about its quality and uninformed buyers can only rely on the information provided by the intermediaries. Intermediaries compete not only in prices, that is fees they ask sellers to pay if they want to be rated, but also in their certification standards, that is the threshold on the quality of the seller above which the seller receives a certificate from the intermediary. Intermediaries first set a quality standard of certification and then compete in their fees. Setting a higher certification standard than the rival, allows for charging a higher fee as a higher standard signals a better quality and therefore buyers are willing to pay more for the good. However, in doing so, intermediaries face a fundamental trade-off: Increasing the fee might tempt the low standard intermediary to decrease its fee and steal the business of the high standard intermediary. Such trade-off becomes more likely when the quality standards of both intermediaries are close to each other.

In equilibrium, intermediaries set different quality thresholds for certification. One intermediary sets a high enough quality standard of certification in order to create enough incentives for its rival to differentiate its services by choosing a lower certification standard. Charging a low fee could induce the high quality sellers to leave the high standard intermediary for its rival. And in order to remove such incentives of capturing the whole market, the high quality intermediary has to leave enough market share for the rival. Therefor, when intermediaries compete both in prices and quality standards, differentiated ratings serve to relax price competition. This follows the same reasoning of classic models of vertical differentiation (e.g Shaked and Sutton, 1983).

Moreover, I empirically test the theoretical predictions of the model. Given the importance

of credit rating industry, a question is whether strategic interactions among rating agencies could affect the way they set their rating standards. Using the credit rating data on commercial banks that received ratings from major rating agencies, I support the result of the model implying that credit rating agencies offer differentiated rating standards. The empirical strategy that I use takes advantage of two institutional settings of the credit rating industry: (i) Rating agencies follow up the credit status of a rated entity over time which allows constructing a *maintained rating* of the banks over time (ii) Around 16% of the banks obtain *multiple ratings* that is they receive ratings from more than one credit rating agency. This allows to test the hypothesis of differentiated ratings through simple tests of comparison of means.

I find that in the market for credit ratings of commercial banks, Standard & Poors offers the highest quality standards in granting an IG rating. In particular, I show that S&P is 4.6% less likely to award an Investment-Grade rating to a bank compared to Moody's who in turn is 2.3% less likely than Fitch to award an IG rating. From a regulation point of view whether an issuers obtains IG or not has important consequences. For example banks and insurance companies have to follow stricter capital adequacy regulations if they hold non-investment grade securities in their portfolio (see e.g. Basel Committee, 2005).

The paper continues by giving an overview of the literature. Section 2 presents the theoretical model of competition in certification markets. In section 3.1 I discuss how through the choice of intermediary, buyers and sellers engage in a signaling game. Next, choice of fees and certification thresholds of the intermediaries are discussed in sections 3.2 and section 3.3. In section 4 I provide an empirical analysis of the credit rating industry to test the hypothesis provided by the theoretical model. Section 5 discusses some of the implications of the paper and concludes.

1.1 Related literature

This paper belongs to the literature on strategic information intermediaries. The classic papers in this area is Lizzeri (1999) that shows that a monopoly intermediary reveals no information in equilibrium and captures all the informational rent. In a similar setup, Albano and Lizzeri (2001) consider the role of disclosure policy and fee structure of a monopoly intermediary on the provision of quality by sellers. There, the presence of the intermediary improves efficiency but the revenue maximizing policy of the intermediary could be implemented in many ways as it is able to choose any fee structure and disclosure rule. Lizzeri (1999) also considers competing

intermediaries and shows that ability to choose the disclosure rule leads to full revelation of information and zero profit for the intermediaries. This approach, although theoretically elegant is limiting as it does not allow analysis of competition among intermediaries. In this paper, in order to study the implications of competition among intermediaries, I depart from these assumptions and limit the intermediaries to minimum quality threshold and flat fees. I describe these assumptions in section 2.

Other papers closest to mine are Hvide (2009), Hvide and Heifetz (2001) and Miao (2009). Hvide (2009) considers price competition among oligopolistic intermediaries whose technology is not exact and observe the quality of the sellers with some error. However the choice of category thresholds is exogenously imposed to the model while in my model it is a choice variable of the intermediaries. Similar to my paper, however, the equilibrium involves a segmented structure of the market where sellers with different quality go to different intermediaries. Closest to this paper is Miao (2009) who considers competition among stock exchanges. However, he construct his model under the assumption that sellers with higher quality also have higher opportunity cost of certification and therefore a high quality seller has lower willingness to pay for certification thus making the adverse selection problem more severe. As a result, this assumption implies that exchange could happen only under certification. In my paper, however, I do not rely on such assumption of increasing opportunity cost and therefore exchange could happen even for firms without certification and this is influencing the behavior of the intermediaries. Moreover, I provide a formal treatment of a signaling stage that naturally arises in my model and formally analyze the relationship between signaling and certification. The result of this paper also involves an equilibrium with segmented market structure where certifiers differ in their choice of quality thresholds and sellers self select according to the quality standard of intermediary. This result appears in my paper as well.

Differentiated quality standards of intermediaries and sellers' signaling of quality through their choice of intermediaries has been considered by several papers. Titman and Trueman (1986) show that when financial intermediaries have different precisions in their analysis, high (low) quality sellers prefer more (less) precise intermediaries. Gill and Sgroi (2008) consider a similar problem from the viewpoint of one seller who needs to communicate its type through its choice of tests with different difficulty levels. Assuming a market in which intermediaries differ in whether they pool or separate high quality sellers, Farhi et al. (2013) consider sellers' strategy in their choice of the intermediary. There, sellers decide whether to ask for certification from

intermediaries who belong to different tiers with different informativeness of their certification. They show that intermediaries tend to hide rejections in order to stigmatize lower-tier rivals and therefore soften competition. Although in my model certification is transparent and sellers never hire a certifier that rejects them, differentiating the quality thresholds serves the same purpose of softening competition.

In contrast to the assumption of perfect commitment in this paper, Bouvard and Levy (2012) consider a model where certifiers engage in a two-period reputation building game for both sellers and buyers sides of the market. They show that the intermediary might face a trade-off in its reputation for accuracy: higher accuracy attracts high quality sellers but could also repel low-quality sellers and hurt intermediaries profits. Similar to my model, they follow the idea that the intermediaries could influence information not through direct manipulation of the signals they produce, but through changing the technology that produces such signals. In doing so, intermediaries choose the amount of effort they exert in order to find out whether the good is faulty. In their model, the payment structure is exogenously given. This is in contrast to my model where intermediaries also use fees as a strategic variable.

This paper also contributes to the literature on credit ratings industry in financial markets. With the financial crisis of 2008, where many considered the credit rating agencies as the main culprits (Partnoy, 1999; Pagano et al., 2012), this industry has been the focus of many papers. An excellent review of the economics of this industry can be found in Jeon and Lovo (2013). In a study of credit rating industry, Skreta and Veldkamp (2009) show that ability of sellers to hide the rating can create a systematic bias since they only disclose favorable ratings. In particular, with an unbiased but noisy technology, when assets are complex, ratings might differ. When this difference is large and often, a potential demand to shop ratings might materialize. This is an alternative theory that attributes differences in rating outcomes of credit rating agencies to their imperfect technology. However, such story could only result in a general inflation in disclosed ratings and does not explain the difference in the average ratings that I find empirically. Faure-Grimaud et al. (2009) is related to the same theme and studies conditions under which secret contracting can be an equilibrium and therefore firms can *own the rating*.

There is also a large literature on strategic intermediaries with imperfect commitment. Bolton et al. (2012), Mathis et al. (2009) and Frenkel (2015) among others, study the reputational concerns of the rating agencies. Possibility of collusion of seller and intermediary has been studied by e.g. Peyrache and Quesada (2011) and Strausz (2005).

2 The model

Primitives and environment There are three types of agents in the market: A seller, two intermediaries with identities $i \in I = \{1, 2\}$, and many risk neutral buyers. Each seller owns a good of quality $t \in [0, 1]$ which has value t for the buyers and is worth zero for the seller and the intermediaries. [3] Seller knows t but buyers and intermediaries only have a prior that t is distributed uniformly on $[0, 1]$. [4]

The seller cannot credibly communicate its quality to the buyers but has the option to hire an intermediary and have its quality evaluated. The two intermediaries have access to a zero-cost inspection technology that allows them to observe the quality of the seller. The intermediaries certify the seller according to a threshold rule. That is, each intermediary $i \in I$ chooses a threshold $q_i \in [0, 1]$ as a minimum quality required to award a certificate. [5] Only those buyers with quality t such that $t \in [q_i, 1]$ can receive a certification from intermediary i and otherwise receive no certificate from i. Moreover, we assume that the intermediaries can perfectly commit to this disclosure rule. [6] This structure is common knowledge to all the players.

Timing The game unfolds according to the following timing:

1. Intermediaries set their quality standards q_i sequentially. [7]

2. Intermediaries set their fees p_i simultaneously.

3. Each seller observes his own quality t, the fees p_i and quality standards q_i of the intermediaries, and decides to which intermediary to go, if any, to acquire a certificate. Upon decision of asking for the service, the seller pays the fee and gets tested by the intermediary. If the seller meets the quality standard of the intermediary, the intermediary issues a certificate for the seller which is publicly observable.

4. Buyers observe the fees and the quality standards set by the intermediaries and the identity of the intermediary from which the seller obtained the certificate, if any. They bid

[3] In the context of financial markets, $t \in [0, 1]$ can be interpreted as the probability of non-default of seller of a financial instrument.

[4] Results in the fee setting subgame are valid for any general distribution function. However, when considering the threshold setting subgame we have to resort to a uniform distribution in order to keep the model tractable.

[5] I use the terms quality standard or quality threshold for such minimum quality interchangeably

[6] The perfect commitment to the disclosure rule could be a result of intermediaries concern for their reputation.

[7] It is therefore implicitly assumed that quality standards are harder to change in reaction to the environment. Moreover, with simultaneous choice of quality standards no pure-strategy equilibrium in quality setting subgame exists that makes the model intractable.

competitively for the good using all the information and the winning buyer pays its bid v to the seller.

Strategies A strategy of the intermediary $i = 1$ is a pair of quality standard and fee $(q_i, p_i) \in [0, 1] \times [0, +\infty)$ for $i = 1, 2$. A strategy of seller is a mapping from its own quality and the two pairs of threshold and fee set by each intermediary into $I \cup \emptyset$, the identity of an intermediary (if any). A strategy of buyer is a bid β from quality thresholds and fees of both intermediaries as well as the identity of the intermediary who issued a certificate (if any) into $[0, +\infty)$.

Strategies The equilibrium notion that I use is Perfect Bayesian Equilibrium. Since buyers are many and bid competitively, seller's (gross) payoff is just the valuation of the buyers. Anticipating this expected valuation of buyers, sellers behave optimally in their choice of intermediary, given the intermediaries choice of fees and thresholds. Intermediaries also behave optimally in their choice of thresholds and fees to maximize their expected profits.

Discussion of assumptions The model is stylized and can fit many situations. In section 4 I apply the model to the credit rating industry in financial markets. In that context, the threshold rule of disclosure is not far from reality. In financial markets, securities rated by rating agencies are often categorized into *investment grade* and *speculative grade* by the market participants. For many institutional investors, due to regulations of capital adequacy in e.g. Basel Committee (2005) having an Investment grade rating becomes essential for many issuers.

In this paper, the credibility of the certification mechanism comes from the intermediaries' ability to commit to their quality standard. This ability to commit could be the result of strong reputational concerns of the intermediary that stops them giving a certificate to an unqualified seller. However, choosing the underlying technology through which sellers are tested is still possible. In the context of Credit Ratings industry, the idea here is that rating agencies do not manipulate the result of a rating but instead can change their risk models such that they can produce a different rating. Therefore,intermediaries can choose a threshold *ex-ante*, but once set they can perfectly commit to the disclosure rule and will certify only those sellers who meet this quality threshold requirement. Another implicit assumption is that the business model of the intermediaries is one where the sellers pay and buyers can all publicly observe the result of the test. One of the goals of this paper is to shed lights on the Credit Rating industry where the predominant business model is the so-called "Issuer-pays" that is the issuer

of a financial product is the entity who pays for the certification service, e.g. credit rating. This business model has raised significant controversy as it could cause a conflict of interest for the rating agencies, highlighting the connection to the ability of intermediaries to commit to their disclosure rule. [8]

3 Competing intermediaries

I construct an equilibrium in which the intermediaries differentiate their quality thresholds. In the equilibrium, intermediary 1 sets a strictly positive quality threshold $q_1 > 0$ and intermediary 2 offers a minimum threshold at 0. This equilibrium is supported by the beliefs of the buyers that a seller who does not acquire a certificate at all must be of the worst type, $t = 0$.

Different choices of quality thresholds and fees by intermediaries induces a signaling game between buyers and sellers. The type of equilibria played in the signaling subgame drives the behavior of the intermediaries as payoffs of intermediaries depend on the equilibria of the signaling game. For example, fully separating equilibria in the signaling subgame, described more precisely below, allows each intermediary to take away a positive market share. However, when pooling happens, an intermediary might loose all its market share to its rival. As a result, payoffs of the intermediaries for some ranges of prices could become discontinuous which induces the mixed strategies in fees.

3.1 Signaling quality through the choice of an intermediary

Assume that intermediaries $i \in \{1, 2\}$ have set their quality thresholds, q_i, as well as their fees, p_i in the previous stage. First, I start by discussing the case where intermediaries set different thresholds. Without loss of generality, assume that one intermediary, has chosen a higher quality standard than the other. Call the intermediary with higher quality threshold h and denote by l the intermediary with lower quality standard. Such choices of thresholds allow us to partition the sellers into three types. Denote different types of the seller by $t_0 = [0, q_l)$, $t_l = [q_l, q_h)$ and $t_h = [q_h, 1]$. I assume that all the sellers who belong to the same interval behave

[8] There are few rating agencies who operate under "Investor-pays" business model however they are covering an insignificant share of the market. These two different business models are partly a results of historical events as well as different institutional settings. For example in the case of credit ratings industry, the business model shifted from investor-pays to issuer-pays around 1970's mostly due to the invention of photocopy machines that was allowing the reports to be copied among investors and causing profits of rating agencies to dissipate. The consequences of either of these business models and its likely effects on the quality of ratings has been studied by Kashyap and Kovrijnykh (2013); Xia and Strobl (2012); Cornaggia and Cornaggia (2013); Xia (2014); Ponce (2012) among others.

the same and that all buyers are homogeneous and share the same belief.

Several types of equilibria arise in the game. In a *fully separating* equilibrium, all different types choose different actions. There are also *partially pooling* equilibria, in which two types of the sellers choose the same action, hence "pool" with each other, and one type of seller choose a different action in the equilibrium.

Observing its own quality and considering the fees and thresholds of the intermediaries, the seller chooses which intermediary to hire, if any. Since intermediaries have the ability to commit to their quality thresholds chosen in the first stage, sellers and buyers engage in a signaling game in which the seller's *choice of an intermediary* can convey information about its quality. This highlights a close relation between certification and signaling.

Equilibrium selection Multiple equilibria exist in the signaling subgame and, to some extent, the results depend on which equilibrium will be played in this subgame. In particular, a seller of type t_h can be certified by either of the intermediaries h or l, while a seller of type t_l can get a certification only from l. This allows the possibility of "high" types to pool with the "low" types while the latter cannot mimic the former. Note that the ability of the intermediaries to commit to their threshold rule puts some restrictions on the beliefs of buyers when considering off-path actions of sellers.

As the main interest of this paper is to study the behavior of intermediaries, I opt for equilibria in which intermediaries play an economic role. I restrict my attention to those equilibria in which: (i) more certification occurs; or (ii) more information is revealed. In particular, whenever both pooling and separating equilibria exist, I assume a separating equilibrium will prevail and whenever there are equilibria with and without certification, the equilibrium with certification will prevail.

Notation To make notations simpler, denote the expected value that the buyers form for a seller who is believed to be of a quality between any a and b with $v(a,b) \equiv \mathbf{E}_t[t|a \leq t \leq b]$. Denote by $\mu(t|c)$ the posterior belief of buyers that a seller who has obtained a certificate $c = h, l, \emptyset$, is of type $t = t_h, t_l, t_0$ respectively.

Fully separating equilibrium First, I construct a fully separating equilibrium in which a seller of type t_h hires intermediary h, a type t_l hires intermediary l and a type t_0 obtains no certificate ($\emptyset$). Buyers beliefs that support such equilibrium are $\mu(t_h|h) = 1$, $\mu(t_l|l) = 1$ and

$\mu(t_0|\emptyset) = 1$. Buyers' best reply that are consistent with such beliefs are $\beta(h,\cdot) = v(q_h, 1)$, $\beta(l,\cdot) = v(q_l, q_h)$ and $\beta(\emptyset) = v(0, q_l)$. Given beliefs of buyers and anticipating their bids, sellers do not have any incentives to deviate from fully separating if fees are such that the following conditions hold:

$$p_h \leq v(q_h, 1) - v(0, q_l), \quad p_h \leq p_l + v(q_h, 1) - v(q_l, q_h), \quad p_l \leq v(q_l, q_h) - v(0, q_l) \tag{1}$$

Note that when the last two inequalities hold, the first inequality always holds too. Also note that all the outcomes are on the equilibrium path and all beliefs are pinned down by the Bayes rule.

Partially pooling equilibria Now consider the subgame with the following fees

$$p_h \leq v(q_h, 1) - v(0, q_l), \quad p_h > p_l + v(q_h, 1) - v(q_l, 1), \quad p_l \leq v(q_l, 1) - v(0, q_l)$$

With such fees, a fully separating equilibrium does not exist anymore. This is because fees are too high for the t_h sellers inducing them to pool with t_l sellers. Buyers' beliefs supporting such an equilibrium are $\mu(t_h|h) = 1$, $\mu(t_0|\emptyset) = 1$, $\mu(t_h|l) = \frac{\Pr(l|t_h)\Pr(t_h)}{\Pr(l|t_h)\Pr(t_h)+\Pr(l|t_l)\Pr(l)}$ and $\mu(t_l|l) = 1 - \mu(t_h|l)$. Buyers' optimal bids given such beliefs are $\beta(h) = v(q_h, 1)$, $\beta(l) = \mu(t_l|l)v(q_l, q_h) + \mu(t_h|l)v(q_h, 1) = v(q_l, 1)$ and $\beta(\emptyset) = v(0, q_l)$. Given the beliefs and anticipating the optimal bids of buyers, a type t_h seller would pool with a t_l type and a t_l type of seller does not have any incentive to pool with a t_0 seller. Note that here observing a seller with a certificate from intermediary h is off the equilibrium path but since the intermediaries are committed to their disclosure rule a belief that a seller with a certificate from h is of t_h type is reasonable.

Similarly, I construct another equilibrium where the t_l type of seller pools with type t_0 sellers and sellers of type t_h separate. Consider the following belief system where $\mu(t_h|h) = 1$, $\mu(t_l|l) = 1$, $\mu(t_l|\emptyset) = \frac{\Pr(\emptyset|t_l)\Pr(t_l)}{\Pr(\emptyset|t_l)\Pr(t_l)+\Pr(\emptyset|t_0)\Pr(t_0)}$ and $\mu(t_0|\emptyset) = 1 - \mu(t_l|\emptyset)$. Buyers' best replies consistent with such beliefs are $\beta(h) = v(q_h, 1)$, $\beta(l) = v(q_l, q_h)$ and $\beta(\emptyset) = \mu(t_l|\emptyset)v(q_l, q_h) + \mu(t_0|\emptyset)v(0, q_l) = v(0, q_l)$. And, given buyers' belief and their optimal bid, sellers will have no incentive to deviate if the fees satisfy the following conditions:

$$p_l \geq v(q_l, q_h) - v(0, q_h), \quad p_h \leq v(q_h, 1) - v(0, q_h), \quad p_h < p_l + v(q_h, 1) - v(q_l, q_h). \tag{2}$$

No certification equilibrium In a large range of fees, there also exists an equilibrium where all the seller types pool and no certification is demanded by the seller. The subgame of fees that has such equilibrium is as following

$$p_h < p_l + v(q_h, 1) - v(q_l, q_h), \quad p_h > v(q_h, 1) - v(0, 1), \quad p_l > v(q_l, q_h) - v(0, 1)$$

Obtaining a certification then is off the equilibrium path but given the ability of intermediaries to commit to their quality thresholds we restrict the beliefs for such outcomes to be that observing a certification from intermediary l (h) reveals that the seller has a type t_l (t_h). Optimal bids of buyers given such beliefs are $\beta(h) = v(q_h, 1)$, $\beta(l) = v(q_l, q_h)$ and $\beta(\emptyset) = v(0, 1)$.

Equilibria where high types pool with low types do not exist There is no equilibrium in which high types pool with low types and intermediate types separate. This is easy to see by checking the intermediate types incentives. For such equilibrium to exist, it must be the case that high types do not have any incentives to to pool with the intermediate types and the intermediate types not to have any incentive to deviate and pool with the low types. Formally, denote by $\hat{v}(\cdot)$, the valuation of buyers for the pool of t_h and t_0, then for such equilibrium to exist we should have $\hat{v} \geq v(q_l, q_h) - p_l$ such that high types do not deviate. But for the intermediate types not to deviate we must have $v(q_l, q_h) - p_l \geq \hat{v}$ which is a contradiction. Therefore there is no set of fees and quality thresholds in which such equilibrium exist.

Considering the equilibria that arise in each of the subgames and the ensuing market shares, I solve for the equilibrium of the fee setting subgame in the next section.

3.2 Setting certification fees

Now we move up one level in the game tree and consider the stage where the intermediaries set the price for the certification service they provide.

Market shares of intermediaries The equilibria of the signaling game directly translate into the payoffs of the intermediaries. In a fully separating equilibrium, the intermediary h will have a market share of $1 - F(q_h)$ and intermediary l obtains a market share of $F(q_h) - F(q_l)$. The range of fees for which such an equilibrium exists are given in inequality eq. (1). However, when $p_h > p_l + v(q_h, 1) - v(q_l, q_h)$ only pooling equilibria exist and therefore, intermediary h will lose all his market share to l as p_h is relatively too high a fee to attract any seller. Similarly,

for fees set by intermediary l that are higher than $\overline{p_l} \equiv v(q_l, q_h) - v(0, q_l)$ the seller prefers to stay out of the certification market and get $v(0, q_l)$ in a partially pooling equilibrium. The same argument holds for h when its fee exceeds $\overline{p_h} \equiv v(q_h, 1) - v(0, q_1)$.

Note that intermediary l can exercise its monopoly power over all the sellers in the interval $[q_l, q_h]$ regardless of the actions of the sellers with a quality higher than q_h and pricing decision of intermediary h. This means that he can guarantee a market share of at least $F(q_h) - F(q_l)$ by charging a price $p_l \leq v(q_l, q_h) - v(0, q_l)$.

On the contrary, intermediary h cannot benefit from a similar monopoly power since getting a certificate from intermediary l is a substitute for sellers with quality above q_h. If high quality sellers faces a relatively expensive certification fee, they can get a lower quality certificate. Therefore, in order to get a positive market share, intermediary h needs to set a fee that not only convinces the seller to acquire a certificate but also leaves enough surplus such that the seller does not prefer a switch to intermediary l. In other words, intermediary h needs to set p_h such that the separating equilibrium in the signaling subgame prevails. To do so, h can set a price $p_h \leq p_l + v(q_h, 1) - v(q_l, q_h)$ which, given p_l, guarantees a market share of $1 - F(q_h)$ for him. This argument is summarized in the following lemma.

Lemma 1. *All $p_h > v(q_h, 1) - v(0, q_l)$ and all $p_l > v(q_h, q_l) - v(0, q_l)$ are dominated and will never be chosen in equilibrium.*

Proof. Note that intermediary l will never set a price higher than $v(q_l, q_h) - v(0, q_l)$ since above such price only pooling equilibrium exists in the subgame and all sellers in the interval $[0, q_h]$ will pool. This will leave l with zero and such prices are strictly dominated by $\overline{p_l} = v(q_l, q_h) - v(0, q_l)$. Similarly all prices $p_h > v(q_h, 1) - v(0, q_l)$ will induce pooling since no separating equilibrium exists above such prices and therefore deliver a market share of zero. All these prices are strictly dominated by $\underline{p_h} = v(q_h, 1) - v(q_l, 1)$ since such price guarantees a market share of $1 - F(q_h)$ regardless of price chosen by l. □

The set of fees chosen by the intermediaries and their resulting payoffs for each intermediary are summarized in figure fig. 1.

Mixed strategy equilibrium in the pricing subgame So far we have shown that there exist a price for each of the intermediaries that can guarantee them a positive market share and therefore positive profit. Now we can proceed to characterize the equilibrium certification

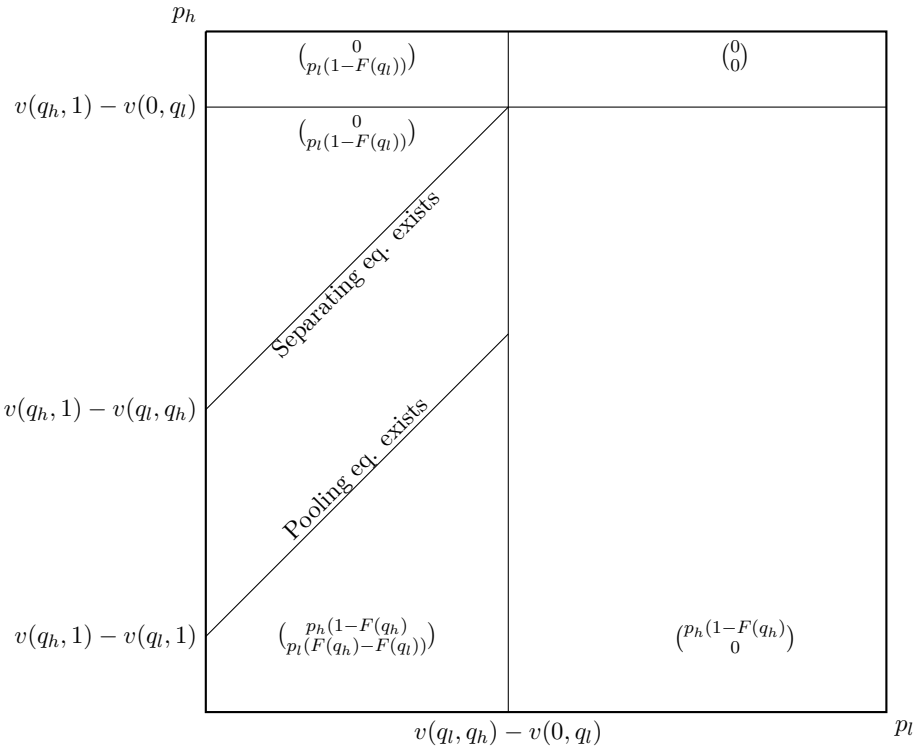

Figure 1: Payoffs in the pricing subgame
The top value in parentheses is payoff of intermediary h and the bottom value is payoff of intermediary l

fees set by intermediaries. First note that the pricing subgame does not have any pure strategy equilibria. The following proposition states this result.

Proposition 1. *For any pair of quality standards $q_h > q_l$, there exists no pure strategy equilibrium in the pricing subgame.*

Proof. Assuming selection of more informative equilibria in the signaling subgame, we proceed by showing that no pure-strategy equilibrium exists in fees exist. Proof is by contradiction. Suppose that a pure strategy equilibrium exists. Furthermore, suppose in such equilibrium, l is charging $\hat{p_l}$. In this case h will optimally charge $\hat{p_h} = \hat{p_l} + v(q_h,1) - v(q_l,q_h)$ which is the highest price that maintains separation. But that makes a profitable deviation by l possible since with a price of $\hat{p_l} - \epsilon$, for a small and positive ϵ, only pooling equilibrium will exist. This means an increase in market share of l to $1-F(q_l)$ at a small loss proportional to ϵ. Now assume that h is charging a price $\hat{p_h} < p_l + v(q_h,1) - v(q_l,q_h)$ that not only maintains separation but also makes a profitable deviation by l impossible. In this case, l will be optimally charging its monopoly price $\hat{p_l} = v(q_l,q_h) - v(0,q_l)$. But then at such $\hat{p_l}$, h can have a profitable deviation by charging $p'_h > \hat{p_h}$. □

The main reason for emerging a mixed strategy equilibria here is that intermediaries could induce sellers to pool or separate when competing in fees. In particular, in any subgame where sellers separate, the intermediary l has the incentive to decrease its fee to the point that pooling is induced and therefore benefit from a sudden increase in its market share. Such discontinuities in payoffs lead to equilibria in mixed strategies. [9]

We proceed by characterizing the probability distribution of fees for each intermediary in the equilibrium. In a mixed strategy equilibrium, given the probability distribution of fees played by the opponent, any price that is played in the support of the equilibrium should be a best reply.

Denote the "premium" that each intermediary could charge over seller's outside option by

$$m_l = v(q_l, q_h) - v(0, q_l) \quad \text{and} \quad m_h = v(q_h, 1) - v(q_l, q_h).$$

The following proposition characterizes the interval of fees for each intermediary in equilibrium as well as the probability distribution according to which the prices are chosen.

Proposition 2. *In the mixed-strategy equilibrium of the fee-setting subgame*
(i) Intermediary l chooses his price from the interval

$$[\underline{p_l}, \overline{p_l}] \equiv \left[(\frac{F(q_h) - F(q_l)}{1 - F(q_l)}) m_l \ , \ m_l \right] \tag{3}$$

And the intermediary with a higher quality threshold, h, sets his price on an interval

$$[\underline{p_h}, \overline{p_h}] = [\underline{p_l} + m_h, \overline{p_l} + m_h] \tag{4}$$

(ii) The equilibrium probability distribution of prices for intermediary l is

$$G_l(x) = \begin{cases} 1 - \frac{[(1-F(q_l))m_h + (F(q_h) - F(q_l))m_l]}{(1-F(q_l))(x+m_h)} & , p_l < \overline{p_l} \\ 1 & , p_l = \overline{p_l} \end{cases}$$

[9] It is worth mentioning that pure strategy equilibria can be supported by an arbitrary choice of pooling or separating equilibria in the signaling subgame. For example assume an equilibrium in prices in which h has set a price $p_h^* < p_l + v(q_h, 1) - v(q_l, q_h)$ such that it does not allow any profitable deviation by l while maintaining separation in the signaling subgame. With selection of separating equilibria whenever they exist, such p_h^* is not a best response since an increase in p_h^* as long as separating equilibrium exists is a profitable deviation. However, without such assumption, a pure strategy equilibrium can be supported by arbitrary choice of equilibria where any increase in price by h induces pooling which makes such increase in price not attractive. Such equilibria, however, are completely dependent on the selection of pooling in the signaling subgame and selection of separating equilibria whenever they exist, serves to eliminate them.

and prices of intermediary h follow the distribution function

$$G_h(x) = \frac{1 - F(q_l)}{1 - F(q_h)} - \frac{(F(q_h) - F(q_l))m_l}{(1 - F(q_h))(x - (m_h)}$$

Proof. See the appendix. □

Note that the equilibrium distribution functions satisfy regularity conditions. Both are strictly increasing in their respective supports, have positive values and are below one. In particular $G_h(\cdot)$ goes from 0 to 1 without any mass point along its support. $G_l(\cdot)$ obtains 0 at $\underline{p_l}$ but has a mass point at $\overline{p_l}$.

The continuation payoff from the equilibrium in the pricing stage for intermediary h is

$$\pi_h(q_l, q_h) = \left[m_h + m_l \frac{(F(q_h) - F(q_l))}{1 - F(q_l)}\right](1 - F(q_h)) \tag{5}$$

and

$$\pi_l(q_l, q_h) = (F(q_h) - F(q_l))m_l \tag{6}$$

for intermediary l. These continuation payoffs are obtained using the property that in a mixed strategy equilibrium each player is indifferent between all pure strategies that are played in the support.

Considering the equilibrium payoffs of the fee-setting subgame, we can see that the π_l is strictly increasing in the quality cutoff chosen by h. This is a direct consequence of l's ability to set generally higher prices and having access to a larger share of the market that can be captured. In particular, l can charge "higher" fees since the support of the distribution of p_l in expression eq. (3) shifts upward as m_l also increases with q_h. The same conclusion can be drawn with regard to p_h as a higher quality set by h together with higher prices set by l permits charging more without inducing pooling. This results, resonating with classic models of quality differentiation (Shaked and Sutton, 1983, e.g.), shows that as quality standard diverge, the price competition gets more relaxed.

3.3 Setting quality thresholds

In this section we move up in the game tree and consider how the intermediaries set their quality thresholds. Recall that setting quality threshold is sequential, therefore assuming intermediary 1 has already set his quality threshold q_1, the second intermediary proceeds by choosing a

q_2 that maximizes his payoff. Since setting quality cutoffs are sequential, the decision of the second intermediary on its quality standard will determine who will be the low or high standard intermediary.

Using the general distribution function of quality of sellers does not give a closed form solution, from here on we use the uniform distribution by setting $F(x) = x$, $x \in [0, 1]$.

Reply from below We proceed by considering two possibilities where the second intermediary sets a higher or lower quality threshold than q_1. Similar to the terminology first introduced by Shaked and Sutton (1982), we define the *best reply from below*, q_2^b, as the profit maximizing choice of q_2 in the interval $[0, q_1)$. Similarly, *best reply from above*, q_2^a can be defined as the optimal choice of q_2 when $q_2 \geq q_1$.

First consider the case where intermediary 2 replies from below. It turns out in such case, the optimal reply is to set $q_2^b = 0$. The following lemma states this result.

Lemma 2. *Upon a reply from below, the optimal choice of intermediary* 2 *is to choose a quality threshold of* 0*.*

Proof. See the appendix. □

This result is consistent with the results given by Lizzeri (1999) since all the sellers with a quality below q_1 have no other choice than going to the second intermediary and the intermediary indeed exerts its monopoly power.

The maximum payoff for the case of the uniform distribution

$$\pi_2^b(q_1, q_2^b(q_1)) = \frac{q_1^2}{2}.$$

Reply from above Now consider the situation where the second intermediary chooses a quality threshold higher than that chosen by the first intermediary. In this case, given q_1, the second intermediary choses a q_2 that is a best response and maximizes its profit. Rewriting eq. (5) for the case of a uniform distribution, payoff of intermediary 2 when it chooses to reply from above is

$$\pi_2^a(q_1, q_2) = \frac{(1 - q_2)\left(q_1^2 - (q_2 + 2)\, q_1 + q_2^2 + 1\right)}{2\,(1 - q_1)}. \tag{7}$$

Since the payoff of reply-from-above in eq. (7) is not quasi-concave, we analyze the optimal payoff in two subsets of the domain. First for $\{(q_1, q_2) : 0 \leq q_1 \leq \frac{1}{2} \text{ and } q_2 \geq q_1\}$ and then for

$\{(q_1, q_2) : \frac{1}{2} \leq q_1 \leq 1 \text{ and } q_2 \geq q_1\}$.

In the second subset, the payoff of replying from above, obtains a unique maximum and we can directly compute the payoff. However, in the first subset, the optimal choice of q_2 has a corner solution where the second intermediary tries to set q_2 as close as possible to q_1. This raises a technical issue that we address through assumption 1:

Assumption 1. *If $q_2^a = q_1$ and in the subsequent stage there exist equilibria in which all the sellers with a quality higher than q_1 go to intermediary 1, such equilibrium will be played.*

This is merely a technical assumption in order to ensure that the best-reply function of the second intermediary exists. [10]

Now we can proceed to find the equilibrium play of intermediary 2 for different values of q_1 when Intermediary 2 chooses a $q_2 \geq q_1$. Denote $q_2^* \equiv argmax_{\{q_2^a, q_2^b\}} \ \pi_2(q_1, q_2)$. The following lemma summarizes the results.

Lemma 3. *(i) For all $q_1 \in [0, \frac{1}{2})$, Intermediary 2 strictly prefers to reply from above by setting $q_2^* = q_1$;*

(ii) For all $q_1 \in [\frac{1}{2}, 1]$, intermediary 2 strictly prefers to reply from below by setting $q_2^* = 0$;

Proof. See the appendix. □

Choice of cutoff by intermediary 1 In lemma 3 we characterize the best response of the second intermediary in response to the quality threshold set by intermediary 1. As a result, the optimal action of the first intermediary with respect to its quality cutoff becomes straightforward. Notably, intermediary 1 never wants to induce a reply from above as he will take away no profit in this case. The optimal cutoff for intermediary 2 is therefore a q_1^* that induces a reply from below from 2 and maximizes the payoff of 1. The following proposition states this result.

Proposition 3. *In the equilibrium, (i) Intermediary 1 sets quality standard $q_1^* = \frac{1}{2}$.*
(ii) Intermediary 2, choose the minimum quality standard of $q_2^* = 0$.

This result indicates that a form of two-tiered market structure arises as a result of intermediaries competing in quality standards. Here, the intermediary with higher quality standard

[10] Without this assumption, when the second intermediary replies from the above and can maximize his payoff by setting a threshold as close as possible to that of intermediary 1, the best reply is not well-behaved since q_2^a will be as close as possible to q_1 but not equal to that. This assumption, therefore only serves to get around this technical issue and does not have any qualitative impact on the results.

wishes to decrease its threshold in order to capture more market share. This, however, creates incentives for the lower quality intermediary to offer a quality standard almost as high and attract all the sellers previously hiring its rival. Instead, the "leader" leaves enough market share for the follower just to induce it to cover the "low-end" sellers and reduce the intensity of competition in fees. In the empirical application of this model in section 4, I look at the Credit Rating industry to test for this "differentiation" phenomenon.

Comparing the payoffs of both intermediaries, we can see that in equilibrium the first intermediary takes away more profit compared to the second one. In addition, the incentives to appropriate the information surplus in the market also plays a role and as a result the second intermediary sets a quality standard of 0 and therefore reveals no information to the market. As mentioned above, this comes from the ability of the second intermediary to exercise its "monopoly" power over all the sellers captive in the interval $[0, q_1^*]$ similar to what is proposed by Lizzeri (1999). In the equilibrium, all these captive sellers (weakly) prefer to pay the intermediary and obtain a certificate rather than opting for no certification as in the latter case they will be valued at 0 by the buyers.

Empirical evidence on over-cutting the rating standard However, the main underlying mechanism leading to this outcome is competition over market share and the need for the leader to set a higher quality standard in order to induce the follower to select the low-end market. In other words, if the leader fails to set a high enough threshold and grant a certificate easily, the follower can "best-reply-from-above" and capture the segment of the market previously served by the leader. This could be seen as another testable hypothesis that the theoretical model of this paper generates: If the leader sets a quality threshold that is too lax, the follower will increase its market share by setting a quality threshold above that of the leader.

There exists empirical evidence to support such prediction of the model. In the study of credit ratings of the insurance industry, Doherty et al. (2012) consider the effects of entry by S&P into the market for rating services of insurance companies, previously served by the incumbent A.M. Best. They show that initially the incumbent was offering a rating that was too lax and many high-quality sellers were pooled together into one rating category. This allowed Standard & Poor's (S&P) to enter the market through a "best-reply from above" by offering a rating standard that was higher than that of A.M. Best and capture part of the market. This is one of the very few instances where entry into a market has happened successfully as in general

the rating services industry has been characterized by high concentration and very little entry (see e.g. Jeon and Lovo, 2013, for an overview).

In another study, Becker and Milbourn (2011) consider the effect of entry by Fitch into the corporate bonds market on the quality of ratings, previously dominated by Moody's and S&P. The focus of this study is empirical and along the way they show a pattern that Fitch increased its market share particularly in those industries in which the Moody's and S&P were issuing more optimistic ratings (Becker and Milbourn, 2011, p.497). This is another case where a more lax rating strategy by the incumbents allowed the entrant to "best-reply-from-above" and capture a segment of the market.

4 Differentiated Rating Standards: Empirical Evidence

The theoretical model developed in the above section is stylized enough to be applied to the credit rating services industry. A credit rating is a measure of creditworthiness of an issuer of a financial instrument in fulfilling their financial obligations. They are a major factor that affects the issuers of financial instruments and corporations who rely on capital markets. Credit ratings can significantly influence the cost of debt, capital structure of the firms (see e.g. Kisgen and Strahan, 2010; Kisgen, 2003) and their investment decisions (Almeida et al., 2017).

Proposition 3 offers an equilibrium model with tiered certification standards of intermediaries. In the following I provide evidence for the prediction of the theoretical model in proposition 3 implying that rating agencies opt for differentiated rating standards. To do so, I empirically test the hypothesis that there exist a difference between the credit rating agencies in their threshold to award an IG rating. [11] Obtaining an IG rating is important as many institutions investing in financial markets, similar to bank themselves, are subject to rating-based regulatory restrictions if they hold speculative grade assets which could sharply decrease the demand for such assets (Campbell and Taksler, 2003).

[11] Rating categories are in the form of a letter grades starting from the highest (AAA) indicating the highest credit quality, to the lowest C and D indicating exceptionally high level of credit risk and default. Depending on the rating agencies, there are between 20 to 24 different rating categories for the long term issuer credit risk. Traditionally credit ratings are divided between *Investment-grade* and *Speculative-grade* categories. For example, using Fitch or S&P grading letters, entities with high credit ratings, those with a rating category ranging from AAA the highest until $BBB-$ (including) are considered Investment-grade. All the ratings below that, from $BB+$ and below, are considered Speculative. Speculative grade is also called Junk or High-yield. See e.g. Langohr and Langohr (2010) Ch.2, Moody's (2018), Standard and Poor's (2019) or Fitch Ratings (2018)).

Why banks? To test this hypothesis I focus on the market for rating services of commercial banks. The rating market of commercial banks is interesting for two main reasons. First, reputational concerns of rating agencies when evaluating credit risk of banks are particularly strong. Banks are important financial intermediaries in the economy and credit ratings of banks could have a widespread effect on the private sector through lending supply (See (Adelino and Ferreira, 2016) and Almeida et al. (2014) among others). This is desirable and in line with the assumption of the model on perfect commitment. Second, banks are subject to various regulations that put constraints on the credit rating methodology used by rating agencies. Basel II regulations require banks to meet several defined risk factors such as adequacy and quality of capital (BCBS (2006), BCBS (2010)) and specifically after the financial crisis of 2008, there has been more regulation at play (see BCBS, 2017, 2016, for example). Such regulations therefore, could serve to bring the rating methodologies used by the rating agencies closer to each other.

Data and empirical strategy The rating data are acquired from CapitalIQ database and cover the long-term issuer rating data of commercial banks between 2010 and 2016. One main empirical challenge that makes drawing a reliable inference difficult is that , as our theoretical model predicts as well, sellers could self-select. If high (low) quality sellers opt for a rating agency with a higher (lower) quality threshold, inference on which agency is more strict in granting an IG rating becomes particularly challenging. A comparison between the quality standards of rating agencies based on the likelihood of firms getting an IG rating would be inconclusive as these agencies are rating different populations of firms.

The empirical strategy that I follow is to take advantage of two institutional settings: (i) *Rating follow-ups*; (ii) *Multiple ratings* i.e some banks might acquire ratings from more than one agency.

Assigning a credit rating is not a one time action. A credit rating received by an institution comes with a continuous process of rating follow-up through which a rated entity is continuously examined by the agency who has assigned the initial rating. The rating follow-up is an important aspect of rating services after the initial rating has been assigned and it aims at keeping the ratings up-to-date as well as giving feedback to the rated entity. At any moment, upon a significant change in creditworthiness of the rated entity, the assigned rating could change (see Langohr and Langohr, 2010, Ch.4).

Rating follow-ups could take several forms. The potential direction of the credit rating of an entity over the intermediate term (six months to two years) is indicated by a *rating outlook*. Similarly, *rating reviews* give a stronger indication of future changes of ratings than outlooks (see Langohr and Langohr, 2010, pp.174-179). Neither rating outlooks nor reviews necessarily mean that the rating will change, however, their mere presence indicates that the creditworthiness of the rated entity is being followed up by the rating agency. Therefore, unless the rating agency decides that the status of the firms has changed in a substantial way that requires a transition, the initial rating still holds. I refer to such ratings as *maintained ratings*.

Moreover, banks obtain ratings from more than one rating agency over time. Acquiring multiple ratings is for several reasons. One is that issuing a financial instrument could require more than one rating. This could be due to informational demands of investors, regulation or strategic considerations of issuers in order to shop around to obtain better ratings for their issue (see Chen (2011), Morkoetter and Westerfeld (2009), Bongaerts et al. (2012) for example). However, since the rating of a financial instrument also depends on the credit rating of the issuer of that instrument, the issuer will receive a credit rating as well.

Rating follow-ups together with obtaining rating from more than one agency over time allows for construction of a dataset where at each time t, a bank $j \in 1, \ldots, J$ has an maintained ratings from rating agencies $i \in 1, \ldots, I$. I construct the main dataset for analysis by only looking at those banks that had maintained ratings at the same time from at least two rating agencies. Among 19162 bank-date-rating observations of maintained rating presented in table 1, around 16.6% have maintained rating from at least two rating agencies at a point in time. Table 1 provides a summary of the maintained ratings of banks by rating agencies and rating category.

	S&P's		Moody's		Fitch	
	Obs.	%	Obs.	%	Obs.	%
Speculative	2626	34.5	2241	31.8	812	18.0
Investment	4986	65.5	4806	68.2	3691	82.0
Total	7612	100.0	7047	100.0	4503	100.0

Table 1: maintained ratings by Rating Agency

Test of hypothesis Restricting our attention to banks who have maintained ratings from more than one rating agency over the time-frame of the sample, we can be more confident that the assigned ratings, if different, could reflect the difference in the quality thresholds of the rating agencies rather than the difference in characteristics of the banks. Using this subsample of firms,

I carry out a simple test of hypothesis to determine whether there is a statistically significant difference between the rating standards of competing rating agencies. For each pair of rating agencies, the sample of the banks will be the same, therefore it will only suffice to compare the average number of banks rated as investment-grade by each rating agency. Formally, I will test the hypothesis that standards of two rating agencies are different against the null hypothesis that there is no difference between them. In so doing, I perform a paired t-test on the same sample of banks with maintained ratings from two rating agencies. The results are presented in table 2.

	S&P's vs. Moody's	S&P's vs. Fitch	Moody's vs. Fitch
Mean difference	-.0467***	-.0597***	-.0235***
	(-5.00)	(-5.91)	(-2.70)
D. of freedom	1026	986	1187

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Average Rating Difference; A negative number indicates that the first-mentioned rating agency is less likely to give an Investment-Grade rating to a bank compared to the other agency

The results confirm the hypothesis generated by the theoretical model that competing intermediaries set different thresholds to grant a certification. First, comparison of the two largest According to the results, S&P is more strict than Moody's as it has granted 4.6% less investment-grade ratings to the same sample of banks than Moody's. Comparing ratings assigned by Moody's and Fitch, we observe the same pattern of a tiered certification market as Moody's is applying more strict rating standards than Fitch.

Our results serve as an evidence for the differentiated rating hypothesis in the market for credit ratings of banks. Moreover, there exists evidence that in other markets similar results might hold. For example, in a study of corporate bonds market Bongaerts et al. (2012) show that similar differentiation results hold. They do not specifically test such hypothesis and focus on finding an explanation for the role of Fitch in this market, but their estimations indicate a similar pattern with the difference that in the corporate bond markets Moody's rating thresholds are the highest. However, apart from explaining the role of Fitch as a tie-breaker, they do not provide any explanation for the differentiated ratings observation.

However, we should also consider the extent to which these results are convincing. A question that could be raised is what other reasons could be behind the observed differentiated ratings? For example, could it be the case that some of the agencies are more specialized in the banking

sector and therefore are better at measuring the credit risks compared to their less skilled rivals? [12] This probably is the case but even under such consideration, the error would have more of an effect on the variance of the ratings and there should not be any systematic error. However, the empirical results are clearly showing a difference in the mean probability of an IG rating for the sample. Another question that comes to mind is what is the mechanism through which the rating agencies might change the quality thresholds that they apply? One proposed mechanism suggested by Kisgen et al. (2016) is that rating agencies might fine tune their stringency in ratings by rewarding accurate or biased analysts. Using data collected from Moody's, they show that although analysts who are accurate are likely to get promoted, those who downgrade frequently are less likely to get rewarded.

5 Conclusion

This paper presents a model of competition between information intermediaries and tests its implications for the market for credit ratings services of commercial banks in Europe.

In the theoretical model that I propose, intermediaries set a minimum quality standard for certification and compete in certification fees. One of the main insights derived from the analysis is that competition among the intermediaries could takes place on the quality dimension as well and the main goal of the current study is to show the implications of such competition. The sellers' choice of the intermediary then becomes an indicator of their quality for the buyers and serves as a signaling device. As a result, the choice of the minimum quality thresholds and certification fees can induce a signaling game between buyers and sellers. In this regard, strategic interaction of the intermediaries determines how signals are generated and what value they carry. What signaling games ensue as a result of intermediaries decisions and what type of equilibria played in the signaling game creates a trade-off for the intermediaries for revenue and quality thresholds. This highlights how signaling and certification are tied together as in here a signaling game naturally arises through interactions of certification intermediaries. This is in contrast to pure signaling models where the process through which signals are generated are exogenous, as in here the competition among the intermediaries leads to a continuum of signaling games endogenously.

My main result is that in the equilibrium, intermediaries differentiate by setting quality

[12] The theoretical model presented here though considers an inspection technology that is exact.

thresholds different form each other in order to serve different segments of the market and relax the competition in fees. In the equilibrium, one intermediary chooses to serve the high end of the market, that is those sellers who have higher quality. However, it faces a trade-off that by decreasing the quality threshold in order to attract more sellers it might induce its rival to capture its market by either setting a lower fee or increasing its quality threshold just enough to convince the sellers to switch. The model also predicts that the ability of intermediaries to exercise their market power over the lower quality sellers who cannot pool themselves with higher quality ones allows the intermediaries to extract the information surplus of sellers. In particular, similar to what has been shown by Lizzeri (1999), the second intermediary will reveal no information to the market. However competition causes the high quality intermediary to set a higher quality standard in equilibrium.

The role of intermediaries and their strategic interactions is particularly important in the financial markets among others. Credit rating agencies are among information intermediaries with great influence in credit markets. Applying the model to the credit rating industry I test the hypothesis generated by the theoretical model suggesting that competing rating agencies offer differentiated rating standards. The empirical strategy that I use, takes advantage of the institutional settings in the bond markets for commercial banks to overcome the empirical challenges. In particular I use rating agency policy of *rating follow ups* and the fact that some of the banks in the sample acquired *multiple ratings*, i.e. ratings from more than one agency to test the implications of the model. With the empirical strategy, a simple statistical test of paired comparison of the means is able to provides evidence in support of differentiated quality standards hypothesis. The results indicate that in the market for rating services of the commercial banks in Europe, S&P's has set the highest rating standard to grant an Investment Grade (IG) rating as it has granted on average 4.6% less IG ratings to the same sample of banks than Moody's and 5.9% less than Fitch. Similarly, the empirical test shows that Moody's, after S&P's, has the highest quality thresholds for granting an IG with an average of 2.3% less IG ratings than Fitch for the same sample of banks.

These results offer some insights to the policy makers and regulators of the financial markets. This is in particular important as the policy discussions around rating agencies, as an important player in the financial markets, have been a part of their agenda for the last decade (see ESMA, 2013, 2015; BCBS, 2010, 2017, for example).

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Appendix

Proof of Proposition 2

Proof. We prove that given the equilibrium choice of each intermediary, the choice of the other is optimal and confirm that any point outside the support of the distribution of prices delivers a lower payoff. Recall from conditions in eq. (1) and eq. (2) that depending on the relative prices of each of the intermediaries, the pooling or separating equilibria might exist and as a result the market share and payoff of the intermediaries change. Given that l chooses his price according to probability distribution function $G_l(\cdot)$, in the realization of prices where $p_h > p_l + v(q_h, 1) - v(q_l, q_h)$, which happens with probability $G_l(p_h - (v(q_h, 1) - v(q_l, q_h)))$, the market share of h is 0. This happens because for these prices a separating equilibrium does not exist. and therefore potential market share of h is captured by l. On the other hand, with the realization of prices where $p_h < p_l + v(q_h, 1) - v(q_l, q_h)$, which happens with complementary probability of $1 - G_l(p_h - (v(q_h, 1) - v(q_l, q_h)))$, separation prevails and marker share of h will be $1 - F(q_h)$. We show that any p_h in the interval (4) is a best response to prices chosen by l. To see this, note that for any such p_h the expected payoff for h is

$$p_h(1 - F(q_h))[1 - G_l(p_h - (v(q_h, 1) - v(q_l, q_h)))].$$

which given $G_l(\cdot)$ delivers W_h . Moreover, since any price choice of $x \leq \underline{p_l}$ is played with probability 0, any $p_h \leq \underline{p_l} + v(q_h, 1) - v(q_l, q_h)$ delivers a payoff of $p_h(1 - F(q_h))$ which is strictly decreasing in p_h and smaller than $\underline{p_h}(1 - F(q_h)) = W_h$. Therefore such price is not a best reply to the opponent and is never played with positive probability by h. Similarly, probability of $p_l \leq \overline{p_l}$ is 1 and therefore any p_h such that $p_h > \overline{p_l} + v(q_h, 1) - v(q_l, q_h)$ will ensure pooling and therefore delivers a payoff of 0 for h. Similarly for intermediary l, we show that any price along the interval (3), delivers the highest possible payoff given the distribution of prices chosen by h. To see this note that under the realization of prices where $p_h < p_l + v(q_h, 1) - v(q_l, q_h)$, the separating equilibrium will prevail in the subgame and therefore l will end up with a market share of $F(q_h) - F(q_l)$. This even will happen with probability $G_h(p_l + v(q_h, 1) - v(q_l, q_h))$. However with the complementary probability, prices might turn out such that $p_h > p_l + v(q_h, 1) - v(q_l, q_h)$ and as a result sellers will not separate. This means capturing all the market above and a market share of $1 - F(q_l)$ for l. The expected payoff of l under these possibilities can be written as

follows

$$p_l\left[(F(q_h)-F(q_l))G_h(p_l+(v(q_h,1)-v(q_l,q_h)))+(1-F(q_l))(1-G_h(p_l+(v(q_h,1)-v(q_l,q_h))))\right]$$

alternatively

$$p_l\left[1-F(q_l)-(1-F(q_h))G_h(p_l+(v(q_h,1)-v(q_l,q_h)))\right]$$

Plugging in G_h, the above equation delivers W_l which is constant for any p_l in the interval (3). Recall from lemma 1 that any price $p_l \geq \overline{p_l}$ was strictly dominated by $\overline{p_l}$ and therefore will not be played. On the other hand for any price $p_l < \underline{p_l}$, $G_h(p_l+(v(q_h,1)-v(q_l,q_h))$ is zero. With these values of p_l, the payoff of l will be $p_l(1-F(q_l))$ which is strictly smaller than $\underline{p_l}(1-F(q_l))$ and therefore cannot be a best response. □

Proof of Lemma 2

Proof. The continuation of payoff of the intermediary with lower quality threshold is π_l which is given in eq. (6). When the second intermediary is replying from below and in case where $F_t(\cdot)$ is uniformly distributed, π_2 takes the following form,

$$(q_1-q_2)(\frac{q_1+q_2}{2}-\frac{q_2}{2}).$$

This payoff is decreasing in q_2 since $\frac{\partial \pi_2(\cdot)}{\partial q_2}=-\frac{1}{2}$. Since the payoff of intermediary 2 upon his choice to reply from below is always decreasing in his action, the optimal choice of quality cutoff for him will be $q_2=0$. □

Proof of Lemma 3 The proof of part *(i)* involves using the following two lemmas. In what follows, we show that in the subgame where $q_1 > \frac{1}{2}$, π_2^a is concave and has a maximum as an interrior solution and for the subgame where $q_1 < \frac{1}{2}$ the payoff of replying from above is decreasing and obtains a maximum at the corner solution of $q_2^a = q_1$.

First, consider the case where $q_1 < \frac{1}{2}$. This result is expressed in the following lemma.

Lemma 4. *When $q_1 < \frac{1}{2}$, and intermediary 2 replies from above, the optimal cutoff of intermediary 2 is $q_2^* = q_1$ which delivers the following payoff*

$$\frac{(1-q_1)^2}{2}$$

Proof. We claim that $\frac{\partial \pi_2^a}{\partial q_2} < 0$ in the interval $q_1 \in [0, \frac{1}{2}]$. Evaluating the derivative of π_2^a,

$$\begin{aligned}\frac{\partial \pi_2^a}{\partial q_2} &= \frac{-q_1^2 + q_1(2q_2+1) - (3q_2^2 - 2q_2 + 1)}{2(1-q_1)} \\ &= \frac{q_1 - (q_2 - q_1)^2 - (q_2^2 + (1-q_2)^2)}{2(1-q_1)}\end{aligned}$$

Which is negative for all $q_1 < \frac{1}{2}$. Therefore the payoff of intermediary 2 is strictly decreasing and the optimal choice of cutoff would be q_1. Moreover, this choice of cutoff delivers

$$\lim_{q_2 \to q_1} \pi_2^a = \frac{(1-q_1)^2}{2}$$

□

Now consider the other subgame where $q_1 \leq \frac{1}{2}$. In this case the payoff function is concave for all $q_1 > \frac{1}{2}$. To see this note that the second derivative of π_2^a, $\frac{\partial \pi_2^a}{\partial q_2^2} = \frac{q_1 - 3q_2 + 1}{1-q_1}$ is negative for any $q_2 > q_1$ and $q_1 > \frac{1}{2}$. In this case we can directly solve the maximization problem. Note the following lemma

Lemma 5. *When $q_1 > \frac{1}{2}$ and the second intermediary is replying from above, the payoff of second intermediary is concave and obtains a maximum when*

$$q_2^a = \frac{1}{3}\left(q_1 + \sqrt{-2q_1^2 + 5q_1 - 2} + 1\right).$$

Moreover, the payoff of such choice of q_2 is

$$\pi_2^a(q_1, q_2^a) = \frac{(2-q_1)\left(-5q_1 + \sqrt{(5-2q_1)\,q_1 - 2} + 4\right)\left(q_1 + \sqrt{(5-2q_1)\,q_1 - 2} - 2\right)}{54\,(q_1 - 1)}$$

Proof. The first order condition of the maximization problem $\max_{q_2} \pi_2^a(q_1, q_2)$ s.t. $q_2 > q_1$ delivers the result immediately. □

(ii) So far we have shown what happens when the second intermediary replies from above but have not considered whether it is optimal to reply from above when $q_1 > \frac{1}{2}$. To answer this question we consider the following

$$\frac{\partial \pi_2^a}{\partial q_1} = \frac{(1-q_2)\left(q_1^2 - (q_2+2)\,q_1 + q_2^2 + 1\right)}{2\,(1-q_1)}$$

The above equation is negative for $\frac{1}{2} < q_1 < 1$ and $q_1 < q_2 < 1$. This means that for $q_1 > \frac{1}{2}$ the value of optimal reply from above keeps decreasing. To see that after $q_1 = \frac{1}{2}$, second intermediary always prefers to reply from below note that at $q_1 = \frac{1}{2}$, $\pi_2^a = \pi_2^b$. Since π_2^b is strictly increasing in q_1 and π_2^a is strictly decreasing for $q_1 > \frac{1}{2}$, the second intermediary will always prefer to reply from below.

Proof of Proposition 3

Proof. Note that the payoff of intermediary 1 upon a reply from below by intermediary 2 is decreasing in q_1 since $\frac{\partial \pi_1(q_1)}{\partial q_1} = -\frac{1}{2}3q_1^2 + q_1 - \frac{1}{2}$ which is always negative for any $q_1 \geq \frac{1}{2}$. So it will be enough for the intermediary 1 to make 2 indifferent between replying from above or below. For this, intermediary 1 chooses his cutoff such that $\pi_2^a(q_1, q_2^a) = \pi_2^b(q_1, q_2^b)$ which means finding the smallest $q_1 \geq \frac{1}{2}$ which makes the following inequality binding

$$\frac{q_1^2}{2} \geq \frac{(2-q_1)\left(-5q_1 + \sqrt{(5-2q_1)\,q_1 - 2} + 4\right)\left(q_1 + \sqrt{(5-2q_1)\,q_1 - 2} - 2\right)}{54\,(q_1 - 1)}$$

The above inequality is binding at $q_1 = \frac{1}{2}$. □