J. Finan. Intermediation 21 (2012) 79–96

Contents lists available at SciVerse ScienceDirect

J. Finan. Intermediation

journal homepage: www.elsevier.com/locate/jfi

Information provision in over-the-counter markets ☆

Tri Vi Dang [a], Mike Felgenhauer [b,*]

[a] Columbia University, International Affairs Building, 420 West 118 Street, New York, NY 10027, USA
[b] University of Mannheim, Economics Department, L7, 3-5, 68131 Mannheim, Germany

ARTICLE INFO

Article history:
Received 25 January 2010
Available online 27 May 2011

JEL classification:
C78
D82
D83

Keywords:
Information provision
Information acquisition
Over-the-counter trading
Rating services

ABSTRACT

This paper analyzes endogenous information provision and purchase in over-the-counter (OTC) markets. On the supply side the optimal strategy of an information provider consists of selling identical information to all OTC traders. On the demand side OTC traders have an incentive to buy information from the same provider. If the incumbent information provider charges not too high a price, then an entrant firm has no demand even though it offers less expensive information of the same quality. This paper provides a rationale for the high level of market power in the industry for financial market data and credit rating services as well as why institutional traders may have no demand for a finer rating system. In addition, this paper shows that it is welfare improving for the security issuer to pay for rating services rather than having OTC traders purchase costly rating reports.

1. Introduction

The market for financial market data is dominated by two big players. Thomson-Reuters is famous for selling terminals (Reuters' screens) with real time financial data and news. In 2006 Reuters served more than 493,000 of such terminals. Bloomberg is well-known for selling terminals embedded with a rich set of historical financial data and analytical tools as well as its electronic trading platforms such as for currency trading in over-the-counter (OTC) markets. Institutional traders in OTC markets typically purchase terminals from both providers.

A similar oligopolistic market structure is present in the market for credit rating services. In 2006 Moody's and Standard & Poor's had a combined market share of 80%. Together with Fitch, the number

☆ An earlier version of this paper was completed when the first author was at the University of Mannheim.

* Corresponding author.
E-mail addresses: td2332@columbia.edu (T.V. Dang), felgenha@staff.mail.uni-mannheim.de (M. Felgenhauer).

1042-9573/$ - see front matter
doi:10.1016/j.jfi.2011.05.001

three, they had over 95%. The operating margin of Moody's was 54% in 2006 and its revenue was growing at close to 20% a year. On top of the ratings of traditional finance products such as investment funds, corporate, municipal and government bonds, the key reason for the boost in revenues before the current financial market crises was the boom in the issuance of structured finance products such as mortgage-backed securities, collateral debt obligations as well as the derivatives linked to them. The Economist (2007) states:

> *The big rating agencies are "as close to Shangri-La as you can get, at Microsoft-plus margins"... Even if the SEC is serious about promoting competition, it may not succeed.... This leaves some wondering if credit ratings are a natural oligopoly, with new entrants offering a level of choice that investors simply do not want... So for the moment the incumbents' dominance is likely to remain, as Ms Tavakoli says, a "gift that just keeps giving".* (Economist (2007), Measuring the measurers, 6/2/2007, Issue 8531, p. 77–78.)

This observation gives rise to the following questions. (i) What is the value of a piece of information for a trader, when other traders have exactly the same piece of information at exactly the same time? Traders see the same quotes on the Reuters' screen and may read the same rating reports. Consequently, what is an information provider's optimal selling strategy? (ii) Why are there only few firms in the market for financial news? Are there any barriers to entry that are peculiar to the business of selling financial information?

This paper addresses this set of questions in a model where both the demand and supply of information are endogenous. In particular, this paper investigates the incentive of firms, such as Bloomberg, to provide information to traders in decentralized over-the-counter markets and the incentive of OTC traders to acquire information.[1] In our model all traders behave strategically and are equally well informed ex ante. They can acquire information about the asset value before they meet and bargain over the price at which to exchange the asset. If trade occurs they realize gains from trade. These gains may, e.g., stem from hedging financial risks and rebalancing portfolio positions, or receiving provisions for executing orders of their customers.[2]

In this setting we find as a first result that a monopolistic information provider sells identical information to all traders and that there is no incentive to add noise to the information. This result is in contrast to Admati and Pfleiderer (1986) who show in a noisy rational expectations equilibrium framework that the information provider's optimal strategy is to add noise to the information and to sell different signals.[3]

The intuition for the first result is the following. If the information cost is low, then the traders face an endogenous lemons problem, i.e., they are concerned about the trading partner being informed. In any trading equilibrium both the buyer and the seller of the financial asset acquire information. There is no equilibrium without information acquisition, since then a trader can profitably deviate by becoming informed and exploiting the opponent by adjusting the bidding behavior. In the equilibrium with information acquisition instead, the motive for information acquisition is the desire to increase the probability of trade: If, e.g., the seller is expected to have a piece of information, then the buyer either (i) does not acquire the signal and always offers the lowest price yielding a low probability

[1] The trading of currencies, US Treasuries, mortgage-backed securities, collateral debt obligations, sales and repurchase agreements (repo), credit default swaps, corporate and municipal bonds are all conducted in OTC markets where the terms of trade are negotiated on a bilateral basis. Some of these markets are much bigger than the stock market in terms of issuance and daily trading volume. For example, in 2007, the total issuance of equity in the US amounted to $246 billion and was much smaller than the issuance of Treasuries ($752 billion), corporate bonds ($1.204 trillion), or mortgage related instruments ($2.047 trillion). Also, in terms of daily trading volume in 2007, $87.1 billion ($68.6 billion) of stocks were traded at the NYSE (NASDAQ), while Agency MBS ($320 billion), Treasury ($546 billion conducted by 19 primary dealers), or repo (5.81 trillion) had a much higher daily trading volume. See SIFMA Research Quarterly, May 2008.

[2] In secondary markets the seller of a financial asset such as a mortgage backed security does not necessarily possess better information than a potential buyer. But they can acquire information before they trade.

[3] The rational traders in such models have no real trading needs. Their only trading motive is to exploit some noise traders (i.e., non-strategic liquidity traders). A rational trader can only earn a speculative profit if he has private information. But if all speculators possess the same information, then they compete away their speculative profit. This lowers their incentive to incur the information cost. See also Admati and Pfleiderer (1988, 1990). We think that rational expectations models with non-strategic noise traders are a good description of large anonymous centralized stock markets, but are not reasonable for decentralized OTC markets where institutional investors bargain on a bilateral basis. For a search based model of OTC trading see Duffie et al. (2005).

of trade or (ii) purchases the same information and bids accordingly. Since trading occurs more often in the latter case, this option is profitable if the signal is cheap. Therefore, the provider can induce information acquisition by charging a not too high price. The provider's motive is to capture the rent that is generated by the financial transactions. By increasing the signal quality, and thus reducing noise, the provider raises the speculative value of information. Furthermore, if the provider sells the same information to both traders, then the trading gain is realized with a high probability. If the provider sells different signals to the traders, then the probability of trade is lower. This means that the expected trading gain is reduced and therefore also the maximum rent the provider can capture.

This paper then analyses the equilibrium market structure of an information provision industry. We show that the demand for financial information in OTC markets exhibits a strategic complementarity in the sense that the traders have a strong incentive to buy information from the same source, i.e., the same signal.[4] This complementarity induces endogenous barriers to entry. The barrier obtains because the traders' incentive to realize speculative gains due to different information is outweighed by a higher chance to realize the trading gain. The incumbent sets prices such that the entry of a competitor does not pay. In addition, we show that if the incumbent offers a signal that is sufficiently precise to make further information signals "useless" in the sense that additional information does not change the agents' trading behavior, then an entrant has no demand even if he offers information for free.[5]

Our approach offers an explanation for the observation that there are only two big information sellers for real time financial data and that they earn high profits. Even though our modeling strategy fits to firms like Bloomberg and Thomson-Reuters, our arguments concerning the value of information in over-the-counter markets and the network effects apply to credit rating agencies as well, although rating services are typically paid by the security issuer and rating reports are provided free of charge to investors and traders. By increasing transparency for traders, Standard & Poors, Moody's and Fitch foster trade in secondary markets. Anticipating the trading opportunities later, this should increase the rents in primary markets and thus the price that may be charged from the issuer of a financial asset. In Section 6 we provide a simple extension of the model and show that it is welfare improving for the issuer of a security to pay for rating services rather than having OTC traders purchase costly rating reports.

In addition, by contrasting our trading environment with trade in centralized markets, we provide an explanation why institutional traders behave so differently when they trade stocks on one hand versus bonds and securitized assets on the other hand. Institutional investors produce a lot of information about stocks. There are many analysts covering stocks, who are working either in independent equity research firms or within the research division of big trading houses and investors are buying equity reports. But institutional investors behave very differently, when they trade bonds and securitized assets in OTC markets. When trading bonds, institutional investors tend not to produce private information, but heavily rely on rating information instead. This paper shows that if the rating information is perceived as just precise "enough", then traders of bonds or securitized products do not have an incentive to acquire more information even if it is for free. An individual OTC trader does not benefit from additional information if other traders do not make use of it. Thus, we provide an answer to the question raised in the Economist's article, why "*credit ratings are a natural oligopoly, with new entrants offering a level of choice that investors simply do not want.*"[6] In addition, this paper highlights, why institutional traders may have no demand for a finer rating system although default risks might be multidimensional.

---

[4] Another type of complementarity due to liquidity concerns (and not information acquisition) in financial markets is investigated, e.g., by Economides and Siow (1988).

[5] Dang et al. (2011b) provide a formal definition of the information acquisition sensitivity of a security, a utility based tailed risk measure, which captures the incentive of a trader to produce private information.

[6] Veldkamp (2006b) analyzes information markets and anonymous centralized trading in a noisy rational expectations Grossmann and Stiglitz (1980) setting with multiple assets and derives a different type of strategic complementarity at the information acquisition stage. In her model the traders have an incentive to purchase private information about the same firm and are indifferent between all signals as long as they have the same precision. We in contrast show that the traders have a strong incentive to purchase the same signal about the firm. A key difference to Veldkamp (2006b) concerns the implications for the price charged by the information provider. She shows that the price in a contestable market is equal to the average cost of information provision. Due to potential competition the provider thus does not have any market power. In our model the price is above the average costs. Due to the entry barrier resulting from the complementarity at the trading stage our information provider has some market power.

The paper is organized as follows. Section 2 describes the model. Section 3 describes the traders' behavior without an information seller. Section 4 investigates a monopolistic provider's optimal selling strategy. Section 5 studies competition in the market for news. Finally, Section 6 concludes.

2. The model

We consider a decentralized market for an indivisible asset with a buyer and a seller. The asset may have two different values $v \in \{v_L, v_H\}$ that are equally likely ex ante, with $v_H > v_L > 0$. In the benchmark case each trader may purchase a signal $z \in \{v_L, v_H\}$ about v from a monopolistic information seller at price c before trade takes place. The provider is endowed with a signal that mirrors the true state of the world with probability $1 - \varepsilon$, where $\varepsilon \in [0, 0.5]$.[7] Information acquisition is not observable by the opponent trader and the realization of the signal is the respective trader's private information.

After the information acquisition stage, the asset is allocated via a double auction. The traders simultaneously submit a bid price b and an ask price s respectively. If the bid price exceeds the ask price, then trade occurs at price $p = \frac{1}{2}(b + s)$. This mechanism captures several features that we deem important for many trades in over-the-counter-markets. In such markets a trader typically calls another financial institution for a proposal. The response has to be made quickly. The decision to purchase, e.g., a Reuters' screen is not contingent on a particular trade. These decisions are long term. Given that a trader receives a proposal, he uses the information available, i.e., previously acquired, in order to determine how to respond. This idea is captured by the sequential structure of the game, where no information acquisition is possible at the trading stage. Furthermore, in order to be willing to incur the costs of information acquisition, a trader must expect to have at least some bargaining power in the future. Otherwise the overall payoff would be negative and abstaining from the market optimal.[8]

We assume that the asset is worth $v - \Delta$ to the seller and $v + \Delta$ to the buyer, where $\Delta > 0$ is an exogenous gain from trade. If trade occurs, then the seller obtains the price p and his net payoff is $p - v + \Delta$ while the buyer pays p and gets the asset and his net payoff is $v + \Delta - p$. If there is no trade, the net payoffs are zero, since there is no change in utility. Whenever the traders purchase information, they have to subtract the respective costs from the net payoffs as well.

We assume that there always is a positive gain from trade 2Δ. This gain may, e.g., stem from a liquidity need of the seller. We assume that Δ is common knowledge. In order to make the problem interesting we impose that the gains from trade are not too large[9]:

Assumption A.

$$\Delta \leqslant \frac{1}{8}(v_H - v_L).$$

Note that information in our setting does not have any social value. From a social point of view trade should occur with certainty in our model, but without prior information acquisition. If information is nevertheless acquired in equilibrium, then this is due to the traders' strategic interaction. In general, information may be socially beneficial. For instance, in primary markets it may help to channel funds into their most productive use. However, it is not obvious whether this is a big issue in secondary markets, say, of MBS trading. For example, after mortgages and loans have been granted, acquiring information about default probabilities has no social value. The underlying (real) assets already exist and trade just determines who is entitled to the uncertain cash flow stream of the assets. We are primarily concerned with institutional investors who have a liquidity motive and engage in

[7] The cost of information provision is introduced later. For the moment we assume that the information provider has zero costs of information provision.

[8] The results do not change qualitatively if we deploy another allocation mechanism, as long as both traders have some (but not necessarily equal) bargaining power. For example, the same qualitative results obtain in a setting where traders first decide to acquire information and then a trader is selected with probability 0.5 to make a take-it-or-leave-it offer.

[9] This assumption ensures that common value uncertainty is important. For example, suppose, in contrast, that $v_L = 101$ and $v_H = 102$ and $\Delta = 100$. For example, a trade at any price between 2.1 and 200.9 is strictly mutually beneficial. In such a case no trader acquires information in equilibrium. In particular, both agents are not concerned whether the "intrinsic" common value of the asset is 101 or 102.

trading in over-the-counter markets. Therefore, we consider the incentive to use information in order to exploit the opponent trader as the dominating force. This incentive plays a role even if the trading gain is uncertain (privately known). Abstracting from uncertainty concerning the traders' private valuations allows us to exclude effects a la Myerson and Satterthwaite (1983), which are already well understood.

The timing in the benchmark case is as follows. First, nature draws the value of the asset. Then the monopolistic information seller sets the price c and the signal quality $1-\hat{\varepsilon}$. We assume that the signal quality $1-\hat{\varepsilon}$ set by the provider cannot exceed the quality $1-\varepsilon$ he is endowed with. Next, the traders choose whether to purchase the provider's signal or to remain uninformed. Finally, the asset is allocated via the double auction and utilities realize.

We use perfect Bayesian equilibrium as the *equilibrium concept*. In the benchmark case with a monopolistic provider this means the following. We require that the traders' behavior at the auction and information acquisition stage satisfies Bayesian Nash equilibrium (BNE). This is reasonable, since the decision to collect information is private. Thus, a trader cannot condition his behavior in the auction on his opponent's decision to acquire information. Finally, the institution anticipates the traders' behavior and decides optimally.

In this class of models there always exist uninteresting no-trade equilibria.[10] In the following we focus on equilibria in which trade occurs with a positive probability.

3. Trading equilibria

We solve the game backwards by first studying the traders' interaction if they may purchase the signal about the asset's value for an arbitrary price c. Lemma 1 tells us how the traders behave in a symmetric BNE.[11]

Lemma 1. *If $\hat{\varepsilon} \geqslant \frac{1}{2} - \frac{\Delta}{v_H - v_L}$, irrespective of information cost c, there exist equilibria where both traders do not acquire information and trade with probability 1. Consider $\hat{\varepsilon} < \frac{1}{2} - \frac{\Delta}{v_H - v_L}$. (i) For low information costs $c \in \left[0, \min\left(\Delta, \left(\frac{1}{4} - \frac{1}{2}\hat{\varepsilon}\right)(v_H - v_L) - \frac{1}{2}\Delta\right)\right]$, in any equilibrium where trade occurs with probability one, both traders acquire information. At signal $z = v_L$, trade occurs at a price $p_L \in [E[v|v_L] + \Delta, E[v|v_L] + \Delta - 2c]$. At signal $z = v_H$, trade occurs at a price $p_H \in [E[v|v_H] - \Delta, E[v|v_H] - \Delta + 2c]$. (ii) Let $\Delta < \left(\frac{1}{4} - \frac{1}{2}\hat{\varepsilon}\right)(v_H - v_L) - \frac{1}{2}\Delta$. For intermediate costs $c \in \left(\Delta, \left(\frac{1}{4} - \frac{1}{2}\hat{\varepsilon}\right)(v_H - v_L) - \frac{1}{2}\Delta\right)$, there exists no pure strategy equilibrium with trade. In a mixed strategy equilibrium, the asset is exchanged with a probability smaller than one and a trader randomizes his information acquisition decision. (iii) For high costs $c \geqslant \left(\frac{1}{4} - \frac{1}{2}\hat{\varepsilon}\right)(v_H - v_L) - \frac{1}{2}\Delta$, there exist equilibria where both traders do not acquire information and the asset is exchanged with probability one at a price $p \in [E[v] - \Delta, E[v] + \Delta]$.*

If the signal offered is too imprecise, i.e., $\hat{\varepsilon}$ is above a threshold, then the information provider cannot induce information acquisition by the traders. Otherwise, the information acquisition behavior depends on the costs. Suppose that $\hat{\varepsilon}$ is below the threshold. If the information cost is low, then in a BNE with trade both traders buy information. To see this, suppose the buyer does not acquire information and chooses the offer price $E[v]$. For simplicity let $\hat{\varepsilon} = 0$. If the seller also chooses the price $E[v]$, then trade occurs and the seller receives $EU = \Delta$. Alternatively, the seller acquires information and speculates.[12] If the seller speculates, no trade occurs in the high state and he forgoes the surplus Δ with prob-

[10] For example, it is an equilibrium if the uninformed seller proposes a price $v_H + \Delta$ or higher and the uninformed buyer proposes the price $v_L - \Delta$ or lower.

[11] Lemma 1 is based on Proposition 1 in Dang (2009). We generalize this proposition by allowing for $\hat{\varepsilon} > 0$. Appendix A contains a sketch of the proof. Dang (2009) analyzes how the size of a centralized market affects the incentives of a trader to acquire information, where the price and the precision of information are exogenously given. Similarly, Dang et al. (2011a,b) assume exogenous information precisions and costs. In contrast, the present paper endogenizes the precision and price of information by analyzing the behavior of information providers and the equilibrium market structure of an information provision industry in an OTC trading context.

[12] There are different notions of "speculation" in the finance literature. Sometimes speculation means that a trader is taking a more risky position. In our paper speculation means that a trader acquires information (potentially off the equilibrium path) and makes an information driven trade.

ability 1/2. Given the buyer's offer, the informed seller only sells the asset, if he sees that the value is low. In this case he realizes the trading surplus. In addition he makes the expected speculative profit $\frac{1}{4}(v_H - v_L)$. This strategy overall yields the expected payoff $\frac{1}{4}(v_H - v_L) + \frac{1}{2}\Delta - c$ to the seller and is better than the first response if $c < \frac{1}{4}(v_H - v_L) - \frac{1}{2}\Delta$, where $\frac{1}{2}\Delta$ is the opportunity cost of speculation.[13] Thus, if c is sufficiently low, then the seller speculates.[14] The buyer faces the same incentive. The less surplus a trader gets the higher is his incentive to speculate. Consequently, if $c < \frac{1}{4}(v_H - v_L) - \frac{1}{2}\Delta$, then there exists no trading equilibrium without information acquisition.[15] If the information cost is sufficiently low, then the trader buys information in equilibrium and the motive for information acquisition is driven by the desire to increase the probability of trade.[16]

The intuition why there exists no pure strategy equilibrium for intermediate information costs is as follows. Suppose again that $\hat{\varepsilon} = 0$. Note first that there exists no pure strategy equilibrium where both traders acquire information, since $2c > 2\Delta$. Suppose next that there were a pure strategy equilibrium where, say, exclusively the seller acquires information. The parameter values imply that the lemons problem is severe. Therefore, the best response of the uninformed buyer is to account for adverse selection by submitting a low bid price. Trade only occurs in the low state. Even if the seller captures the full gains from trade (i.e., 2Δ), this does not cover his information costs, because the probability of trade is 1/2. It follows that there exists no pure strategy equilibrium where one trader acquires information. Finally, suppose that there were a pure strategy equilibrium with trade, where both traders are uninformed. The set of mutually acceptable prices for two uninformed traders is $[E[v] - \Delta, E[v] + \Delta]$. If a trader submits a price within this range, then the best response of the other trader is to deviate by acquiring information, because in such a case the speculative gains are larger than the information costs. Therefore, there is no pure strategy equilibrium with trade if the information costs are larger than the trading surplus and smaller than potential speculative profits.

If the information cost is high, then both traders are not concerned about the endogenous lemons problem and trade occurs with probability one. As in a "standard" double auction with symmetric information, there is a continuum of trading equilibria. In all subsequent sections, this paper focuses on symmetric equal-split equilibria.

4. Optimal selling strategy

Given the traders' behavior we can now analyze the monopolistic provider's optimal selling strategy. We are interested in whether the information provider has an incentive to add noise to the information he sells and whether it is optimal to sell different signals to the traders. For the latter, we compare two situations. On the one hand the information provider may offer the same signal z with maximum precision $(1 - \varepsilon)$ to both traders. On the other hand the provider may sell the signal z^j to trader j, where each z^j has the same precision $(1 - \varepsilon)$, but the signals are conditionally independent.

Proposition 1. *Let $\varepsilon < \frac{1}{2} - \frac{\Delta}{v_H - v_L}$. (i) It is weakly optimal for the information provider to sell his information as precise as possible, in particular he does not add noise to his information. (ii) The information provider offers the same signal to both traders. (iii) The information provider charges $c = \min\left(\Delta, \left(\frac{1}{4} - \frac{1}{2}\varepsilon\right)(v_H - v_L) - \frac{1}{2}\Delta\right)$.*

[13] If $\hat{\varepsilon} > 0$, then the expected payoff from speculation is $\frac{1}{2}(1 - \hat{\varepsilon})(b - (v_L - \Delta)) + \frac{1}{2}\hat{\varepsilon}(b - (v_H - \Delta)) - c = (\frac{1}{4} - \frac{1}{2}\hat{\varepsilon})(v_H - v_L) + \frac{1}{2}\Delta - c$. Speculation is a profitable deviation if $(\frac{1}{4} - \frac{1}{2}\hat{\varepsilon})(v_H - v_L) + \frac{1}{2}\Delta - c > \Delta$. The RHS of the inequality is the payoff from trade without information acquisition. The smallest possible cost is $c = 0$. The LHS is larger than the RHS for $c = 0$ if $\hat{\varepsilon} < \frac{1}{2} - \frac{\Delta}{v_H - v_L}$. In this case trade without information acquisition is not a BNE.

[14] Assumption A implies that this is true. Otherwise there exist trading equilibria without costly information acquisition and the problem discussed in this paper is not relevant.

[15] The opportunity cost is $\frac{1}{2}\Delta$ and highest for both traders, if the surplus is shared equally.

[16] Suppose $\hat{\varepsilon} = 0$ and $c = \Delta$. The following behavior constitutes a BNE: (i) both traders acquire information with probability one, (ii) the offer prices at v_L are equal to $b(v_L) = s(v_L) = v_L + \Delta$ and (iii) the offer prices at v_H are equal to $b(v_H) = s(v_H) = v_H - \Delta$. The equilibrium payoff for each trader is $\Delta - c = 0$ and no trader has a profitable deviation.

Proof. The condition $\varepsilon < \frac{1}{2} - \frac{\Delta}{v_H - v_L}$ ensures that the information provider can induce information acquisition for some c and $\hat{\varepsilon}$ (see Lemma 1). Given the counter party does not acquire information and bids $E[v]$, a trader's expected payoff from an unilateral deviation to acquire information and speculate is $\left(\frac{1}{4} - \frac{1}{2}\varepsilon\right)(v_H - v_L) + \frac{1}{2}\Delta - c$. This payoff is larger than Δ (i.e., the payoff when there is trade without information acquisition) if $c < c^{\max} \equiv \left(\frac{1}{4} - \frac{1}{2}\varepsilon\right)(v_H - v_L) - \frac{1}{2}\Delta$.

According to Lemma 1, both traders acquire information in any BNE, where trade occurs with probability 1.

(i) Adding noise, i.e., $\hat{\varepsilon} > \varepsilon$, reduces the price the provider can charge, since the maximum price $c^{\max}(\hat{\varepsilon})$ is decreasing in $\hat{\varepsilon}$. If the provider adds too much noise, then there is no equilibrium at the trading and information acquisition stage, where the traders purchase information. This is the case if $\hat{\varepsilon} > \frac{1}{2} - \frac{\Delta}{v_H - v_L}$.

(ii) If the provider offers different signals to different traders, then the probability of trade is weakly lower, as the seller's signal may suggest a high value and the buyer's signal a low value. Therefore, the rent that the provider can extract is also weakly lower than if he sells the same signal to both traders.

(iii) If $\Delta \geqslant \left(\frac{1}{4} - \frac{1}{2}\varepsilon\right)(v_H - v_L) - \frac{1}{2}\Delta$, then the profit maximizing price for the information provider to charge is $c^* = \left(\frac{1}{4} - \frac{1}{2}\varepsilon\right)(v_H - v_L) - \frac{1}{2}\Delta$. A higher price does not induce information acquisition, because the costs from purchasing information exceed the potential speculative gain (off the equilibrium path). If $\Delta < \left(\frac{1}{4} - \frac{1}{2}\varepsilon\right)(v_H - v_L) - \frac{1}{2}\Delta$, then the profit maximizing price for the information provider to charge is $c^* = \Delta$. A higher price does not induce both traders to buy information in equilibrium because the total information costs exceed the total gains from trade. □

Admati and Pfleiderer (1986) show in a rational expectations framework that it may be optimal for an information seller to add noise to his news. In our model, Proposition 1 asserts that the provider does not gain by adding noise. Furthermore, by synchronizing the traders' information the institution ensures that trade always occurs. If different information is sold instead, then it may be that the seller's signal suggests a high asset value but the buyer's signal is opposite. Thus, by causing potential asymmetries the institution weakly reduces the amount of trade and also the rent it may capture. As c is a function of ε, the information provider's optimal price depends on the precision of his signal. If his signal is perfect, i.e., $\varepsilon = 0$, then the optimal price is $c(\varepsilon) = \Delta$ (given Assumption A) and the provider can extract the entire rent. If his signal is imprecise, he reduces the price. If it is too imprecise, he cannot induce information purchase.

5. Competition and entry barrier

Let us now investigate a variant of the benchmark model that studies the endogenous entry barriers. Suppose that there are two information providers competing in the market for news. An incumbent I may acquire a signal $z_I \in \{v_L, v_H\}$ with quality $1 - \varepsilon_I$ and an entrant E may acquire the signal $z_E \in \{v_L, v_H\}$ with quality $1 - \varepsilon_E$ and $corr(z_I, z_E) < 1$. "Incumbent" is a label for a firm. The label is chosen to illustrate that if traders in equilibrium coordinate on a well known established firm, then this firm may successfully deter entrance of an additional firm even if it sets a higher price. The signals are drawn independently and signal z_i mirrors the asset value with probability $1 - \varepsilon_i$, for each $i = I, E$. In order to illustrate best the entry barrier we assume that $\varepsilon_I = \varepsilon_E = \varepsilon$. A firm has to pay $\gamma > 0$ in order to acquire its signal. Each provider may choose the precision of the signal he sells. Naturally, the signal sold cannot be more precise than his own information. It is common knowledge, that the traders have the same information if they buy from the same provider. A trader may purchase from the providers one signal, two signals or remain uninformed.[17] The game now has four players, namely the information providers E and I, the trader B (buyer of the financial asset) and the trader S (seller of the financial asset).

[17] Abstracting from the traders' option to search for information on their own does not affect the nature of the argument. The traders also cannot condition their choice to purchase a second signal on the realization of the first signal. This captures that we consider information acquisition as a long term decision.

The timing is adjusted as follows. First the providers simultaneously set prices, $c_E \geqslant 0$ and $c_I \geqslant 0$, and the signal qualities they offer.[18] Then the traders simultaneously determine how many signals they wish to purchase. Then a provider who is asked to deliver a signal acquires his signal at cost γ and provides it to the respective trader(s). Otherwise the provider does not acquire a signal and has zero profit. These assumptions ensure that the entry barrier is not due to sunk costs. The other assumptions from the benchmark model are maintained. In an equilibrium the providers anticipate the traders' BNE behavior at the trading stage and set their prices and signal precisions such that they are mutually best responses.

We show in this section that there can be an equilibrium where both traders acquire information from the incumbent even if he offers the same information quality as the entrant and charges a higher price for his signal. Let us first look at the precision of the signals that the providers offer. We focus on an equilibrium in which no trader increases his demand for a signal z_i if the quality of this signal ceteris paribus decreases.[19]

Remark 1. For each provider i: Given that the opponent provider $-i$ offers the signal quality $1 - \hat{\varepsilon}_{-i}$, it is a weak best response to offer the maximum signal quality, i.e., to set $\hat{\varepsilon}_i = \varepsilon$. Therefore, it is a best response for both providers to offer the maximum quality.

The reasoning is analogous to the monopolistic provider's incentive not to add noise to the information. For each (c_I, c_E) combination, the value of a signal z_i for each trader ceteris paribus weakly decreases as the quality of the signal decreases. By reducing the signal quality, a provider reduces the speculative value of the information. This in turn implies a competitive disadvantage that can be avoided at zero costs simply by handing over the most precise information available.

The entry barrier, if it exists, is driven by the traders' strategic interaction. So let us again look at the trading stage. On the one hand a trader likes to realize the trading gain. He can do so by purchasing the signal from the same source as his opponent. If this is equilibrium behavior, then trade takes place with probability one. On the other hand, a trader has a motive to speculate, e.g., by purchasing a different signal than his opponent.

Speculation by purchasing a different signal may be beneficial for a trader. To illustrate this, suppose that both traders choose the offer prices $b = s = E[v|v_L]$ when they receive the signal that suggests a low asset value. If both traders buy information from the same provider, then the best estimate of the asset value is $E[v|v_L]$. The transaction price reflects the fair value of the asset. If the traders buy information from different providers, then, conditional on observing the price $E[v|v_L]$, the best estimate of the asset value is now $E[v|v_L, v_L] < E[v|v_L]$. In such a case the buyer knows that he pays more than the fair value of the asset. Analogously, if the traders acquire information from different providers, both observe a high signal and they trade at the price $E[v|v_H]$, then the seller knows that he receives less than the fair value. A further implication of buying from different providers is that no trade occurs if trader B receives a low signal while trader S gets a high signal. The latter point is similar to the case with a monopolistic seller who may add noise to the signals.

A trader may also speculate by acquiring the signal from the entrant in addition to the incumbent's signal. In a hypothetical equilibrium in which both traders exclusively purchase the incumbent's signal, a trader who deviates by purchasing both signals knows his opponent's signal realization and can deduce the corresponding bid. Observing the entrant's signal may be beneficial. Suppose the buyer chooses the offer prices $b = E[v|z_I]$. If the seller acquires two signals, then he can choose whether trade occurs. Trade occurs if he sets $s = b = E[v|z_I]$, in which case the price is $E[v|z_I]$. Suppose the seller observes

(i) $(z_I, z_E) = (v_L, v_L)$ then trade occurs, since $E[v|v_L, v_L] < E[v|v_L]$,
(ii) $(z_I, z_E) = (v_L, v_H)$ then no trade occurs if the trading gain is sufficiently small, since $E[v|v_L, v_H] = E[v] \gg E[v|v_L]$,

[18] There is no price discrimination.

[19] The traders' strategies are functions of the signal precisions. In general, there is a multiplicity of mutually best responses at the information acquisition stage. In principle, the traders could use the precisions as a coordination device and switch between the providers depending on the qualities they offer. This in turn may deter a provider from offering the highest quality information. Note that it is weakly optimal for a trader to behave as supposed given his opponent's behavior.

(iii) $(z_I, z_E) = (v_H, v_L)$ then trade occurs, since $E[v|v_H, v_L] = E[v] \ll E[v|v_H]$,
(iv) $(z_I, z_E) = (v_H, v_H)$ then trade occurs if the trading gain is sufficiently high, since $E[v|v_H, v_H] > E[v|v_H]$.

In cases (i) and (iv) the seller's trading behavior is as in the hypothetical (equal split) equilibrium. Since these contingencies occur with the same probability and the speculative gain in case (i) is the same as the speculative loss in case (iv), the gain and the loss "cancel out" in the seller's decision problem. In the remaining two cases the information is particularly valuable for the seller. In case (ii) the seller prefers not to sell the asset and his utility is zero, whereas in case (iii) the buyer is significantly exploited and the seller's utility is very high. However, if the information acquired is precise, i.e., ε is small, then cases (ii) and (iii) occur with a small probability and hence the expected gain from acquiring two signals ceteris paribus is low. A further disadvantage from purchasing two signals is that the second signal costs c_E.

A priori it is not clear whether the desire to realize the trading gain or the motive for speculation and the concern about a potential lemons problem is the dominating force. It is not even clear whether the traders have best responses in pure strategies, since they not only decide whether to buy information but also where to buy it. The next proposition addresses the behavior of the traders, given that the providers have set their prices c_i.

Proposition 2. *Suppose* $0 < \varepsilon < \frac{\Delta}{v_H - v_L}$, $c_I \leqslant \frac{1}{2}\Delta$ *and* $c_E \geqslant \max\left(c_I - (\varepsilon - \varepsilon^2)\Delta,\ \varepsilon\left(\left(\frac{1}{2} - \frac{3}{2}\varepsilon + \varepsilon^2\right)(v_H - v_L) - (1-\varepsilon)\Delta\right), 0\right)$. *For $c_I > c_E$: There exists a pair of best responses at the trading stage such that both traders buy information from provider I and trade with probability 1.*

The proof can be found in Appendix B.

Proposition 2 states that if one trader acquires information from provider I, then the best response of the other trader is also to buy information from provider I even though provider E charges a lower price. The first term in $\max(\cdot)$ ensures that no trader has an incentive to deviate by purchasing exclusively the entrant's signal in the proposed equilibrium. This is not optimal even though $c_E < c_I$. The second term in $\max(\cdot)$ ensures that no trader has an incentive to acquire both signals. The costs c_I do not appear in this expression, since the utility from acquiring exclusively the incumbents's signal has to be compared with the utility from purchasing both signals and hence c_I cancels out.

Proposition 2 implies that the desire to deviate is more than compensated by the incentive to realize the trading gain. Given the traders' motive to obtain information from the same source, they basically face a coordination problem. Given the above prices, the traders could jointly improve if they both simultaneously switch to the entrant. An unilateral deviation instead is not profitable.[20] The complementarity at the trading stage exists regardless on how the traders coordinate. There also exists a pair of best responses such that both traders purchase information from the entrant. Coordinating on acquiring information from the more expensive incumbent is thus costly. Historical market shares, long term contracts with the information provider, marketing activities, reputation and uncertainty about whether the opponent switches speak against a coordination success. Thus, an established incumbent firm that already has a customer (and this is expected by the other trader) can charge a higher price than a potential entrant without losing demand. Put differently, a trader who knows that his opponent uses a Reuters' screen also wants to subscribe, even though this information is expensive and (different) information of the same quality may be obtained more cheaply elsewhere.

The competitive effect depends on the exogenous signal quality ε. For example, if the signals perfectly mirror the asset value, i.e., $\varepsilon = 0$, then it does not matter, where a trader purchases his information because there is no coordination problem. Thus, the incumbent only has a demand if he charges the same price as an entrant. In this case the incumbent has no market power. However, an exogenous decrease in the signal quality increases the incumbent's market power. The following proposition

[20] Caillaud and Jullien (2003) study a model where the firms may choose negative prices in order to attract switching. (E.g., an entrant may offer a negative price to one trader and charge a positive price from the opponent.) In our setting price discrimination would not change the complementarity, but it would reduce the market power of the incumbent provider. Prices below costs have the disadvantage that they may attract customers who just want to obtain the "gift", often rendering such a pricing strategy unprofitable.

takes the competition stage into account and describes the equilibrium of the whole game by endogenizing both the demand and the supply of information.

Proposition 3. *Suppose $\varepsilon < \frac{\Delta}{v_H - v_L}$ and $\gamma \in (2\varepsilon((\frac{1}{2} - \frac{3}{2}\varepsilon + \varepsilon^2)(v_H - v_L) - (1-\varepsilon)\Delta), \Delta - 2(\varepsilon - \varepsilon^2)\Delta)$. There is a pure strategy equilibrium where provider E sets the price $c_E = \frac{\gamma}{2}$, provider I sets $c_I = \frac{\gamma}{2} + (\varepsilon - \varepsilon^2)\Delta$, the traders buy information from provider I and trade with probability 1.*

Proof. The condition $\gamma \leqslant \Delta - 2(\varepsilon - \varepsilon^2)\Delta$ ensures that the condition $c_I \leqslant \frac{1}{2}\Delta$ in Proposition 2 is satisfied with $c_I = \frac{\gamma}{2} + (\varepsilon - \varepsilon^2)\Delta$. Similarly the condition $\gamma \geqslant 2\varepsilon((\frac{1}{2} - \frac{3}{2}\varepsilon + \varepsilon^2)(v_H - v_L) - (1-\varepsilon)\Delta)$ ensures that $c_I - (\varepsilon - \varepsilon^2)\Delta = \max(c_I - (\varepsilon - \varepsilon^2)\Delta, \varepsilon((\frac{1}{2} - \frac{3}{2}\varepsilon + \varepsilon^2)(v_H - v_L) - (1-\varepsilon)\Delta))$ if $c_I = \frac{\gamma}{2} + (\varepsilon - \varepsilon^2)\Delta$. It can easily be seen that there are parameters such that the interval for γ is non-empty.[21] The provider E does not set $c_E < \frac{\gamma}{2}$, since he could not recover the costs even if both traders purchased his signal. For $c_E \geqslant \frac{\gamma}{2}$, provider E has zero demand given that $c_I = \frac{\gamma}{2} + (\varepsilon - \varepsilon^2)\Delta$ according to Proposition 2.

Note that if there is an equilibrium where both trader purchase information from the incumbent in case $c_I > c_E$, then there also is another equilibrium at the trading and information acquisition stage, where both traders acquire information from the entrant. We are now going to show that if the incumbent sets a higher price than $c_I = \frac{\gamma}{2} + (\varepsilon - \varepsilon^2)\Delta$, then the equilibrium at the trading and information acquisition stage in which the traders purchase information from the incumbent ceases to exist. In this case the traders exclusively purchase information from the entrant and trade for all signal realizations.

Suppose the incumbent charges a higher price than $c_I = \frac{\gamma}{2} + (\varepsilon - \varepsilon^2)\Delta$. In this subgame it may potentially be that (i) both traders purchase information from I or (ii) the traders obtain news from different providers or (iii) both traders acquire information from E or (iv) traders acquire two signals. Case (i) is inconsistent with BNE, since in the proof of Proposition 2 we show that the seller has an incentive to deviate, remain uninformed, and choose $s = E[v|v_L]$. By an analogous argument as in Proposition 2 case (ii) is not compatible with BNE, since the trader purchasing news from the incumbent can do better by switching to the entrant. In this subgame, again analogous to Proposition 2, both traders in a BNE purchase information from E.

Therefore, provider I loses his entire demand and this deviation is not profitable. Case (iv) is also not consistent with BNE since we know from the proof of Proposition 2 that $c_E = c_I - (\varepsilon - \varepsilon^2)\Delta > \varepsilon((\frac{1}{2} - \frac{3}{2}\varepsilon + \varepsilon^2)(v_H - v_L) - (1-\varepsilon)\Delta)$ implies that no trader has an incentive to acquire two signals. Therefore, if $c_I - (\varepsilon - \varepsilon^2)\Delta = \max(c_I - (\varepsilon - \varepsilon^2)\Delta, \varepsilon((\frac{1}{2} - \frac{3}{2}\varepsilon + \varepsilon^2)(v_H - v_L) - (1-\varepsilon)\Delta), 0)$, then the incumbent's optimal price satisfies $c_I - (\varepsilon - \varepsilon^2)\Delta = \frac{\gamma}{2}$ given that the entrant sets $c_E = \frac{\gamma}{2}$. Provider I's optimal price is $c_I = \frac{\gamma}{2} + (\varepsilon - \varepsilon^2)\Delta$, since this ensures that the traders just purchase the information from I. The incumbent's price c_I is greater than $\frac{\gamma}{2}$ and hence he has a positive profit. Given the prices c_I and c_E, the traders' behavior is optimal according to Proposition 2. □

Potential competition does not drive the price down to average costs due to the endogenous entry barrier, which arises because the traders' interaction in the OTC market exhibits a strategic complementarity that induces traders to buy information from the same information provider.

6. Conclusion

This paper analyzes endogenous information provision and endogenous information purchase in over-the-counter markets. Most of the theoretical literature on market microstructure focuses on centralized trading and the informational role of prices within the noisy rational expectations equilibrium (REE) framework. Canonical models are Grossmann and Stiglitz (1980) and Kyle (1985, 1989). Models based on this framework apply more to equity trading, but not to the trading of bonds, mortgage backed securities, collateral debt obligations, credit default swaps, repo and currencies in over-the-counter (OTC) markets where institutional traders negotiate over the terms of trade bilaterally and that by their very nature have much less price transparency. Footnote 1 highlights the significance of these markets in terms of daily trading volumes. We therefore depart from the noisy REE framework and assume that all traders behave strategically.

[21] E.g., the parameters at the end of the proof of Proposition 2 in Appendix B.

One of the main results of the paper concerns the market structure of the industry for financial market data. This paper shows that the traders in OTC markets have a strong incentive to purchase information from the same provider. We interpret this result as a potential explanation for the almost duopolistic structure in information industries. The industry for financial market data is dominated by Bloomberg and Thomson-Reuters.

In the basic model, this paper analyses a monopolistic information market. In practice, traders in, say OTC market of currency trading, typically have both a Reuters and Bloomberg' screen. This observation can be reconciled with the model in the following sense. When the traders have purchased information from two incumbents, then they have no further demand for additional information if the joint information is perceived as precise enough. The more information has been acquired, the smaller is the value of additional information.[22] Furthermore, traders have no incentive to buy from an entrant firm instead because information demands are strategic complements. Traders have a desire to realize trading gains, but there is also a motive for speculation. If the gains from trade are relatively large, then in equilibrium the former incentive is stronger and traders prefer to purchase news from the same source, i.e., identical information. The resulting barrier tends to hinder competition and incumbent firms enjoy rents. In addition to a well known competitive advantage of an incumbent in an industry with sunk costs and price competition, this paper thus identifies another source of entry barriers.[23]

We think that our analysis is particularly appropriate for firms like Bloomberg or Thomson-Reuters, who charge traders for the information they provide. There are differences between these firms and credit rating agencies. Rating agencies typically charge the issuers of financial assets in primary markets for their evaluation and provide it free of charge to investors. Nevertheless, the endogenous lemons problem in OTC markets proposed above is not affected. Offering reports for free, rating agencies foster trade in secondary markets. Anticipating the trading opportunities later, this should increase the rents in primary markets and thus the price that such an agency may charge from the issuer of a financial asset.

The following extension of the basic model shows that it is socially more efficient for an issuer to pay for the rating services rather than having the traders pay for rating reports. Consider the case where there are N pairs of traders. A pair i of traders consists of a trader with a valuation of $v + \Delta_i$ and another one with valuation $v - \Delta_i$, where each Δ_i is an independently distributed random variable with positive support on the interval $(0, \overline{\Delta})$ and mean Δ. Δ_i is the private information of the pair i of traders, i.e., both traders of pair i know the realization of Δ_i before they trade. but Δ_i is unknown to the provider. Suppose the provider is not able to engage in price discrimination, then for any price $c > 0$, a pair of traders with $\Delta_i < c$ does not acquire information. Yet, there is no trade because of the endogenous lemons problem. The total expected gains from trade are $2N * E[\Delta_i] = 2N\Delta$. For any $c > 0$, the expected gains from trade are strictly smaller than $2N\Delta$. By charging the issuer for services, this can foster efficient trades in secondary markets. Since $c = 0$ all traders become equally informed and all gains from trade are realized.

The SEC (2003) report documents that institutional investors are concerned about adverse selection problems in secondary market trading when investors have to pay for rating reports and states "*several hearing participants expressed concern regarding the special, and perhaps inappropriate, access to rating information and analysts available to rating agency subscribers.*" (p. 23) Regarding issuer influence, the

[22] To highlight the intuition for the decreasing marginal value of information, suppose the buyer and the seller obtain two high signals and the seller demands a price $p = E[v|v_H, v_H]$. How does a third signal affect the best response of the buyer? Suppose the third signal indicates v_L. Then $E[v|v_H, v_H, v_L] < E[v|v_H, v_H] = p$. Loosely speaking, if $E[v|v_H, v_H] - E[v|v_H, v_H, v_L] < \Delta$, then the buyer is still willing to buy. Thus, the third signal has no value to him because it does not change his trading behavior as a best response to the seller who only observes two signals. More generally, define X as the vector of K signals, and Y as X plus one more signal. Then $|E[v|Y] - E[v|X]|$ is decreasing in K. If the information is precise enough in this formal sense, then OTC traders have no demand for additional information, even if it is cheap.

[23] The SEC (2003, p. 37) report states "*Many believe this [entry barrier] is due primarily to the longstanding dominance of the credit rating business by a few firms – essentially the NRSROs – as well as the fact that the marketplace may not demand ratings from more than two or three rating agencies.*" Such an entry barrier does not exist in typical markets for consumption goods with better informed suppliers. In such markets consumers do not care whether they buy different signals about the good's quality as long as they have the same precision and price simply because consumers typically do not interact with each other.

report states "*In general, hearing participants did not believe that reliance by rating agencies on issuer fees leads to significant conflicts of interest.*" (p. 23)

This paper shows that a trader has a strong incentive to buy information from a provider where many other traders are also obtaining information from. Therefore, incumbent rating firms, like Moody's, may have an incentive to make it difficult for a new entrant to establish a customer base by cross-subsidizing unsolicited rating reports and provide them to traders for free.

By contrasting our trading environment with trade in centralized markets, we provide an explanation why institutional traders behave so differently when they trade stocks on the one hand versus bonds and securitized assets on the other hand. This paper shows that if the information provided is considered as precise enough in the sense that additional information does not change the trading behavior of an individual trader in an OTC market (as described in footnote 22), institutional traders have no demand for further information even if it is free. Thus, this paper provides a rationale for why the rating system is relatively coarse and there is no demand for finer rating information although default risks may be multidimensional. In contrast, institutional traders demand and acquire much more information, when the trade stocks in centralized markets.[24]

Trades in OTC markets are bilateral. In practice, a trader may use the same information to transact bilaterally with multiple parties. The option to use the same information for multiple trades makes the information more valuable for a trader. In an equilibrium in which everyone becomes informed, deviating to remain uninformed means to forego many profitable trades. Hence, there is a strong incentive to acquire information.

In an earlier working paper version, we show that the efficiency effects of increasing the size of the OTC market are ambiguous. An information provision industry may increase efficiency by reducing lemons problems via the reduction of costs and help to avoid the duplication of wasteful information acquisition costs. On the other hand if the information provision cost is high, an information provider may be responsible for socially useless information provision in a large market, which would not be provided in a small market since there is not enough demand to cover the high cost.[25]

Competition among information providers is an interesting field for further research. We have treated the signal quality the providers are endowed with as exogenous, e.g., given by acquisition technologies. Competition may trigger a race for the development of new acquisition and transmission technologies. For example, Reuter used 45 pigeons to transmit news between Aachen and Brussels in 1850, beating the railroad by 6 h. Later telegraphs replaced them and nowadays computer networks are used. Due to competition, the rents from trade are not just redistributed from the traders to the information sellers. A part of the rents that the information providers capture should be wasted on R& D.

This paper suggests that information providers have a predatory character and capture rent. Information providers typically cannot control whether the information sold is used in OTC or centralized markets. The literature so far treated these markets separately and it would be an interesting avenue for future work to study information sellers acting in both kinds of markets. Our framework might prove to be a convenient starting point since we allow traders to have a trading gain as well as the incentive to speculate.

Acknowledgments

We thank Wolfgang Bühler, Gary Gorton, Hans Peter Grüner, Andrea Prat, Ernst-Ludwig von Thadden, S. Viswanathan (Editor) and especially an anonymous referee for their detailed comments and suggestions. We also benefited from the feedback of participants at the seminar at the MPI for Collec-

[24] For example, institutional investors who trade, say General Electric stocks are interested in reading different equity reports by independent research firms that analyze the cashflows generated by the thousands of projects that GE Capital and all its other subsidiaries are investing in so as to come up with a stock valuation. In contrast, institutional investors who trade MBS typically solely rely on one or two rating reports which analyze the cashflows generated by the pool of underlying mortgages. Dang et al. (2011b) show that equity is strictly more information acquisition sensitive than a bond. Dang (2009) shows that the incentive to acquire information increases with the size of the centralized market.

[25] Kessler (1998) and Levin (2001) study how information asymmetries affect the amount of trade. Biglaiser (1993) and Lizzeri (1999) also study information sellers and intermediaries but with a different focus.

tive Goods in Bonn and ESEM 2008 in Milan. The first author gratefully acknowledges the DFG research grants DA1163/1-1 and DA1163/1-2 from the Deutsche Forschungsgemeinschaft.

Appendix A. Sketch of the proof of Lemma 1

Suppose the traders do not acquire information. In a pair of (bidding) best responses, the buyer and seller choose $b = s$ which yields a price $p = b = s$. Any price $p = E[v] + k$ with $k \in [-\Delta, \Delta]$ is mutually acceptable and $EU^B = \Delta - k$ and $EU^S = \Delta + k$, with EU^i being the expected utility of trader $i \in \{B, S\}$.

Suppose the buyer deviates unilaterally by acquiring information and bidding $b_L < s$ at v_L and $b_H = s$ at v_H. This response yields

$$\begin{aligned}
EU^B &= \frac{1}{2}[\hat{\varepsilon}(v_L + \Delta - p) + (1-\hat{\varepsilon})0] + \frac{1}{2}[\hat{\varepsilon}0 + (1-\widehat{\varepsilon})(v_H + \Delta - p)] - c \iff \\
EU^B &= \frac{1}{2}v_H + \frac{1}{2}\hat{\varepsilon}(v_L - v_H) + \frac{1}{2}\Delta - \frac{1}{2}p - c \iff \\
EU^B &= -\frac{1}{2}\hat{\varepsilon}(v_H - v_L) + \frac{1}{2}\Delta - \frac{1}{2}(p - v_H) - c.
\end{aligned}$$

Plugging in $p = \frac{v_H + v_L}{2} + k$ and collecting terms yields

$$EU^B = \frac{1}{2}\left(\frac{v_H - v_L}{2} - k\right) - \frac{1}{2}\hat{\varepsilon}(v_H - v_L) + \frac{1}{2}\Delta - c. \tag{1}$$

Analogously, for the seller. If he unilaterally deviates and speculates, then

$$EU^S = \frac{1}{2}\left(\frac{v_H - v_L}{2} + k\right) - \frac{1}{2}\hat{\varepsilon}(v_H - v_L) + \frac{1}{2}\Delta - c. \tag{2}$$

For $k = 0$ (i.e., an equal split of trading gains), Eqs. (1) and (2) are identical. Therefore, speculation is not profitable for both traders, if $\frac{1}{4}(v_H - v_L) - \frac{1}{2}\hat{\varepsilon}(v_H - v_L) + \frac{1}{2}\Delta - c \leqslant \Delta$, which is equivalent to $c \geqslant \frac{1}{4}(v_H - v_L) - \frac{1}{2}\hat{\varepsilon}(v_H - v_L) - \frac{1}{2}\Delta$.

The first two terms are the expected speculative profit and the third term is the opportunity cost of speculation (i.e., the forgone trading gain).

(a) If $c > \frac{1}{4}(v_H - v_L) - \frac{1}{2}\hat{\varepsilon}(v_H - v_L) - \frac{1}{2}\Delta$, then there exists a continuum of BNE where no trader acquires information and chooses $b = s = E[v] + k$ where k is such that Eq. (1) is weakly larger than $\Delta - k$ and (2) is weakly larger than $\Delta + k$.
(b) If $c = \frac{1}{4}(v_H - v_L) - \frac{1}{2}\hat{\varepsilon}(v_H - v_L) - \frac{1}{2}\Delta$, then the BNE without information acquisition and where trade occurs with probability 1 is unique. The traders choose $b = s = E[v]$.
(c) If $c < \frac{1}{4}(v_H - v_L) - \frac{1}{2}\hat{\varepsilon}(v_H - v_L) - \frac{1}{2}\Delta$, then there exists no BNE where trade occurs with probability 1 and where no trader acquires information.
(d) If $\Delta < c < \frac{1}{4}(v_H - v_L) - \frac{1}{2}\hat{\varepsilon}(v_H - v_L) - \frac{1}{2}\Delta$, then there is no pure strategy BNE with a positive probability of trade. $c > \Delta$ implies $2c > 2\Delta$. Hence, there is no BNE where both traders acquire information. Suppose one trader acquires information. Because of the lemons problem and Assumption A this implies that the best response of the uninformed trader is to choose defensive bids. E.g., if the buyer is uninformed, the maximum he bids is $b = E[v|v_L] + \Delta$. An uninformed seller demands at least $s \geqslant E[v|v_H] - \Delta$. Trade occurs with probability 1/2. The expected payoff (surplus) of the informed traders is at most $\frac{1}{2}2\Delta$, which is smaller than the information cost. Therefore, there is no pure strategy BNE where one trader acquires information. The arguments above show that there is also no pure strategy BNE with trade if both traders are uninformed. For a characterization of a BNE in mixed strategies, see Dang (2009).
(e) If $c \leqslant \min\left[\Delta, \frac{1}{4}(v_H - v_L) - \frac{1}{2}\hat{\varepsilon}(v_H - v_L) - \frac{1}{2}\Delta\right]$, then there exist BNE where trade occurs with probability 1. In any such BNE both traders acquire information. To see this, suppose both traders acquire information. The following bid strategies constitute best responses: $E[v|v_L] + \Delta$ in state v_L, and $E[v|v_H] - \Delta$ in state v_H. In such a case, $EU^B = EU^S = \Delta - c$. The following arguments show that there exists no profitable unilateral deviation. Suppose the buyer does not acquire information. If he bids $E[v|v_H] - \Delta$, trade occurs in both states but $EU^B < 0$. Any bids between

$b \in (E[v|v_L] + \Delta, E[v|v_H] - \Delta)$ yield no trade in state v_H and trade at price $p > E[v|v_L] + \Delta$ in state v_L, which is strictly dominated by bidding $E[v|v_L] + \Delta$. This strategy yields $EU^B = 0$. An analogous argument shows that the seller also does not have profitable unilateral deviations. If $c = \Delta$, this strategy pair is the unique BNE where trade occurs with probability 1. If $c < \Delta$, then strategy pairs yielding trade at price $E[v|v_L] + \Delta - \delta$ at v_L and $E[v|v_H] - \Delta + \delta$ at v_H also constitute a BNE where δ depends on c. Dang (2009) characterizes the full set of (symmetric and asymmetric) equilibria.

Appendix B. Proof of Proposition 2

We are going to show that there exists an equal split BNE at the trading stage, where both traders purchase their information from the incumbent, given that ε is not too large. Each trader bases his offer on his own signal. In the BNE the opponent's offer does not convey new information, since both traders purchase the same signal. In an equal split BNE the asset's price reflects its fair value, given all information available. The proposed BNE offers are:

$$s_L = b_L = E[v|v_L] = v_L + \varepsilon(v_H - v_L)$$
$$s_H = b_H = E[v|v_H] = v_H - \varepsilon(v_H - v_L)$$

Given these offers, trade occurs with probability one and both traders realize the payoff $\Delta - c$.

We are now going to show for the seller that an unilateral deviation is not profitable.[26] If the seller purchases his signal from the incumbent, then he clearly has no incentive to deviate from the above offer strategy, since this would reduce the probability of trade or the price resulting from the auction. Step 1 below proves that any deviation of the seller to buy the entrant's signal instead is not profitable. Step 2 shows that not purchasing any signal cannot be profitable. Step 3 shows that purchasing two signals is also not a profitable deviation for the seller.

Step 1

Trader S acquires the entrant's signal z_E. Given that trader S acquires information from provider E, then he has the following three (potentially) profitable ask price strategies.

Deviation (1):

$$s = \begin{cases} b_L & \text{if } z_E = v_L \\ b_H & \text{if } z_E = v_H \end{cases}$$

The seller's ex ante (gross) expected payoff is

$$\begin{aligned} EU^S = \frac{1}{2}\Big\{&(1-\varepsilon)^2[E[v|v_L] - v_L + \Delta] + (1-\varepsilon)\varepsilon\left[\frac{1}{2}(E[v|v_L] + E[v|v_H]) - v_L + \Delta\right] \\ &+\varepsilon(1-\varepsilon)0 + \varepsilon^2[E[v|v_H] - v_L + \Delta]\Big\} + \frac{1}{2}\Big\{(1-\varepsilon)^2[E[v|v_H] - v_H + \Delta] + (1-\varepsilon)\varepsilon 0 \\ &+\varepsilon(1-\varepsilon)\left[\frac{1}{2}(E[v|v_L] + E[v|v_H]) - v_H + \Delta\right] + \varepsilon^2[E[v|v_L] - v_H + \Delta]\Big\} \end{aligned}$$

The first part of this equation (i.e., $\frac{1}{2}\{\cdot\}$) corresponds to the seller's expected utility conditional on the realization of state $v = v_L$ times the probability of this event. If $v = v_L$, then the traders' signals may both equal v_L (with conditional probability $(1-\varepsilon)^2$) or both differ (with conditional probability $\varepsilon(1-\varepsilon)$) or both be equal to v_H (with conditional probability ε^2). In the first case trade realizes at price $E[v|v_L]$ yielding the benefit $E[v|v_L] - v_L + \Delta$. If the seller obtains a low signal and the buyer a high signal then trade occurs at the price $\frac{1}{2}(E[v|v_L] + E[v|v_H])$ yielding the respective benefit. If the seller obtains a high

[26] The reasoning for the buyer is analogous.

signal but the buyer gets the low signal then no trade occurs. And in the final case where both signals suggest a low asset value trade occurs at price $E[v|v_H]$ and thus yields the benefit $E[v|v_H] - v_L + \Delta$. The second part of EU^S is interpreted similarly.

Substituting for $E[v|v_L]$ and $E[v|v_H]$ in EU^S yields:

$$EU^S = (1 - \varepsilon + \varepsilon^2)\Delta.$$

We will show below that this deviation does not pay.

Deviation (2):

$$s = \begin{cases} b_L & \text{if } z_E = v_L \\ > b_H & \text{if } z_E = v_H \end{cases}$$

The seller's ex ante (gross) expected payoff is

$$EU^S = \frac{1}{2}\left\{(1-\varepsilon)^2[E[v|v_L] - v_L + \Delta] + (1-\varepsilon)\varepsilon\left[\frac{1}{2}(E[v|v_L] + E[v|v_H]) - v_L + \Delta\right]\right\} + \frac{1}{2}\left\{\varepsilon(1-\varepsilon)\left[\frac{1}{2}(E[v|v_L] + E[v|v_H]) - v_H + \Delta\right] + \varepsilon^2[E[v|v_L] - v_H + \Delta]\right\},$$

which simplifies to

$$EU^S = \frac{1}{2}\varepsilon(1-2\varepsilon)(1-\varepsilon)(v_H - v_L) + \frac{1}{2}\Delta,$$

after substituting for $E[v|v_L]$ and $E[v|v_H]$. We will show below that this behavior is worse than deviation (1) if $\varepsilon < \frac{\Delta}{v_H - v_L}$.

Deviation (3):

$$s = \begin{cases} b_H & \text{if } z_E = v_L \\ > b_H & \text{if } z_E = v_H \end{cases}.$$

The seller's ex ante (gross) expected payoff is

$$EU^S = \frac{1}{2}\{(1-\varepsilon)\varepsilon[E[v|v_H] - v_L + \Delta]\} + \frac{1}{2}\{(1-\varepsilon)\varepsilon[E[v|v_H] - v_H + \Delta]\},$$

which simplifies to

$$EU^S = \frac{1}{2}(1-\varepsilon)\varepsilon(1-2\varepsilon)(v_H - v_L) + (1-\varepsilon)\varepsilon\Delta,$$

after substituting for $E[v|v_L]$ and $E[v|v_H]$.

Let us now rank the deviations according to their payoffs and then finally investigate whether deviating is profitable. Notice that $(1-\varepsilon)\varepsilon < \frac{1}{2}$ and thus the expected utility from deviation (3) is always lower than the payoff from deviation (2). Thus, deviation (3) is dominated.

Next we show that deviation (1) is better than deviation (2), given that ε is below the threshold in Proposition 2. Deviation (1) yields a higher payoff than deviation (2) if

$$(1 - \varepsilon + \varepsilon^2)\Delta \geqslant \frac{1}{2}\varepsilon(1-2\varepsilon)(1-\varepsilon)(v_H - v_L) + \frac{1}{2}\Delta$$
$$\iff \frac{\Delta}{v_H - v_L} \geqslant \frac{\varepsilon(1-2\varepsilon)(1-\varepsilon)}{1 - 2\varepsilon(1-\varepsilon)} \tag{3}$$

The next step is to observe that the right hand side of inequality (3) is smaller than one, i.e., $(1-\varepsilon)\varepsilon\frac{1-2\varepsilon}{1-2\varepsilon(1-\varepsilon)} \leqslant 1$. Thus, it must also hold that $\varepsilon\frac{(1-\varepsilon)\varepsilon(1-2\varepsilon)}{1-2\varepsilon(1-\varepsilon)} \leqslant \varepsilon$ and we get

$$\frac{\Delta}{v_H - v_L} > \varepsilon \geqslant \varepsilon \frac{(1-\varepsilon)\varepsilon(1-2\varepsilon)}{1-2\varepsilon(1-\varepsilon)}. \tag{4}$$

Thus, if the condition $\frac{\Delta}{v_H - v_L} > \varepsilon$ from Proposition 2 holds, then deviation (1) is better than deviation (2).

The final step is to show that deviation (1) is worse than equilibrium behavior. If the seller does not deviate he has the gross payoff Δ. Deviating therefore does not pay if

$$\Delta - c_I \geqslant (1-\varepsilon+\varepsilon^2)\Delta - c_E,$$

which simplifies to $c_E \geqslant c_I - (\varepsilon - \varepsilon^2)\Delta$.

Step 2 Trader S does not acquire information and remains uninformed. (i) If he chooses $s = b_H$, then $EU^S = \frac{1}{2}\Delta$. (ii) If he chooses $s = b_L$, then his expected payoff is given by

$$\begin{aligned} EU^S &= \frac{1}{2}\{E[v|v_L] - v_L + \Delta\} + \frac{1}{2}\left\{\frac{1}{2}(E[v|v_L] + E[v|v_H]) - v_H + \Delta\right\} \\ &= \frac{1}{2}\varepsilon(v_H - v_L) - \frac{1}{4}(v_H - v_L) + \Delta. \end{aligned}$$

Behavior (i) is not profitable since $c \leqslant \frac{1}{2}\Delta$. Behavior (ii) is not profitable if $\frac{1}{2}\varepsilon(v_H - v_L) - \frac{1}{4}(v_H - v_L) + c \leqslant 0$. Suppose $c = \frac{1}{2}\Delta$. Then $\frac{1}{2}\varepsilon(v_H - v_L) - \frac{1}{4}(v_H - v_L) + \frac{1}{2}\Delta \leqslant 0$ if $\varepsilon \leqslant \frac{1}{2} - \frac{\Delta}{v_H - v_L}$. This is true because $\frac{1}{2} - \frac{\Delta}{v_H - v_L} > \frac{\Delta}{v_H - v_L}$ due to Assumption A.

Step 3 Suppose trader S deviates from the equilibrium and purchases two signals. The buyer B in equilibrium purchases the signal from the incumbent and bids according to his equilibrium strategy. Trader S also acquires the incumbent's signal and thus can deduce B's bid. We first derive the seller's optimal bidding behavior and the resulting utility for all signal constellations given that he observes the signals z_I and z_E. Then we calculate the ex ante utility from purchasing both signals and show that not acquiring the entrant's signal is optimal if it is too expensive.

If $z_I = v_L$ and $z_E = v_L$, then S's best bid is $s = E[v|v_L]$: The fair price of the asset is $E[v|v_L, v_L]$ but the price at which the asset is exchanged is $E[v|v_L] > E[v|v_L, v_L]$. The seller's expected utility in this contingency is

$$EU^S(z_I = v_L, z_E = v_L) = E[v \mid v_L] - E[v|v_L, v_L] + \Delta.$$

If $z_I = v_L$ and $z_E = v_H$, then the fair value of the asset is $E[v|v_L, v_H] = E[v]$. We are now going to show that for $z_I = v_L$ and $z_E = v_H$ it is best for the seller to bid such that no trade occurs. Trade occurs if $s \leqslant E[v|v_L]$ and the best s for S conditional on inducing trade is $s = E[v|v_L]$. The seller's utility from this bid is $E[v|v_L] - E[v] + \Delta$. The seller's expected utility from bidding $s > E[v|v_L]$ and thus not trading is 0. Trading is optimal if the trading gain is sufficiently large, i.e., $\Delta \geqslant E[v] - E[v|v_L]$. Note that $E[v|v_L] = v_L + \varepsilon(v_H - v_L)$ increases in ε. Hence, as the signal becomes more precise $E[v|v_L]$ decreases. Another condition that has to be satisfied according to the proposition is that $\varepsilon \leqslant \frac{\Delta}{v_H - v_L}$. Trade takes place for some of these ε if it takes place for $\varepsilon = \frac{\Delta}{v_H - v_L}$. Plugging $\varepsilon = \frac{\Delta}{v_H - v_L}$ and $E[v] = \frac{1}{2}(v_H + v_L)$ and $E[v|v_L] = v_L + \varepsilon(v_H - v_L)$ into $\Delta \geqslant E[v] - E[v|v_L]$ yields

$$\begin{aligned} &\Delta \geqslant E[v] - E[v|v_L] = \frac{1}{2}(v_H + v_L) - \left(v_L + \frac{\Delta}{v_H - v_L}(v_H - v_L)\right) \\ &\iff \Delta \geqslant \frac{1}{4}v_H - \frac{1}{4}v_L. \end{aligned}$$

According to Assumption A it must be that $\Delta \leqslant \frac{1}{8}(v_H - v_L)$. Hence, it cannot be that trade takes place if $z_I = v_L$ and $z_E = v_H$. In this contingency it must be that

$$EU^S(z_I = v_L, z_E = v_H) = 0.$$

If $z_I = v_H$ and $z_E = v_L$, then it can easily be seen the S's best bid is $s = E[v|v_H]$: The fair price of the asset is $E[v|v_L, v_H] = E[v]$ but the price at which the asset is exchanged is $E[v|v_H] > E[v]$. The seller's expected utility in this contingency is

$$EU^S(z_I = v_H, z_E = v_L) = E[v|v_H] - E[v] + \Delta = v_H - \varepsilon(v_H - v_L) - \frac{1}{2}(v_H + v_L) + \Delta.$$

If $z_I = v_H$ and $z_E = v_H$, then the fair value of the asset is $E[v|v_H, v_H]$. If the trading gain is sufficiently large, then bidding $s = E[v|v_H]$ and thereby inducing trade is optimal. The expected utility from inducing trade must hence be greater than zero, which boils down to $E[v|v_H] - E[v|v_H, v_H] + \Delta > 0$, i.e., $v_H - \varepsilon(v_H - v_L) - E[v|v_H, v_H] + \Delta > 0$. Note that $E[v|v_H, v_H] = E[v|v_H]$ for $\varepsilon = 0$ and $\varepsilon = 1/2$ and both expected values monotonically decrease in ε. According to the proposition it must be that $\varepsilon \leqslant \frac{\Delta}{v_H - v_L}$ and according to Assumption A it must be that $\Delta \leqslant \frac{1}{8}(v_H - v_L)$. Thus, $\varepsilon \leqslant 1/8$. For $\varepsilon \leqslant 1/8$, the difference between $E[v|v_H, v_H]$ and $E[v|v_H]$ decreases if the precision of the information increases, i.e., the smaller ε. The utility from trade is therefore greater for all $\varepsilon \leqslant \frac{\Delta}{v_H - v_L}$ if the utility from trade is greater for $\varepsilon = \frac{\Delta}{v_H - v_L}$. Thus, $v_H - \frac{\Delta}{v_H - v_L}(v_H - v_L) - E[v|v_H, v_H] + \Delta > 0 \iff v_H - E[v|v_H, v_H] > 0$, which clearly is true. The seller's expected utility in this contingency is

$$EU^S(z_I = v_H, z_E = v_H) = E[v|v_H] - E[v|v_H, v_H] + \Delta.$$

Let us next calculate the seller's ex ante utility from purchasing both signals and show that deviating from the equilibrium does not pay if the entrant's price is too high. The seller's ex ante utility from acquiring both signals is

$$\begin{aligned} EU^S &= prob(z_I = v_L,\ z_E = v_L)EU^S(z_I = v_L,\ z_E = v_L) + prob(z_I = v_L,\ z_E = v_H)EU^S(z_I = v_L,\ z_E \\ &= v_H) + prob(z_I = v_H,\ z_E = v_L)EU^S(z_I = v_H,\ z_E = v_L) + prob(z_I = v_H,\ z_E = v_H)EU^S(z_I \\ &= v_H,\ z_E = v_H) - c_E - c_{I.} \end{aligned}$$

Note that $prob(z_I = v_L, z_E = v_L) = prob(z_I = v_H, z_E = v_H)$ and $EU^S(z_I = v_L, z_E = v_H) = 0$, hence

$$\begin{aligned} EU^S &= -c_E - c_I + prob(z_I = v_L,\ z_E = v_L)(E[v \mid v_L] - E[v \mid v_L,\ v_L] + E[v \mid v_H] - E[v \\ &\quad \mid v_H, v_H] + 2\Delta) + prob(z_I = v_H, z_E = v_L)(E[v \mid v_H] - E[v] + \Delta) \end{aligned}$$

Note further that $E[v|v_L] - E[v|v_L, v_L] = -(E[v|v_H] - E[v|v_H, v_H])$, hence

$$EU^S = -c_E - c_I + prob(z_I = v_L, z_E = v_L)2\Delta + prob(z_I = v_H, z_E = v_L)(E[v|v_H] - E[v] + \Delta).$$

The seller's ex ante utility from acquiring exclusively the incumbent's signal is

$$EU^S = \Delta - c_I.$$

The seller's utility from exclusively acquiring the incumbent's signal is greater if

$$\begin{aligned} &\Delta - c_I \geqslant -c_E - c_I + prob(z_I = v_L, z_E = v_L)2\Delta + prob(z_I = v_H, z_E = v_L)(E[v|v_H] - E[v] + \Delta) \\ &c_E \geqslant 2prob(z_I = v_L, z_E = v_L)\Delta + prob(z_I = v_H, z_E = v_L)(E[v|v_H] - E[v] + \Delta) - \Delta \\ &c_E \geqslant 2(\varepsilon^2 - \varepsilon + \frac{1}{2})\Delta + (\varepsilon - \varepsilon^2)(v_H - \varepsilon(v_H - v_L) - \frac{1}{2}(v_H + v_L) + \Delta) - \Delta \\ &c_E \geqslant \varepsilon\left(\left(\frac{1}{2} - \frac{3}{2}\varepsilon + \varepsilon^2\right)(v_H - v_L) - \Delta(1 - \varepsilon)\right). \end{aligned}$$

Finally, it can easily be checked that there are parameter constellations such that there is a $c_E < c_I$, such that no deviation is profitable, e.g., for $c_I = \frac{1}{2}\Delta$ and $\varepsilon = \frac{1}{2}\frac{\Delta}{v_H - v_L}$ and $\Delta = \frac{1}{16}(v_H - v_L)$, where the first two equation satisfy the conditions in the proposition and the last equation satisfies Assumption A. □

References

Admati, A.R., Pfleiderer, P., 1986. A monopolistic market for information. J. Econ. Theory 39 (2), 400–438.
Admati, A.R., Pfleiderer, P., 1988. Selling and trading on information in financial markets. Amer. Econ. Rev. 78 (2), 96–103.

Admati, A.R., Pfleiderer, P., 1990. Direct and indirect sale of information. Econometrica 58 (4), 901–928.
Biglaiser, G., 1993. Middlemen as experts. RAND J. Econ. 24 (2), 212–223.
Caillaud, B., Jullien, B., 2003. Chicken & egg: competition among intermediation service providers. RAND J. Econ. 34 (2), 309–328.
Dang, T.V., 2009. Information Acquisition, Noise Trading and Speculation in Double Auction Markets. Working Paper, University of Mannheim.
Dang, T.V., Gorton, G.B., Holmström, B., 2011a. Ignorance and the Optimality of Debt. Working Paper, Yale University.
Dang, T.V., Gorton, G.B., Holmström, B., 2011b. Information Acquisition Sensitivity. Working Paper, Yale University.
Duffie, D., Garleanu, N., Pedersen, L., 2005. Over-the-counter markets. Econometrica 73 (6), 1815–1847.
Economides, N., Siow, A., 1988. The division of markets is limited by the extent of liquidity (spatial competition with externalities). Amer. Econ. Rev. 78, 108–121.
Grossmann, S.J., Stiglitz, J.E., 1980. On the impossibility of informationally efficient markets. Amer. Econ. Rev. 70 (3), 393–408.
Kessler, A.S., 1998. The value of ignorance. RAND J. Econ. 29 (2), 339–354.
Kyle, A.S., 1985. Continuous auctions and insider trading. Econometrica 53 (6), 1315–1335.
Kyle, A.S., 1989. Informed speculation with imperfect competition. Rev. Econ. Stud. 56 (3), 317–355.
Levin, J., 2001. Information and the market for lemons. RAND J. Econ. 32 (4), 657–666.
Lizzeri, A., 1999. Information revelation and certification intermediaries. RAND J. Econ. 30 (2), 214–231.
Myerson, R.B., Satterthwaite, M.A., 1983. Efficient mechanisms for bilateral trading. J. Econ. Theory 29 (2), 265–281.
Securities Industry and Financial Markets Association (SIFMA), Research Quarterly, May 2008.
U.S. Securities and Exchange Commission (SEC), Report on the Role and Function of Credit Rating Agencies in the Operation of the Securities Markets, January 2003.
Veldkamp, L., 2006b. Media frenzies in markets for financial information. Amer. Econ. Rev. 96 (3), 577–601.