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COMPETITION IN QUALITY STANDARDS*

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In this paper, I model certifers' choices of quality standards under various market and ownership structures. I consider an economic environment where adverse selection is so severe that no trade occurs in the absence of certification. Certification facilitates trade by alleviating information asymmetry; but a monopoly certifier sets an excessively high standard. Competition generally leads to a more efficient outcome, in the sense that a lower, closer to optimal, standard is set by an entrant, but two-tier markets do not always improve social welfare. The implications of the model are discussed in the context of stock exchanges.

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Certification exists in a variety of markets: laboratories assign grades to industrial goods; companies and associations offer certification tests to engineers; academic journals accept papers of certain quality; stock exchanges list firms that meet their requirements. In all these examples, sellers know more about the product quality than buyers, and certification facilitates trades by alleviating information asymmetry.

A defining feature of certification is the use of a minimum standard policy: a product is certified only if its quality is above some certain standard that is set and published by the certifier. The choice of a quality standard plays a central role in certification because it determines the value of certification and influences the volume of trades. It may therefore be worthwhile to examine whether the quality standard chosen by a private certifier is socially optimal, and, if not, whether competition between certifiers can improve the outcome. A related question is how the ownership structure of competing certifiers affects the market outcome. To address and answer these questions, I develop a simple model of certification in this paper.

I find that a minimum standard policy in certification can improve social welfare, but the quality standard chosen by a monopoly certifier is in general more restrictive than the social optimal. Competition between duopoly certifiers may result in two-tier markets, whose existence increases the volume of trades. However, two-tier markets are not always welfare improving. Inefficient entry may occur, especially under independent ownership.

My model builds on an insightful paper by Lizzeri (1999), who discusses the optimal disclosure rule of information intermediaries.[1] He finds that the minimum standard policy is optimal for a monopoly intermediary and that the monopoly standard coincides with the social optimal when sellers have identical opportunity costs. My model differs from his in two key aspects: first, I limit my attention to the minimum standard policy; second, I assume that sellers have increasing opportunity costs.[2] The focus on the minimum standard policy is motivated by its simplicity and its prevalence in certification markets, although it is not necessarily the optimal disclosure rule.[3] At the same time, the assumption of increasing opportunity costs allows me to study certification

[1] It should be noted that disclosure discussed in Lizzeri (1999) and this paper refers to the revelation of information by an information intermediary, not by a public firm in the context of corporate governance.

[2] Please see Section i. for a more detailed discussion.

[3] As shown by Lizzeri (1999) through examples, when sellers have different opportunity costs or when there are competing information intermediaries, an information intermediary may adopt disclosure rules that differ from the minimum standard policy.

in markets with adverse selection; in particular, I consider an economic environment where adverse selection is so severe that no trade occurs in the absence of certification.

The organization of the paper is as follows: Section 2 reviews literature. In Section 3, I present the model and discuss assumptions. Section 4 considers the monopoly case. Section 5 analyzes duopolistic interactions between certifiers under different ownership structures. Section 6 discusses the implications of the model in the case of stock exchanges. Section 7 concludes. Any formal proofs omitted from the main text are contained in the appendix.

I. Literature Review

Several papers extend Lizzeri's model. Guerra (2001) finds that a disclosure of ordered ranks (say A, B, C) instead of the minimum standard policy is optimal if buyers have a noisy estimate of product quality in the absence of quality certificate. By endogenizing sellers' quality choices, Albano and Lizzeri (2001) study quality provision in the presence of a certification intermediary. Hvide and Heifetz (2001) consider a free-entry model of certification, allowing each certifier to choose certification standards and certification fee. Similar to my model, they find that certifiers differentiate their grading criteria and that the certification fee increases with the stringency of grading criterion. However, like Lizzeri (1999), they assume that different quality sellers have identical opportunity costs, so the welfare implication of their model is different than mine.

The result of my monopoly model is quite similar to Leland (1979), who finds that a self-regulating profession chooses a higher standard than the social optimal. However, his result relies upon the assumption of a downward sloping demand curve for certified goods. Under this assumption, eliminating sellers of low quality not only raises the average quality but also pushes up the equilibrium price through reduced supply. In my model, the second effect is absent. Thus my model shows that inefficiency may arise even under weaker conditions if there is a monopoly in third-party certification.[4] At the same time, my assumption of a horizontal demand curve for certified goods is arguably more relevant in the context of stock markets.

There is an emerging literature on the competition between stock exchanges. Huddart, Hughes and Brunnermeier (1999) discuss the role of disclosure requirements for firms in the context of

[4] In fact, if a self-regulating profession existed in my model, it would choose the same standard as a social planner.

liquidity traders trading against rent-seeking corporate insiders. In Foucault and Parlour (2004), exchanges differentiate between each other by adopting different trading technologies. Santos and Scheinkman (2001) develop a model of competition among exchanges in which exchanges design margin requirements in order to attract trading volume and maximize profits. Their model deals with pure financial contracts, not firms' listing choices. Macey and O'Hara (2002) weigh the economic costs and benefits of listing fees and listing requirements from a stock exchange's perspective, but they provide no formal analysis. Most closely related to my study is a paper by Chemmanur and Fulghieri (2006), who also study the certification effect of listing standards. Whereas the listing standard in my model is a set of publicly known criteria, the listing standard in theirs refers to the rigor of an exchange enforcing its rules and is unknown to investors. Because of this difference, the two models reach opposite conclusions on whether the listing standard of a profit-maximizing exchange is too high or too low.

II. Model

As in Lizzeri (1999), there are four agents in the economy: one informed seller, two uninformed buyers, and an exchange.[5] The seller owns a product, worth q to a buyer. The product quality q is exogenously given and cannot be altered. Buyers have a prior on the value of q represented by distribution $F(q)$, strictly increasing with continuous density on the closed interval $[a, b]$. The seller knows the exact value of q and has a reservation value of $c(q)$, increasing and convex on $[a, b]$. I assume that there exists $q \in [a, b]$ such that $c(q) < q$ and that $c(a) > a$. This implies that some but not all trades, if allowed, are efficient. The exchange can test the product quality at no cost.[6] It adopts a minimum standard policy, that is to reveal nothing but whether a seller's quality is above or below a preset standard q^l through its listing decision. This structure is common knowledge to all participants in the market.

The game has 6 stages.

Stage 1. The exchange sets q^l and a listing fee p to maximize its expected profits.

[5] To facilitate my later discussion of the model in the context of stock markets, I use "exchange" to refer to certifiers and use "listing" to refer to certification. Thus, getting listed on an exchange should be understood the same as getting certified by a certifier.

[6] As long as an exchange can learn a seller's quality with lower cost than buyers (or superior technology in identifying sellers), my results will not change qualitatively.

Stage 2. Nature chooses the type of seller, q, according to the distribution F.

Stage 3. Having observed p, q^l and q, the seller decides whether to apply for listing. If there is a tie, then the seller chooses to list.

Stage 4. If the seller applies for listing, the exchange lists the product as long as $q \geq q^l$.

Stage 5. If the product is not listed, the seller gets $c(q)$ and the game ends; if the product is listed, buyers bid independently and simultaneously after observing q^l and p.

Stage 6. All transactions clear: the winning buyer pays her bid B to the seller and the seller pays p to the exchange.

A strategy for the exchange is a pair (p, q^l), i.e., a listing fee and a quality standard. As in Lizzeri (1999), I assume that the listing fee cannot be conditioned upon the product quality. This assumption is partially relaxed in Section ii., where I consider two-tier markets. A behavioral strategy for the seller is a function ρ from $\mathbb{R}_+ \times \mathbb{R} \times [a, b]$ into $\{0, 1\}$ that maps the triplet (p, q^l, q) into the listing choice as a function of type, listing fee and quality standard. A strategy for a buyer is a function β from $\mathbb{R}_+ \times \mathbb{R}$ into $\mathbb{R}_+$ that maps (p, q^l) into bids for a listed product. As in Lizzeri, the equilibrium notion I use is sequential equilibrium.

i. Opportunity Cost

The main departure of my model from Lizzeri (1999) is the assumption of increasing opportunity costs.[7] Depending on the particular market we study and the alternatives available to sellers, the opportunity cost can be interpreted in a number of ways. It can be the production cost, the reservation wage, or a seller's profit after undertaking some costly activities to signal her product quality (e.g., free trials). In the context of stock markets, the opportunity cost may be the payoff of a firm that stays private and uses internal finance or short-term bank loans.

Because of increasing opportunity costs, there is an adverse selection problem in the markets I study. It is well known that severe adverse selection can lead to market breakdown (Akerlof 1970). Such a market failure is more likely to occur either when there is a large proportion of low quality sellers or when buyers' and sellers' valuations of a product are close. In these markets, certification

[7] In Lizzeri (1999), he also considers a special case of increasing opportunity costs, in which $q - c(q)$ is a constant, but his objective is to characterize the optimal disclosure rule, which is found to be different from the minimum standard policy. Note that in this special case, all trades are equally efficient therefore there may be indeterminacy in the monopoly standard under certain conditions (e.g., when F is uniform).

can play a crucial role. Therefore, I focus on such markets and assume that no trade takes place without certification. However, making this assumption is not without loss of generality. When adverse selection is not too severe, markets may remain open and a seller has the option of selling her product without getting certified. Whether my result extends to those markets remains an open question.

III. A Monopoly Exchange

Before comparing a monopoly exchange's quality standard with the social optimal, a distinction must be made between the first-best quality standard and the second-best. In my model, the first-best standard is defined as the lowest quality that can be traded under perfect information, whereas the second-best is the quality standard chosen by a social planner under a minimum standard policy. While the two standards coincide in the special case discussed by Lizzeri (1999), they are in general not the same.

i. Comparison with The First-Best

To achieve the first-best, a social planner can disclose all sellers' quality information to buyers and trades take place for all $q \geq c(q)$. Lizzeri shows that the same outcome can be achieved under a monopoly exchange's minimum standard policy. In his model, sellers' opportunity costs are identical, $c(q) = c$, so they have the same willingness to pay for listing. The monopolist thus faces a flat demand curve for its certification service. This means that it can capture the entire social surplus thereby internalizing the effect of minimum standard on the volume of efficient trades. Therefore, setting the minimum standard at c maximizes its profit as well as total surplus.

However, if sellers have different opportunity costs, then the monopolist will face a downward-sloping demand curve, causing it to supply less than the social optimal. Let q_M^l denote the quality standard chosen by a monopoly exchange and let q^f denote the first-best standard.

Proposition 1 $q_M^l \geq q^f$, *the inequality holds if* $c(q)$ *is strictly increasing.*

I first prove the following lemma, which states that potential customers of the exchange are a continuum of sellers. Let $\{q_M\}$ denote the set of sellers listed on the monopoly exchange.

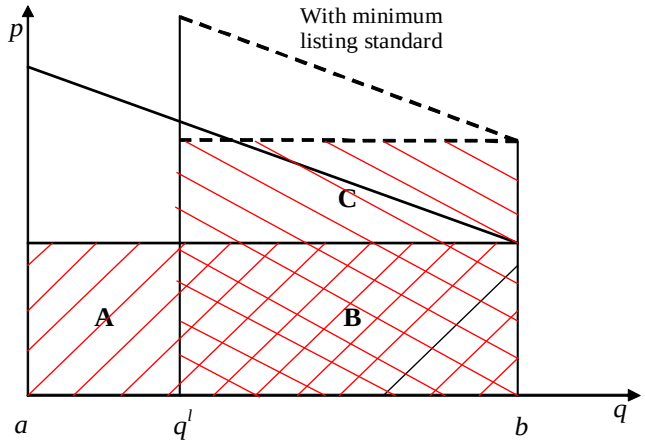

Figure 1: Minimum Listing Standard Shifts Up the Demand Curve

Lemma 1 *$\{q_M\}$ is connected, i.e., $\{q_M\} = [q_M^l, q_M^h]$, where $q_M^l = \min\{q_M\}$ and $q_M^h = \max\{q_M\}$.*

Proof of Proposition 1. Since sellers have increasing opportunity costs, a higher quality seller has a lower willingness to pay for listing. This means that the marginal customer is the highest quality seller listed on the exchange, and it is her willingness to pay that determines the listing fee. Thus $p = E(q|q_M^l \leq q \leq q_M^h) - c(q_M^h) = \frac{\int_{q_M^l}^{q_M^h} qf(q)dq}{F(q_M^h)-F(q_M^l)} - c(q_M^h)$. The exchange's problem is

$$\max_{q_M^l, q_M^h} \int_{q_M^l}^{q_M^h} qf(q)dq - \{c(q_M^h)[F(q_M^h) - F(q_M^l)]\} \tag{1}$$

Differentiating it with respect to q_M^l, we get $-q_M^l f(q_M^l) + f(q_M^l)c(q_M^h) = 0$. Hence $q_M^l = c(q_M^h) \geq c(q_M^l)$. The social surplus is $W = \int_{q_M^l}^{\overline{q}} [q - c(q)]f(q)dq$, where $\overline{q}$ is either b or the highest q that satisfies $q = c(q)$. By definition, W is single-peaked at q^f. Since $\frac{dW}{dq_M^l} = [c(q_M^l) - q_M^l]f(q_M^l) \leq 0$, we have $q_M^l \geq q^f$. The strict inequality holds if $c(q)$ is strictly increasing. ■

In Figure 1, the downward sloping solid (respectively, dashed) line is the demand curve for certification when the minimum standard is a (respectively, q^l). Demand for certification is downward sloping because sellers have different opportunity costs. We can see that excluding low quality sellers increases the average quality of listed products and shifts up the demand curve. The exchange's profit increases from $A + B$ to $B + C$, but it may result in a higher than optimal quality standard, which prevents some valuable trades from taking place.

ii. Comparison with The Second-best

The first-best outcome can only be achieved under a full disclosure policy. If a social planner has to use a minimum standard policy, then the standard may differ from the first-best. One way to strengthen my result is to show that a monopoly exchange's quality standard is also higher than the standard set by a social planner. To do this, I impose some restrictions on the cost function.

Denote by q_M^l the quality standard chosen by a monopoly, q_o^l the second-best quality standard chosen by a social planner.

Proposition 2 *If $q \sim U[a,b]$ and $c'(b) \leq 1$, then $q_M^h = q_o^h = b$ and $q_M^l \geq q_o^l$ (the inequality holds if $c(q)$ is strictly increasing).*

The condition $c'(b) \leq 1$ implies that $q - c(q)$ increases with q. Therefore, as long as the gain from trade increases with quality, a monopoly exchange will set a more restrictive quality standard than a social planner.

Example 1 *In the classic Akerlof (1970) model, $c(q) = dq$, where $q \sim U[0,1]$. When $d > 0.5$, no trade takes place. Thus certification improves social welfare. The first-best quality standard is 0, the second-best is $2d-1$ and the monopoly standard is d. Clearly, $0 < 2d-1 < d$. The exchange's profit is $\frac{(1-d)^2}{2}$. We can see that an exchange's quality standard increases with d whereas its profit decreases with d. In the context of stock markets, d can be seen as a measure of the cost of alternative financing (e.g., bank loan or internal finance): the higher d, the lower cost. This means that if firms have easier access to bank loans, then an exchange's quality standard increases but its profit decreases.*

iii. No-Disclosure

Given that the monopoly exchange has perfect information about a seller's type, a question naturally arises: can the monopolist earn more information rents by following a policy of full disclosure, under which it reveals a seller's exact type q upon receiving a listing fee? Surprisingly, Lizzeri (1999) finds that the answer is no. The key insight is that sellers differ in their willingness to pay (for a listing) if their types are revealed. This hinders the monopolist's ability to extract sellers' surplus. No-disclosure increases its profit by flattening the demand curve. In my model, Lizzeri's

insight still has its force: if the differences in sellers' opportunity costs are not too big (so that the demand curve under a minimum standard policy is sufficiently flat), then the exchange prefers the minimum standard policy to full disclosure. Since it is not the focus of my paper, I use an example to illustrate the point.

Example 2 *I continue with the above linear cost example. With full disclosure, the listing fee is* $(1-d)q^l$*, the exchange's profit is* $\frac{(1-d)}{4}b^2$ *and sellers with qualities below* $\frac{b}{2}$ *are excluded; with a minimum standard, its profit is* $\frac{(1-d)^2}{2}b^2$ *and sellers with qualities below* db *are excluded. When* $d < \frac{1}{2}$*, the exchange lists more sellers and earns higher profits under the minimum standard policy.*

Interestingly, compared to full disclosure, the minimum standard policy benefits the society as well as the monopoly exchange. In fact, a requirement of full disclosure by the exchange may lead to a higher degree of exclusion and lower welfare. Let q_d^l (respectively, q_d^h) denote the lowest (respectively, highest) quality seller listed under a full disclosure policy.

Proposition 3 *If* $q \sim U[a,b]$ *and* $c'(b) < \frac{1}{2}$*, then* $q_d^h = q_M^h = b$ *and* $q_d^l > q_M^l$*.*

This result rings alarm bells over some intervention policies that aim to solve the information problem by requiring a high level of disclosure. While greater information transmission is often desirable, it cannot eliminate distortions arising from market structure imperfections, but only make them more transparent.

IV. Two-Tier Markets

In this section, I consider duopoly exchanges' choices of quality standards under two ownership structures. Under independent ownership, exchanges operate independently and compete for listings; under common ownership, exchanges maximize their joint profits. I show that, in both cases, duopoly exchanges set differentiated standards thus forming a two-tier market, with a lower, closer to optimal, standard being set by a new entrant. The availability of a second-tier market increases the volume of trades, but the private gain exceeds the social gain. Therefore, two-tier markets may, but do not always, improve social welfare.

For tractability, I concentrate on the linear cost case, i.e., $c(q) = dq$, $d \in (0.5, 1)$, and assume that sellers' types are uniformly distributed on $[0, 1]$.

i. Independent Ownership

To examine whether competition improves welfare, I consider a model in which two exchanges set their quality standards sequentially then compete in listing fees. More specifically, the order of moves is as follows:

Stage 1. Exchange I (the incumbent) sets a quality standard first; exchange E (the entrant) sets a quality standard second;

Stage 2. Exchange I sets a listing fee first; exchange E sets a listing fee second.

The rest of the game is the same as the one in the monopoly exchange case. The assumption that exchanges set quality standards before competing in fees is to capture the observation that the latter is easier to change than the former. The assumption that exchanges set listing fees sequentially is somewhat artificial. I make this assumption because a pure strategy equilibrium does not exist in a simultaneous pricing game. While a mixed strategy equilibrium always exists, it seems unrealistic that exchanges randomize their listing fees.

A segmentation result analogous to Lemma 1 is readily obtained. Let $\{q_x\}$ be the set of sellers listed on exchange X, $q_x^h = \max\{q_x\}$ and $q_x^l = \min\{q_x\}$, where $X = I, E$.

Lemma 2 $\{q_x\} = [q_x^l, q_x^h]$.

Denote by q_I the quality standard set by the incumbent, q_E by the entrant, $q^H = \max(q_I, q_E)$ the higher of the two exchanges' quality standards and q^L the lower one. In all of the following, I construct equilibria that involve all sellers with $q \geq q^H$ listings on the higher standard exchange, all sellers with $q \in [q^L, q^H)$ listing on the lower standard exchange and all sellers listing on the incumbent if $q^H = q^L$. Any sellers seeking listing on the lower standard exchange while meeting the high standard are off the equilibrium path. Buyers' beliefs are uniquely determined by Bayes' rule, causing offers of $E(q|q \geq q^H)$ if the seller gets listed on the higher standard exchange and offers of $E(q|q^L \leq q < q^H)$ if the seller gets listed on the lower one. These beliefs are consistent with sellers' choices.

I first solve for the entrant's equilibrium strategies. Given a quality standard set by the incumbent, the entrant can choose either a higher standard or a lower standard. Following Shaked and Sutton (1982), I define q_E^a as the entrant's "optimal reply from above" if q_E^a is the quality standard within $[q_I, 1]$ that maximizes the entrant's profit, i.e., $q_E^a(q_I) = \{q_E|\pi_E(q_I, q_E) = \max \pi_E(q_I, q); q \geq$

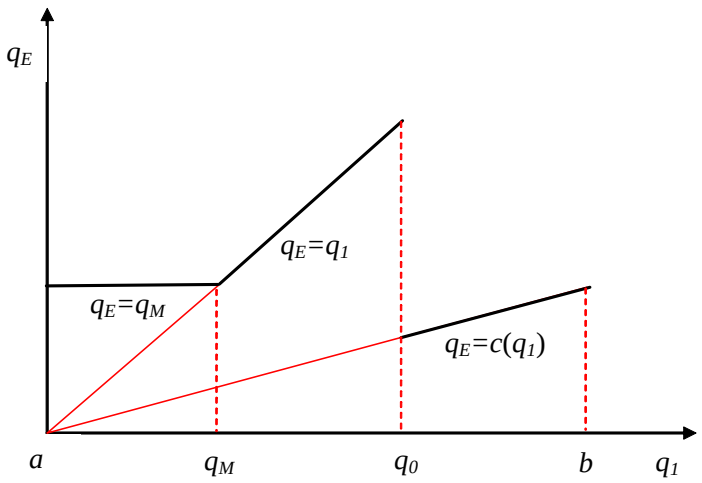

Figure 2: The Entrant Exchange's Best Response in Listing Standard.

$q_I\}$, where $\pi_E(q_I, q_E)$ is the entrant's profit. Similarly, I define the entrant's "optimal reply from below" as $q_E^b(q_I) = \{q_E | \pi_E(q_I, q_E) = \max \pi_E(q_I, q); q < q_I\}$.

Lemma 3 *$\forall q_I \in [0,1]$, $q_E^a(q_I) = \max(q_M^l, q_I)$ and $q_E^b(q_I) = dq_I$, where q_M^l is the quality standard set by a monopoly exchange.*

According to Lemma 3, the best response of the entrant involves either setting the quality standard a hair above the incumbent's to capture all high quality sellers (if the incumbent's standard is below the monopoly standard) or setting a low standard to specialize in low quality sellers, as shown in Figure 2.

Proposition 4 *For duopoly exchanges under independent ownership, the incumbent sets the quality standard at $q_I = \frac{d+\sqrt{2}\sqrt{(1-d)^3}}{1+(1-d)^2}$ and lists all sellers of qualities above q_I; the entrant sets the standard at dq_I and lists all sellers of qualities between dq_I and q_I.*

According to Proposition 4, competition between the two exchanges leads to the establishment of two-tier markets, with the incumbent listing high quality sellers and the entrant low quality ones. It should be noted that, in this model, the entrant chooses to position itself in the "low-end" market even in the absence of reputational mechanisms. In fact, the entrant enjoys a second-mover advantage. If the incumbent lowers its quality standard to attract more sellers, then the entrant may set a quality standard just above the incumbent's and capture all eligible sellers. To prevent

the entrant from "over-cutting" its standard, the incumbent has to restrict itself in serving only the highest quality sellers and give up the "low-end" market to the entrant.

A standard result in the literature is that, when competitors sell identical products or services, profits may be driven down to zero. In fact, in the oligoply model considered in Lizzeri (1999), there is a set of equilibria in which at least two intermediaries set a fee equal to zero and fully disclose quality to buyers. Interestingly, such an intense competition will never be an equilibrium if intermediaries use a minimum standard policy. The reason can be easily seen from the above linear cost case. First, no exchange will set a minimum standard at 0 since no trade will take place on such an exchange. Hence all exchanges will set positive minimum standards, but this means that an exchange can always guarantee itself a positive profit by catering to unlisted sellers. In other words, exchanges tend to differentiate in quality standards thereby relaxing competition.

a. Excessive Entry

Corollary 1 *The entrant obtains a profit of* $\pi_E = \frac{1}{2}(1-d)^2 q_I^2$, *greater than the social gain from the volume increase of trades* $\Delta S = \frac{1}{2}(1-q_I^2)d^2(1-d)$.

According to this result, the private benefit from entry exceeds the social gain. This implies that inefficient entry may occur and competition does not necessarily improve social welfare. In fact, if an exchange must incur a fixed set-up cost F upon entry, then there will be inefficient entry when $\Delta S < F \leq \pi_E$. This is the familiar entry bias resulting from the business stealing effect: a second-tier market steals business from the incumbent exchange, and this can potentially lead to excessive entry from a social standpoint (Mankiw and Whinston 1986).

ii. Common Ownership

A monopoly exchange may also have an incentive to set up two-tier markets in order to accommodate more sellers.

Proposition 5 *For duopoly exchanges under common ownership, the top-tier market sets the quality standard at* $q_1 = \frac{1}{2-d}$ *and lists all sellers of quality above* q_1; *the second-tier market sets the standard at* dq_1 *and lists all sellers of quality between* dq_1 *and* q_1.

Now I compare the two ownership structures.

Corollary 2 *(i) The standards of a second-tier market under both ownership structures are lower than the monopoly standard but higher than the social optimal; (ii) Both the standard and the profit of the second-tier market are lower under common ownership than those under independent ownership (even though the joint profits of the two-tier markets are higher under common ownership); (iii) if* $F \in (\frac{(1-d)^2}{2}\frac{d}{2-d}, \frac{(1-d)^2}{2}(q_I)^2]$, *where* $q_I = \frac{d+\sqrt{2}\sqrt{(1-d)^3}}{1+(1-d)^2}$, *then a second-tier market will be established only under independent ownership.*

On one hand, two-tier markets operated by the same exchange, by setting lower standards, accommodate a greater volume of trades than two-tier markets do under independent ownership. On the other hand, its second-tier market is less profitable than its counterpart under independent ownership. Moreover, the exchange has to shift the top-tier market's quality standard away from the monopoly standard, further reducing the benefit of developing a second-tier market.[8] This means that an existing exchange has a much weaker incentive to invest in a second-tier market than a new one, even though two-tier markets under common ownership appear to be more efficient.

V. Implications, Limitations, and Extensions

i. Implications

The stock market provides a potentially useful setting to test my model. First, stock markets are characterized by information asymmetry, with stock exchanges traditionally providing a valuable service of certification (Macey and O'Hara, 2002); second, even today the choice of a firm that seeks listing is still largely confined to a couple of domestic exchanges, despite the rapid development of international capital markets.[9] These features match the assumptions of my model.

It may be helpful, however, to clarify first what I mean by the quality of a firm and the listing standard of an exchange. I refer to factors that determine a firm's valuation as quality. A firm's value depends on many things, such as earnings growth, risk, liquidity, etc. To collapse everything into a single variable and call it quality is a gross yet necessary simplification. To use one variable, "listing standard," to represent a set of listing requirements including firm size, earnings history

[8] In my model, developing a second-tier market does not have a strategic entry deterrence effect, since a profitable entry can always be made by simply replicating an existing exchange's standard. Admittedly, this is an unsatisfactory feature of the model.

[9] Investors' home bias may have played a role in this regard.

and number of shares (or shareholders) is another simplification. I justify these simplifications by observing that firms that meet more stringent listing requirements tend to be traded at a premium: strict disclosure rules and other regulations may lead to good corporate governance; a history of positive earning may be a signal of continuing growth and low risk. Besides the published criteria, an exchange such as the New York Stock Exchange (NYSE) also weighs a firm's position and stability in the industry. Thus, "Listed on the NYSE" often conveys a positive image for a firm. My assumption that a high listing standard signals a high quality of listed firms serves to capture these observations.

My model of certification yields a number of direct implications: (1) exchanges use both listing fees and listing standards to screen firms; (2) a monopoly exchange sets an excessively high listing standard; (3) a new exchange adopts a lower listing standard to distinguish itself from the incumbent; (4) an exchange under independent ownership, as opposed to common ownership, has a stronger incentive to invest in a second-tier market.

How well do these predictions hold up? A salient feature of all major stock exchanges is the existence of listing standards. Most national exchanges not only charge a hefty listing fee[10] that may discourage start-up firms, but also prohibit such listings through stringent requirements, even though some firms may actually be willing to pay the fee to get listed. For example, the NYSE stipulates that, to be eligible for listing, a company must have net income in the current fiscal year of at least $2.5 million before federal income tax and $2 million in each of the preceding two years.

At the same time, there are considerable variations in listing standards across stock exchanges. Compared to the NYSE, the NASDAQ market's listing requirements are much less stringent. Firms do not have to show positive earnings to qualify for a NASDAQ listing. In fact, around a third of NASDAQ IPOs come from companies that are not making profits at the time of listing.[11]

There is a notable difference between the US and many European countries in the development of second-tier markets: in the US, the NASDAQ is independent from its main competitor, the NYSE, and has established itself as a fierce competitor for the listings of start-up firms; in Europe,

[10] Trading revenue, not listing fee, is the most important source of income for most exchanges. It should be noted, however, that the listing fee discussed in this paper should be interpreted in a broad sense: it includes not only the typical fee paid upon listing but also the present value of all future trading income. In this sense, the initial listing determines a far larger share of exchange revenues than implied by the narrow definition of listing fee.

[11] Giudici and Roosenboom (2004) report that IPO firms on new issue markets in Europe are also smaller, younger and riskier than main market IPO firms.

most second-tier markets are sponsored by the national exchanges and are less successful. Some market commentators lament that the lack of independent ownership hinders the development of second-tier markets:

> There is a fundamental contradiction between the objectives of those responsible for promoting the main listed market, who seek to prove that only companies of the highest standards are listed, and those responsible for promoting a second tier market, who have to accept that some companies might present a high risk to the potential investor. To have both markets run by the stock exchange was therefore always likely to produce tensions.[12]

The above evidence and argument appears compatible with my model, which shows that an existing exchange has a far weaker incentive to invest in a second-tier market than an independent entrant. To summarize, stock exchanges' behaviors provide mixed evidence on the predictions of my model. It seems worthwhile, therefore, to examine some of the limitations of my model.

ii. Limitations and Extensions

First, no entry barrier exists in my model. Profitable entry can be made by replicating an existing exchange's quality standard. This unrealistic feature is due to my omission of the reputation consideration in a firm's choice of exchange. In this respect, my study is complemented by Chemmanur and Fulghieri (2006), who discuss the role of reputation in stock exchanges' competition.

Second, I assume that certification is the only information source for buyers. This simplifying assumption leads to the prediction that there is a complete segmentation of two exchanges. This is hardly the case in reality: some firms eligible for the NYSE listing actually choose to list on the NASDAQ.[13] Clearly these firms (e.g. Microsoft and Google), which have already been identified as high quality firms by investors, gain little benefit from listing on the NYSE. It will thus be useful to extend the model to examine cases in which there are competing information channels.

[12] *Financial Times*, December 16, 1992.

[13] However, according to a study by Corwin and Harris (2001), only one fifth of the NYSE-eligible firms chose to list on NASDAQ during the period of 1991-1996.

Third, I have only considered markets in which sellers can only trade through an exchange. When adverse selection is not too severe, a seller will have the option of selling her product without listing. Whether my result extends to those markets can be explored in future research.

VI. Concluding Remarks

Some regulators are concerned that competition between standard bearers may lead to a race for the bottom, meaning that private agencies set inefficiently low standards to broaden their customer bases. Others argue that competition will lead to a race for the top. My paper shows that neither view is complete. Second-tier agencies may emerge under competition, but this is an improvement over the inefficient monopoly outcome; a race is unlikely to occur because competitors have a tendency to differentiate their standards. At the same time, my paper cautions against the blind optimism that two-tier markets are necessarily welfare improving.

A Proofs

Proof of Lemma 1. Suppose there exists some $q' \in [q_M^l, q_M^h]$ for which $q' \notin \{q_M\}$, then we must have $B - p < c(q')$. Since $c(q_M^h) \geq c(q')$, q_M^h should not list, either. Contradiction. ■

Proof of Proposition 2. For the monopoly exchange, the partial derivative of eq.(1) with respect to q^h is $\frac{q^h - q^l}{F(q^h) - F(q^l)} f(q^h) - c'(q^h)$. This equals to $1 - c'(q^h)$ when q is uniformly distributed. Since $c'' > 0$ and $c'(b) \leq 1$, we must have $1 - c'(q) \geq 0$ for all $q \in [a, b]$. This means that $q_M^h = b$ and $q_M^l = c(b)$, according to the proof of Proposition 1. A social planner's problem is $\max_{q^l} \int_{q^l}^{q^h} [q - c(q)] f(q) dq$, where $c(q^h) \leq \frac{\int_{q^l}^{q^h} q f(q) dq}{F(q^h) - F(q^l)}$, and the Lagrangian is $\mathcal{L} = \int_{q^l}^{q^h} [q - c(q)] f(q) dq - \lambda [c(q^h)[F(q^h) - F(q^l)] - \int_{q^l}^{q^h} q f(q) dq]$, $\lambda \geq 0$. Hence the first order condition is $-[q_o^l - c(q_o^l)] f(q_o^l) - \lambda [q_o^l - c(q_o^h)] f(q_o^l) = 0$. We obtain $q_o^l = \frac{c(q_o^l) + \lambda c(q_o^h)}{1 + \lambda} < c(q_o^h)$ since $c' > 0$. Thus $q_o^l < c(q_o^h) \leq c(b) = q_M^l$. Note that if the constraint is not binding, then we have $\lambda = 0$ and $q_o^l = c(q_o^l) = q^f$ (the second-best quality standard is the same as the first-best). ■

Proof of Proposition 3. Denote by p the listing fee. (1) Full disclosure. A seller is willing to pay up to $q - c(q)$. Since $c' < 1$, $q - c(q)$ increases with q thus $p = q_d^l - c(q_d^l)$. The exchange's problem is $\max_{q_d^l} [q_d^l - c(q_d^l)] \frac{b - q_d^l}{b - a}$. The first-order condition is $b - 2q_d^l - (b - q_d^l)c' + c(q_d^l) = 0$.

(2) Minimum standard. According to the proof of Proposition 2, $q_M^l = c(b)$. Define $g(x) = x - 2c(x) - [x - c(x)]c'(x) + c[c(x)]$. Thus, $\forall x \geq q^l, g'(x) = -xc'' - 2 + q^l c'' + 2c' = c''(q^l - x) + 2(c' - 1) < 0$ and $g(q_M^l) = [b - c(b)][1 - c'(b)] - [c(b) - c(c(b))] = [b - c(b)][1 - c'(b) - c'(\beta)]$, where $\beta \in [c(b), b]$. Since $c'' > 0$, $c'(b) \leq \frac{1}{2}$ and $c(b) < b$, we must have $g(q_M^l) > 0$. Hence $q_M^l < q_d^l$, where $g(q_d^l) = 0$. ■

Proof of Lemma 2. Under the minimum standard policy, sellers listed on the same exchange receive the same bid and pay the same listing fee. Denote by p_x the listing fee on exchange X. Suppose there exists some $q' \in [q_E^l, q_E^h]$ for which $q' \notin \{q_E\}$, then we must have either $B_E - p_E < c(q')$ or $B_E - p_E < B_{E'} - p_{E'}$, where E' is the exchange that offers q' a better payoff. Since $q' \leq q_E^h$ and $c(q') \leq c(q_E^h)$, q_E^h should not list on E, either. Contradiction. ■

Proof of Lemma 3. When the entrant "replies from above", the average quality of sellers listed on the entrant is higher than the incumbent. Hence the entrant can always match the incumbent's listing fee and list all eligible sellers. Expecting that it is unable to attract any sellers eligible for

the entrant, the incumbent gives up all sellers of qualities above q_E and acts as a monopoly for $q \in [q_I, q_E)$. Note that the low listing fee of the incumbent attracts no sellers of $q \geq q_E$, because q_E gets zero surplus from listing on the incumbent but a positive surplus from listing on the entrant and an exchange lists a continuum of sellers (Lemma 2). Therefore, the entrant maximizes its profit subject to the only constraint $q_E^a \geq q_I$. Since $c' = d < 1$, there is no upside exclusion (seller b is listed) so the exchange's profit is $(\frac{1+q^l}{2} - d)(1 - q^l)$, decreasing in q^l, $\forall q^l \geq q_M^l = d$. Therefore $q_E^a(q_I) = \max(q_M, q_I)$.

An analogous proof applies if the entrant "replies from below": since the average quality of sellers listed on the entrant is lower than the incumbent, the incumbent can always lower its listing fee such that the entrant gives up sellers of qualities above q_I and acts as a monopoly for $q \in [q_E, q_I)$. According to the proof of Proposition 1, $q_E^b(q_I) = dq_I$. ■

Proof of Proposition 4. Denote by $q_E(q_I)$ the entrant's best response in quality standard when the incumbent's standard is q_I. I prove the result in two steps. First I show that the entrant's best response involves a cutoff strategy, i.e., $q_E(q_I) = dq_I$ if $q_I > q_0$ and $q_E(q_I) = \max(q_M, q_I)$ otherwise. Second, I show that the incumbent is better off by inducing the entrant to "reply from below".

(1) For a given q_I, the entrant has two options: either $q_E^a = \max(q_M, q_I)$ or $q_E^b = dq_I$ according to Lemma 3. Let $\Delta(q_I) = \pi_E(q_I, q_E^a) - \pi_E(q_I, q_E^b)$. Since $\pi_E(q_I, q_E^a)$ decreases with q_I and $\pi_E(q_I, q_E^b)$ increases with q_I, $\Delta(q_I)$ is continuous and decreasing in q_I. At the same time, $\Delta(q_I) < 0$ when $q_I = 1$ and $\Delta(q_I) > 0$ when $q_I = 0$. Hence there is a unique solution to $\Delta(q_I) = 0$. Denote it by q_0. At this point, the entrant is indifferent between q_E^a and q_E^b (To break tie, I assume that the entrant sets q_E^b). Since $\Delta(q_I) = (\frac{1+q_I}{2} - d)(1 - q_I) - \frac{(1-d)^2}{2} q_I$, we get $q_0 = \frac{d+\sqrt{2}\sqrt{(1-d)^3}}{1+(1-d)^2}$. Note that $q_0 > q_M$.

(2a) The incumbent chooses to elicit a "reply from below". Its problem is $\max_{p_I, q_I} p_I(1 - q_I)$ subject to $\frac{(1-d)^2}{2}(q_I)^2 \geq (p_I - \frac{1-dq_I}{2})(1 - dq_I)$ and $p_I \leq \frac{1+q_I}{2} - d$. Its profit must be $\min[(\frac{(1-d)^2 q_I^2}{2(1-dq_I)} + \frac{1-dq_I}{2})(1 - q_I), (\frac{1+q_I}{2} - d)(1 - q_I)]$, which equals $(\frac{1+q_I}{2} - d)(1 - q_I)$ for all $d \in (0.5, 1)$ and decreases with q_I for any $q_I > q_M$. This means that the incumbent's optimal strategy is to set q_I at $q_0 = \frac{d+\sqrt{2}\sqrt{(1-d)^3}}{1+(1-d)^2}$, below which the entrant will "reply from above". In this case, the incumbent's profit is $(\frac{1+q_0}{2} - d)(1 - q_0)$.

(2b) The incumbent chooses to elicit a "reply from above". According to the proof of Lemma 3, its best strategy is to set the standard at dq_M and earn a profit of $\frac{(1-d)^2}{2}(q_M)^2 = \frac{[(1-d)d]^2}{2}$. It is

easy to verify that this is always lower than the profit that the incumbent could earn by eliciting a "reply from below" as in (2a).

Therefore, in the equilibrium, the incumbent sets its quality standard at $q_0 = \frac{d+\sqrt{2}\sqrt{(1-d)^3}}{1+(1-d)^2}$ and the entrant sets $q_E = dq_I < q_I$. ■

Proof of Corollary 1. Immediate from Proposition 4. Also note that $d < q_I < 1$. ■

Proof of Proposition 5. Denote by $p_1(p_2)$ the listing fee of the top-tier market (resp. the second-tier market), and $q_1^l(q_2^l)$ the corresponding quality standard. We have $p_1 = \frac{1+q_1^l}{2} - d$ and $p_2 = \frac{q_2^l+q_1^l}{2} - dq_1^l$. We must also have $q_2^l = dq_1^l$ according to the proof of Proposition 1. Thus the exchange's total profits are $\max_{q_1^l}(\frac{1+q_1^l}{2} - d)(1 - q_1^l) + \frac{(1-d)^2}{2}(q_1^l)^2$, maximized at $q_1^l = \frac{1}{2-d}$, and the second-tier market's profit is $\pi_2 = \frac{(1-d)^2}{2}(q_1^l)^2 = \frac{(1-d)^2}{2}(\frac{1}{2-d})^2$. At the same time, the top-tier market's profit is $\pi_1 = (\frac{1+q_1^l}{2} - d)(1 - q_1^l) = \frac{(3-2d)(1-d)^2}{2(2-d)^2} > \pi_2$. Note that the low listing fee of the second-tier market attracts no sellers of $q \geq q_1$, since q_1 gets zero surplus from listing on the second-tier market but a positive surplus from listing on the top-tier market. The marginal benefit of having a two-tier market is $\pi_1 + \pi_2 - \frac{(1-d)^2}{2} = \frac{d}{2-d}\frac{(1-d)^2}{2}$. Since the existence of two-tier market lowers the standard from d to $\frac{1}{2-d}$, it is easy to see that the social gain is $\frac{1}{2}[1 - \frac{1}{(2-d)^2}]d^2(1-d)$. ■

Proof of Corollary 2. (i) According to Proposition 5, the top-tier market under common ownership earns a higher profit than the second-tier market. Now suppose that the second-tier market earns a higher profit than the entrant under independent ownership, then the top-tier market's quality standard must be higher than the incumbent's under independent ownership. This means that if the entrant under independent ownership overcuts the incumbent's quality standard, it can earn at least the top-tier market's profit under common ownership, which is higher than the second-tier market's profit. Contradiction.

(ii) is immediate from Proposition 5. Also note that the first-best standard is 0 and the second-best (as defined above) is $2d - 1$.

(iii) directly follows Corollary 1 and Proposition 5. ■

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