Competition and cooperation among exchanges: A theory of cross-listing and endogenous listing standards[☆]

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Abstract

We analyze firms' choice of exchange to list equity and exchanges' choice of listing standards when insiders have private information about firm value, but outsiders can produce (noisy) information at a cost. Exchanges are populated by two kinds of investors, whose numbers vary across exchanges: sophisticated (low information production cost) investors and ordinary (high–cost) investors. While firms are short-lived, exchanges are long-lived, value-maximizing agents whose listing and disclosure standards evolve over time. The listing standards chosen by exchanges affect their "reputation," since outsiders can partially infer the rigor of these standards from the post-listing performance of firms. We show that, while exchanges use their listing standards as a tool in competing for listings with other exchanges, this will not necessarily lead to a "race to the bottom" in listing standards. Further, a merger between two exchanges may result in a *higher* listing standard for the combined exchange relative to that of either of the merging exchanges. We develop several other implications for firms'

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listing choices and resulting valuation effects, the impact of competition and co-operation among exchanges on listing standards, and the optimal regulation of exchanges.

1. Introduction

The recent process of international capital market integration has led a growing number of firms to list their equity outside their country of origin. Correspondingly, the number of listing venues available to firms has increased, with stock exchanges exposed to an unprecedented level of competition for listings. In this paper we develop a theory of the determinants of a firm's decision of where to list among several possible exchanges. Specifically, we study how the recently intensified competition (as well as cooperation in the form of alliances or mergers among stock exchanges) affects the listing standards decision of exchanges, and in turn the listing decisions of firms.

International listing of firm equity has now become a rather common phenomenon. Many European firms are listed on the New York Stock Exchange (NYSE), and many firms from emerging market countries (e.g., Israel) are listed not only on the NYSE, but also on various other American and European exchanges. These firms include those going public for the first time (Global Initial Public Offerings) or those, already public, choosing to list on an additional exchange (dual listing). While some evidence documents the benefits of international listing (in terms of increase in shareholder wealth), there has been relatively little theoretical analysis of the factors that affect such benefits, with the notable exception of the market segmentation literature (which we discuss in more detail later).[1] Indeed, there are few analyses of the factors that drive a firm's listing market choice, either among domestic exchanges (e.g., Nasdaq vs. NYSE) or internationally (e.g., should a Swedish firm choosing to list on a foreign market, or on the London Stock Exchange (LSE) or the NYSE?).

A mirror image of the above phenomenon is the increased competition among exchanges, both in the U.S. and in Europe, to attract firms' listings. For example, the NYSE and the LSE have engaged in vigorous competition to attract listings from firms in third countries (especially those from emerging economies). A natural question that arises is the effect of such competition on the "listing standards" set by exchanges. To answer such questions, however, one has to analyze the determinants of exchanges' listing standards in the first place.

This paper's objective is to develop a theoretical analysis that allows us to address both kinds of questions (i.e., regarding a firm's listing choice and an exchange's listing standards choice) in a unified framework. Some of the specific issues that we address in this paper are as follows: (i) what are the incentives for firms in one country to list in another country? (ii) what determines an exchange's choice of listing requirements and what are the

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[1]Some examples of the market segmentation literature that discuss this issue are Stapleton and Subrahmanyam (1977), Stulz (1981), and Alexander et al. (1988).

consequences of an exchange's listing standard choice for firm valuation? (iii) does it pay for a firm to be listed on multiple exchanges? (iv) how can the notion of an exchange's "reputation" be operationalized, and how does it drive a firm's listing choice? How is the reputation of an exchange related to its own choice of listing standard? (vi) how do exchanges compete for firms' listings and what is the effect of competition and cooperation among exchanges on listing standards?

It is useful to clarify here what we mean by an exchange's "listing standard." Exchanges usually have several requirements regarding the profitability record, number of shares (float), minimum market capitalization, etc. of firms applying for listing (and for continued listing), and such requirements tend to be more stringent in more reputable exchanges.[2] However, the listing requirements more relevant to our model relate to the form and content of required firm disclosures, and the extent to which an exchange monitors (for example, an exchange may have to engage in extensive fact-checking to unearth violations) and enforces these policies (clearly, firms must abide by these requirements if they are to remain listed on an exchange). Throughout the paper we use the term "listing requirements" in this broader sense, to cover not only the initial listing requirements, but also the stringency of their disclosure and other regulations, and the rigor with which these regulations are enforced.

Developing a theory capable of addressing the above questions is important because the answers determine a firm's costs of accessing capital markets in general, and the equity market in particular. These issues have assumed greater significance with the increasing economic integration of markets around the world, especially in Europe (driven by the adoption of the Euro). Moreover, several exchanges in Europe and in the U.S. have either entered into tie-ups with each other or are considering one. Our analysis has implications for the advantages and disadvantages of such tie-ups and sheds some light on the characteristics of those exchanges that will emerge as winners, in contrast to those that face decreasing listings (and eventually will go out of business).

We consider an equity market characterized by asymmetric information, where insiders have private information about firm value. Outsiders can reduce their informational disadvantage by producing (noisy) information at a cost. There are two kinds of investors: those with a cost advantage in producing information about true firm value ("low-cost investors") and those without such a cost advantage ("high-cost investors"). In practice, one can think of low-cost investors as financial analysts, portfolio managers, or other professional investors knowledgeable about a given industry or firm, and who therefore have special expertise in valuing the firm; high-cost investors are ordinary investors without such expertise.

Five important ingredients drive our analysis. First, from a firm's point of view, the number of low-cost information producers (those with a cost advantage in evaluating the firm) may vary from exchange to exchange. For example, investors with expertise (and therefore a cost advantage) in evaluating technology companies may dominate trading at the NASDAQ, but be far fewer at other exchanges. Second, different exchanges have different listing and disclosure requirements, which affect not only the kind of firms that are listed, but also the ongoing policing of financial disclosures, and therefore the precision

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[2]It is also worth noting that listing is not automatic for firms that meet these minimum initial listing requirements; exchanges have the discretion to reject applications for listing even from firms that meet these minimum requirements.

of the information available to outsiders in evaluating the firm. Third, while the rigor with which the listing and disclosure policies of an exchange are implemented, which evolves over time, is not fully observable to outsiders, outsiders can assess the stringency of an exchange's true listing requirements by studying the performance of firms listed in prior years. This performance history, therefore, affects the exchange's "reputation." Fourth, since an exchange can alter its listing and disclosure requirements over time, reputation considerations affect the exchange's endogenous choice of listing standards.[3] Fifth, exchanges may alter listing standards to compete with other exchanges for listing candidates (or as a result of a merger with another exchange), taking into account the impact of any alteration of these standards on their reputation.[4]

We develop our analysis in two steps. First, we develop a theory of the determinants of a firms's listing decision, which depends on the benefits that a firm expects to obtain from listing at various exchanges (as well as from multiple listings). We show that firms benefit from the presence at an exchange of more investors who can produce information about them at low cost, and from an exchange that is more stringent in its listing and disclosure requirements, which enhances such investors' effectiveness in producing information. Based on the above theory of listing choice, we then turn to the analysis of an exchange's equilibrium choice of listing standard. We examine how competition (as well as cooperation) among exchanges affects this listing standards choice. We show that exchanges have an incentive to develop a reputation for stringency in designing a listing standard, since they benefit from such a reputation by attracting firms that seek to list. Further, we show that competition among exchanges will not necessarily result in a race either to the top or to the bottom in terms of listing standards, but may result in an endogenous segmentation of the market for listings. Rather, a likely outcome of competition among exchanges is that high–reputation exchanges set high listing standards and become first–tier stock markets, while low–reputation exchanges set lower listing standards and become lower–tier markets. Finally, we analyze the incentives of exchanges to merge to increase their competitive position and solve for the impact of a merger on the listing standards of the merged exchange and on the other exchanges that compete with it.

Our research is related to several strands in the theoretical and empirical literature. One implication of the large market segmentation literature is that cross-listing can facilitate improved risk sharing, thereby reducing expected return (see, e.g., Stulz, 1981; Stapleton and Subrahmanyam, 1977). Chowdhry and Nanda (1991) introduce multimarket trading into a Kyle (1985)-type model in which the informed trader has several avenues to exploit

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[3]That exchanges' reputations are affected by problems involving firms listed on them, and that exchanges take this into consideration in designing their listing standards is illustrated by the news story titled, "YBM Probe Leaves Toronto exchange Red-faced, a Year after Bre-X Scandal," (*Wall Street Journal*, June 14, 1998). We quote: "This time, damage to Canada's biggest stock exchange's reputation stems from YBM Magnex International Inc., a Canadian-registered industrial magnet maker, that is the focus of an investigation by the federal bureau of investigation.... John Carson, the TSE's executive vice president, market regulation, defended the exchange's screening process for new listings. He added that, since the Bre-X debacle, the exchange has beefed up its disclosure requirements for mining companies."

[4]The vigorous competition among global exchanges for listings, and the trade-offs involved in a firm's choice between exchanges are illustrated by the news stories, "Global Stock Exchanges Vie for a slice of China's IPO Pie" (*Wall Street Journal*, December 2, 2004), which discusses the competition among the NYSE, Nasdaq, LSE, and even smaller exchanges such as the Tokyo Stock Exchange to attract listings from Chinese firms, and "U.S. Markets Battle to List Foreign Firms," (*Wall Street Journal*, September 5, 1997), which discusses similar competition among exchanges to attract listings from Indian and other developing country firms.

his private information. Their focus is on the effect of such trading on market liquidity and informativeness of prices. In contrast, our focus is on the listing decisions by firms and the listing standards of exchanges. Two related contemporaneous papers are Huddart et al. (1999) and Foucault and Parlour (1998). The former paper uses a Kyle-type setting in which the firm's listing choice is driven by the insider's desire to list in the exchange with the greatest number of liquidity traders, enabling him to mask his trades. The latter paper focuses on the relation between trading costs and listing fees, and predicts an inverse relation between the two.[5] In contrast to this literature, in our paper the firm's listing choice is driven by the presence (or absence) of skilled analysts and investors in various markets, and the extent of information about the firm available to these investors.

Our work is also related to the empirical literature that looks at the determinants of a firm's choice of foreign exchange listing (see, e.g., Saudagaran, 1988; Saudagaran and Biddle, 1995; Blass and Yafeh, 2000; Pagano et al., 2002), the large empirical literature on announcement effects on the stock price of foreign firms listing on U.S. exchanges (see, e.g., Jayaraman et al., 1993; Forester and Karolyi, 1993; Alexander et al., 1988; Miller, 1999), and also the empirical literature that focuses on the announcement and other effects of overseas listing by U.S. firms (e.g., Howe and Kelm, 1987; Lau et al., 1994).

The paper is organized as follows. In Section 2 we develop a single-period model in which exchanges' listing standards and listing fees are exogenous. Section 3 describes the equilibrium of the model that allows a firm to list on only one exchange. Section 4 allows a firm to choose among exchanges: Section 4.1 allows a firm to be listed on only one exchange at a time, while Section 4.2 allows for dual listings. Sections 5 and 6 build on the single-period model to develop a dynamic (two-period) model in which exchanges are long-lived value-maximizing agents, and endogenizes exchanges' listing policies and fees. In Section 5, the exchange is a monopolist, and determines its listing standard taking into account considerations of reputation alone. In Section 6, we allow exchanges to compete and cooperate with each another: in Section 6.1 we study how competition alone interacts with reputation considerations to determine the listing standard set by each exchange (and also the listing decisions of firms), and in Section 6.2 we allow for cooperation (through alliances or mergers) as well as competition among exchanges. Section 7 summarizes the empirical and other implications of our model. Section 8 concludes. The proofs of propositions are given in the appendix. The critical values of various parameters (specified as part of restrictions to be satisfied for various propositions to hold) are also defined in the Appendix.

2. The model

The basic (single–period) model consists of two dates. At time 0, a risk–neutral entrepreneur has a firm with monopoly access to a single project. The firm's project requires a certain investment at time 0, which the entrepreneur wishes to raise from outside investors through an initial public offering (IPO) of equity, since he has no capital. He can

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[5]Santos and Scheinkman (2001) develop a model of competition among exchanges in which exchanges design securities in order to attract clientele and maximize profits. Their focus, however, is on the design of margin requirements (set to protect investors from potential defaults); they do not study the listing decisions of firms or the choice of listing standards by exchanges. Our paper is also related to the literature on IPOs and other stock issues in an environment of asymmetric information or information production (see, e.g., Allen and Faulhaber, 1989; Chemmanur, 1993).

obtain this capital by listing his firm's shares either in exchange X (the domestic market) alone, in exchange Y (a foreign market) alone, or through dual listing (i.e., listing in both exchanges X and Y). To begin, the equity in the firm is assumed to be divided into a large number of shares m, all owned by the entrepreneur. The entrepreneur sells a certain number of additional shares to outsiders in an IPO after listing the equity in one or more exchanges, which lowers the fraction of equity that he holds in the firm. At time 1, the firm's project pays off its cash flow, which depends on project (firm) quality or "type," f, about which the entrepreneur has private information. We assume that the risk-free rate of return is zero.

Thus, there is only one round of firms entering the equity market in the basic model. In Sections 5 and 6, where we develop a dynamic two-period model, we allow a new round of firms to enter the equity market at time 1, with their cash flows realized at time 2. The sequence of events in the dynamic model is depicted in Fig. 1. Table 1 provides a list of the symbols used in the model, along with their definitions.

2.1. The entrepreneur's private information and project technology

Firms (projects) are of two types: "good" ($f = G$) or "bad" ($f = B$); type-G projects have a greater expected value of time-1 cash flow than do type-B projects. The time-1 cash flow from the project, denoted by $v_f(\iota)$, depends on project quality as well as the amount invested in the project at time 0, denoted by ι. This cash flow is given by the following investment technology:

$$v_f(\iota) = k_f \iota \text{ for } \iota < I, \quad v_f(\iota) = k_f I \text{ for } \iota \leqslant I; \, f \in \{G, B\}, \text{ with } k_G > k_B > 1. \quad (1)$$

From (1), we can see that the firm's technology is such that any amount invested at time 0 lower than or equal to a certain upper limit I yields a time-1 cash flow k_f times ι, $f = G, B$. However, for investment amounts above I, the cash flow generated remains at $k_f I$, so that no entrepreneur chooses an investment level above this amount I. Further, for any given level of investment, type-G firms yield a greater expected cash flow compared to type-B firms. Denote by V_G and V_B the entrepreneur's time-0 expectation (for the type-G and the
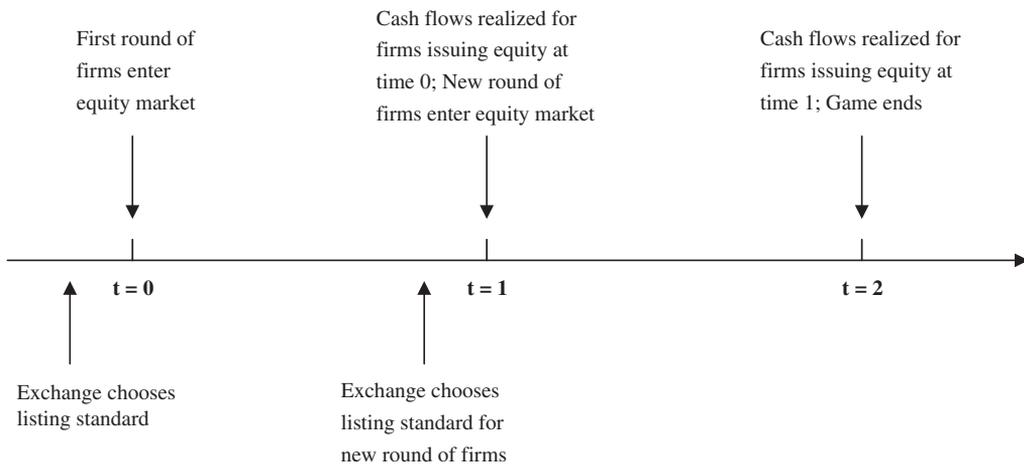

Fig. 1. Sequence of events in the dynamic model.

Table 1
List of symbols with definitions

f	Type of firm: $f = $ G, "good" or $f = $ B, "bad"
ι	Amount invested by a firm in its project
$v_f(\iota)$	Cash flow from the project for a firm of type f at an investment level ι
k_G, k_B	Productivity of a firm of type G or type B, respectively
I	Full-investment level of a firm's project
V_f	Entrepreneur's expectation of time-1 cash flow, from a firm of type f, $f = $ G, B, at the full-investment level
m	Number of shares originally owned by an entrepreneur in his firm
ω	Outsiders' prior probability assessment that a firm is of type G
$c_h, c_\ell,$	Evaluation cost of high-cost and low-cost investors, respectively
e	Evaluation obtained from information production, with $e = g$ (good) or $e = b$ (bad)
γ^E	Precision of investors' evaluations for a firm listed on exchange E, $E = X, Y$; also referred to as transparency of an exchange E, $E = X, Y$
N^E	Number of potential investors in a firm's equity offering on exchange E, $E = X, Y$
N_h^E, N_ℓ^E	Number of potential high-cost and low-cost investors, respectively, in an equity offering on exchange E, $E = X, Y$
α_h, α_ℓ	Fraction of high-cost and low-cost investors, respectively, participating in an equity offering as information producers
δ_h, δ_ℓ	Total fraction of high-cost and low-cost investors, respectively, participating in an equity offering (either as informed or as uninformed investors)
p_H	Issue price per share set by a type-G firm; also, issue price per share set by a type-B firm if it pools with a type-G firm
p_L	Issue price per share set by a type-B firm if it separates from a type-G firm
n_H	Number of shares issued by a type-G firm; also, the number of shares offered by a type-B firm if it mimics a type-G firm by setting a price p_H
n_L	Number of shares issued by a type-B firm if it sets a price p_L per share
$\hat{n}_H$	Number of shares actually sold by a firm of type B if it sets an issue price p_H
β	Probability that a type-B firm mimics a type-G firm in a partially pooling equilibrium
λ	Fractions of shares sold by a type-B firm if it mimics a type-G firm
θ	Outsiders' probability assessment that a firm offering n_H shares at a price p_H is a type-G firm in a partially pooling equilibrium
q_t^E	Listing standard set by an exchange E, $E = X, Y$, at time $t = 0,1$, $q_t \in [0, \bar{q}]$
$\bar{q}$	Highest feasible listing standard that can be set by an exchange
F_t	Exchange's listing fees in the single-period model at time t, $t = 0,1$
ρ_0^E	Reputation of exchange E, $E = X, Y$, at time $t = 0$
$\rho_1^{EG}, \rho_1^{EB}, \rho_1^{EN}$	Updated $t = 1$ reputation of exchange E, $E = X, Y$, conditional on the firm listed at $t = 0$ being revealed at $t = 1$ to be of type G, B, or if no firm is listed by the exchange at $t = 0$, respectively
$V_{H1}^{EG}, V_{H1}^{EB}, V_{H1}^{EN}$	Total equity values of a firm listed on exchange E, $E = X, Y$, at the price p_H at $t = 1$, conditional on the firm listed at $t = 0$ being revealed to be of type G, B, or if no firm is listed at $t = 0$, respectively
w_t	Verification and regulatory costs incurred by exchange E, $E = X, Y$, at time $t = 0, 1$
Q_t	Expected volume of firms listed on an exchange at time $t = 0, 1$
s	Share of firm value charged by an exchange as a listing fee in the dynamic model
η	Probability that a firm of type G is rejected by any exchange in the dynamic model
q_0^{Xm}, q_0^{Ym}	Listing standards set at $t = 0$ by exchanges X and Y, respectively, if they are monopolists
q_0^{Xc}, q_0^{Yc}	Listing standards set at $t = 0$ by exchanges X and Y, respectively, if they face competition

type-B firm, respectively) of his firm's time-1 cash flow, at the full investment level I (i.e., $V_G \equiv k_G I$, and $V_B \equiv k_B I$). At time 0, the entrepreneur chooses his firm's listing decision as well as the number of shares to sell and the price per share (which affects in turn the amount of external financing raised, and therefore the firm's investment decision) in order to maximize the expected value of the time-1 cash flow accruing to him.[6]

2.2. Outsiders' evaluation technology and strategies

Outside investors do not observe the true quality or type of the firm approaching them for capital, but only the prior probability ω of the firm being of type G. However, when offered equity in any firm, they can choose to expend additional resources and produce more information about the firm in order to reduce their informational disadvantage. At a cost $c > 0$, outsiders can obtain a noisy "evaluation" (e) of the firm, which can have one of two outcomes: "good" ($e = g$) or "bad" ($e = b$), as follows:

$$Prob\{e = g | f = G\} = 1, \quad Prob\{e = g | f = B\} = 1 - \gamma, \quad 0 < \gamma < 1. \qquad (2)$$

Thus, the precision of the evaluation is captured by γ. We also assume that, when a number of investors produce information about a type-B firm, a fraction $1-\gamma$ of these investors obtain good evaluations, while the remaining fraction γ obtain bad evaluations.[7]

An outsider's evaluation cost depends on several factors. First, the magnitude of c depends on the amount of information about the firm and its management already available in the public domain in the market where the firm is listed. For example, an established software firm such as Microsoft, with a track record of successfully developing products, may be easier to evaluate (and hence have a lower c) than a start-up software firm with great potential but no track record. A second (related) factor may be the familiarity of investors in a given market with the firm, its products, or its management. For example, Swedish investors may find it easier than U.S. investors to evaluate a Swedish natural resources firm that has not done any business in the U.S., since they (unlike U.S. investors) have been familiar with it for a long time. Third, the size of c may depend on a firm's industry membership: projects of firms that belong to certain industries may be intrinsically more complex and therefore difficult to evaluate than those of firms in other industries. Finally, for a given industry and in a given equity market, investors may differ in their evaluation costs. For example, a technology analyst working for a top U.S. investment bank may have a lower cost of evaluating a French software company compared to most ordinary investors in the US, and possibly compared to many ordinary French investors as well.

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[6]In this setting, the entrepreneur cares about obtaining a higher price for his firm's equity upon listing, since doing so allows him to raise the required amount of external financing by selling a smaller number of shares, thereby minimizing the dilution in his equity holdings resulting from the IPO. In practice, firm insiders may care about obtaining a higher current share price for their firm for other reasons as well. For instance, the compensation of a firm's top management may be tied to the current share price. Alternatively, insiders may wish to minimize the threat of takeovers (which is decreasing in the firm's share price) by rivals.

[7]If we were to assume instead that investors producing information about a type-B firm obtain independent signals, the expected value of the fraction of these investors that obtain good evaluations will still remain γ. However, in this case, many of our expressions will involve the distribution of this fraction of investors who obtain good evaluations for a bad firm. Clearly, this would add unnecessary computational complexity to the model without generating any commensurate economic insights, thus we adopt the correlated information structure above.

We assume that, from the point of view of any given firm, the number of low-cost information producers may vary from exchange to exchange. For example, investors with expertise (and therefore a cost advantage) in evaluating technology companies may dominate trading at the NASDAQ, but be far fewer in number at other exchanges. This may arise from the fact that, while investors who normally trade on one market (like the NASDAQ) can trade on another market (say, the Milan Stock Exchange), at least some of them incur significant additional costs to do so: e.g., overcoming the lack of familiarity with the local language and accounting (and other conventions) related to the latter market, higher transactions costs, and the costs associated with setting up additional trading operations or working with unfamiliar intermediaries in the new market. This implies that many investors who trade as low-cost information producers on one market may be able to trade only as high-cost information producers on another market, so that the number of low-cost information producers trading on a particular exchange may be limited.

To capture the above ideas, we assume that in each market there are two kinds of investors: those with a high cost $c = c_h$ of evaluating the firm ("high-cost investors"), and those with a low cost, $c = c_\ell$ ("low-cost investors"). Of the N potential investors in the firm's equity offering, a number N_ℓ are low-cost investors, while the remaining $N_h = N - N_\ell$ are high-cost investors (we use the subscripts h and ℓ to denote various variables associated with high-cost and low-cost investors, respectively; in contrast, we use the subscripts H and L to denote variables associated with a firm's choice of a high or a low share price, respectively, in its equity offering). To capture the notion that investors in different exchanges may have different levels of sophistication in valuing a given firm, we allow N_ℓ and N_h to differ across exchanges (we will superscript these numbers with X and Y as required when we allow these to differ across exchanges).[8] We will often refer to the number of low-cost investors in a given exchange as its "low-cost investor-base."

When a firm makes an equity offering on a given exchange, investors (traders) in that exchange can choose to do one of three things: ignore the IPO altogether; engage in uninformed bidding for shares in the IPO; or conduct a costly evaluation of the firm and, depending on its outcome, bid (if the evaluation is good) or not bid (if the evaluation is bad) for shares.[9] We assume that each investor bids for only one share, regardless of whether he bids as informed or uninformed.[10] We assume that the investor's wealth not invested in firm's equity, or devoted to evaluating the firm, is invested in the risk-free asset.

The proportion of high-cost and low-cost investors participating in the equity offering who choose to become informed, denoted by α_h and α_ℓ, respectively, is determined as follows. After observing the price and number of shares offered by the firm in the IPO, each investor chooses between not participating in the IPO at all and participating as an informed investor with a probability α_i, $i = h, \ell$. In other words, if an investor decides to participate in the IPO, he conducts a costly evaluation of the firm with probability α_i

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[8]Since, throughout this paper, we analyze the listing decision of a given firm, we emphasize the fact that N_ℓ varies across exchanges for a particular firm. However, note that N_ℓ is a function of firm characteristics as well: for a given exchange, N_ℓ varies across firms.

[9]Clearly, it is never optimal for any investor to produce information and then choose to bid for a share in the IPO after getting a bad evaluation.

[10]None of our results are driven by the assumption of each investor buying only one share, which we make for modeling simplicity. Indeed, our model can be generalized to the case in which each investor can buy multiple shares, and also to the case in which different investors may buy different numbers of shares. Allowing for these cases here simply complicates the model without generating commensurate insights.

(and follows the optimal bidding strategy depending on its outcome) and makes an uninformed bid with probability $1-\alpha_i$. The probability α_i therefore measures the extent of information production across types of investors participating in the offering.[11] The fraction of high-cost and low-cost investors in any market adopting these strategies depends on the price set by the firm in the equity offering, investors' prior probability belief on the firm's true value, and the cost and precision of the evaluation technology available to each type of investor. Further, when the firm has a choice with respect to the exchange on which to list equity, the particular exchange where the firm is listed and the listing standards of the exchange where the firm is listed may also convey information to investors and thereby affect investor strategies (and consequently, the pricing of equity).

2.3. The exchange's listing procedure

When approached by a firm for listing, the exchange conducts an investigation of the firm, requiring that it provide various pieces of information and that it recast its financial statements and other disclosures in the format prescribed by the exchange. The rigor of the investigation performed by the exchange prior to listing, and the investor accessibility to the information contained in the firm's financial statements subsequent to listing (i.e., the "transparency" of the firm's disclosures), depends on the "listing standards" set by the exchange. Typically, as an exchange's listing standards grow more stringent, a smaller fraction of the firms applying for listing are accepted, and perhaps even more important, the financial disclosures made by firms listed at that exchange become more transparent (i.e. not only is more information available to outsiders, but available information becomes more credible because of the more stringent policing of firm disclosures by the exchange). To capture these ideas, we model the exchange's listing procedures in the following manner: At any time t, each exchange chooses a "listing standard" q_t, which affects both the probability of the firm being accepted for listing, and also the "transparency" of the firm's financial statements. The probability of a firm being listed is given by

$$Pr\{accepted/f = G\} = 1, \quad Pr\{accepted/f = B\} = 1 - q_t. \tag{3}$$

Thus, the higher the listing standard q_t, the better the average quality of firms listed on the exchange, with $q_t \in [0, \bar{q}]$. Further, we capture the notion of greater transparency of financial statements made by firms listed on an exchange with higher listing standards by

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[11]Since, in equilibrium, each investor is indifferent between informed and uninformed bidding in the IPO, and information production costs are identical *within* a given cost group (i.e., high-cost or low-cost), the exact identity of those who produce information within the group and those who engage in uninformed bidding is irrelevant here. Formally, we assume that investors follow a randomized strategy, with a fraction α choosing to produce information, and the remaining fraction $1-\alpha$ choosing to bid uniformed in the IPO, based on the outcome of a collectively observed randomization device. This way of modeling the choice between informed and uninformed bidding, where investors choose to produce information with a certain probability (rather than confining them to pure strategies) seems to be the most elegant modeling approach here, since it yields a symmetric equilibrium (where identical agents make identical choices). An alternative modeling approach involving only pure strategies would measure the extent of information production in the new issues market by the number of investors producing information in equilibrium (Chemmanur, 1993, uses this alternative approach in a model of IPO underpricing). However, this alternative approach would require that only some members of an otherwise identical cohort of investors choose to produce information so that the equilibrium would be asymmetric. See also Milgrom (1981), who uses both of these approaches to model auctions with information production, and demonstrates the essential equivalence of these alternative approaches.

assuming that the precision of the outsiders' evaluation, γ_t, is a strictly increasing function of the exchange's listing standard q_t, i.e., $\gamma_t = \gamma(q_t)$. In our single-period model, we assume that the exchange's listing standard q is exogenous and publicly known (we suppress the time subscript t when it is not required for clarity of exposition). In our dynamic model, we endogenize the exchange's choice of listing standard, allowing an exchange to choose its listing standards privately.[12] We further assume that, if rejected by both exchanges X and Y, a firm may delay its IPO or raise capital from other sources, both of which are less advantageous to the entrepreneur (i.e., the entrepreneur prefers to raise capital by conducting an equity offering on any one of the two exchanges X or Y).[13]

The cost to the firm of listing on an exchange consists of two components, namely the actual listing fee and the costs associated with complying with the exchange's transparency requirements (which may, in fact, be the larger component in many cases). For simplicity, we lump these items together and refer to it as the "listing cost," denoted by F. We will allow these listing costs to vary across exchanges in our multiperiod model (we will use the superscripts X and Y to denote the fees on the two exchanges when required).[14] In general, these listing costs may be greater for exchanges with higher listing standards (partly because of the greater magnitude of the compliance cost), though we will *not* assume this to be the case always.

3. Equilibrium with listing in only one market

In this section, we assume that each firm is allowed to list its equity only in the domestic market. This allows us to examine the details of the equilibrium in a given equity market, without the additional complication of exchange choice, which we introduce in the next section.

Definition of equilibrium. The equilibrium concept we use is that of efficient perfect bayesian equilibrium (PBE).[15] An equilibrium consists of: (i) a choice of share price by the

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[12]Notice that there are two effects to an exchange setting a higher listing standard in our model. First, it will accept a lower proportion of the firms that approach it for a listing. Second, it will investigate firms applying for listing and enforce regulations (e.g., regarding the form and truthfulness of disclosures) with a greater degree of stringency (e.g., by delisting with a greater probability firms that are found to have violated various rules and regulations), so that more reliable information is available to outsiders evaluating firms, thus increasing the precision of these evaluations ("transparency" in our model). While these two aspects of a higher listing standard go together, it is this second aspect of listing standards that we have in mind when we allow an exchange to choose its listing standards privately in the dynamic model.

[13]This assumption is appropriate, given that the objective of this paper is neither the choice of a firm between public and private equity financing, nor the optimal timing of a firm's going public decision. For a model addressing these issues, see Chemmanur and Fulghieri (1999).

[14]In practice, both of these components of the listing cost seem to vary somewhat across exchanges. For example, comparing the costs to a foreign company of obtaining a listing on the NYSE versus the LSE, it has been documented (see, e.g., Fanto and Karmel, 1997) that both the direct listing costs and the indirect reporting and compliance costs are significantly greater for the NYSE than for the LSE. While the indirect costs of listing on the NYSE are greater because of having to meet the much more stringent SEC requirements, the direct costs of listing on the NYSE are $100,000 in initial listing fees and $16,000 to $30,000 in annual fees, versus an initial listing fee of only $6,000 and a $3,000 annual fee on the LSE.

[15]Thus, we look for the perfect bayesian equilibrium (PBE) involving the least amount of dissipative costs (see Milgrom and Roberts (1986) for an application). In Section 4, we characterize the equilibrium in a setting in which firms have a choice of exchanges on which to list. From Section 5 onwards, we characterize the equilibrium in a dynamic model in which the listing standard of exchanges is endogenous. The general definition of equilibrium used in these sections is the same as the one described here.

entrepreneur making the equity offering, along with the choice of the number of shares to offer to outsiders, and the choice of on which exchange to list equity; (ii) a choice by the exchange about whether to list a firm's equity (and in Section 5 onwards, a choice of listing standard as well); and (iii) a decision by each investor about whether or not to participate in the IPO, and if he participates, a choice about the probability of producing information. Each of the above choices must be such that: (a) the choices of each party maximize their objective, given the equilibrium beliefs and choices of others, and (b) the beliefs of all parties are consistent with the equilibrium choices of others; further, along the equilibrium path, these beliefs are formed using Bayes' rule; and (c) any deviation from the equilibrium strategy by any party is met by beliefs by other parties that yield the deviating party a lower expected payoff compared to that obtained in equilibrium.

In Proposition 1, we characterize the basic structure of an equilibrium with information production. We discuss the nature of this equilibrium at some length, since we build on this basic equilibrium in subsequent sections of the paper.[16]

Proposition 1. (*Equilibrium without exchange choice*). *When a firm is allowed to list on only one exchange, an equilibrium with information production involves the following:*[17]

(i) *The type-G firm issues n_H shares, each at a price p_H, raising a total amount I for investment.*

(ii) *With probability β, $0 < \beta \leq 1$, the type-B firm pools with the type-G firm by issuing n_H shares at the price p_H, of which only a number λn_H are bought by investors in equilibrium ($0 < \lambda < 1$); thus, it raises only an amount λI. With probability $1-\beta$, the type-B firm separates from the type-G firm by issuing n_L shares at a lower price p_L ($n_L > n_H$, $p_L < p_H$); thus, it raises the entire amount I required for investment.*

(iii) *Investors: (a) If $N_\ell \geqslant \bar{N}_\ell$, then low-cost investors are the marginal information producers in equilibrium. In this case, a fraction δ_ℓ participates in the IPO, and α_ℓ of these investors produce information, while the remaining fraction $1-\alpha_\ell$ bid uninformed. A fraction δ_h of high-cost investors participate in the equity offering as uninformed bidders (i.e., none produce information). (b) If $N_\ell \geqslant \bar{N}_\ell$, then high-cost investors are the marginal information producers. In this case, all low-cost investors participate in the equity offering as information producers ($\delta_\ell = 1$, and $\alpha_\ell = 1$) and a fraction δ_h of the high-cost investors participate in the equity offering, of which a fraction α_h produce*

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[16]Throughout this paper, our focus is on partially pooling equilibria, where the two types of firms pool (with some probability) by making similar decisions about equity pricing, number of shares to offer, and listing, so that there is a need for costly information production by investors. Thus, we will not focus on equilibria in which (a) the information technology is so costly or noisy that there is no incentive for any investor to evaluate firms in equilibrium, and the equilibrium is fully pooling, or (b) the actions taken by the two types of firms are different in equilibrium, so that the equilibrium is fully separating, thus eliminating any need for costly information production by outsiders. Fully pooling equilibria (category (a)) are clearly uninteresting, in the sense that they arise only when information of any significant precision is unavailable to outsiders at a reasonable cost, so that the issues of interest to us in this paper do not arise at all (the parametric restrictions on c and γ under which the equilibrium is of this nature is available from the authors). Fully separating equilibria (category (b)) are perhaps of some intrinsic interest, but can be shown not to exist in our setting (to see why, note that if good and bad firms were to separate in equilibrium, then investors have no incentive to acquire costly information in the first place, generating an incentive for bad firms to mimic good firms).

[17]The out-of-equilibrium beliefs supporting the above equilibrium are that outsiders infer that any firm setting a price other than p_H or p_L, or offering a number of shares other than n_H (at the price p_H) or n_L (at the price p_L), is a type-B firm with probability 1.

information, while the remaining fraction $1-\alpha_h$ engage in uninformed bidding for a share of stock. This equilibrium will always exist if the outsiders' evaluation cost is not too high, so that $c < c_s$.

In equilibrium, the type-G firm always sets the high price p_H, since it is confident that it will always be able to raise the full amount I required for investment (since all investors who conduct an evaluation of the firm obtain a good evaluation for a type-G firm). The number of shares offered for sale is given by

$$p_H n_H = I. \tag{4}$$

The type-B firm has to pay a price if it mimics the type-G firm by setting the same price, p_H, and number of shares offered, n_H. Among informed investors, only a fraction $1-\gamma$ get a good evaluation, while the remaining fraction γ get a bad evaluation and do not bid for shares. Thus, of the n_H shares offered by the type-B firm, some may go unsold, leading the firm to scale back its investment project (wasting value). We denote by λ the fraction of shares offered that are sold by a type-B firm if it mimics, and by $\hat{n}_H$, the number of shares sold in this case ($\hat{n}_H = \lambda n_H$).

Alternatively, if the type-B firm separates by setting a different (lower) price p_L, it is revealed as the type-B firm, but is able to sell as many shares as it would like, since the price would then be the true (full information) price. It is thus able to raise the full investment amount I, thus avoiding any scaling back in investment. This separating price, p_L, and the corresponding number of shares issued, n_L, then satisfy

$$p_L = \frac{1}{m + n_L} V_B; \quad p_L n_L = I. \tag{5}$$

We will see later that, in equilibrium, the type-B firm will be indifferent between mimicking the type-G firm, and separating by setting a different price-share combination; it will mimic the type-G firm with a certain probability β, while separating with probability $1-\beta$. Denote by θ the probability assessed by an uninformed investor that a firm offering n_H shares at a price p_H per share is a type-G firm (taking into account the type-B firm's equilibrium strategy of pooling with the type-G firm with probability β). Using Bayes' rule, this probability is given by

$$\theta = Prob\{f = G/p = p_H, n = n_H\} = \frac{\omega}{\omega + \beta(1 - \omega)}. \tag{6}$$

Further, any investor (high-cost or low-cost) participating in the equity offering as an uninformed bidder must be able to recoup the price paid (in terms of expected value), giving the inequality

$$p_H \leqslant \theta \frac{V_G}{m + n_H} + (1 - \theta) \frac{\lambda V_B}{m + \lambda n_H}. \tag{7}$$

We now discuss how the fraction of investors producing information, and the probability β of the type-B firm pooling with the type-G firm, are determined in equilibrium. First, we discuss the case in which low-cost investors are the marginal information producers. For a low-cost investor to have an incentive to produce information, the cost c_ℓ must be less than or equal to the expected benefit (which arises from the ability to avoid bidding for a share in a bad firm if the informed investor receives a bad evaluation). Thus, any equilibrium in which low-cost investors are the marginal

information producers will satisfy

$$c_\ell \leqslant \gamma(1-\theta)\left[p_H - \frac{\lambda}{m+\lambda h_H}V_B\right] < c_h. \tag{8}$$

The fraction of low-cost investors producing information, α_ℓ, is determined in this equilibrium as follows. Consider first the extreme case in which most low-cost investors engage in uninformed bidding. In this case, the cost imposed on the type-B firm (in terms of having to scale back its investment) is very low, so that it has an incentive to mimic the type-G firm by setting the high price p_H very often (thus creating an incentive for more low-cost investors to produce information). At the other extreme, if most low-cost investors in the IPO market choose to become informed, the cost to the type-B firm from pooling with the type-G firm will then be very high, so that it rarely mimics the type-G firm (thus creating an incentive for more investors to remain uninformed). Thus, the equilibrium α_ℓ will be such that the type-B entrepreneur is indifferent between selling λn_H shares at price p_H (thereby owning a larger fraction of the smaller firm with expected time-1 cash flow λV_B after the equity issue), and selling n_L shares at price p_L (and therefore owning a smaller fraction of a larger firm with expected time-1 cash flow V_B after the equity issue). Thus, in equilibrium we have

$$\frac{m}{m+n_L}V_B = \frac{m}{m+\lambda n_H}\lambda V_B. \tag{9}$$

The probability β with which the type-B firm mimics the type-G firm by setting the high price p_H, is determined such that each low-cost investor participating in the IPO is indifferent between producing and not producing information. At one extreme, if the type-B firm mimics the type-G firm very often, the expected benefit to low-cost investors from producing information is very high, creating an incentive for a larger fraction of these investors to produce information (thus inducing the type-B firm to reduce the mimicking probability β). At the other extreme, if the type-B firm mimics the type-G firm rarely, there is little benefit to outsiders from producing information, thus driving down the fraction of low-cost investors who produce information (thereby inducing the type-B firm to increase the probability β). The equilibrium value of β will be such that all low-cost investors are indifferent between producing and not producing information, so that the left-hand side (LHS) of (8) holds as an equality in equilibrium. No high-cost investors produce information in this equilibrium ($\alpha_h^* = 0$). Further, since the equity market is competitive, (7) holds as an equality. In summary, the values of α_ℓ, β, and λ are determined simultaneously in equilibrium, such that (7), the LHS of (8), and (9) hold as equalities.

It now remains to show how the fraction of each type of investors participating in the equity offering is determined. Recall that when uninformed, low-cost and high-cost investors are identical (since the only difference between them is in their information production cost). Assuming therefore, for ease of exposition, that any shares not taken by informed low-cost investors are first bought by uninformed low-cost investors and then by uninformed high-cost investors (i.e., $\delta_h = 0$ if $\delta_\ell < 1$), δ_ℓ and δ_h are uniquely determined from (10). Notice that (10) reflects the fact that a type-G firm is able to sell equity to all information producers, while a type-B firm sells only to uninformed investors (of both kinds, if need be) and to low-cost information producers who (erroneously) receive a good evaluation. In summary, an equilibrium in which low-cost investors are the marginal information producers consists of a collection of variables

$\{n_H^*, \hat{n}_H^*, n_L^*, p_H^*, p_L^*, \alpha_h^*, \alpha_\ell^*, \delta_h^*, \delta_\ell^*, \lambda^*, \theta^*, \beta^*\}$ such that (4)–(10) hold as equalities.

$$n_H = \delta_\ell N_\ell + \delta_h N_h, \quad \hat{n}_H = (1 - \gamma\alpha_\ell)\delta_\ell N_\ell + \delta_h N_h. \tag{10}$$

We now discuss the equilibrium in which high-cost investors are the marginal information producers. Here, the high-cost investor's information production cost must satisfy:

$$c_h \leqslant \gamma(1 - \theta)\left[p_H - \frac{\lambda}{m + \lambda n_H} V_B\right]. \tag{11}$$

Further, since $c_\ell < c_h$, low-cost investors make a positive expected profit from information production, hence all low-cost investors participate in the equity offering (and engage in informed bidding), so that $\alpha_\ell = \delta_\ell = 1$. In equilibrium, high-cost investors are indifferent between producing or not producing information; β, λ, and α_h (the fraction of high-cost investors producing information) are determined simultaneously such that (7), (9), and (11) hold as equalities. The fraction δ_h of high-cost investors participating in the offering is given by

$$n_H = N_\ell + \delta_h N_h, \quad \hat{n}_H = (1 - \gamma)N_\ell + (1 - \alpha_h\gamma)\delta_h N_h, \tag{12}$$

where (12) reflects the fact that the type-B firm now sells equity to uninformed high-cost investors, and informed high-cost and low-cost investors who erroneously receive good evaluations (all low-cost investors are informed in this case). In summary, an equilibrium in which high-cost investors are the marginal information producers consists of a collection of variables $\{n_H^*, \hat{n}_H^*, n_L^*, p_H^*, p_L^*, \alpha_h^*, \alpha_\ell^*, \delta_h^*, \delta_\ell^*, \lambda^*, \theta^*, \beta^*\}$ such that (4)–(7), (9), (11), and (12) hold as equalities.

Note that, in this partially pooling equilibrium in which high-cost investors are the marginal information producers, either type of firm pays a larger cost per share sold to informed investors (since investor information production costs are borne in equilibrium by the firm through a lower share price) compared to the case in which low-cost investors are the marginal information producers.[18] When the firm is constrained to list only on the domestic exchange, it has no control over the kind of equilibrium that prevails. This changes, however, when the firm has a choice with respect to on which exchange to list its equity. Finally, regardless of whether the high-cost or the low-cost investors are the marginal information producers, the price p_H increases as the transparency γ of the exchange increases. Intuitively, this occurs because, as the transparency γ of the exchange increases, the precision of the information produced by outsiders increases, increasing the cost to the type-B firm of mimicking the type-G firm (through having to scale back its positive net present value project to a greater extent). This, in turn, leads the type-B firm to mimic the type-G firm less often as transparency increases, increasing the equilibrium share price (we prove these results in the appendix).

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[18]Unlike in microstructure models with "liquidity traders," in which it is often the ratio of liquidity demand to informed demand that determines the informativeness of prices, in our setting the equilibrium offer price is affected only by the number of low-cost information producers (rather than the relative numbers of low-cost and high-cost investors in an exchange). In liquidity trader models, such traders trade (suboptimally) despite their information disadvantage relative to informed investors, so that their very presence in the market affects prices. In contrast, in our setting, the behavior of both categories of investors is fully endogenous: in equilibria where low-cost investors are the marginal information producers, high-cost investors (optimally) choose not to produce any information, participating in the equity issue (if at all) only as uninformed investors, so that the number of high-cost investors has no effect on the offer price in the equity issue.

4. Equilibrium with exchange choice

We now allow the firm to choose between the domestic exchange X and the foreign exchange Y. We first assume (in Section 4.1) that listing on only one exchange at a time is allowed (so that no firm can dual list, i.e., list on both exchanges X and Y simultaneously). We introduce dual listing in Section 4.2.

4.1. Exchange choice with listing on only one exchange at a time

Without loss of generality, we assume that the listing standard set by the foreign exchange Y is higher than that set by the domestic exchange, i.e., $q^Y > q^X$. This, in turn, implies that $\gamma^Y > \gamma^X$, i.e., the transparency of the foreign exchange is better than that of the domestic exchange. Since listing on only one exchange at a time is allowed in this section, the nature of the equilibrium remains essentially the same here as in the previous section, except that the firm has to make the additional choice with respect to on which exchange to list its equity. We continue to use notation similar to the previous section, with superscripts X and Y attached to variables to denote exchanges X and Y, respectively.[19]

Proposition 2. (*Exchange listing choice*). *Let both exchanges have the same listing fees* $(F^X = F^Y = F)$. *Then*:

(i) *If* $N_\ell^Y \geqslant N_\ell^X$, *both firm types choose to list on exchange* Y.
(ii) *If* $N_\ell^Y < N_\ell^X$, *both firm types choose to list on exchange* X *if the number of low-cost investors on exchange* X *is large enough* $(N_\ell^Y \geqslant \bar{N}_\ell^X)$, *the number of low-cost investors on exchange* Y *is small enough* $(N_\ell^Y < \bar{N}_\ell^X)$, *and the transparency of exchange* Y *is not too large* $(\gamma^Y < \bar{\gamma}^Y)$. *They choose to list on exchange* Y *otherwise*.[20]

Proposition 2 (i) deals with the less complicated case in which the more transparent exchange, Y, also has a larger low-cost investor base. In this case, there are three possibilities: (i) the low-cost investors are the marginal investors if the firm chooses to list and issue equity in either exchange; (ii) the high-cost investors are the marginal investors if the firm chooses to list and issue equity in either exchange; (iii) the low-cost investors are marginal if the firm chooses exchange Y, and the high-cost investors are marginal if the firm chooses X (to see why the reverse is not possible, see the analysis in the appendix proof of Proposition 2). In all three of these cases, both types of firm are better off listing on exchange Y, since their equilibrium price per share will be greater when exchange Y is

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[19]Since our focus in Section 4 is on a firm's choice with respect to which exchange to list, and firms are directly concerned about the transparency of the exchange, we describe all propositions developed in these sections in terms of the transparency γ of an exchange rather than in terms of the listing standard q. However, the reader should keep in mind that all restrictions on γ can be directly translated into restrictions on the listing standard q, since the listing standard and the transparency of that exchange are one-to-one functions of each other. From Section 5 onwards, where we endogenize the exchanges' choice of listing standards, we shift our focus to exchanges' choice of listing standards, and will therefore characterize results in terms of q.

[20]The out-of-equilibrium beliefs of outsiders supporting the equilibria characterized in Proposition 2 and subsequent propositions regarding a firm's choice between exchanges is as follows: Any firm choosing to list on an exchange different from that specified in equilibrium, or setting a price other than p_H^* or p_L^*, or offering a number of shares other than n_H^* (at the price p_H^*) or n_L^* (at the price p_L^*) is a type-B firm with probability 1.

chosen. The assumption that the listing fees are the same across exchanges ensures that this fee is not a consideration in the listing decision.[21]

Since we assume, consistent with practice at most exchanges, that a firm pays the listing fees only if it obtains listing, the type-B firm has an incentive to mimic the type-G firm by applying to list on exchange Y (it will apply to exchange X only if rejected by exchange Y). Pooling with the type-G firm by applying for listing to the same exchange does not require the type-B firm to incur additional costs, while it allows it to obtain a higher share price with some probability (on the other hand, applying to an exchange different from the type-G firm would reveal itself to be a type B with probability 1, yielding a lower share price). Thus, both firm types choose to apply for listing on the same exchange even in a setting with exchange choice, so that the nature of the equilibrium is essentially similar to that in Proposition 1, in the sense that it is a partially pooling equilibrium with information production. Focusing on such equilibria (rather than on separating equilibria, where the two firm types apply to different exchanges to begin with) is justified by our assumption that only firms accepted for listing need to pay the listing fee (in other words, any upfront fees charged for exploring a listing on an exchange are negligible).[22] We focus on such partially pooling equilibria with information production (where the type-B firm pools with the type G by applying to the same exchange) throughout the paper.

Proposition 2 (ii) deals with the more complex case wherein the domestic exchange X has the advantage of having a larger base of low-cost investors, while the foreign exchange Y has the advantage of greater transparency. In this case, a firm's exchange choice is determined by the trade-off between greater transparency (of the foreign exchange) and the desire of the firm to obtain an equilibrium in which low-cost investors are marginal. Thus, if the proportion of low-cost information producers in the foreign exchange is not large enough, so that a listing on that exchange results in an equilibrium in which the high-cost investors are the marginal information producers, then firms choose to be listed on the (less transparent) domestic exchange X if this results in the more desirable equilibrium in which

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[21]Due to space limitations, in the single-period model we present only our analysis of situations in which the listing fees are the same across exchanges (since exchanges' listing fees are endogenous in our multiperiod model, different listing fees arise naturally there). However, if the listing fees charged by the foreign exchange are larger, it can be shown even in our single-period model that both types of firm will list on the foreign exchange if (and only if) the combined benefits provided by the additional transparency afforded by the higher listing standards of the foreign exchange and the potential switch to an equilibrium in which low-cost investors are the marginal information producers is large enough to overcome the disadvantage of this larger listing fee.

[22]In practice, most exchanges do not seem to have substantial upfront application fees and any such upfront fees or costs to firms arising from merely exploring the possibility of a listing are negligible compared to the benefits of obtaining listing at a more reputable exchange However, even if substantial upfront application fees were to exist, it can be shown in a model with multiple (>2) firm types that there will always be a partial pooling equilibrium in which several types of firms pool by applying to the same exchange in equilibrium. To illustrate, consider a setting in which there are three types of firms: Good, Bad, and Worse. If the application fees are significant (but not too large), the worse type will choose to separate by applying only to the lower listing standard exchange (to save paying the application fee for the higher listing standard exchange, since it views its chances of obtaining a successful listing there to be very low); however, the good and bad types of firms will both pool by applying first for a listing to the high listing standard exchange. Based on the insights from this three-type model, we can see that, in a setting with a number of firm types, the essential nature of the equilibrium will remain unchanged even in the presence of significant upfront application fees, except that the extent of pooling will become smaller as the magnitude of the upfront listing fees increases. Detailed characterization of the equilibrium in this extended model is available from the authors upon request.

the low-cost investors are the marginal information producers. On the other hand, firms continue to prefer the foreign exchange if its superior transparency is large enough (i.e., $\gamma^Y > \bar{\gamma}^Y$) that this advantage in transparency overcomes the disadvantage of an equilibrium in which high-cost investors are the marginal information producers. Further, even without such an overwhelming advantage in transparency, firms may prefer to list on the foreign exchange if the number of low-cost investors in that exchange, while smaller than that in the domestic exchange, is nevertheless large enough to ensure an equilibrium in which low-cost investors are the marginal information producers (as in the case where $N_\ell^Y \geqslant \bar{N}_\ell^Y$). Finally, if the proportion of low-cost investors even in the domestic exchange is so low that the equilibrium even with a listing in the domestic exchange will be one in which the high-cost investors are the marginal information producers, then firms again choose to list on the foreign exchange, since the better transparency of that exchange makes it the preferred exchange.

4.2. Exchange choice with dual listing

In this section, we introduce the possibility of dual listing.[23] Dual listing has two effects. First, it widens the base of low-cost investors available to evaluate the firm: upon dual listing, the number of low-cost investors becomes $N_\ell = N_\ell^X + N_\ell^Y$ and the number of high-cost investors becomes $N_h = N_h^X + N_h^Y$. Perhaps the more interesting effect of dual listing, however, is on transparency: the precision of the information available to investors in both exchanges goes up to γ^Y under dual listing (assuming as in the previous section that $\gamma^Y > \gamma^X$), since the additional regulations on disclosure imposed by the exchange with the more stringent listing standards would help investors trading even in the exchange with the lower listing standards access better-quality information when valuing the firm.

However, the advantages of dual listing in terms of investor base and transparency have to be traded off against the additional listing costs charged by the second exchange and the additional costs of complying with additional regulations due to the second listing. Dual listing may be chosen in equilibrium in two different cases. The first (and simpler) case is the one in which the foreign exchange Y has both greater transparency and a larger low-cost investor base than the domestic exchange (so that, if dual listing were not possible, firms would always prefer to list on the foreign exchange Y rather than on the domestic exchange X alone). In this case, dual listing enlarges a firm's low-cost investor base but has no effect on precision, since, in any case, the firm would have listed on the more transparent exchange Y in the absence of dual listing. In this case, firms choose dual listing if listing on the domestic exchange in addition to the foreign exchange widens the investor base to such an extent that it allows the equilibrium to switch to one in which it is the low-cost (rather than high-cost) investors who are the marginal information producers, and further, the fees and compliance costs of listing on the additional exchange are not so large that they swamp these additional benefits. The second (and more complicated) case arises when the domestic exchange X has the advantage of having a larger low-cost investor base over the foreign exchange. Now, the most interesting scenario arises when neither the domestic exchange X nor the foreign exchange Y has a pool of low-cost investors large enough that an equilibrium with low-cost investors will not arise from listing in either

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[23]Due to space limitations, we confine ourselves to intuitive discussions of various results in this section. Formal derivations of these results are available in Chemmanur and Fulghieri (2005).

exchange X alone or Y alone. In this case, dual listing not only increases the low-cost investor base, but also ensures that the transparency of trading will be that of the exchange with the higher listing standard, Y. Dual listing will be the equilibrium choice in this case if the enlarged investor base switches the equilibrium to one where the low-cost investors are the marginal information producers, provided that the additional listing fees and compliance costs are not so high that these benefits from dual listing are overcome.

5. Exchange reputation and listing standard choice

We now build on our single-period model to develop a dynamic model (two periods, three dates: 0, 1, and 2) to endogenize an exchange's listing standard choice. We assume in this section that the exchange acts as a monopolist, setting standards to maximize the sum of its cash flows in isolation. We also endogenize the listing fees charged by each exchange in this section. In the dynamic model, at dates 0 and 1 a new round of firms enter the equity market and apply for a listing to the exchange. Before the firms' entry, the exchange decides on its listing standard for applicant firms. The cash flows of firms listed at time 0 are realized at time 1 (prior to the entry of a new round of firms), while the cash flows of firms listed at time 1 are realized at time 2, at which point the game ends (see Fig. 1). The remaining events occurring at each date are the same as in our single-period model.

The exchange's listing procedure continues to be as discussed in Section 2.3, with the exchange's listing standard, q_t, determining both the fraction of firms that are listed, given by (3), and the precision of the information available to information producers (transparency of the exchange), given by $\gamma_t = \gamma_t(q_t)$. However, here we simplify the $\gamma_t(\cdot)$ function by assuming that $\gamma_t(q_t) = q_t$. Further, we assume that the listing costs of each firm consist solely of listing fees (ignoring any dissipative compliance costs incurred by firms), so that the entire amount F expended by firms in listing costs goes to the exchange as listing fees.[24]

We now assume that at each date, exchange E chooses its listing standard, denoted by q_t^E, privately.[25] To model the notion of an exchange's "reputation," we introduce two types of exchanges: while most exchanges are "Value Maximizing" (type M), a small proportion are "Standard Maximizing" (type S). The objective of a value-maximizing exchange M is to set its listing standards to maximize the sum of its cash flows from future listing fees. The standard-maximizing exchange S simply sets the highest possible standard, $\bar{q}$, at each date $t = 0, 1$. While each exchange knows its type, at any date t outsiders (firms and investors) observe only a probability assessment, ρ_t, $t = 0, 1$, of an exchange being of type S (as we discuss later, ρ_t measures an exchange's reputation for setting a stringent listing standard at date t).

Clearly, the value-maximizing exchange is subject to moral hazard, which arises from two sources. First, if it sets higher standards, it may have to incur greater verification and regulatory costs. We denote such costs by $w_t(q_t^E)$ and assume that they are increasing in the

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[24]This essentially implies that the compliance costs are the same across exchanges, so that such costs can be normalized to equal zero. We make this assumption for ease of exposition since we do not wish to study the effects of differential compliance costs. However, differences in compliance costs across exchanges can be reintroduced easily, but at the expense of some additional notation.

[25]While the formal listing requirements of an exchange are typically public information, the rigor with which an exchange engages in the fact checking required to enforce these standards is usually information private to an exchange. As we clarify in the introduction, our assumption that exchanges choose their listing standards privately should be interpreted in this broader sense.

exchange's listing standards. Second, by raising the listing standard, the exchange reduces its expected cash flow from listing fees, since a smaller fraction of firms that apply for listing are accepted. Thus, our definition of a type-S exchange is simply that of an "idealized" exchange that is not subject to this pressure to lower the listing standard in order to maximize revenue.

Given that standard-maximizing exchanges set the highest possible listing standard $\bar{q}$ at each date, the probability ρ_0 of an exchange being of type S measures its reputation at time 0 for setting stringent listing standards.[26] At time 1, outsiders update this probability based on whether the firm listed by the exchange at time 0 turned out to be of type B or of type G (inferred from its true cash flows, realized and publicly observed prior to time 1), or whether any firm was listed by the exchange at all at time 0 (we normalize the number of firms applying for listing on each exchange at each date to equal one).[27]

The expected volume Q_t of firms listed at date t at an exchange with listing standards q_t is given by $Q_t = \omega + (1 - q_t)(1 - \omega)$. Assuming that the exchange charges a constant fraction s, $0 < s < 1$, of equity value, the listing fee collected by an exchange at date t is given by

$$F_t = sV_{Ht} = s(m + n_{Ht})p_{Ht}, \tag{13}$$

where V_{Ht} is the total equity value of a firm at the high share price p_{Ht} (to minimize complexity, we assume that a firm is not charged a listing fee if it separates itself in equilibrium, since, in this case, there is no information production in equilibrium, so that the exchange's listing standard does not create any value for a firm). Given that the type-S exchange always sets the highest possible listing standard at any date t, all outsiders (both firms and investors) expect the transparency of an exchange with a reputation ρ_t to be

$$\gamma_t = \rho_t \bar{q} + (1 - \rho_t)q_t^M, \tag{14}$$

where q_t^M is the listing standard endogenously set by exchange M. Let ρ_1^G, ρ_1^B, or ρ_1^N, respectively, denote the updated value of the exchange's time-1 reputation, conditional on the firm listed at time 0 being revealed at time 1 to be of type G or type B, or if no firm is listed at time 0 (we will add an additional superscript E, $E = X$, Y, to ρ_1^G, ρ_1^B, or ρ_1^N, in Section 6 when we study competition between exchanges). These are given by

$$\rho_1^G = \frac{\dfrac{\omega\rho_0}{\omega + (1 - \bar{q})(1 - \omega)\beta_0^*}}{\dfrac{\omega\rho_0}{\omega + (1 - \bar{q})(1 - \omega)\beta_0^*} + \dfrac{\omega(1 - \rho_0)}{\omega + (1 - q_0^M)(1 - \omega)\beta_0^*}}, \tag{15}$$

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[26] The assumption of a stock exchange not being subject to moral hazard and therefore setting up the highest possible standard always (type S or standard-maximizing exchanges) is simply a modeling device (now standard in the literature) to model reputation acquisition in a finite-horizon model. The finite-horizon approach was first adopted by Kreps and Wilson (1982a, b): see Chemmanur and Fulghieri (1994) for a finance application. This assumption of a standard-maximizing exchange is not essential to studying the economics of the problem we analyze, since, in principle, we could model this reputation acquisition by exchanges in an infinite-horizon model. However, given the rich strategy space in our setting, such an infinite horizon model of reputation acquisition by exchanges would be intractable. Thus, we adopt a finite-horizon modeling approach here.

[27] Our results remain qualitatively unchanged even if we do not adopt this normalization, but instead allow several firms to apply for listing at a given date. In this case, the reputation updating at time 1 is based on the fraction of firms applying for listing that are accepted by the exchange at time 0, and on the proportion of the firms listed at time 0 that turn out to be good or bad at time 1.

$$\rho_1^B = \frac{\dfrac{(1 - \bar{q})(1 - \omega)\beta_0^* \rho_0}{\omega + (1 - \bar{q})(1 - \omega)\beta_0^*}}{\dfrac{(1 - \bar{q})(1 - \omega)\beta_0^* \rho_0}{\omega + (1 - \bar{q})(1 - \omega)\beta_0^*} + \dfrac{(1 - \bar{q})(1 - \omega)\beta_0^* \rho_0}{\omega + (1 - q_0^M)(1 - \omega)\beta_0^*}}, \quad \rho_1^N = \frac{\bar{q}\rho_0}{\bar{q}\rho_0 + (1 - q_0^M)(1 - \rho_0)}.$$

$$(16)$$

At time 0, the value-maximizing exchange chooses its listing standard q_0^M in order to maximize the sum of cash flows received from listing fees over time 0 and time 1, given by

$$\pi_0(q_0^M) = [\omega + (1 - q_0^M)(1 - \omega)\beta_0^*] sV_{H0}(\rho_0) + \omega s V_{H1}^G(\rho_1^G)$$
$$+ (1 - q_0^M)(1 - \omega)\beta_0^* s V_{H1}^B(\rho_1^B) + q_0^M(1 - \omega)\beta_0^* s V_{H1}^N(\rho_1^N) - \omega(q_0^M), \quad (17)$$

where V_{H1}^G, V_{H1}^B, and V_{H1}^N, respectively, denote the total equity values of a firm listed at the high share price p_H in the exchange at time 1, corresponding to whether the firm listed at time 0 turns out to be good or bad, or no firm was listed at time 0 (we will add an additional superscript E to V_{H1}^G, V_{H1}^B, and V_{H1}^N, respectively, $E = X, Y$, in Section 6 when we study competition between exchanges). Each of the above three equity values depends on the exchange's time-1 reputation updated from its time-0 reputation according to (15) and (16). The first term on the right hand side (RHS) of (17) gives the exchange's cash flow from listing fees at time 0 (which is a function of its time-0 reputation). The sum of the second, third, and fourth terms gives the sum of time-1 listing fees collected by the exchange, with each individual term giving the listing fee depending on the exchange's updated time-1 reputation. The last term on the RHS gives the exchange's verification and regulation cost at time 0.

Proposition 3. (*Exchange reputation and endogenous listing standards*). (*i*) *The equilibrium listing standards chosen by the type-M exchange is given by* $0 \leqslant q_0^{M*} < \bar{q}$ *and* q_1^{M*}. *The type-S exchange, on the other hand, always sets the highest possible standard,* $q_0^{S*} = q_1^{S*} = \bar{q}$. (*ii*) *Let the highest possible listing standard that can be set by an exchange,* $\bar{q}$, *be above a threshold value* $\hat{q}$, *and let the time-0 reputation of the value-maximizing exchange,* ρ_0, *be below a critical value* $\hat{\rho}$. *Then, the listing standard chosen by a value-maximizing exchange,* q_0^{M*}, *is increasing in its current reputation.*[28]

The listing standard chosen by the value-maximizing exchange (whose behavior we are concerned with here) at time 0 emerges from the following dynamic trade-off: on the one hand, lowering the time 0 listing standard increases current listing fees to the exchange, and reduces current verification cost and, on the other hand, doing so increases the chance of

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[28]The conditions on $\bar{q}$ and ρ_0 here and in following propositions ensure the monotonicity of q_0^{M*} as a function of ρ_0. In their absence, the firm may have an incentive to "milk" its reputation so that q_0^{M*} may not necessarily be increasing in ρ_0, so that the relationship between the current exchange reputation and listing standard is ambiguous. For instance, when ρ_0 is close to one, the exchange has an incentive to "milk" its current reputation by lowering standards and increasing volume. However, as far as we can see, this effect is primarily due to the fact that we limit ourselves to a two-period reputation model. We find that once we include a larger number of future periods in our model, the number of future periods that the exchange has to enjoy its reputation becomes larger, and the incentive to "live off" its current reputation by lowering standards prevails only for a smaller range of parameter values, since any such move imposes a larger penalty on the exchange by hurting its revenue stream over a larger number of future periods.

losing reputation at time 1 (reducing the market value of the firms listed at time 1), and consequently the exchange's time-1 cash flows from listing fees. Reputation thus allows the exchange to commit to both investors and firms that it will not lower its standards excessively in order to attract a larger volume of firms to list on it, or to reduce verification costs. The listing standard set by a value-maximizing exchange at time 0 is increasing in its current reputation: the greater the reputation of the exchange, the more it has to lose from lowering standards. At time 1, however, the value-maximizing exchange has no concern about losing reputation (since it is the last period), and it sets the lowest possible standard, $q_1^{M*} = 0$.

6. Competition and cooperation among exchanges

In this section, we examine how competition and cooperation among exchanges interacts with exchange reputation in determining listing standard choice. We first study the effect of competition alone (Section 6.1) before analyzing the effects of both cooperation and competition among exchanges (Section 6.2).

6.1. The effect of competition alone on listing standard choice

In order to allow for competing exchanges, we enrich our model further by allowing each exchange to make two-sided errors when screening firms that apply for listing, as follows:

$$Pr\{accepted/f = G\} = \eta, \quad Pr\{accepted/f = B\} = \eta - q_t, \qquad (18)$$

where each type of firm is rejected with the complementary probability, $q_t \in [0, \bar{q}]$ and $q_t \leqslant \bar{q} < \eta < 1$. Notice that this modified evaluation technology makes the model slightly more realistic by allowing for a positive probability of the type-G firm being rejected by any exchange (since $\eta < 1$); setting $\eta = 1$ gives us the same listing procedure as in the previous sections. Note also that, even under this modified listing technology, a type-G firm will continue to be accepted by an exchange with a greater probability than a type-B firm.

As before, there are two exchanges X and Y. When exchanges compete, we allow for the possibility that a firm rejected for listing by one exchange may apply for listing to the other exchange in equilibrium. Denote an exchange's prior probability that a firm applying for a listing is of type G by ω^E, $E = X, Y$ (the quality of the pool of firms applying for listing in equilibrium may now vary across exchanges). The reputation formation process is similar to that in the previous section: at any date t, $t = 0, 1$, outsiders assess that each exchange E, $E = X, Y$, is of the standard-maximizing type (S) with the probability ρ_t^E (recall that this probability captures the exchange's reputation) and of the value-maximizing type (M) with the complementary probability. The objective of each value-maximizing exchange E, $E = X, Y$, is modified to

$$\pi_0^E(q_0^E) = [\omega^E \eta + (\eta - q_0^E)(1 - \omega)\beta_0^{E*}]sV_{H0}^E(\rho_0^E) + \omega^E \eta s V_{H1}^{EG}(\rho_1^{EG})$$
$$+ (\eta - q_0^E)(1 - \omega^E)\beta_0^{E*}sV_{H1}^{EB}(\rho_1^{EB}) + (1 - \eta + q_0^E)(1 - \omega^E)\beta_0^{E*}sV_{H1}^{EN}(\rho_1^{EN}) - w(q_0^E).$$
$$(19)$$

Proposition 4. (*Equilibrium with competing exchanges*). *Let $N_\ell^X \leqslant N_\ell^Y$ and let the reputation of the two exchanges and the proportion of type-G firms in the pool of applicant firms be below certain critical values ($\rho_0^X < \rho_0^Y < \bar{\rho}$ and $\omega < \hat{\omega}$). Then:*[29]

(i) *The high-reputation exchange Y sets higher current listing standards than the low-reputation exchange X in equilibrium: $q_0^{Y*} > q_0^{X*}$.*

(ii) *Both firm types first apply for listing to the higher-reputation exchange, moving on to the lower-reputation exchange only if rejected.*[30]

The above proposition examines the case in which exchange Y has at least as many low-cost investors as exchange X, and the two exchanges compete only through listing standards (one can now think of this case as two exchanges competing in the same country, dropping our earlier interpretation of X as the domestic exchange and Y as the foreign exchange). In this case, exchange Y has an advantage in that it can use its greater reputation as a device to commit to outsiders that its listing standards are higher than those of exchange X. This is because the listing standard that would be set by each exchange as a monopolist serves as an upper bound for the listing standard set by the same exchange in a setting with competition. Further, recall that the listing standard when each exchange acts as a monopolist is increasing in current reputation. Thus, firms apply first to exchange Y, ceteris paribus (to take advantage of the greater transparency associated with higher listing standards), applying to the lower-reputation exchange X only if rejected by exchange Y.[31]

We now study how competition interacts with considerations of building and maintaining reputation in determining exchanges' listing standards. Denote by q_0^{Xm*} and q_0^{Ym*} the equilibrium listing standards that would be set by exchanges X and Y respectively if they were monopolists, and denote the corresponding equilibrium time 0-listing standards when the two exchanges compete by q_0^{Xc*} and q_0^{Yc*}, respectively.

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[29]In Propositions 4, 5, and 6, the condition $\omega < \hat{\omega}$ ensures that the listing standard set by an exchange is monotonic in the quality of the pool of firms applying to it for listing. This condition rules out the extreme scenario in which the quality of the pool of applicant firms approaching an exchange is so high that an exchange has an incentive to lower listing standards (rather than raise them) as this quality increases (since, given the already high quality pool of applicant firms, the benefit to the exchange of raising the listing standard and thus devoting additional resources to screening firms would be small enough that that it is overcome by the incremental cost of doing so). The condition $\rho_0^Y < \bar{\rho}$ guarantees the monotonicity of q_0^{Y*} as a function of ρ_0^Y, since otherwise the exchange may have an incentive to milk its reputation (see the discussion in footnote 28). In the absence of these restrictions, we would be unable to characterize the relation between the listing standards set by the high- and low-reputation exchanges (as we do in Proposition 4), and between the listing standards set by the same exchange when it is a monopolist versus when it faces competition (as we do in Propositions 5 and 6).

[30]Note that, since we take listing fees charged by exchanges as endogenous here, no condition on the magnitude of these fees is required for this proposition to hold (unlike in earlier sections, wherein listing costs are exogenous). Since exchanges charge a fraction $s < 1$ of market capitalization as fees, it always makes sense for firms to obtain a listing on that exchange in which their equity will be more highly valued.

[31]In practice, we may not explicitly observe firms applying to a given exchange, being rejected, and then applying to another exchange. However, we do read about firms being in negotiations with several exchanges about the feasibility of obtaining a listing, and then announcing that they have obtained a listing on one of these exchanges (which may not be the most reputable among the group of exchanges it has been in negotiations with). In many of these instances, a firm ends up obtaining a listing on a less reputable exchange only because it has been privately informed by more reputable exchanges that it did not meet their listing standards.

Proposition 5. (*Competition and listing standard choice when the higher reputation exchange has a larger low-cost investor base*). *Let $N_\ell^X \leqslant N_\ell^Y$ and let the reputation of the two exchanges and the proportion of type-G firms in the pool of applicant firms be below certain critical values ($\rho_0^X < \rho_0^Y < \bar{\rho}$, and $\omega < \hat{\omega}$). Then:*

 (i) *The listing standard set by the high-reputation exchange Y will be the same as would be set by the same exchange if it were a monopolist ($q_0^{Yc*} = q_0^{Ym*}$).*
(ii) *The listing standard set by the low-reputation exchange in this case is lower than that set by the same exchange if it were a monopolist ($q_0^{Xc*} < q_0^{Xm*}$).*

The above proposition isolates the effect of competition on the choice of listing standard by the two exchanges. Since the two exchanges have a similar number of low-cost investors, and they compete only through listing standards, Proposition 4 shows that the higher-reputation exchange sets higher listing standards in equilibrium. Thus, exchange Y has an applicant pool of the same volume and quality as it would have if it were a monopolist, since all firms apply first to exchange Y, going to X only if rejected by Y. The solution to the higher-reputation exchange's maximization problem is therefore the same as that in which it is a monopolist, with no effect on listing standard. The lower-reputation exchange, on the other hand, now faces a reduction in the size and quality of the pool of applicant firms compared to the case when it is a monopolist (since only firms rejected by exchange Y apply for listing on exchange X). Thus, it will optimally set a lower equilibrium listing standard under competition than under monopoly.

Proposition 6. (*Competition and listing standard choice when the lower reputation exchange has a larger low-cost investor base*). *Let $N_\ell^X > N_\ell^Y$ and let the reputation of the two exchanges and the proportion of type-G firms in the pool of applicant firms be below certain critical values ($\rho_0^X < \rho_0^Y < \bar{\rho}$, and $\omega < \hat{\omega}$). Further, let N_ℓ^X be large enough ($N_\ell^X \geqslant \bar{N}_\ell^X$) and N_ℓ^Y be small enough ($N_\ell^Y < \bar{N}_\ell^Y$). Then:*
 (i) *If $\rho_0^Y \geqslant \rho_2(\rho_0^X)$, exchange X sets $q_0^{Xc*} < q_0^{Xm*}$ and exchange Y sets $q_0^{Yc*} = q_0^{Ym*}$.*
(ii) *If $\rho_0^Y < \rho_1(\rho_0^X)$, exchange X sets $q_0^{Xc*} = q_0^{Xm*}$ and exchange Y sets $q_0^{Yc*} < q_0^{Ym*}$.*

The assumption here is that, since exchange X has a much larger investor base than the more reputable exchange Y, the equilibrium will be one in which the low-cost investors are the marginal information producers if the firm is listed on exchange X alone, while it will be one in which the high-cost investors are the marginal information producers if the firm is listed on exchange Y alone. The interesting question here is whether the disadvantage of exchange Y in terms of low-cost investor base can be bridged by its greater reputation relative to exchange X. This is indeed the case if the reputation of exchange Y is overwhelmingly larger than that of exchange X (i.e., when $\rho_0^Y \geqslant \rho_2(\rho_0^X)$). In this case, exchange Y acts like a monopolist, setting the same listing standard under competition that it would set as a monopolist. Firms, inferring this equilibrium behavior, first approach it for a listing, going to exchange X only if rejected; the equilibrium listing standard set by exchange X is correspondingly lowered (relative to the case in which it is a monopolist) to adjust for the smaller, poorer quality applicant pool it faces. On the other hand, if the reputation levels of the two exchanges are close enough (i.e., when $\rho_0^Y < \rho_1(\rho_0^X)$, so that the advantage enjoyed by exchange X in terms of its larger base of low-cost information producers cannot be overcome by exchange Y even by setting the same high listing

standard that it would set if it were a monopolist, then it will be exchange X that acts like a monopolist in equilibrium. In this case, exchange Y will be the one which has to face the poorer quality applicant pool consisting of rejects from exchange X, and will consequently lower its listing standard (relative to the monopolist situation) in order to maximize its long-term profit in the face of such an applicant pool.[32]

6.2. The effect of both cooperation and competition on listing standard choice

We now study the situation in which some exchanges cooperate (by forming alliances or merging with each other) while competing with others.[33] We assume that there are three exchanges to begin with: X, Y, and Z. We study the effects of a merger or an alliance between exchanges X and Z, and the subsequent competition between the combined exchange (denoted by XZ) and the stand-alone exchange Y on the equilibrium behavior of both these exchanges, and of firms planning to list on one of these exchanges. A merger between exchanges X and Z means that all investors who previously traded on either one of them can now trade in a common market place. Further, stocks that were previously listed on either exchange X or exchange Z are now listed on the combined exchange XZ. Thus, one effect of the merger is that the pool of low-cost investors available to trade in these stocks now increases to $N_\ell^{XZ} = N_\ell^X + N_\ell^Z$. This larger pool of low-cost investors may, in turn, lead to two other effects, first, on the listing behavior of firms, and second, on the listing standards endogenously chosen by the merged exchange XZ and the stand-alone exchange Y that competes with it.

To focus on the case in which a merger between exchanges affects firms' listing choices and exchanges' listing standards most dramatically, we assume that, prior to the merger, exchange Y has a greater reputation compared to the two exchanges X and Z individually, so that $\rho^Y > \max\{\rho^X, \rho^Z\}$, and that it has the largest number of low-cost investors, i.e., $N_\ell^Y > \max\{N_\ell^X, N_\ell^Z\}$. These two assumptions together imply (using Proposition 5) that, prior to the merger between X and Z, exchange Y dominates these two exchanges (in the sense that all firms would prefer to be listed on this exchange rather than on the other two). In this situation, the stand-alone exchange Y will dominate even after the merger between X and Z if the number of low-cost investors in that exchange is more than that in the combined exchange XZ, so that all firms prefer to be listed on Y rather than on the combined exchange XZ (recall that the listing standard set by the stand-alone exchange Y will also be higher than that of XZ, assuming that the exchange Y retains the advantage of having a greater reputation than XZ).[34] If, however, the number of low-cost investors in the combined exchange is sufficiently greater than that in the stand-alone exchange, then firms will make their listing choice by trading off the advantage provided by the higher listing standard set by the stand-alone exchange against the benefit of the greater number of low-cost investors in the combined exchange. In particular, if the advantage of the larger low-cost investor base of the merged exchange is significant enough that it dominates the

[32]If $\rho_1(\rho_0^X) < \rho_0^Y < \rho_2(\rho_0^X)$, it is not possible to rank firms' preferences among exchanges and characterize the relations between q_0^{Xc*} and q_0^{Xm*} and between q_0^{Yc*} and q_0^{Ym*} without further assumptions.

[33]Due to space limitations, we confine ourselves to intuitive discussions of various results in this section. Formal derivations of these results are available in Chemmanur and Fulghieri (2005).

[34]Assuming that this condition is satisfied, our results do not depend on how the reputation of the merged exchange is derived from those of the constituent exchanges, so that we do not assume a particular reputation formation rule for the combined exchange in deriving this result. See Chemmanur and Fulghieri (2005) for details.

effect of the higher listing standard set by the stand-alone exchange *Y*, then all firms will prefer to be listed in the merged exchange. In this case, the stand-alone exchange Y will attract only a lower-quality pool of applicant firms, forcing it to lower its listing standards subsequent to the merger. Finally, if the combined exchange's reputation is not too low (so that it is above a certain threshold value), then the equilibrium listing standard set by this exchange will be *higher* than that set by either of the two exchanges *X* or *Z* before merging (since the equilibrium listing standard set by the merged exchange will correspond to its better pool of applicant firms relative to that of exchanges *X* and *Z* before their merger).

7. Implications of the model

(i) *Listing on foreign exchanges alone, dual listing, and global IPOs*: Firms will list on a foreign exchange alone if most of the group of investors who have a comparative advantage in evaluating their firm (low-cost investors) trade in the foreign exchange rather than in the domestic exchange, and the foreign exchange has the same or greater transparency than the domestic exchange. This applies, for instance, in the case of many high-technology firms from abroad (e.g., Israel) that obtain a NASDAQ listing rather than a listing on an exchange in their own country (with a smaller base of investors with a comparative advantage in evaluating such firms).[35] Firms will dual list when they have a significant base of low-cost information producers in their own country, but would like to enlarge that base by listing in the foreign exchange, or take advantage of the higher transparency of the foreign exchange, or both. Our model predicts that the types of firms that will be likely to take advantage of dual listing will be those about which foreign investors have, for various reasons, a significant amount of information available to them (so that a substantial number of investors with a cost advantage in evaluating the firm are present in the foreign market). Consistent with this implication, Pagano, Roell, and Zechner (2002) find that European firms that choose to obtain an additional listing on the NYSE are either high-tech companies or large export-oriented companies that have become familiar to American investors through having used a product or service of the listing firm.[36]

(ii) *Price effects of cross-listings*: Our model predicts a positive announcement effect of a listing decision on the equity of the listing firm when the foreign exchange has a higher

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[35]Evidence supporting this implication is provided by Blass and Yafeh (2000), who find that high-tech firms from Israel are more likely to be listed on the Nasdaq rather than on the Tel Aviv exchange, despite the fact that it would be cheaper (in terms of listing fees) for these firms to list on the Tel Aviv exchange. Additional anecdotal evidence supporting this implication is provided by high-tech firms from other countries (e.g., France) listing on NASDAQ without listing on any exchange in their home country.

[36]Additional evidence supporting this implication is provided by Saudagaran and Biddle (1995) and Saudagaran (1988), who find a strong association between the foreign listing location of a given firm and the level of its exports to that country. While such evidence can also be interpreted as a foreign listing helping the firm in the product markets in that country (rather than a presence in the product market motivating a foreign listing), anecdotal evidence seems to indicate that the motivation goes both ways. For example, consider the following quote (WSJ, October 5, 1993) from one of the officers of Daimler–Benz, the German auto-maker, about its decision to list on the NYSE: "'We have 300,000 Mercedes drivers in the U.S., and about two-thirds of them are certainly wealthy,' says Mr. Liener, suggesting that the company's image will help it tap the U.S. financial markets." Also, the listing of the German software firm SAP on the NYSE was motivated, at least in par, by the presence in the U.S. of a large number of software and other high-technology professionals and investors that have considerable familiarity with evaluating and investing in technology firms (Economist, August 14, 1998).

listing standard than the domestic exchange, or a substantial base of investors who have a comparative advantage in evaluating the firm, or both. In the absence of these two factors, our model predicts a negative or zero announcement effect to foreign listings (since such a listing might be value-reducing if significant additional listing costs are incurred). Thus, when European firms list their equity in the US, our model predicts a positive listing (and therefore announcement) effect. However, when an American firm lists its equity on a European exchange, our model predicts a negative or zero announcement effect on stock prices.[37]

(iii) *Cross-listing and financial analyst following*: A directly testable implication of our model is that cross-listing by foreign firms, say, at the NYSE, should be followed by increased analyst coverage (since increased information production, and increased transparency arising from higher listing standards are the two factors motivating firms to cross-list in our model). This also implies that, holding listing standards constant, the increase in analyst coverage should be larger for firms listing on the exchange with greater listing costs (since the advantage of listing on that exchange has to compensate for the higher listing cost). In a comparative study of firms cross-listed on the NYSE or the LSE, Baker (1999) provides strong empirical support for this implication. First, they document that firms cross-listed on either one of these exchanges experienced a significant increase in analyst following. Second, in the set of firms which seem to broadly satisfy the listing standards of either exchange, the increase in analyst following is significantly greater for firms cross-listed on the NYSE, where both the direct as well as indirect listing costs are significantly greater.

(iv) *Exchange reputation, listing standards, and competition among exchanges*: Our model predicts that the greater the reputation of an exchange, the higher the listing standard set by that exchange. Further, an exchange's concern for its future reputation allows it to commit not to lower listing standards excessively. Finally, when two exchanges compete, the effect of this competition on listing standards depends, among other things, on the reputation level of the two exchanges, and the base of low-cost investors trading in each exchange. If the low-cost investor base is the same for both exchanges, then the higher-reputation exchange is dominant, and competition may not affect its listing standards at all. In contrast, the lower-reputation exchange sets significantly lower standards (compared to the case in which it does not face any competition).[38] Alternatively, if the investor base of the two exchanges are different, so that the higher-reputation exchange has a significantly smaller base of low-cost investors than the lower-reputation exchange, it is the higher-reputation exchange that has to lower its listing standards in equilibrium.[39]

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[37]The empirical evidence seems to support this implication of our model. Most research that focuses on foreign firms listing in the U.S. market (e.g., Jayaraman et al., 1993; Forester and Karolyi, 1993; Alexander et al., 1988) concludes that the announcement of a foreign listing on a U.S. exchange is associated with a positive market reaction. In contrast, the empirical research focusing on overseas listing of U.S. firms (e.g., Howe and Kelm, 1987; Lau et al., 1994) finds either negative or insignificant changes in shareholder wealth.

[38]One example that comes to mind is the competition between NYSE and the American Stock Exchange (AMEX), which have the same investor base. Clearly, the NYSE has significantly greater reputation and higher listing standards than the AMEX; it seems to be the case that, while competition between the two exchanges has not affected the NYSE listing standards in any significant way, the AMEX seems to be struggling to attract firms to list on that exchange.

[39]A real-world illustration of this implication is provided by the competition for listing firms from emerging market countries between the LSE and the NYSE, with the latter usually regarded as having a better reputation and higher listing standards than the former. Assuming that the two exchanges have perhaps similar investor

Thus, we show that a "race to the bottom" in listing standards need not materialize as a result of competition between exchanges. In fact, we show that exchanges with different reputations and therefore listing standards can coexist.

(v) *Cooperation and competition among exchanges*: There has been a recently accelerating trend of mergers or alliances between exchanges in a bid to improve their competitive position relative to other exchanges. Our model provides several insights into the effects of such mergers or alliances between exchanges not only on the exchanges involved in the merger, but also on the exchanges that compete with the combined exchange. First, our model demonstrates how two smaller exchanges can improve their competitive position against a third, larger exchange by merging and thereby pooling their low-cost investor base. Second, our model predicts the effect of a merger between exchanges on the listing standard set by the combined exchange and also by the other exchanges competing with it. It is an often-expressed fear that when two exchanges merge or form an alliance, the listing standard of the combined exchange will be set at the lower of the listing standards of the two constituent exchanges (the "lowest common denominator"). Our analysis indicates that this fear need not always be realized: the listing standard set by the combined exchange depends on the competitive position of this exchange subsequent to the merger. If this exchange is sufficiently dominant, then the listing standard set by it will in fact be higher than that of either of the exchanges that form the merger or alliance. In this case, exchanges competing with the combined exchange will optimally have to lower their listing standards as a result of the merger, since the quality of their applicant pool will be reduced by it.[40]

(vi) *Competition, listing standards, and the optimal regulation of exchanges*: Our analysis also contributes to the debate on the optimal regulation of exchanges after they go public and thus become value-maximizing corporations. Some have argued that exchanges should be stripped of their self-regulatory authority after going public, with all such authority resting in a centralized regulatory authority common to exchanges.[41] Our analysis suggests

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(*footnote continued*)

bases in terms of their low-cost investor base in evaluating firms from emerging economies, our model predicts that the NYSE would not lower its listing standards in the presence of competition from the LSE, whereas the LSE would have to significantly lower its listing standards for such firms. In contrast, consider a potential attempt by the NYSE to attract listings from firms based in the U.K. In this case, the LSE can be expected to have a considerable advantage in terms of its low-cost investor base capable of evaluating British firms, which may be large enough to overcome the advantage of the NYSE in terms of greater reputation and listing standards. If this is the case, competition from the NYSE would not induce the LSE to lower listing standards for British firms; if anything, the NYSE will have to lower its listing standards to attract British listings.

[40]A real-world illustration of this is provided by the merger of the Amsterdam, Brussels, and Paris stock exchanges to form "Euronext" in September 2000. One of the stated goals of the management of the combined exchange has been to tighten the disclosure requirements on firms listing on the combined exchange after the merger, which seems to be consistent with an *increase* in listing requirements.

[41]See, for instance, an article by Jeffrey Garten, Dean of the Yale School of Management ("How to Keep NYSE's Stock High," *Wall Street Journal*, January 11, 2000). To quote: "If the exchange goes public, its self-regulating authority would create huge conflicts of interest between the Big Board's legitimate mandate to enrich its shareholders by attracting new listings, and the requirement to regulate many of those same shareholders as they trade on the exchange's floor. A second conflict would arise in setting listing requirements for new companies, as there would be a temptation to dilute standards or relax surveillance over them in order to sign up more corporate clients…. A far better option is to strip the exchanges of most of their regulatory authority and to create one independent national self-regulating body…. it could apply uniform standards on all market participants." A somewhat similar proposal was also endorsed by former SEC chairman Arthur Levitt (see, e.g., "SEC seeks One Market Regulator," *Washington Post*, Sept 22, 1999).

first that even when exchanges act as value-maximizing entities, they have strong incentives to set appropriately high listing standards in order to protect their reputation and thus maximize their own long-run profits and therefore stock value. Second, our analysis implies that reposing all regulatory authority in a centralized agency and adopting a "one size fits all" approach may affect the economic viability of value-maximizing exchanges, since, in order to survive, they need the flexibility to optimally tailor their listing standards to their pool of applicant firms, with the quality of this pool varying as a result of competitive pressures from other exchanges.

8. Conclusion

We analyze firms' choice of exchange to list equity and exchanges' listing standards choice, when insiders have private information about firm value but outsiders can produce (noisy) information at a cost. In our model, exchanges are populated by two kinds of investors, whose numbers vary across exchanges: sophisticated (low information production cost) investors and ordinary (high-cost) investors. While firms are short-lived, exchanges are long-lived, value-maximizing agents whose listing and disclosure standards evolve over time. The listing standards chosen by exchanges affect their "reputation," since outsiders can partially infer the rigor of these standards from the post-listing performance of firms. We show that while exchanges use their listing standards as a tool with which to compete for listings with other exchanges, this will not necessarily lead to a "race to the bottom" in listing standards. Further, a merger between two exchanges may result in a *higher* listing standard for the combined exchange relative to that of either of the merging exchanges. We develop several other implications for the listing choices of firms and the resulting valuation effects, the impact of competition and cooperation among exchanges on listing standards, and the optimal regulation of exchanges.

Appendix

Proof of Proposition 1. A partially pooling equilibrium in which investors with low information production cost are marginal information producers is a collection $\{n_H^*, \hat{n}_H^*, n_L^*, p_H^*, p_L^*, \alpha_h^*, \alpha_\ell^*, \delta_h^*, \delta_\ell^*, \lambda^*, \theta^*, \beta^*\}$ such that conditions (4)–(10) are satisfied, $0 < \alpha_\ell^* < 1$, and $\alpha_h^* = 0$. Similarly, a partially pooling equilibrium in which investors with high information production cost are marginal information producers is a collection $\{n_H^*, \hat{n}_H^*, n_L^*, p_H^*, p_L^*, \alpha_h^*, \alpha_\ell^*, \delta_h^*, \delta_\ell^*, \lambda^*, \theta^*, \beta^*\}$ such that conditions (4)–(7), (9), (11), and (12) are satisfied, $\alpha_\ell^* = 1$, and $0 < \alpha_h^* < 1$. This proof is structured in three parts. In the first part, we determine whether high-cost or low-cost investors are the marginal information producers, given the amount of shares offered for sale in equilibrium by a good quality firm, n_H^*. In the second part, we study the conditions for the existence of a partially pooling equilibrium for a given information production cost c. In the third and last part, we characterize the overall equilibrium, and we establish when low-cost investors are the marginal information producers.

Part 1. If $n_H^* \leq N_\ell$, the number of low-cost investors is sufficiently large with respect to the number of shares sold; hence, in this case, low-cost investors are the marginal information producers. Consider now the case in which $n_H^* > N_\ell$. Define $\lambda^*(n_H^*) \equiv \hat{n}_H / n_H^*$,

and note that, from (9), in equilibrium we have that

$$\lambda^*(n_H^*) \equiv \frac{\hat{n}_H}{n_H} = \frac{m}{m + n_L - n_H^*} \geqslant 1 - \gamma. \tag{A.1}$$

By direct calculation, note that $\lambda^*(N_\ell) > 1 - \gamma$ and that λ^* is an increasing, convex function of n_H^*, with $\lambda^*(n_L) = 1$. Define $\bar{\lambda}(n_H^*)$ to be the fraction λ that obtains when all low-cost investors produce information, i.e., when $\delta_\ell = \alpha_\ell = 1$. This is given by

$$\bar{\lambda}(n_H^*) = 1 - \frac{\gamma N_\ell}{n_H^*}, \tag{A.2}$$

since $\hat{n}_H = n_H - \gamma N_\ell$. Note next that $\bar{\lambda}(N_\ell) = 1 - \gamma$, and that $\bar{\lambda}(n_H^*)$ is an increasing, concave function of n_H^* with $\lambda(n_L) < 1$. We consider the case in which λ^* and $\bar{\lambda}$ have (two) intersections, $N_0(N_\ell)$ and $N_1(N_\ell)$, with $N_0 < N_1$. If these curves have no intersections, low-cost investors are always marginal information producers. With two intersections, high-costs investors are marginal information producers when $N_0 < n_H^* < N_1$. For simplicity, we assume that N_1 is large, so that $n_H^* < N_1$ is always verified in equilibrium (it is straightforward to verify that this is the case when n_L is sufficiently large). This implies that if $n_H^* \leqslant N_0$, low-cost investors are marginal information producers, and if $n_H^* > N_0$, high-cost investors are marginal information producers. Finally, note that $N_0(N_\ell)$ is a strictly increasing function of N_ℓ.

Part 2. We consider now the condition for the existence of a partially pooling equilibrium for a given cost of information production, c. Set (7) and the LHS inequality in (8) to hold as an equality, with $c_\ell = c$, and let $\psi \equiv 1 - \theta$. After repeated substitutions, we can simplify (7) and the LHS of (8), obtaining

$$H(\psi, n_H) \equiv (1 - \psi)\frac{n_H}{m + n_H}k_G + \psi n_H \frac{k_B - 1}{m} = 1, \tag{A.3}$$

$$G(\psi, n_H, c/I) \equiv \psi\gamma\left[\frac{1}{n_H} - \frac{k_B - 1}{m}\right] - \frac{c}{I} = 0. \tag{A.4}$$

A solution to (A.3) and (A.4) with $0 \leqslant \psi \leqslant 1 - \omega$ gives the desired $\{n_H^*, \theta^*\}$ pair for a given c (if there are multiple solutions, choose the one with the minimum n_H). Consider now (A.4), which may be rewritten as

$$n_H = g(\psi) \equiv \frac{\psi}{c/\gamma I + (k_B - 1)\psi/m}. \tag{A.5}$$

After some algebra, it may be verified that $g(\psi)$ is an increasing and concave function of ψ, with $g(0) = 0$. Define $\hat{n}_H \equiv g(1 - \omega)$. Consider now condition (A.3), and note that it may be rewritten as

$$\psi n_H^2(k_B - 1) + n_H[(1 - \psi)k_G + \psi(k_B - 1) - 1)]m - m^2 = 0. \tag{A.6}$$

Solving (A.6) for n_H, define $n_H = h(\psi)$ to be the solution in which the root with the positive sign is taken. Note that the discriminant of (A.6) is always positive, so a solution exists.

Furthermore, from implicit function differentiation of (A.3), we have

$$h'(\psi) = -\frac{\partial H/\partial \psi}{\partial H/\partial n_H} > 0, \tag{A.7}$$

since, from (7), it may be immediately verified that $\partial H/\partial \psi = k_B/(m + n_L) - k_G/(m + n_H) < 0$ and $\partial H/\partial n_H > 0$. Finally, let

$$\underline{n}_H \equiv h(0) = \frac{m}{k_G - 1} \quad \text{and} \quad \bar{n}_H \equiv h(1 - \omega). \tag{A.8}$$

Since $g(0) = 0 < \underline{n}_H = h(0)$, we have that $\hat{n}_H > \bar{n}_H$ and continuity of (A.5) together ensure the existence of a solution to the system (A.3)–(A.4). Furthermore, from (A.5), the condition $\hat{n}_H > \bar{n}_H$ holds if and only if

$$c < c_s \equiv (1 - \omega)\gamma \left[\frac{1}{\bar{n}_H} - \frac{k_B - 1}{m} \right] I. \tag{A.9}$$

Part 3. Let $\{n_H^*(c), \theta^*(c)\}$ be a solution to (A.3)–(A.4) for a given information production cost c. From implicit function differentiation of (A.3)–(A.4), we have

$$\frac{\partial n_H}{\partial(c/\gamma I)} = -\frac{\begin{vmatrix} \partial H/\partial \psi & 0 \\ \partial G/\partial \psi & -1 \end{vmatrix}}{\begin{vmatrix} \partial H/\partial \psi & \partial H/\partial n_H \\ \partial G/\partial \psi & \partial G/\partial n_H \end{vmatrix}} > 0, \tag{A.10}$$

since $\partial H/\partial \psi < 0$, and $h'(\psi) < g'(\psi)$ implies that the Jacobian determinant in (A.10) is negative. Hence, $\partial n_H^*(c)/\partial c > 0$. Let $\bar{N}_\ell(c_\ell)$ be implicitly defined by the equality $N_0(\bar{N}_\ell) = n_H^*(c_\ell)$. The proof is concluded by noting that increasing monotonicity of $N_0(\bar{N}_\ell)$ implies that if $N_\ell \geq \bar{N}_\ell(c_\ell)$, low-cost investors are marginal information producers, and if $N_\ell < \bar{N}_\ell(c_\ell)$, high-cost investors are marginal information producers. $\square$

Proof of Proposition 2. Consider first a firm of type G. For type-G firms, the advantage of listing on exchange X rather than Y is given by

$$W^G(\gamma^X, \gamma^Y) \equiv \frac{mk_G I}{m + n_H^{*X}(\gamma^X)} - \frac{mk_G I}{m + n_H^{*Y}(\gamma^Y)}. \tag{A.11}$$

The objective of a type-G firm is to minimize dilution of its initial shareholders; hence, it chooses the exchange that allows it to raise the desired investment I by selling the lowest number of shares, n_H^*. Note that from (A.10), the number of shares sold on an exchange, n_H^*, is a decreasing function of the precision γ.

If $N_\ell^Y \geq N_\ell^X$, two cases are possible. (i) If in both exchanges the same group of investors are marginal (that is, either the low-cost or the high-cost investors but not both are marginal information producers), then (A.10) and $\gamma^Y > \gamma^X$ together imply that exchange Y strictly dominates. (ii) Alternatively, since $N_\ell^Y \geq N_\ell^X$, low-cost investors are marginal information producers in exchange Y while high-cost investors are marginal information producers in exchange X, (A.10) implies that exchange Y dominates exchange X.

If $N_\ell^X > N_\ell^Y$, then a firm of type G chooses as follows. (i) If $N_\ell^X \geq \bar{N}_\ell^Y$ (where $\bar{N}_\ell^E$ is defined for exchange $E = X, Y$ in a way similar to the definition of $\bar{N}$ in the proof of

Proposition 1), then low-cost investors are marginal on exchange Y, and (A.10) together with $\gamma^Y > \gamma^X$ imply that $n_H^{*Y} < n_H^{*X}$, and thus a type-G firm prefers exchange Y. (ii) If $N_\ell^Y < \bar{N}_\ell^Y$, then the high-cost investors are marginal information producers on exchange Y. Hence, if (a) $N_\ell^X \geqslant \bar{N}_\ell^X$, then low-cost investors are marginal information producers on exchange X, and a type-G firm prefers exchange Y only if $n_H^{*Y}(\gamma^Y) < n_H^{*X}(\gamma^X)$. From (A.10), this is the case for $\gamma^Y > \bar{\gamma}^Y$, where $\bar{\gamma}^Y$ is implicitly defined by $n_H^{*Y}(\bar{\gamma}^Y) = n_H^{*X}(\gamma^H)$. (b) If, instead, $N_\ell^X < \bar{N}_\ell^X$, then high-cost investors are marginal information producers on exchange X as well, and $\gamma^Y > \gamma^X$ implies that a type-G firm prefers exchange Y. Finally, given the out-of-equilibrium beliefs, if a type-B firm chooses an exchange different from the one chosen by a type G, it will reveal its type and will sell its shares only at the full-information price p_L. Thus, firms of type B prefer to mimic a firm of type G, listing on the same exchange as a type-G firm. $\quad\square$

Proof of Proposition 3. *Part* (i). The standard-maximizing exchange S minimizes the probability of a loss of reputation by optimally setting the highest possible standards, that is $q_0^{S*} = q_1^{S*} = \bar{q}$. The value-maximizing exchange M sets at time 1 the lowest possible standards, that is $q_1^{M*} = 0$. Furthermore, if $q_1^{M*} = \bar{q}$, from (15) and (16) we have that $\rho_1^G = \rho_1^B = \rho_0$, so $V_{H1}^G = V_{H1}^B$ and the first-order condition for (17), which is given by

$$H(q_0^{M*}, \rho_0) \equiv (1 - \omega)\beta_0^* s[V_{H1}^N - V_{H1}^B - V_{H0}] - w'(q_0^{M*}) = 0, \qquad (A.12)$$

is never satisfied. Hence, at an optimum, $0 \leqslant q_0^{M*} < \bar{q}$.

   Part (ii). Consider the first-order condition for q_0^M, given by Eq. (A.12). Then consider the updating rules (16), which may be rewritten as

$$\rho_1^\tau = \frac{\rho_0}{\rho_0 + h^\tau(1 - \rho_0)} \quad \text{with} \quad \frac{\partial \rho_1^\tau}{\partial \rho_0} = \frac{h^\tau}{(\rho_0 + h^\tau(1 - \rho_0))^2}, \qquad (A.13)$$

where $\tau = B$ if the firm listed at time 0 is revealed at time 1 to be of type B, and $\tau = N$ if no firm is listed by the exchange at time 0, and

$$h_B \equiv \frac{1 - q_0^M}{1 - \bar{q}} \frac{\omega + (1 - \bar{q})(1 - \omega)\beta_0^*}{\omega + (1 - q_0^M)(1 - \omega)\beta_0^*}, \quad h^N \equiv \frac{q_0^M}{\bar{q}}. \qquad (A.14)$$

By implicit function differentiation of (A.12), we obtain that $\partial q_0^{M*}/\partial \rho_0 = -(\partial H/\partial \rho_0)/(\partial H/\partial q_0^M)$, with $\partial H/\partial q_0^M < 0$, by the second-order conditions of the optimization with respect to q_0^M. Hence, we have $\partial q_0^{M*}/\partial \rho_0 > 0$ if

$$(q - \omega)\beta_0^* k \left(\frac{\partial V_{H1}^N}{\partial \rho_1^N} \frac{\partial \rho_1^N}{\partial \rho_0} - \frac{\partial V_{H1}^B}{\partial \rho_1^B} \frac{\partial \rho_1^B}{\partial \rho_0} - \frac{\partial V_{H0}}{\partial \rho_0} \right) > 0. \qquad (A.15)$$

From differentiation of (15) and (16) with respect to ρ it can be shown that for $\rho \to 0$, we have that $\partial V_{H0}/\partial \rho_0 = \partial V_{H1}^G/\partial \rho_1^G = \partial V_{H1}^B/\partial \rho_1^B > 0$. Hence, setting $\partial V_{H0}/\partial \rho_0 = \partial V_{H1}^G/\partial \rho_1^G = \partial V_{H1}^B/\partial \rho_1^B > 0$ in (A.15) and differentiating the two terms in (A.13) with respect to ρ_0 we obtain that, by continuity, there is a $\hat{\rho} > 0$ such that $\partial q_0^{M*}/\partial \rho_0$ is positive if $\rho_0 < \hat{\rho}$ and $(1/h^N) - (1/h^B) - 1 > 0$, or, from (A.14), if

$$\frac{\bar{q}}{q_0^M} - \frac{(1 - \bar{q})(\omega + (1 - q_0^M)(1 - \omega)\beta_0^*)}{(1 - q_0^M)(\omega + (1 - \bar{q})(1 - \omega)\beta_0^*)} > 1. \qquad (A.16)$$

Thus, there is a pair $\{\hat{\rho}, \hat{q}\}$ such that for $\bar{q} > \hat{q}$ and $\rho < \hat{\rho}$, inequality (A.16) is satisfied and $\partial q_0^{M*}/\partial \rho_0 > 0$.

Proof of Proposition 4. In equilibrium, firms of both types seek a listing first on exchange Y and if rejected, on exchange X. Thus, the ex ante probability that a firm applying to a high-reputation exchange is of the good type is ω, while for the low-reputation exchange the probability is

$$\omega^X(q_0^{Y*}) = \frac{(1-\eta)\omega\rho_0^Y}{(1-\eta)\omega + (1+\bar{q}-\eta)(1-\omega)} + \frac{(1-\eta)\omega(1-\rho_0^Y)}{(1-\eta)\omega + (1+q_0^{Y*}-\eta)(1-\omega)},$$

(A.17)

where q_0^{Y*} is the choice of standards by exchange Y. It is easy to verify that $\omega^X < \omega$: since good firms are more likely to be accepted for listing in the high-reputation exchange Y, the low-reputation exchange X faces in equilibrium a worse pool of applicants than the high-reputation exchange. Thus, a value-maximizing exchange with high reputation, $E = Y$, has $\omega^Y = \omega$, and thus chooses q_0^Y so as to maximize again (14). Conversely, a value-maximizing exchange with low reputation, $E = X$, will choose q_0^X so as to maximize (17), given that, from (A.17), we now have that $\omega^X < \omega$. By implicit function differentiation with respect to ω of the first-order condition (A.12), and by following a procedure similar to the one we adopt in the proof of Proposition 3, it can be shown that $\partial q_0^{X*}/\partial \omega > 0$ for $\omega \to 0$. Hence, following an argument similar to the one we discuss in the proof of Proposition 4, it can be shown that there is $\bar{\rho}$ and $\hat{\omega} > 0$ such that for $\omega < \hat{\omega}$ and $\rho_0^X < \bar{\rho}$, then $\partial q_0^X/\partial \rho > 0$. Thus, $\rho_0^X < \bar{\rho}$ and $\omega^X < \hat{\omega}$ together imply that $q_0^{Y*} > q_0^{X*}$. Consider now a firm of type-G. From (14) and (A.10), $q_0^{Y*} > q_0^{X*}$ implies that a firm of type-G prefers to seek a listing with the high-reputation exchange Y first, where, if admitted, it will raise the desired amount of capital by selling a lower number of shares. If rejected, a type-G firm will apply to the low-reputation exchange. The proof is concluded by noting that, given the out-of-equilibrium beliefs, if a firm of type B chooses an exchange different from the one chosen by a firm of type G, it will reveal its type and will be able to sell its shares only at the full information price, p_L. Thus, again, a firm of type B prefers to mimic a firm of type G, and lists on the same exchange as a type-G firm. $\square$

Proof of Proposition 5. This proposition follows from the proof of Proposition 4. If the number of low-cost investors in the two exchanges is the same, $N_\ell^X = N_\ell^Y$, Proposition 4 implies that both types of firms approach first the high-reputation exchange Y. Hence, this exchange sets the standards q_0^{Y*} as if it were a monopolist, giving (i). To see (ii), note that, from (A.17), we have that $\omega^X(q_0^{Y*}) < \omega$. From implicit function differentiation of the first order condition of (A.12), it may immediately be verified that for $\omega \to 0$, we have that $\partial q_0^{X*}/\partial \omega > 0$. This implies that there is $\hat{\omega} > 0$ such that for $\omega < \hat{\omega}$ we have that $q_0^{X*}(\omega^H(q_0^{Y*})) < q_0^{X*}(\omega)$. $\square$

Proof of Proposition 6. This proposition follows an argument similar to the one of Proposition 4. If $N_\ell^Y < \bar{N}_\ell^Y$ and $N_\ell^X < \bar{N}_\ell^X$, then low-cost investors are marginal information producers in the low-reputation exchange X, and high-cost investors are marginal in the high-reputation exchange Y. Furthermore, since, from (13), listing fees F_0 are proportional to firm value, a type-G firm chooses to seek a listing first on the exchange in which it can

obtain a higher potential valuation, V_{H0}. Consider then part (i). In this case, a type-G firm goes first to the low-reputation exchange X, where the low-cost investors are marginal information producers, and, if rejected, to the high-reputation exchange Y. From Proposition 4, this implies that exchange X sets $q_0^{Xc*} = q_0^{Xm*}$ and exchange Y will instead set $q_0^{Xc*} < q_0^{Xm*}$. Note that this sequential choice of exchanges is an optimal strategy for a firm of type G if $V_{H0}^X > V_{H0}^Y$ (since a type-G firm is accepted for listing on either exchange with the same probability η). Consider now ρ_1, implicitly defined by $V_{H0}^X(\rho_0^X;\omega) = V_{H0}^Y(\hat\rho_1, \omega^Y(q_0^{X*}))$, where $\omega^Y(q_0^{X*})$ is defined in a way similar to (A.17). Thus, ρ_1 represents the level of exchange Y's reputation that makes a firm of type G indifferent between approaching exchange X first, and then, if rejected, exchange Y (since it obtains the same valuation on both exchanges). Hence, from the proof of Proposition 4, $\rho_0^Y < \min\{\rho_1; \bar\rho\}$ yields that $\partial q_0^X / \partial\rho > 0$, which implies $V_{H0}^X > V_{H0}^Y$, and therefore that it is indeed optimal for a firm of type G to seek a listing on the low-reputation exchange X first. Part (ii) is proved in a similar way, by setting $\rho_0^Y > \rho_2$, where ρ_2 is implicitly defined by $V_{H0}^X(\rho_0^X; \omega^X(q_0^{X*})) = V_{H0}^Y(\hat\rho_2, \omega)$. Finally, given the out-of-equilibrium beliefs, a type B firm prefers to mimic a type-G firm, and lists on the same exchange as a type-G firm. □

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