

# The Certification Role of Listings

Sarah Draus<sup>1</sup>

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## Abstract

I propose a model in which firms can convey their quality by listing on a stock exchange. To list, firms must comply with costly listing requirements allowing investors to recognize imperfectly their quality. A profit maximizing exchange may set listing requirements leading to high information efficiency in equilibrium. However, this is strongly linked to market conditions and firm characteristics. The information content of a listing depends not only on the level of listing requirements, but also on the characteristics of firms incited to list. High listing requirements are not a guarantee for the highest efficiency and the latter may be achieved with low requirements. Whether information efficiency is socially desirable depends on compliance costs and forgone growth opportunities which reduce welfare. The analysis yields implications for the choice of the listing locations by firms, as well as the organization of stock markets.

Keywords: stock markets, regulation, listing costs, efficiency, certification

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<sup>1</sup> Université Paris-Dauphine, DRM Finance; Place du Maréchal de Lattre de Tassigny, 75775 Paris Cedex 16, France ; tel. : +33 (0)1 44 05 42 57 ; Fax : +33 (0)1 44 05 40 23  
E-mail address : [sarah.draus@dauphine.fr](mailto:sarah.draus@dauphine.fr)

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# The Certification Role of Listings

## 1. Introduction

This paper studies to what extent listing on a stock market can reduce information asymmetries between firms and investors. One important traditional function of exchanges has been to certify the quality of listed firms. Many stock markets list firms on the basis of some requirements going from a minimum market capitalization to specific corporate governance standards. However, the stock market industry has been deeply changing in the last decades since competition among exchanges for volume and listings has sharpened and exchanges are increasingly demutualized and listed companies. There is now a debate on whether profit maximizing and competing exchanges will or even should continue to regulate listings. Also, while regulators tend to tighten listing requirements, exchanges increasingly create lightly regulated listing venues. Although some argue that certification is not compatible with profit maximization (Macey and O'Hara (2005)), others show that exchanges may set high listing requirements in equilibrium because this enhances their reputation (Chemmanur and Fulghieri (2006), or increases liquidity (Huddart et al. (1999)). In these papers, firms only differ in quality. The present paper complements this literature by analyzing how difference in listing incentives among firms of the same quality affect the listing decision of firms, and thereby the decision upon listing requirements by an exchange as well as the reaction of an exchange to imposed listing requirements through the creation of additional segments.

The present analysis shows that optimal listing requirements set by a profit maximizing exchange depend on the efficiency of these requirements which in turn depends strongly on the structure of the incentives of firms to list. If incentives differ among firms of the same quality, their need for regulation is different and they may sort between differently regulated exchanges according to factors that are not correlated with their quality. Thus, listing requirements have an indirect effect on the informativeness of a listing by influencing the number and types of listed firms. The sorting of firms may either enforce or counter the intended effect of listing requirements. If the former is the case, a profit maximizing exchange is incited to set a high level of listing requirements and this also leads to high information efficiency in the economy. However, for the highest levels of possible listing requirements, the sorting of firms is always detrimental to efficiency because firms of a high quality stop listing. An exchange may offer efficient certification services in equilibrium. However, this is

tightly linked to market conditions and may occur at a relatively low level of listing requirements.

The model's main ingredients are the following. There is an exchange which sets listing requirements that firms must satisfy if they list. The quality of firms is unknown to investors. Listing requirements allow investors to observe a noisy signal about the firms' quality. Investors update their belief about the firms' value according to their information. Complying with listing requirements is costly for firms and these costs differ across firms. When firms apply for a listing they trade off the expected increase in their market value against compliance costs. The exchange charges a listing fee which is proportional to the firms' market value. It trades off a high number of firms against highly valued firms when setting the level of listing requirements.

Costs related to listing requirements can be correlated with the quality of firms: high quality firms might bear fewer costs to comply with a given level of requirements than low quality firms. But listing costs might also vary with firm characteristics unrelated to the firms' quality. Depending on the institutional environment of firms, or on their internal organization and corporate habits, complying with a given level of requirements can represent a more or less important financial effort. It is the component of costs which is not correlated to the quality of firms that is analyzed here. This cost component creates different incentives to list for firms of the same quality.

Results are the following. If the difference in compliance costs for firms of the same quality is small, the impact of changing compliance costs in the firms' incentives to list is similar for all firms. The main determinant of the firms' listing decision is the revaluation which is diverging between good and bad firms: a higher level of listing requirements always increases the valuation gain good firms can obtain from listing, whereas it lowers the valuation gain of bad firms. This may incite a profit maximizing exchange to set a high level of listing requirements at which good firms separate from bad firms by listing, in equilibrium. In this case it is not worthwhile for bad firms to mimic good ones by listing, because compliance costs exceed the expected valuation gain. Information about firm values is perfectly revealed through this sorting effect.

If the difference in compliance costs is high, the incentives of firms are not only determined by valuation gains that diverge depending on the firms' type, but also to a larger extent by compliance costs which influence incentives in the same way regardless of the quality of firms. In this case, the effect of listing requirements is always weakened because while good firms with high costs are deterred from listing, bad firms with low costs still list.

Thus the sorting occurs not only according to quality but also according to compliance costs. In this case, separation is impossible. The exchange never sets a high listing requirement since the valuation gains of listing firms are smaller. Valuations are inefficient on the exchange because firms of different qualities pool (except for a high enough level of listing requirements at which only good firms with low costs list). However, the sorting due to listing requirements also affects the efficiency of values outside the exchange since non listed firms of different qualities also pool. Information efficiency in the economy is always worse when incentives to list differ strongly among firms of the same quality.

While increasing listing requirements may improve efficiency in the economy in the case compliance costs are not too different, this raises welfare issues. Non listed firms do not bear compliance costs but forgo a growth opportunity. If growth opportunities are large, efficiency occurs at a welfare loss. However, this also represents an opportunity cost for the exchange. Thus, if firms have large growth opportunities, the exchange is less likely to set a high level of listing requirements in equilibrium.

If a regulator imposes a level of listing requirements, an exchange always creates a more regulated segment if the mandatory standards are small and the valuation gain of firms listing on the more regulated segment is high. Although information efficiency is improved for firms with low costs, it renders the less regulated segment less attractive and reduces therefore the total number of listed firms deteriorating thereby not only efficiency for firms with high costs, but also welfare. If the imposed level of listing requirements is high, the exchange optimally creates a less regulated segment if it can attract many new listings. This is in particular the case, if firms diverge in compliance costs, and if their growth opportunities are large.

The contribution of this paper is twofold. First, this paper complements existing literature on the listing choices of firms by considering explicitly the impact of listing costs, and in particular compliance costs of firms. Costs related to the compliance with listing requirements seem to play an important role in the listing decision of firms.<sup>2</sup> This paper demonstrates that these costs may have an important influence on the optimal decisions of exchanges and firms and, in particular, may impede a potential certification role of exchanges.

Second, this paper complements literature on stock market organization and in particular literature on listing / disclosure requirements, since this literature mostly takes the

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<sup>2</sup> See Bancel and Mittoo 2001, Baba and Yamori 2001, Houston and Jones 2002 and Mittoo 1992 for enquiries of managers from Canadian, European and Japanese firms having listed their firms in the US. The World Federation of Exchanges underlined in its « Disclosure Survey » for 2003 the necessity for regulators to take into account the costs created by regulations concerning listings.

characteristics of exchanges as given and focuses on the endogenous choices of firms and traders (exceptions are Chemmanur and Fulghieri 2006, Huddart et al. 1999 and Foucault and Parlour 2004).<sup>3</sup> Considering the listing conditions of an exchange as an endogenous outcome resulting from the optimization of its profit, allows determining what the opportunities of firms are regarding listing choices. In particular, if listing acts as an information revelation mechanism, all high quality firms should prefer the exchange with the highest requirement in the absence of some deterring costs to obtain the highest market value. If, however, a profit maximizing exchange optimally sets a low listing standard in the first place, firms cannot use the stock market to reveal information on their quality efficiently.

The listing decisions of firms are often motivated by the possibility for firms to send a signal about their quality. Staughton et al. (2001) develop a model in which firms list on a stock market in order to signal the quality of their products. Consumers infer the product quality from the stock price<sup>4</sup>. In the field of cross-listings, several enquiries of managers whose firms are listed in the US show that revealing information about the firm's quality is one of the most important motivations for cross-listings (Bancel and Mittoo 2001, Baba and Yamori 2001, Houston and Jones 2002, Mittoo 1992). The idea of signaling in the context of cross-listings is related to the theories of legal bonding (Coffee, 2002) or reputational bonding (Siegel, 2005). Firms signal their quality by bonding themselves to tough listing requirements, strong regulatory bodies, or reputational intermediaries.<sup>5</sup> Based on these theories, Fuerst (1998) develops a model in which firms issuing high profitability reports list on the strictest regulated exchange whereas firms issuing low profitability reports list on less strict exchanges, provided that the difference in regulatory strictness between exchanges is high enough. Consistent with the signaling hypothesis, Doidge et al. (2004 and 2007) document an increase in the market value of firms cross-listed in the US (the so called "cross-listing premium"), evidence also supported by Sarkissian and Schill (2007).

However, some literature challenges the signaling hypothesis by showing that many other criteria than listing requirements determine the choice of listing places: the presence on the foreign product market (Biddle and Saudagaran 1995, Pagano et al. 2002), the size, sector

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<sup>3</sup> Papers on listing or trading choices include: Doidge et al. 2004, Easley and O'Hara 2007, , Foucault and Gehrig 2007, Fuerst 1998, Barth et al. 1999.

<sup>4</sup> The certification mechanism stems from the willingness of the listed firms to subject themselves to the scrutiny of outside analysts and relies on the existence of a large body of investors that engage actively in the price discovery process.

<sup>5</sup> Siegel shows that in the case of Mexican firms cross-listed in the US, the market punished firms that were accused of large-scale asset taking in Mexico, but that were not prosecuted by the SEC. Business press and analysts tracking governance abuses strengthen this reputation mechanism.

and strategy of firms (Pagano et al. 2002)<sup>6</sup>, the origin as well as the economic, industrial, cultural and geographic proximity<sup>7</sup> of the host country relative to the home country (Sarkissian and Schill 2004, Pagano et al. 2001, Bancel and Mittoo 2001). Tough disclosure requirements tend even to be considered as a disadvantage by firms as they seem to prefer to list on markets with less stringent disclosure requirements than those on their home market (Biddle and Saudagaran 1995, Pagano et al. 2001).

The way in which firms choose listing places affects competition among exchanges. Chemmanur and Fulghieri (2006), who analyze competition among exchanges on listing requirements, as well as Foucault and Parlour (2004), who analyze stock market competition without addressing listing requirements, advance the idea of exchanges differentiating in their organization in equilibrium. Chemmanur and Fulghieri (2006) model how exchanges set optimal listing requirements in the presence of reputation considerations. Firms almost always prefer to list on the market with the most stringent listing requirements. With two competing exchanges, the high reputation exchange sets higher listing standards than the low reputation exchange if the investor base is similar on both exchanges. Firms apply first on the high standard exchange. In case of a rejection, they apply on the low standard exchange. However, if investors on the high reputation exchange incur high information costs, whereas investors on the low standard exchange incur low information costs, the reputation of the high standard exchange must be overwhelmingly higher to offset its disadvantage in terms of investor base and attract all firms first. In Chemmanur and Fulghieri's model, the type of the firm is private information of the manager and listing requirements contribute to reveal the true type of firms. The only listing cost incurred by firms is the fee which is a fraction of the firm's equity value. Costs related to the compliance with listing requirements are ignored.

My model is related to this literature as it also leads to the conclusion that differentiation might be an equilibrium outcome. However, this is not only obtained under competition, but also for a segmented monopolist exchange. This result fits to the observation that many exchanges in the world act locally as monopolies (most firms list on their home exchange), and have several segments. Competition between exchanges similar to the NYSE – Nasdaq case seems to be rather rare. In addition, in contrast to Chemmanur and Fulghieri,

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<sup>6</sup> Pagano et al. (2002) show that European firms that listed in the U.S. between 1986 and 1998 were different from those listed in Europe. U.S. listed firms pursued a strategy of rapid equity-funded expansion and belonged in the majority to high-tech sectors. On the contrary, in Europe listed firms were more mature and less growing, relied less on exports and didn't come from high-tech sectors.

<sup>7</sup> Geographic proximity is the great circle distance between the capitals of countries, economic proximity is the percentage of country *i*'s exports to country *j*, industrial proximity is the correlation between industry rankings, and cultural proximity is a dummy variable equal to one if languages are the same, or if there was a colonial relationship between countries.

listing costs are explicitly addressed. Firms do not have the same preferences concerning the exchange on which they list because they face different cost – benefit tradeoffs.

The article is organized as follows. Section 2 sets out the model. Section 3 describes the incentives of firms and the equilibrium choices of an exchange upon listing requirements. Section 4 discusses information efficiency and welfare, and shows how these are related to the incentives of firms and the exchange's optimal decisions. Section 5 presents the equilibrium outcome with a segmented monopolist by describing how an exchange reacts to imposed listing requirements by creating differently regulated segments. This section also outlines competition. Section 6 discusses implications. Conclusions are stated in section 7. All proofs are given in the appendix.

## 2. Model

Consider firms which are either good ( $x_g$ ), or bad ( $x_b$ ), with  $x$  the firms' value known only to the firm's manager and  $x_g > x_b$ . The proportion of good firms is  $\omega \in (0,1)$  and is common knowledge. Firms can realize a growth opportunity,  $z$ , if they list on an exchange.

Listing firms must pay a fee to the exchange. It is a fraction,  $f$ , of the firms' market value.<sup>8</sup> The exchange also sets listing requirements that all listed firms must satisfy. Listing requirements comprise reporting information about the firms' prospects as well as meeting corporate governance rules. They allow investors to observe a signal,  $s$ , about the value of listed firms. The level of listing requirements is represented by the precision of the signal,  $\theta > 0.5$ , which is common knowledge.<sup>9</sup> With probability  $\theta$  investors observe the true type of listed firms. They observe the wrong type otherwise.

To comply with listing requirements, firms incur compliance costs:  $C(\theta) = c \frac{\theta^2}{2}$ , with  $c$  uniformly distributed over the interval  $[c_l, c_h]$ . They represent direct costs as well as indirect costs. Direct costs are for instance the establishment of reports according to some standards, changes in the internal structure of firms to comply with the requirements. These costs may differ across firms due to different internal structure, corporate habits, or cultural contexts. Indirect costs may represent costs firms incur due to more transparency and enhanced

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<sup>8</sup> A similar definition of the listing fee is used in Chemmanur and Fulghieri (2006). Many exchanges have listing fees which are staggered according to the size of the issuing firms or the number of issued shares. The case of a fixed listing fee is discussed at the end.

<sup>9</sup> In Chemmanur and Fulghieri (2006), the exchange selects the firms for listing. They define listing requirements in a similar way: the latter determine the probability with which the exchange accepts a firm that is not qualified for listing.

reputation. The latter may for instance intensify competition on the product market leading to “proprietary” costs.<sup>10</sup> The cost can also be interpreted as an opportunity cost: the time spent to comply with the requirements is not used to develop new projects. Since these costs are to a large extent unobservable, I assume that they are private knowledge of the firm.

Firms are assumed to disclose nothing else than what is imposed by the exchange. This is a restrictive assumption since good firms always benefit from signaling voluntarily their type to investors to the extent that the gains from signaling are not offset by the costs. However, an equilibrium without exchange never unravels completely because bad firms are incited to mimic at least a sub set of good firms. Allowing firms to disclose voluntarily some information about their type is left for brief discussion at the end.

Investors observe whether a firm is listed and the signal provided by listing requirements. They adjust their beliefs about the quality of the firm according to their information. The updated probabilities that the firm is a good firm given a good respectively a bad signal, are  $P(x_g | s = x_g) = p_{x_g}$  and  $P(x_g | s = x_b) = p_{x_b}$ . If a firm is not listed, the probability that it is a good firm is  $p_{nl}$ . All non listed firms have the same value.

The game is organized in three stages. In the first stage, the exchange determines its level of listing requirements to maximize its profit,  $\Pi$ . In stage 2, firms decide whether to list to maximize their market value net of the listing fee and compliance costs. In stage 3, investors update their beliefs.

### 3. Optimal listing requirements

**Firms’ incentives.** Listing firms realize their growth opportunity and since there is a signal about their quality, their market values are closer to their true type than without the existence of an exchange. Firms list only if they expect their market value to increase enough to offset listing costs. The expected value net of costs if firms list is for good and bad firms respectively:

$$E(MV)_g = (1-f)\left(z + x_b + \Delta x(p_{x_b} + \theta(p_{x_g} - p_{x_b}))\right) - C(\theta) \quad (1)$$

$$E(MV)_b = (1-f)\left(z + x_b + \Delta x(p_{x_b} + (1-\theta)(p_{x_g} - p_{x_b}))\right) - C(\theta) \quad (2)$$

$$\Delta x = x_g - x_b$$

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<sup>10</sup> See for instance Verrecchia 2001



The expected market value of both types of firms increases with the size of the growth opportunity. The precision of information affects market values in opposite ways. While it allows good firms to be better recognized and increases their valuation, it renders hiding more difficult for bad firms of which the value decreases. Since firms differ in compliance costs, their incentives to list depend not only on their quality and the precision of information, but differ also depending on their cost level,  $c$ . The firm among good and bad firms respectively which is indifferent between listing and not listing is the marginal firm,  $c_i^*$  with  $i = g, b$ . Only firms with cost levels below those of the marginal firms, list. At a given precision,  $\theta$ , incentive constraints are the following for good and bad firms respectively.

$$c \leq c_g^* \text{ with } c_g^* = \text{Max} \left\{ \text{Min} \left\{ [(1-f)z - fx_b + \Delta x \Delta I_g(c_b^*, c_g^*, \theta)] \frac{2}{\theta^2}, c_h \right\}, c_l \right\} \quad (\text{ICg})$$

$$c \leq c_b^* \text{ with } c_b^* = \text{Max} \left\{ \text{Min} \left\{ [(1-f)z - fx_b + \Delta x \Delta I_b(c_b^*, c_g^*, \theta)] \frac{2}{\theta^2}, c_h \right\}, c_l \right\} \quad (\text{ICb})$$

$$\Delta I_g = (1-f)(p_{x_b} + \theta(p_{x_g} - p_{x_b})) - p_{nl}$$

$$\Delta I_b = (1-f)(p_{x_b} + (1-\theta)(p_{x_g} - p_{x_b})) - p_{nl}$$

$\Delta I_i$ , with  $i = g, b$ , represents the valuation gain of firms due to the signal they have provided to the market (further on the revaluation). It is the only difference in the gain from listing of good and bad firms, since all firms implement the same growth opportunity if they list. Good firms have a higher valuation gain than bad ones. Thus, the marginal good firm is always higher than the marginal bad one ( $c_g^* > c_b^*$ ). For any level of listing requirements, listed good firms are more numerous than listed bad firms. A higher precision increases the revaluation of good firms whereas it decreases the one of bad firms. If all good firms are the only one to list,  $\Delta I_g = (1-f)$  since information revelation is perfect.

Both marginal firms increase the higher the net gain from listing is. This is the case, the lower the listing fee is, the higher the growth opportunity is and the higher the difference in qualities,  $\Delta x$ , is. However, changes in the marginal firms affect posterior beliefs of investors and thus the revaluations of firms, which in turn influence the equilibrium marginal firms. Changes in the firms' values due to information are not only determined by the level of listing requirements but also by the number and type of listed firms. The latter determine also the value of non listed firms. The fewer bad firms and the more good firms list, the higher is the revaluation of all listed firms which incites more firms of both types to list. However, a

higher number of bad listing firms reduces the revaluation of both types of firms, inciting fewer of them to list. Besides the precision of information, the ratio of the number of listing good firms to the number of listing bad firms,  $c_g^* - c_l / c_b^* - c_l$  (further on the proportion of good firms) determines investors' updated beliefs. If this ratio increases, the probabilities to observe a good firm on the exchange ( $p_{x_b}$  and  $p_{x_g}$ ) become higher.<sup>11</sup> This probability diminishes outside the exchange ( $p_{nl}$ ).

How the level of the listing requirements affects the number and type of listed firms depends on how changes in the marginal firms influence revaluations. A change in the listing requirements affects the number of listing firms directly through the change in costs and the precision, and indirectly through the impact of changing marginal firms on the expected valuation gains. This indirect effect finds its origin in the differing cost factors among firms of the same quality. If compliance costs were equal for all firms or inversely correlated to their quality (bad firms incurring higher compliance costs than good ones), good firms would always list as long as bad firms list since their valuation gain is always higher.<sup>12</sup>

While the direct effect of an increase of the precision is always negative for the marginal bad firm (the revaluation decreases but the compliance cost increases), it has an ambiguous effect on the marginal good firm since the listing cost as well as the revaluation increase.<sup>13</sup> However, if the marginal good firm increases with  $\theta$ , the valuation gain of bad firms increases, inducing more of them to list, which in turn reduces the valuation gains of both types of firms. On the other hand, the fewer bad firms list the higher is the valuation gain of both types of firms and more of them are incited to list.

**Incentives and listing requirements.** Bad firms benefit always less from listing than good firms. Those firms among bad ones with the highest costs are deterred from listing at levels of listing requirements at which all good firms still list (precisions for which  $c_g^* = c_h$ ). If the cost interval ( $c_h - c_l$ ) is small, incentives are mainly driven by the revaluation. In this

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<sup>11</sup>  $\frac{\partial p_{x_i}}{\partial \frac{c_g^* - c_l}{c_b^* - c_l}} > 0$  with  $i = g, b$

<sup>12</sup> Selection occurs through the precision of the signal and not through the different costs borne by firms as in Spence (1973).

<sup>13</sup>  $\frac{\partial c_b^*}{\partial \theta} = \left(1 - \frac{2}{\theta^2} \Delta x \frac{\partial \Delta I_b}{\partial c_b^*}\right)^{-1} \frac{2}{\theta^2} \left(-\frac{2}{\theta} [(1-f)z - fx_b + \Delta x \Delta I_b] + \Delta x \frac{\partial \Delta I_b}{\partial \theta} + \Delta x \frac{\partial \Delta I_b}{\partial c_g^*} \frac{\partial c_g^*}{\partial \theta}\right)$   
 $\frac{\partial c_g^*}{\partial \theta} = \left(1 - \frac{2}{\theta^2} \Delta x \frac{\partial \Delta I_g}{\partial c_g^*}\right)^{-1} \frac{2}{\theta^2} \left(-\frac{2}{\theta} [(1-f)z - fx_b + \Delta x \Delta I_g] + \Delta x \frac{\partial \Delta I_g}{\partial \theta} + \Delta x \frac{\partial \Delta I_g}{\partial c_b^*} \frac{\partial c_b^*}{\partial \theta}\right)$

case the difference in the marginal firms is high since their common factor, the compliance cost, weights little compared to the diverging revaluations. There is a level of listing requirements,  $\theta_{sep}$ , at which all bad firms are deterred from listing while all good firms list. This precision is such that the constraint, ICb, is binding. For  $\theta_{sep}$  to be attractive for the good firms with the highest compliance costs, the cost interval,  $c_h - c_l$ , must be small enough. A necessary condition for separation of firms is:

$$\Delta c \leq \frac{2\Delta x}{\theta_{sep}^2} (1 - \Delta I_b(c_h, c_b^* = c_l, \theta_{sep})) = \Delta c_T \quad (3)$$

$$\Delta c = c_h - c_l$$

A higher listing fee,  $f$ , and a higher minimum cost level decrease the net gain bad firms can obtain from listing and therefore also the precision up from which bad firms do not list. The cost difference, up to which firms separate,  $\Delta c_T$ , is higher. A higher difference in qualities,  $\Delta x$ , has an ambiguous effect on  $\Delta c_T$  since it increases the valuation gain of both firm types. However, if the cost difference is large relative to the difference in qualities ( $\Delta c > 2\Delta x$ ), separation is never possible.

If the cost interval is small enough to allow for separation of firms, the marginal bad firm decreases the higher the precision is since it is adversely affected through a higher compliance cost and a smaller valuation gain. If only good firms list, an increase in the precision also reduces the number of listed firms since besides the higher compliance cost, their valuation gain decreases. Information revelation is perfect on the exchange but since some good firms do not list, the value of non listed firms increases which reduces the attractiveness of a listing.

If the difference in costs is high, good firms with high costs are deterred from listing while bad firms still list and there is no level of listing requirements separating both firm groups. In this case, there is a range of small listing requirements<sup>14</sup> at which only bad firms are deterred from listing when the precision increases inside this range, and their number decrease monotonically with the precision. There is also a range of high listing requirements<sup>15</sup>

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<sup>14</sup>  $0.5 < \theta < \sqrt{\frac{2}{c^h} [(1-f)z - fx_b + \Delta x \Delta I_g(c_b^*, c^h, \theta)]}$

<sup>15</sup>  $\sqrt{\frac{2}{c_l} [(1-f)z - fx_b + \Delta x \Delta I_b(c_g^*, c_l, \theta)]} < \theta < 1$

for which only good firms with low cost list. As the precision increases inside this range, the number of listing good firms decreases monotonically. Finally, there is a range of medium listing requirements between the two extreme intervals, at which good as well as bad firms with high costs are deterred from listing. In this case, the number of good and bad listing firms can either decrease or increase (provided that  $c_i^* < c_h$  with  $i = g, b$ ) with the level of listing requirements. An increasing precision deters bad and good firms with the highest costs from listing. This has two opposite effects on the valuation gain of listing firms: the revaluation decreases the fewer good firms list but increases the fewer bad firms list. While the smaller number of bad firms incites more of both firms to list, the smaller number of good firms deters even more bad firms from listing but this attracts more good firms.

**Lemma 1**

Given that  $\Delta c > \Delta c_T$ , the number of listing good firms increases the higher the level of listing requirements is, if the increase in their valuation gain due to more precise information is large.

If the positive revaluation of good firms obtained through the direct effect of a higher listing requirements is large enough to offset the increasing compliance costs, the number of listed good firms increases with the level of listing requirements. However, an increasing number of good listing firms also attracts bad firms on the exchange. Thus, when the number of good listing firms increases much, which occurs when the increase in the valuation gain is large, more bad firms are attracted on the exchange despite the higher listing requirement. Ceteris paribus, the revaluation of bad firms becomes smaller the more precise information revelation is. However, investors' beliefs about the value of listed firms for both types of firms increase the higher the number of good firms relative to bad firms is on the exchange. If a high precision increases the number of good listed firms to a large extent, the valuation loss of bad firms due to a higher precision is offset by the upward shift of beliefs. This may induce more bad firms to list. Thus, although the valuation of bad firms decreases with the precision, this decrease is offset by the better possibility to hide among good firms. Also, since fewer good firms remain unlisted, the value of unlisted firms decreases and bad firms are less incited to remain unlisted.

The revaluation of good firms due to the direct effect of a higher level of listing requirements (holding the number of listing firms constant) increases the higher the initial level of precision is and the smaller the listing fee is. The change in the revaluation increases also with the number of good firms as long as it is small. When there are many good firms in

the economy, the precision of information becomes less important in the revaluation of good firms.

**Exchange's decision.** The exchange has only revenues from the listing fee which is proportional to the market value of listed firms. There is a tension between listing many firms (including bad firms), and excluding bad firms from listing to increase the market value of the other listed firms. The sorting effect related to a higher listing requirements may increase the proportion of good firms on the exchange, which makes all values higher and increases the exchange's profit.

If the cost interval is small enough, the exchange can implement a separating equilibrium for a high enough level of listing requirements. This is optimal only if the smaller number of listed firms (only good firms list) is compensated by the valuation gain of good firms. If the cost interval is high and separation impossible, good and bad firms always pool either on the exchange or outside the exchange.

**Proposition 1**

If separation is possible, the exchange sets a level of listing requirements deterring all bad firms from listing if and only if  $\Pi(\theta_{sep}) \geq \Pi(\theta)$  for all  $\theta \neq \theta_{sep}$ . The optimal level of listing requirements is determined by the following equation:

$$\theta_{sep} = \sqrt{\frac{2}{c_l} [(1-f)z - fx_b + \Delta x \Delta I_b(c_h, c_l, \theta_{sep})]}. \quad (4)$$

Otherwise, the optimal level of listing requirements is always smaller than  $\theta_{sep}$ .

Following equation 1, firms can separate if the cost interval is small enough. In this case the exchange sets either a precision above  $\theta_{sep}$  and lists only good firms, or a smaller precision and lists also bad firms. In any case, the number of listing firms always decreases the higher the precision is. Thus, the exchange only sets a high level of listing requirements if the increase in the market value of firms compensates their smaller number. If the exchange implements an equilibrium in which only good firms list, firms are valued at their true type. In this case, the exchange never sets the precision above  $\theta_{sep}$  since this only lowers the number of listing firms but does not increase their value. Therefore, the optimal level of listing requirements never exceeds  $\theta_{sep}$  in the case firms can separate.

If firms cannot separate (if  $\Delta c$  is high), the exchange always sets a smaller level of listing requirements than  $\theta_{sep}$  in equilibrium. Since up from a particular precision level, good

firms stop listing while bad firms still list<sup>16</sup>, a listing becomes less valuable for bad firms. They are recognized with a higher probability which lowers their expected valuation gain. Thus, since for high levels of listing requirements, only a fraction of good firms list, bad firms stop listing for a level of listing requirements smaller than  $\theta_{sep}$ .<sup>17</sup> Separation of firms is precluded for a high cost interval. Therefore good firms with high costs never list at a level of listing requirements at which bad firms with the smallest costs list, even though the number of listing good firms may increase for some levels of smaller listing requirements.

The highest level of listing requirements a profit maximizing exchange may set in equilibrium (which is the one separating good and bad firms), increases the higher the gain from listing of bad firms is. This is the case the higher the growth opportunity is, the smaller the minimum quality is, the higher the difference in qualities is, and the smaller the listing fee is. However, the higher  $\theta_{sep}$  is, the smaller is the valuation gain good firms obtain through separation, which reduces the additional profit of separation and renders a separating equilibrium less likely. Although a high proportion of good firms in the economy translates into a high number of listed firms in the case of separation, it also reduces the valuation gain good firms obtain from separation since  $\theta_{sep}$  increases. Thus, a high proportion of good firms in the economy may reduce the likelihood that the exchange implements the equilibrium with the highest level of listing requirements.

#### 4. Efficiency and welfare

**Efficiency.** The more information about the true values of firms is reflected in their market value, the more efficient are the latter. Efficiency may be considered solely for listed firms. However, since listing requirements not only make the values of listed firms more efficient, but contribute also to separate firms (the number of good listed firms is always higher than the number of bad listed firms), the existence of the exchange has also an impact on the efficiency of firm values outside the exchange. Therefore, the efficiency measure used here reflects the magnitude of the reduction of information asymmetry in the entire economy. The less information asymmetry remains after the listing, the more informative is the listing and the more efficient is the equilibrium. Initially the market values of firms are distorted as

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<sup>16</sup> See footnote 13

<sup>17</sup> From footnote 14,  $\sqrt{\frac{2}{c_l} [(1-f)z - fx_b + \Delta x \Delta I_b(c_g^*, c_l, \theta)]}$  is the precision level up from which no bad firm lists. Since  $\Delta I_b(c_g^* < c_h, c_l, \theta) < \Delta I_b(c_h, c_l, \theta)$ , this precision level is smaller than  $\theta_{sep}$ .

bad firms are over valued and good firms under valued. The listing is able to reduce this distortion by revealing information about the firms' type. In the best case, firms are valued at their true type after listing took place. An efficiency measure,  $E$ , is computed by calculating the distance between the average values of good and bad firms and their true value. If efficiency is perfect, this distance is zero.

The precision of information affects efficiency in several ways. On the one hand, a higher precision affects directly the revaluation of listed firms by making them more efficient. On the other hand, a higher precision affects the number of listed firms. If only bad firms stop listing as the level of listing requirements increases, fewer bad firms are misevaluated and the value of good firms is closer to their true value, which increases efficiency. However, the value of listed bad firms may become less efficient if the effect of a higher precision is offset by an increase in their value due to a higher proportion of listed good firms on the exchange. Thus whether efficiency increases with the level of listing requirements depends on how sensitive the revaluation of bad firms is to changes in the proportion of good relative to bad listed firms. If this sensitivity is small, a higher information precision always increases efficiency if separation is possible.

If, however, the cost difference is high, and good firms with high costs stop listing at precisions at which bad firms with low costs still list, the effect of an increasing precision on efficiency becomes more ambiguous. The more good firms remain outside the exchange the less efficient are the values of non listed firms. However, as good firms stop listing, values of listed firms may also become less efficient despite the higher listing requirement. These efficiency impediments are attenuated if the marginal good firms is increasing in the precision. In this case, the values of non listed bad firms and listed good firms become closer to their true type.

Thus, depending on differences in the firms' incentives to list, and depending on how listing requirements affect the revaluation of firms, a higher level of listing requirements does not necessarily improve efficiency in the economy. The direct positive impact of the precision of information on efficiency is larger, the smaller the difference in incentives among firms of the same quality is, and the higher the revaluation of good firms is.

The changing marginal firms do not only impede efficiency in the economy, but also efficiency on the exchange, since an increasing proportion of good firms may deteriorate efficiency of the values of bad listed firms, whereas a high proportion of bad firms may deteriorate efficiency of the values of good listed firms.

## **Lemma 2**

The separating equilibrium leads to the highest efficiency in the economy as well as on the exchange since all firms are valued at their true value ( $E=0$ ). All other equilibria lead to a lower efficiency.

In all equilibria, a listing conveys information to the market unless the exchange sets its listing requirement level at 0.5. However, inefficiency arises due to two factors: the imperfect precision of the signal conveyed by the listed firms and the listing behavior of firms. If all good firms list, non listed firms are only bad ones. Information outside the exchange is perfectly revealed, whereas there is information asymmetry on the exchange. The precision of the signal is small but concerns many firms. In the case only good firms list, information is perfectly revealed on the exchange. However, information asymmetry is only completely removed if separation is possible. In this case, all firms are valued at their true value and  $E = 0$ . Otherwise, information asymmetry remains outside the exchange.

Proposition 1 shows that if the cost interval is small and under some particular economic circumstances, the exchange sets a high enough level of listing requirements to achieve separation of firms in equilibrium. In this case, a listing certifies efficiently the quality of firms. Otherwise, information asymmetry on the exchange and/or outside the exchange always impedes efficiency, in which case the listing does not certify efficiently the quality of firms. The certification role of listing is indeed related to the level of listing requirements. However, it is determined by the incentives of firms to list and in particular by the possible separation of firms the listing requirements induce. In this sense, listing requirements improving the precision of information on the exchange, have an impact on the efficiency of the values of firms outside the exchange by affecting the listing decisions of firms. The differences in firms' incentives determine not only the optimal decision of the exchange, but also the feasibility of an efficient certification through listing. If firms differ strongly in listing incentives, a efficient certification effect through self selection of firms is not possible.

**Welfare.** Because signaling is costly and because these costs differ across firms, listing requirement raise a welfare issue. Listing firms realize their growth opportunity which increases welfare, but at the expense of compliance costs which reduces welfare. Since investors are inactive in this model, they implicitly keep their holdings until payoffs are realized. Costs related to the compliance with listing requirements as well as forgone investment opportunities reduce the payoff of shareholders and therefore their welfare.



Investors' welfare is also affected by misvaluation of firms. However, with some additional assumptions, the welfare gains and losses related to information asymmetry offset. If a firm lists, the old shareholders sell the firm entirely to new shareholders. If the firm is a good one and there is information asymmetry, they sell the firm below its value and incur therefore a potential welfare loss. However, this welfare loss is also a welfare gain of investors who buy the firm cheaper than its final payoff. Thus gains and losses offset. If the old shareholders sell an overvalued bad firm, they have a welfare gain which corresponds to the welfare loss of new shareholders. If the firm does not list, old shareholders keep their shares until the payoff is realized and are therefore not affected by changes in the value of their shares due to information revelation. Thus, changes in the firms' values do not affect social welfare. To assess the described welfare effects, a measure,  $W$ , is computed by adding compliance costs and realized growth opportunities by listed firms. The level of listing requirements impacts welfare directly by influencing the size of compliance costs and indirectly by determining the number of listing firms. A higher number of listed firms has an ambiguous effect on welfare since more firms realize their growth opportunity but more of them also bear compliance costs.

**Lemma3**

- (i) If separation is possible, welfare increases in the level of listing requirements if the cost savings are large relative to forgone growth opportunities and the marginal bad firm changes sluggishly.
- (ii) If separation is not possible, welfare increases in the level of listing requirements if marginal firms decrease sluggishly, or increase quickly.

Whether welfare increases or decreases with the level of listing requirements depends on the listing behavior of firms. If separation of firms is possible and the exchange sets a level of listing requirements which is smaller than  $\theta_{sep}$ , increasing the precision reduces the number of listed bad firms and increases the compliance costs of listed firms. The smaller number of listed bad firms reduces welfare because those that stop listing forgo their investment opportunity. However, since they also do not bear compliance costs and bad firms remaining listed have a small cost factor, a smaller number of listed bad firms has also a positive impact on welfare. On the other hand, compliance costs increase for all listed firms which reduces welfare. If the exchange sets  $\theta_{sep}$  in equilibrium, the negative welfare effects due to fewer realized growth opportunities and higher compliance costs increase. Thus, there is a tension between welfare and efficiency since the most efficient equilibrium is not

necessarily the most welfare improving one. If the separation of firms is not possible, the effects of an increasing precision on the total compliance costs are ambiguous. However, the more slowly marginal firms decrease the smaller is the welfare loss due to forgone growth opportunities. If marginal firms increase, additional compliance costs may be offset by the implementation of additional growth opportunities. The speed of changing marginal firms affects the amount of forgone or additional (if  $\partial c_g^*/\partial\theta > 0$ ) growth opportunities and determines whether welfare increases with the level of listing requirements.

Information efficiency may not be socially beneficial because it occurs at a cost which is not necessarily compensated by social gains. However, information efficiency can bring many advantages. If good firms are not confounded with bad ones, they may be able to raise capital at lower cost and thus realise more investment opportunities. Informative prices are also useful to structure the incentives of managers (Holmström and Tirole 1993), or of an insider to engage in value-increasing activities (Faure-Grimaud and Gromb 2004). If managers are only imperfectly informed about the quality of their firm, an efficient stock price may help them to take better investment decisions (Foucault and Gehrig 2008). Consumers may be able to infer the quality of firms' products from the stock price (Staughton et al. 2001).

## 5. Segmentation and competition

**Segmentation.** It is now commonly observed that listing requirements are often imposed by independent regulators. Exchanges with self-regulating competencies regarding listing requirements are rare. Macey and O'Hara (2005) indicate that listings and delisting are increasingly regulated by independent agencies and provide a table showing that self-regulating exchanges were the exception among large stock markets in 2005. However, one also observes that exchanges create lightly regulated segments which provide listing services but are not subject to the regulation prevailing on their main segments. This is for instance the case with the AIM since firms listing on the AIM have neither to comply with requirements imposed by the European Directives nor with full FSA requirements. In the last years, a growing number of exchanges have set up lower tier segments resembling the AIM in London.<sup>18</sup> This is in particular the case in the US where a new listing venue has been created, OTCQX, on which firms can list without complying with SEC rules.<sup>19</sup> On the other hand, some exchanges have also created segments with stricter regulation than the one imposed by

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<sup>18</sup> see Mendoza (2008) for examples

<sup>19</sup> See : [www.otcqx.com](http://www.otcqx.com)

their national regulator. This was the case on the Brazilian stock market, which created tightly regulated segments which contributed to increase the value of firms and their liquidity (Chavez and Silva (2006)). Thus, creating differently regulated segments seems to be an answer of exchanges to either low or too tough regulation.

An argument advanced against strong regulation is that firms differ in their need for regulation (Mendoza 2008). Lemmas 2 and 3 show that this exclusion may impede efficiency as well as welfare, and eventually weaken the beneficial effect of listing requirements. In this context, creating differently regulated segments may mitigate negative effects due to self selection of firms. This section analyses the incentives of an exchange to create a more regulated segment (upper tier segment) or a less regulated segment (lower tier segment) if a level of listing requirements,  $\theta_{reg}$ , is imposed exogenously by a regulator.

If the exchange creates an upper or a lower tier segment (with  $\theta \neq \theta_{reg}$ ), the segment with the imposed precision,  $\theta_{reg}$ , is labeled the “main segment” further on. Compared to the situation in which only the main segment exists, the possibility to list on another differently regulated venue induces some firms that would have listed anyway, to list on the additional segment instead of the main one, and may also induce firms that would not have listed otherwise, to list on one of both segments. Firms which would have listed on the main segment without an additional listing venue, list on the additional segment if and only if the valuation gain they obtain is larger than the additional compliance costs in the case of an upper tier segment, or if the valuation loss is compensated by compliance cost savings in the case of a lower tier segment. The growth opportunity and the listing fees are assumed to be the same on both listing venues.

If two segments exist, the proportion of good firms on the main segment is likely to change and thereby also the valuation gain firms obtain by listing on the main segment, even though the listing requirements remain the same. The informativeness of a listing on both listing venues depends now on the marginal firms listing on the main segment,  $c_{g,m}^*$  and  $c_{b,m}^*$ <sup>20</sup>, and the marginal firms listing on the additional segment created by the exchange:  $c_{g,s}^*$

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<sup>20</sup> Marginal firms listing on the main segment are determined by the following equations:

$$\begin{aligned} \text{Max} \left\{ \text{Min} \left[ \left[ (1-f)z - fx_b + \Delta x \Delta I_g(c_{b,m}^*, c_{b,s}^*, c_{g,m}^*, c_{g,s}^*, \theta_{reg}) \right] \frac{2}{\theta^2}, c_h \right], c_l \right\} &= c_{g,m}^* \\ \text{Max} \left\{ \text{Min} \left[ \left[ (1-f)z - fx_b + \Delta x \Delta I_b(c_{b,m}^*, c_{b,s}^*, c_{g,m}^*, c_{g,s}^*, \theta_{reg}) \right] \frac{2}{\theta^2}, c_h \right], c_l \right\} &= c_{b,m}^* \end{aligned}$$

and  $c_{b,s}^*$ <sup>21</sup>. Since the creation of an additional segment changes the number of listing firms and their listing place, it changes also the value of unlisted firms.

Because revaluations depend on the proportions of good firms on the different segments, the potential valuation gains or losses due to a higher or lower precision on the segments may be amplified or offset by the listing decisions of firms. If the exchange creates an upper tier segment, the revaluation of firms listing on this segment increases if they are good firms and decreases if they are bad firms for equal proportions of good firms on both segments. If however, the proportion of good firms is higher on the upper tier segment than on the main segment, the increase in the value of good firms is amplified since the posterior probabilities of investors,  $p_{x_g}$  and  $p_{x_b}$ , increase. However, higher updated beliefs also increase the expected value of bad firms and lower therefore the negative effect of a higher precision on the expected value of bad firms. Bad firms may even expect a valuation gain on the upper tier segment compared to the main segment despite more precise information. This is only the case if the proportion of good firms on the upper segment exceeds the proportion of good firms on the main segment and is large enough so that the posterior probabilities to be a good firm conditional on the signal on the upper tier segment are higher than on the main segment.

If the exchange creates a lower tier segment, the revaluation of firms listing on the lower tier segment decreases if they are good firms and increases if they are bad firms at equal proportions of good firms on both segments. If however, the proportion of good firms is higher on the lower tier segment than on the main one, the valuation of good firms on the additional segment is even smaller which amplifies the effect of a smaller precision. The valuation of bad firms becomes also smaller, which diminishes the effect of a lower precision on the valuation of bad firms. If, on the contrary, the proportion of good firms is higher on the lower tier segment than on the main segment, the negative effect of a low level of listing requirements on the valuation of good firms is offset because of their higher proportion among listed firms, but the valuation of bad firms listed on the lower tier segment increases further since in addition to the low precision, they are recognised with a smaller probability.

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<sup>21</sup> Marginal firms listing on the additional segment are determined by the following equations

$$\begin{aligned} \text{Max} \left\{ \text{Min} \left[ 2\Delta x \left[ \Delta I_g(c_{b,m}^*, c_{b,s}^*, c_{g,m}^*, c_{g,s}^*, \theta) - \Delta I_g(c_{b,m}^*, c_{b,s}^*, c_{g,m}^*, c_{g,s}^*, \theta_{reg}) \right] \left[ \theta^2 - \theta_{reg}^2 \right]^{-1}, c_h \right\} c_l \right\} &= c_{g,s}^* \\ \text{Max} \left\{ \text{Min} \left[ 2\Delta x \left[ \Delta I_b(c_{b,m}^*, c_{b,s}^*, c_{g,m}^*, c_{g,s}^*, \theta) - \Delta I_b(c_{b,m}^*, c_{b,s}^*, c_{g,m}^*, c_{g,s}^*, \theta_{reg}) \right] \left[ \theta^2 - \theta_{reg}^2 \right]^{-1}, c_h \right\} c_l \right\} &= c_{b,s}^* \end{aligned}$$

**Proposition 2**

If a level of listing requirements,  $\theta_{reg}$ , is imposed by a regulator, an exchange may optimally create an additional less regulated (lower tier) segment on which firms with high costs list, or an additional more regulated (upper tier) segment on which firms with low costs list.

- (i) If  $\theta_{reg}$  is high, the exchange implements a lower tier segment if the number of listing firms on this segment is high enough.
- (ii) If  $\theta_{reg}$  is small, the exchange only implements an upper tier segment if the valuation gain of good firms with low cost is high enough.
- (iii) The level of listing requirements on the upper tier segment never exceeds the smallest precision at which no bad firm lists on that segment ( $\theta_{sep}^u$ ).

**Upper tier segment.** If the exchange sets up an upper tier segment, some good firms with low costs list on this segment (instead of listing on the main segment) since they expect a revaluation which is high enough not to be offset by the higher compliance costs. This reduces the proportion of good firms on the main segment, and makes a listing on it less valuable to good as well as bad firms. The probability that bad firms are recognized becomes higher on the main segment compared to a situation without segmentation. This may induce some bad firms with high costs to leave the exchange completely. However, some bad firms with low costs may also be incited to list on the upper tier segment if they can obtain a valuation gain. Even if some low cost bad firms list on the upper tier segment, the marginal good firm ( $c_{g,s}^*$ ) is always higher than the marginal bad firm ( $c_{b,s}^*$ ) since good firms benefit from both, the higher precision and the higher proportion of good firms.

**Lemma 4**

If the exchange creates an upper tier segment, the number of firms listing on the main segment decreases compared to the situation without segmentation:  $c_{g,m}^* < c_g^*$  and  $c_{b,m}^* < c_b^*$ .

The self selection of firms leads to a smaller proportion of good firms on the main segment and thus to a smaller valuation gain from listing. The marginal firms listing on the main segment become smaller compared to a situation without segmentation, even though the level of listing requirements remains the same. Thus, the creation of a listing venue with higher standards on which firms with low costs can better signal their type leads to exclude firms with high costs from the less regulated segment. Information efficiency is the best on the upper tier segment since the precision is high and the number of bad firms listing on this segment is small (efficiency is perfect if no bad firm lists).

If there is a level of listing requirements at which firms can separate and if the imposed level of listing requirements is below this threshold, creating an upper tier segment only deters bad firms from listing. This makes the value of bad firms more efficient since more of them are valued at their true type outside the exchange, and the value of those bad firms listed on the main segment is on average closer to their true value. The values of good firms become more efficient only for those which are listed on the upper tier segment. Good firms with high costs are penalized by a less efficient value. To the extent that the valuation loss of good firms with high costs is not too large, introducing an upper tier segment increases efficiency in the economy not only because of the higher precision and the selection effect on the upper tier segment, but also because the crowding out effect on the main segment further contributes to separate firms. These efficiency gains create social costs since fewer firms implement their growth opportunity and some firms bear higher compliance costs. If the size of the growth opportunity is large enough to offset the compliance cost savings of excluded firms, an upper tier segment always deteriorates welfare.

If compliance costs are different enough so that separation is not possible, the upper tier segment may also deter good firms with high costs from listing on the main segment. In this case, efficiency deteriorates not only on the main segment but also outside the exchange since some good firms with high costs pool with bad ones. The crowding out effect leads also to fewer realized growth opportunities. Thus, if incentives of firms of the same quality differ strongly (and if marginal firms are decreasing in the precision), creating an upper tier segment exacerbates the welfare loss and does not necessarily improve efficiency. Only the upper tier segment always benefits from a high efficiency. If the marginal good firm is increasing in the precision, the exchange lists more good firms on its upper tier segment. This increases the attractiveness of this segment and induces even more firms to list on the upper tier segment instead of the main segment. In this case, more firms benefit from a better efficiency. However, this also exacerbates the exclusion effect since expected revaluations on the main segment become smaller.

**Lower tier segment.** If the exchange creates a lower tier segment, firms with high compliance costs list on the lower tier segment instead of the main segment. On the one hand, these firms may be firms that would have listed on the main segment without segmentation. Listing on the less regulated segment benefits more to bad firms which prefer always lower listing requirements. Thus, there are more bad firms than good firms listing on the lower tier segment instead of the main segment. On the other hand, the smaller compliance costs attract

firms on the exchange which do not list at all on the main segment. Compared to a situation without segmentation, the existence of a lower tier segment increases the proportion of good firms on the main market. The high proportion of good firms makes the main segment with the higher listing requirements more attractive to good firms, increasing further the proportion of good firms on the main segment and the proportion of bad firms on the lower tier segment. However, the main segment loses listings.

If the cost difference of firms is small enough to allow for separation of firms, new listing firms are only bad firms since all good firms list anyway. As before, firms separate not only according to their costs but also according to their quality. The main segment loses mainly listings from bad firms. Thus, the value of the remaining good firms becomes more efficient although the listing requirements remain the same. Good firms listing on the lower tier segment incur, as before, an efficiency loss. Efficiency also decreases for newly listing bad firms since they were valued at their true value outside the exchange, but are pooled with some good firms and are thus on average overvalued. Thus, the effects of the existence of a lower tier segment on information efficiency in the economy are mixed compared to a situation without segmentation. Only the main segment benefits in terms of efficiency. More firms realize their growth opportunity which improves welfare. However, more high cost firms also pay compliance costs, which reduces welfare. If the listing requirements on the lower tier segment are small and the growth opportunity high enough, introducing a lower tier segment improves welfare.

If firms cannot separate, a lower tier segment allows also some good firms to list and to realize their growth opportunity. Since these firms were pooled with bad firms outside the exchange and benefit from a signal on the exchange (even though it is not precise), their values become on average more efficient. This also increases efficiency outside the exchange. Thus, compared to a situation without the lower tier segment, introducing the latter if the incentives of firms are very diverging has better efficiency and welfare consequence than when these incentives are similar.

**Exchange's decision.** Regardless of whether an exchange creates an upper or lower tier segment, firms listed on the more tightly regulated segment benefit from a higher valuation in the case of segmentation. However, the source of the valuation gain is different depending on which of both segments is implemented. In both cases, firms listed on the more regulated segment benefit from a separation effect since with segmentation, the proportion of good firms is higher on the more regulated segment. However, firms on the upper tier

segment benefit in addition from the higher level of listing requirements. The expected market value of firms is more sensitive to changes in the proportion of good firms when the precision of information is small. Since the level of listing requirements is higher on the upper tier segment than on the main segment, the major source of valuation gain for firms listed on the upper segment is the higher precision. If the exchange implements a lower tier segment, firms listed on the main segment benefit exclusively from the separation of good and bad firms.

If the imposed level of listing requirements ( $\theta_{reg}$ ) is high, an upper tier segment procures only a small benefit to good firms for two reasons: their value is already high on the main segment and it is also less sensitive to changes in the proportion of good firms. On the other hand, since many firms are excluded from listing without segmentation, a lower tier segment allows many firms to list. However, valuation gains are modest as well on the lower tier segment since the precision of information is small and the proportion of good firms is small, as on the main segment because the expected value of firms is not very sensitive to changes in the proportions of firms' types.

If the imposed level of listing requirements is small, creating an upper tier segment benefits low cost good firms because they have a large valuation increase. However, those firms remaining on the main segment are also more sensitive to changes in the proportion of firms' types, which amplifies the crowding out effect of firms with high costs. Thus, although valuation gains are higher, the number of listed firms diminishes even more than with a high imposed listing requirement. In the case of a lower tier segment, the number of new listed firms is small. Since the difference in compliance costs is small, only few firms list on the lower tier segment instead of the main segment. Thus, although firms remaining on the main segment are sensitive to changes in the proportion of firms' types, the latter changes only a little which reduces the valuation gain of firms listed on the main segment.

The income of the exchange depends on the one hand on the number of listed firms but is also proportional to their market value. If the exchange sets up a lower tier segment, it benefits from the higher number of listed firms. The value of newly listed firms is small and the one of those firms remaining on the main segment is either not responsive to changes in the firms' types proportion, or the change in this proportion is small. Thus, the exchange is more likely to set up a lower tier segment in equilibrium, if the imposed level of listing requirements is high and if the number of newly listed firms is high. The latter increases if the cost interval is large and separation not possible, since in this case bad as well as good firms with high costs are attracted into the market. If the cost difference is small, good firms always



list and newly listed firms are only bad firms with high costs. Thus, strongly diverging incentives to list across firms increase the likelihood of a lower tier segment in equilibrium.

The level of listing requirements set by the exchange on the lower tier segment is always smaller than  $\theta_{reg}$  per definition, but is not necessarily the smallest possible. The precision has opposite effects on the profit of the exchange. On the one hand, a relatively high precision on the lower tier segment reduces the number of new listed firms and the number of firms listing on the lower tier instead of the main segment. The smaller number of newly listed firms reduces the exchange's profit but the smaller number of switchers has an ambiguous effect. On the one hand, this lowers the valuation gain of those firms remaining on the main segment. On the other hand, switching firms pay smaller fees (at least the good ones). The more sensitive the exchange's profit is to changes in the number of listed firms, the smaller is the level of listing requirements. It may be completely uninformative in equilibrium ( $\theta = 0.5$ ). This is in particular the case, when the growth opportunities of firms are high. But a low level of listing requirements is also more likely, the higher the imposed precision is. In this case, the value of firms on the main segment is less sensitive to changes in the proportion of the firms' types which lowers the revenue of the exchange stemming from the revaluation gain on the main segment. This leads the exchange to attract even more high cost firms.

If the exchange sets up an upper tier segment, it always loses listings. This loss increases the smaller the imposed precision is. The exchange only increases its revenue through the higher valuation of firms listed on the upper tier segment. However, this valuation gain is also higher the smaller the imposed precision is. Thus, the exchange only sets up an upper tier segment in equilibrium if the valuation gain of good firms with high costs is large enough to compensate the loss of listed firms on the main segment. If firms' incentives are heterogeneous enough so that separation is not possible, and if the marginal good firm listing on the upper tier segment increases in the precision, the exchange benefits also from more listed firms if it sets up an upper tier segment since it captures the listing of those firms that would not have listed on the main segment. Thus, a strong heterogeneity in firms' incentives to list increases the benefit from an upper tier segment and makes it more likely in equilibrium. Since the exchange's profit is negatively affected by the loss of listings, the exchange is less likely to set up an upper tier segment if the growth opportunity of firms is high. In this case, deterring firms from listing represents an important opportunity cost of the exchange.

The precision set by the exchange on an upper tier segment never exceeds the level of listing requirements at which no bad firms lists on the upper tier segment,  $\theta_{sep}^u$ . In this case, the revaluation of the good firms listed on the upper tier segment is the highest possible since they are valued at their true value. Increasing the precision further only reduces the number of good firms on the upper segment since compliance costs increase without valuation gains, and lowers the profit of the exchange.

The previous analysis assumed implicitly that the impose level of listing requirements is below the one separating completely good firms from bad firms. If  $\theta_{reg}$  was higher, in which case only good firms list on the exchange, the exchange never sets up an upper tier segment. If the exchange creates a lower tier segment, the profit stemming from the main segment diminishes because efficiency is already perfect. The exchange only benefits from more listed firms.

**Competition.** Theoretical literature on exchange competition predicts that similar segmentation results could arise from competition. In the present setting two competing exchanges could exploit the different needs for regulation of firms in the same way as a monopolist exchange creating several segments, and specialise on firms with different costs by setting different levels of listing requirements.

If one exchange has a listing requirement equal to  $\theta_{reg}$ , another exchange may enter and compete for listings with a different level of listing requirements. If the entrant sets a higher level of listing requirements, the incumbent exchange loses listings because good firms list increasingly on the entrant exchange. This renders a listing on the incumbent exchange less attractive (see lemma 4). Thus, the profit of the incumbent exchange diminishes since in addition of losing listings, the value of listed firms decreases. If the incumbent can bypass  $\theta_{reg}$  by changing its status, it will reopen as a lightly regulated exchange to capture the listing of bad firms and good firms with high compliance costs. Competition from a more tightly regulated exchange incites the incumbent to lower its level of listing requirements because it loses its certification ability due to self selection of firms.

If an entrant exchange sets a lower listing requirement than  $\theta_{reg}$ , the incumbent exchange also loses listings but since the proportion of good firms becomes higher, market values increase. Thus, competition does not necessarily decrease the incumbent's profit if it comes from a lightly regulated exchange. Since the incumbent benefits from the high

valuations of listed firms it may increase its listing requirement above  $\theta_{reg}$ . In this case, the incumbent becomes an exchange specialized on low cost and good firms and exerts an efficient certification role. On the entrant exchange, on the contrary, the values of firms are not efficient, but many firms with high costs can implement their growth opportunity.

**Proposition 3**

- (i) If two exchanges with a single level of listing requirements on each compete for listings, they differentiate in listing requirements. One exchange sets always a precision lower than  $\theta_{reg}$ . The other exchange sets a high one.
- (ii) Exchanges never set the highest possible level of listing requirements.

Differentiation of exchanges stems from the different incentive of firms to list. Exchanges can always capture either the listings of otherwise unlisted firms or elsewhere listed firms, and attract some firms with high costs on a less regulated segment or some firms with low costs on a tightly regulated segment.

The competition result is close to Chemmanur and Fulghieri (2006). However, it is achieved with a different mechanism. In their paper, an incumbent sets a high level of listing requirements to keep a good reputation. Since some firms are rejected by the incumbent, an entrant sets a lower level of listing requirements in equilibrium to list those firms rejected by the incumbent. However, this result relies on the hypotheses that the incumbent rejects firms and makes selection errors, and that firms systematically prefer the most regulated exchange. In the paper here, differentiation is obtained because firms have different benefits from regulation and self select therefore on differently regulated exchanges. Even without reputation concerns (the exchange only sets the rules of the game, but does not select listed firms), there is no race to the bottom because some firms always benefit from a higher level of listing requirements and the exchange can increase its profit by excluding firms and ensuring high market values to listed firms. There is neither a race to the top because firms bear compliance costs.

**6. Discussion and Implications**

**Listing fees.** The model is analyzed under the assumptions that the listing fee is proportional to the market value of firms and that it is the same on all segments (or exchanges in the case of competition). However, an exchange could set different fees (different fractions of the market value of listed firms) on different segments. In this case, the sensitivity of the value of firms to changes in the beliefs of investors increases the smaller the listing fee is.

Thus, an exchange of which the profit is mainly determined by valuation changes of listed firms has an incentive to set a low fee, whereas an exchange benefiting mainly from a high number of listed firms has the incentive to set a high fee. In the case of segmentation or competition, the more strictly regulated segment (or exchange) may set a smaller fee than the more lightly regulated segment (or exchange).

The exchange could also set a fixed listing fee. In this case, the fee also contributes to exclude high cost firms from listing. If the exchange lists firms of both types, the fee is the one the marginal bad firm is willing to pay, since bad firms have the lower valuation gain. This may induce the exchange to set a small listing requirement since its revenue is higher the more firms list and the higher the market value of bad firms is. If only good firms list on the exchange, the listing requirement never exceeds the one separating good from bad firms, but the fee might be such that some good firms with high costs do not list (even if separation is possible). The exchange may increase its profit by excluding good firms with high costs from listing to set a higher listing fee. Thus, if the fee is fixed, the exchange is less likely to set a high level of listing requirements, which impedes its certification role.

**Competition for listings.** There is a debate about whether the American exchanges have lost their competitiveness with respect to listings as a consequence of the Sarbanes-Oxley Act. Opponents of this act argue that it imposes excessive costs on firms. However, Doidge et al. (2007) show that despite fewer listings, the NYSE still attracts foreign firms and these also experience a cross listing premium. The present analysis shows that even though a tough regulation always deters firms from listings, including good firms, it may also attract firms that have a high benefit related to more precise information and that do not incur high compliance costs. Thus, firms expected to list on a tightly regulated segment or exchange, are those which suffer from a high information asymmetry, but which can afford the high listing requirements. Thus whether an exchange loses market shares (with respect to listings) with higher listing requirements depends first on the characteristics of targeted firms: not only their quality, but also factors affecting on the one hand their compliance costs and on the other hand their gain from high listing requirements.<sup>22</sup>

There is also a debate on whether a profit maximizing exchange may systematically set a low level of listing requirements, in particular if it competes with other listing venues. A race to the bottom may not occur because an exchange may want to keep a good reputation

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<sup>22</sup> Macey and O'Hara (2002) also argue that stock exchanges should only keep tight listing requirements if firms need exchanges as a certification intermediary.

(Chemmanur and Fulghieri (2006)), or because it has a higher liquidity with tough listing requirements (Huddart et al. (1999)). The present paper shows that even with competition, a profit maximizing exchange may not necessarily set a low level of listing requirements if the firms which should list on that exchange experience a high increase in their value due to the signal the listing and the compliance with listing requirements represents. Thus, if listing requirements lead to a sorting of firms enforcing the effect of listing requirements on their value, an exchange is likely to set a high level of listing requirements. If however, this sorting is counterproductive in that it offset the benefic effects of the requirements, firms listing on the exchange have not a high value and the exchange is less likely to set a high listing standard.

**Valuation effects.** Several studies have highlighted positive valuation effects related to the tightness of listing requirements when firms cross list (Doidge et al. 2004, 2007, Sarkissian and Schill 2007, Roosenboom and van Dijk 2007). The findings in the present paper complement these studies by proposing a theory for a finer analysis of these valuation effects. Since the effect of a particular level of listing requirements depends not only on the precision of the information revealed through the compliance, but also on the type and number of firms that comply, valuation effects after cross listings or changes of listing places should differ depending on three elements: the characteristics of the firm, the characteristics of firms in the same sector or industry or coming from the same country, and the characteristics of firms listed on the considered exchange. The valuation effect should also depend on the structure of the exchange industry. Depending on whether there are several segments or competing exchanges with different regulations, the firms listing on the most regulated segment or exchange are not the same. In particular, firms' values should increase more, if there is segmentation or competition that leads to different levels of listing requirements since firms separate more according to their quality.

**Incentives.** Since the effect of listing requirements depends on which firms list, bad firms are not necessarily better recognized as such the higher the level of listing requirements is. Thus, if a listing requirement attracts many good firms and few bad firms, the latter may be able to hide better than on a segment with a lower level of listing requirements because of the high proportion of good firms on the exchange. This has an impact on the effect of listing requirements on the incentives of managers. Doidge et al. (2004) ground their models on the idea that the cost of diverting cash-flows increases the stricter regulation on the stock

exchange is. Implicitly, these papers make the assumption that hiding value destroying activity becomes harder for a manager the tighter regulation is which increases its costs. As a result, the fraction of diverted cash flows diminishes the higher regulation is. However, if a manager is extracting private benefits and conditions this activity upon the probability to be caught, he may be incited to divert more cash flows on a more tightly regulated exchange even though investors have more precise information about firms, since his probability to be recognized may be smaller. Thus, the sorting effect among listing firms induced by listing requirements, has also an effect on how listing requirements affect the incentives of managers.

**Listing place choices and firm characteristics.** The results in this paper stem from the effects of listing choices of firms. How firms react to changes in regulations and how firms from different sectors, industries or geographical regions choose in general their listing places is observable. This information can be useful to assess on the one hand decisions of a profit maximizing exchange or the possible development of the industry, and on the other hand characteristics of firms. In particular, analyzing listing and delisting decisions in relation with listing and disclosure requirements may be an indication about the existence of proprietary costs of firms.

The results in this paper also raise a question about the causality link between the existence of growth opportunities and the listing decision. It is sometimes argued that firms with high growth opportunities list on tightly regulated exchanges to obtain a cheaper financing for the implementation of their projects (for instance Doidge et al. (2004)). However, under the assumption that firms bear different listing costs, firms with high listing costs may not list because the listing is too costly compared to the expected gains from information and from the realization of their growth opportunity. Thus, ex post these firms do not implement growth opportunities and are not expected to do so since the financing is too expensive. However, these firms may possibly have realized their growth opportunity if the access to the stock market had been cheaper. Thus, excessive compliance costs may prevent the realization of investment projects of firms that may have highly profitable ones.

If an exchange creates another segment, some firms switch because of their compliance costs and not because of their quality. Thus, if a segment (or another exchange) with a low regulation is created, firms changing their listing place from the highly regulated segment to the new segment are not necessarily bad firms since they may simply bear high compliance costs and a lower level of listing requirements may lead to a higher market value (net of listing costs) for these firms. The same is true for firms switching to a more tightly

regulated segment since they may be bad firms with low costs. The idea that down or up-switching is not necessarily a signal about the quality of switching firms, is consistent with the result of Ramadorai and Jenkinson (2007) who show that initial stock price reactions after firms switch from the main market to the AIM and vice versa are reversed after some months.

**Voluntary disclosure.** The exchange exerts its certification role not only through the precision of information inherent to listing requirements, but also by inciting firms to separate according to their type. If firms could voluntarily disclose the amount of information that maximizes their market value net of compliance costs, at least a sub set of good firms is mimicked by bad firms because of the different compliance costs of firms without the existence of an exchange. In this case, a listing may still be valuable to firms, because through the self selection good firms are less mimicked by bad ones and voluntary disclosure may become more efficient.

## 7. Conclusion

I propose a model in which firms can convey their quality by listing on a stock exchange. To list, firms must comply with costly listing requirements allowing investors to recognize imperfectly their quality. A profit maximizing exchange may set listing conditions leading to high information efficiency in equilibrium. However, this is strongly linked to market conditions and firm characteristics. The information content of a listing depends not only on the level of listing requirements, but also on the characteristics of firms incited to list. High listing requirements are not a guarantee for the highest efficiency and the latter may be achieved with low requirements. Whether information efficiency is socially desirable depends on compliance costs and forgone growth opportunities which reduce welfare. The analysis yields implications for the choice of the listing locations by firms, as well as the organization of stock markets.

## Appendix

### Lemma 1

The derivatives of the marginal firms are determined by the following equations (see footnote 12):

$$\frac{\partial c_b^*}{\partial \theta} = D_b^{-1} \frac{2}{\theta^2} \left( B + \Delta x \frac{\partial \Delta I_b}{\partial c_g^*} \frac{\partial c_g^*}{\partial \theta} \right) \quad (\text{A1})$$

$$\frac{\partial c_g^*}{\partial \theta} = D_g^{-1} \frac{2}{\theta^2} \left( G + \Delta x \frac{\partial \Delta I_g}{\partial c_b^*} \frac{\partial c_b^*}{\partial \theta} \right) \quad (\text{A2})$$

Solving for  $\frac{\partial c_b^*}{\partial \theta}$  and  $\frac{\partial c_g^*}{\partial \theta}$  yields the following equations:

$$\frac{\partial c_g^*}{\partial \theta} = \underbrace{\left( 1 - D_g^{-1} \frac{2}{\theta^2} \frac{\partial \Delta I_b}{\partial c_g^*} \frac{\partial \Delta I_g}{\partial c_b^*} \Delta x^2 \right)^{-1}}_{>0} D_g^{-1} \frac{2}{\theta^2} \left( G + D_b^{-1} B \frac{\partial \Delta I_g}{\partial c_b^*} \frac{2}{\theta^2} \Delta x \right) \quad (\text{A3})$$

$$\frac{\partial c_b^*}{\partial \theta} = \underbrace{\left( 1 - D_b^{-1} \frac{2}{\theta^2} \frac{\partial \Delta I_b}{\partial c_g^*} \frac{\partial \Delta I_g}{\partial c_b^*} \Delta x^2 \right)^{-1}}_{>0} D_b^{-1} \frac{2}{\theta^2} \left( B + D_g^{-1} G \frac{\partial \Delta I_b}{\partial c_g^*} \frac{2}{\theta^2} \Delta x \right) \quad (\text{A4})$$

With:  $B = -\frac{2}{\theta} [(1-f)z - fx_b + \Delta x \Delta I_b] + \Delta x \frac{\partial \Delta I_b}{\partial \theta} < 0$

$$D_b = \left( 1 - \frac{2}{\theta^2} \Delta x \frac{\partial \Delta I_b}{\partial c_b^*} \right)$$

$$G = -\frac{2}{\theta} [(1-f)z - fx_b + \Delta x \Delta I_g] + \Delta x \frac{\partial \Delta I_g}{\partial \theta}$$

$$D_g = \left( 1 - \frac{2}{\theta^2} \Delta x \frac{\partial \Delta I_g}{\partial c_g^*} \right)$$

$$\frac{\partial c_g^*}{\partial \theta} > 0 \text{ if and only if } G > -D_b^{-1} B \frac{\partial \Delta I_g}{\partial c_b^*} \frac{2}{\theta^2} \Delta x$$

### Proposition 1

Separation is possible if  $\Delta c > \Delta c_T$ . The exchange sets  $\theta_{sep}$  if and only if:

$$MV_g \omega + MV_b \frac{(c_b^* - c_l)}{\Delta c} (1 - \omega) \leq x_g \omega. \text{ For } \theta > \theta_{sep}, \frac{\partial x_g}{\partial \theta} = 0 \text{ but } \frac{\partial c_g^*}{\partial \theta} < 0. \text{ This is never optimal for the exchange.}$$

If separation is not possible, the exchange sets  $\theta'_{sep} = \sqrt{\frac{2}{c_l} [(1-f)z - fx_b + \Delta x \Delta I_b (c_g^*, c_l, \theta'_{sep})]}$

if and only if:  $MV_g \omega (c_g^* - c_l) + MV_b (c_b^* - c_l) (1 - \omega) \leq x_g \omega (c_g^* (\theta'_{sep}) - c_l)$ . A higher precision is never optimal for the exchange since it only decreases the number of listing good firms.

### Lemma 2

The efficiency measure is computed by adding the average misevaluations of all firms weighted by their number. It is positive by construction.

$$E = \frac{\omega}{\Delta c} \left( (c_g^* - c_l) (x_g - \overline{MV}_g) + (c_h - c_g^*) (x_g - MV_{nl}) \right) + \frac{(1-\omega)}{\Delta c} \left( (c_b^* - c_l) (\overline{MV}_b - x_b) + (c_h - c_b^*) (MV_{nl} - x_b) \right) \quad (\text{A5})$$



Rearranging terms yields:

$$E = \frac{\Delta x}{\Delta c} \left( -\omega(c_g^* - c_l)\Delta I_g + (1-\omega)(c_b^* - c_l)\Delta I_b + \Delta c(\omega + (1-2\omega)p_{nl}) \right) \geq 0 \quad (\text{A6})$$

In the case of the separating equilibrium,  $\Delta I_g = 1$ ,  $c_g^* = c_h$ ,  $c_b^* = c_l$  and  $p_{nl} = 0$ . This gives

$E = \Delta x\omega - \Delta x\omega = 0$ . The separating equilibrium yields the highest possible efficiency.

In all other equilibria, at least one term of equation (A5) is strictly positive. Thus, efficiency is never the highest.

### Lemma 3

The welfare measure is computed by subtracting total compliance from the sum of realized growth opportunities:

$$W = z \left( \frac{c_g^* - c_l}{\Delta c} \omega + \frac{c_b^* - c_l}{\Delta c} (1-\omega) \right) - \omega \frac{\theta^2}{2} \int_{c_l}^{c_g^*} \frac{c}{\Delta c} dc - (1-\omega) \frac{\theta^2}{2} \int_{c_l}^{c_b^*} \frac{c}{\Delta c} dc \quad (\text{A7})$$

Developing and rearranging terms yields:

$$W = \frac{1}{\Delta c} \left( z(\omega c_g^* + (1-\omega)c_b^* - c_l) \right) - \frac{\theta^2}{4} \left( \omega(c_g^*)^2 + (1-\omega)(c_b^*)^2 - c_l^2 \right) \quad (\text{A8})$$

In the case of separation,  $c_g^* = c_h$ . Welfare increases in the precision if and only if:

$$\frac{\partial c_b^*}{\partial \theta} > \frac{\theta}{2} \left( \omega(c_g^*)^2 + (1-\omega)(c_b^*)^2 - c_l^2 \right) (1-\omega)^{-1} \left( z - \frac{\theta^2}{2} c_b^* \right)^{-1} \quad (\text{A9})$$

If separation is not possible, welfare increases in the precision if and only if:

$$\frac{\partial c_b^*}{\partial \theta} (1-\omega) \left( z - \frac{\theta^2}{2} c_b^* \right) + \frac{\partial c_g^*}{\partial \theta} \omega \left( z - \frac{\theta^2}{2} c_g^* \right) > \frac{\theta}{2} \left( \omega(c_g^*)^2 + (1-\omega)(c_b^*)^2 - c_l^2 \right) \quad (\text{A10})$$

### Proposition 2

The exchange sets up an upper tier segment if and only if:

$$\omega \left( (c_{g,s}^* - c_l) (\overline{MV}_{g,s} - \overline{MV}_{g,m}) \right) + (1-\omega) \left( (c_{b,s}^* - c_l) (\overline{MV}_{b,s} - \overline{MV}_{b,m}) \right) \geq \omega \left( \overline{MV}_g (c_g^* - c_l) - \overline{MV}_{g,m} (c_{g,m}^* - c_l) \right) + (1-\omega) \left( \overline{MV}_b (c_b^* - c_l) - \overline{MV}_{b,m} (c_{b,m}^* - c_l) \right) \quad (\text{A11})$$

Assume that only good firms list on the upper tier segment. In this case, the LHS of equation A11 is increasing the smaller  $\theta_{reg}$  is, if the increase in the valuation gain of good firms is higher than the increase in compliance costs such that  $c_{g,s}^*$  also increases. If also bad firms list on the upper tier segment, their valuation gain decreases the smaller  $\theta_{reg}$  is. Thus, for the LHS to increase, the gain of good firms must be even higher. A smaller  $\theta_{reg}$  has ambiguous effects on the RHS of equation A11 since marginal firms listing on the main segment increase the smaller  $\theta_{reg}$  is, the values of good firms decrease and the values of bad firms increase. The higher  $\theta_{reg}$  is, the smaller is the LHS. For high levels of  $\theta_{reg}$ , A11 does not hold and the exchange does not set up an upper tier segment. If  $\theta_{reg}$  is small, A11 holds provided that the valuation gain of good firms is high enough. In this case, the exchange optimally implements an upper tier segment.

By a similar argument than in proposition 1, the exchange never sets the precision higher than  $\theta_{sep}^u$  on the upper tier segment, with  $\theta_{sep}^u$  the smallest precision such that  $c_{b,s}^* \leq \underline{c}$ .

The exchange sets up a lower tier segment if and only if :

$$\begin{aligned} ((c_{g,m}^* - c_l) \overline{MV}_{g,m} - (c_g^* - c_l) \overline{MV}_g) + (1 - \omega)((c_{b,m}^* - c_l) \overline{MV}_{b,m} - (c_b^* - c_l) \overline{MV}_b) \geq \\ \omega(c_{g,m}^* - c_{g,s}^*) \overline{MV}_{g,s} + (1 - \omega)(c_{b,m}^* - c_{b,s}^*) \overline{MV}_{b,s} \omega \end{aligned} \quad (A12)$$

The higher  $\theta_{reg}$  is, the smaller are the values on the upper tier segment and the smaller are the marginal firms listing on the main segment. Thus the RHS of equation A12 is decreasing in  $\theta_{reg}$ . A change in  $\theta_{reg}$  has ambiguous effects on the LHS. If  $\theta_{reg}$  is high, A12 holds provided that the number of new listing firms is high.

#### Lemma 4

If  $\Delta I_g(\theta) - \Delta I_g(\theta_{reg}) > 0$ ,  $c_{g,s}^* - c_l$  good firms list on the upper tier segment. Since  $\Delta I_g(\theta) - \Delta I_g(\theta_{reg}) > \Delta I_b(\theta) - \Delta I_b(\theta_{reg})$ ,  $c_{g,s}^* > c_{b,s}^*$ . Therefore, the proportion of good firms among listed firms decreases on the main segment. It follows that  $\Delta I_g(\theta_{reg})$  and  $\Delta I_b(\theta_{reg})$  decrease. Since the valuation gains decrease, the marginal firms also decrease and:  $c_{g,m}^* < c_g^*$  and  $c_{b,m}^* < c_b^*$  with  $\Delta I_g(c_b^*, c_g^*, \theta_{reg}) > \Delta I_g(c_{b,m}^*, c_{b,s}^*, c_{g,m}^*, c_{g,s}^*, \theta_{reg})$  and  $\Delta I_b(c_b^*, c_g^*, \theta_{reg}) > \Delta I_b(c_{b,m}^*, c_{b,s}^*, c_{g,m}^*, c_{g,s}^*, \theta_{reg})$ .

#### Proposition 3

Assume the incumbent exchange sets  $\theta_I = \theta_{reg}$ . An entrant can enter and set a higher precision,  $\theta_E > \theta_{reg}$ . To avoid that the incumbent over cuts the entrant, the latter sets its precision such that  $\Pi_I(\theta_{reg}, \theta_E) = \Pi_I(\theta_E + \varepsilon)$  with  $\varepsilon > 0$ . The incumbent can increase its profit by setting a lower precision. This also incites the entrant to lower its precision up until  $\Pi_I(\theta_I < \theta_{reg}, \theta_E) = \Pi_I(\theta_E + \varepsilon)$  to avoid that the entrant over-cuts.

An entrant can also set a lower precision,  $\theta_E < \theta_{reg}$ . To avoid undercutting by the incumbent,  $\theta_E$  is such that  $\Pi_I(\theta_{reg}, \theta_E) = \Pi_I(\theta_E - \varepsilon)$ .

Since firms bear compliance costs, listings become fewer the higher the precisions are. Thus, it is never optimal for exchange to set the highest possible level of listing requirements.

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