Stock Price Informativeness, Cross-Listings and Investment Decisions [1]

Thierry Foucault
HEC School of Management, Paris and CEPR
78351 Jouy en Josas, France.
Email:foucault@hec.fr
AND
Thomas Gehrig
University of Freiburg and CEPR
79085 Freiburg, Germany
E.mail:thomas.gehrig@vwl.uni-freiburg.de

April, 2006

[1] We are grateful for the comments and suggestions by Sudipto Bhattacharya, Michael Melvin, Sebastien Michenaud, Giovanna Nicodano, Helene Rey, Bruno Solnik and Mark Van Achter as well as seminar participants at the Bank of Finland - ECB Conference in Helsinki, at Arizona State University, Phoenix and Nagoya University. Financial support under EU-grant HPSE-CT-1999-00007 and the Volkswagen Stiftung is gratefully acknowledged.

Abstract

Stock Price Informativeness, Cross-Listings and Investment Decisions

We show that a cross-listing allows a firm to make better investment decisions because it enhances stock price informativeness. This theory of cross-listings yield several predictions. In particular, it implies that the sensitivity of investment to stock prices should be larger for cross-listed firms. Moreover, the increase in value generated by a cross-listing (the "cross-listing premium") should be positively related to the size of growth opportunities and negatively related to the quality of managerial information. We also analyze the effects of the geography of ownership (the distribution of holdings between foreign and domestic investors) on the cross-listing premium. In particular, we show that the sensitivity of the cross-listing premium to the size of growth opportunities increases when holdings (resp. market shares) become more evenly distributed between foreign and domestic investors (resp. markets). Last, we show that concentration of trading in the home market ("flow-back") can indeed increase the cross-listing premium for some firms.

Keywords : Cross-listings, cross-listings premium, price informativeness, investment decisions, flow-back, ownership.

1 Introduction

Multiple listings of a given firm on several exchanges is an enduring phenomenon. Cross-listings in national markets were frequent (see Gehrig and Fohlin (2005) for Germany). Moreover, transatlantic cross-listings have been observed as early as the 18th century (Sylla, Wilson, Wright (2004)) and the number of non-U.S. firms seeking a listing in the U.S. has more than doubled over the nineties (see Karolyi (2006)). Yet, the determinants and effects of the cross-listings decisions are still not fully understood (see Karolyi (2006) for a discussion). We advance a new explanation for this phenomenon and we propose several testable predictions regarding (i) the effects of cross-listings on firm value and (ii) the factors affecting the decision to cross-list.

We show theoretically that managers of cross-listed firms make more efficient investment decisions because their stock price is more informative. Accordingly, a cross-listing can increase the value of a firm. Our approach hinges upon the hypothesis that firm managers can learn information from stock prices, as in recent theories developed by Dow and Gorton (1997) and Subrahamanyam and Titman (1999).[1] This hypothesis is consistent with the well-documented positive correlation between stock prices and investment decisions (e.g. Morck, Shleifer and Vishny (1990) or Blanchard, Rhee and Summers (1993)). Moreover, recent empirical findings suggest that this correlation could indeed stem from managers learning information contained in stock prices and using this information for investment decisions.[2] For instance, Durnev et al.(2004) find that firms with more informative stock prices make more efficient investment decisions while Chen et al. (2005) show that the sensitivity of investment to stock price increases with stock price informativeness.[3] Given these pieces of evidence, it is natural to investigate improvements in stock price informativeness as a motivation for cross-listings.

Our results follow from a simple intuition. When markets are informationally segmented, informed investors can trade in, say, the foreign market without *immediately* affecting prices in the domestic market. Thus, a cross-listing leverages their ability to profit from their information. Accordingly, a cross-listing has two effects : (i) it induces informed traders to trade more aggressively on their information and (ii) it increases the number of informed traders. These two effects enhance the informativeness of their stock price for cross-listed firms. Hence, a cross-listing enables managers to obtain more precise information from stock prices and, thereby, to make more efficient investment decisions. Hence,

[1] See also Allen (1993).

[2] More informative stock prices can also help to discipline managers and thereby affect firms' values (see Holmström and Tirole (1993)).

[3] See also Yook (2005) and Markovitch, Steckel and Yeung (2005).

the value of a cross-listing increases with the size of growth opportunities and firms with sufficiently large growth opportunities benefit from a cross-listing. Interestingly, growth opportunities appear to be an important factor for explaining the cross-listing decision and the related price effects (see for instance Pagano et al.(2002) or Doidge et al.(2004)).

There exist several explanations for cross-listings (see Karolyi (1998) or Karolyi (2005) for reviews). In particular, cross-listings can be a way to (i) overcome investment barriers ("segmentation hypothesis"), (ii) increase the firm visibility ("recognition hypothesis"), (iii) enhance firm liquidity, (iv) signal the quality of the firm and (v) commit to restrain expropriation from minority shareholders by controlling shareholders (Coffee (1999) and Stulz (1999)). These explanations yield several predictions about the determinants of the cross-listing decision. They have also been used to interpret the price effects associated with cross-listings. For instance, Doidge et al.(2004) show that there is a "cross-listing premium" for firms cross-listed in the U.S. (i.e. these firms have a larger Tobin-q than, otherwise similar, non cross-listed firms) and that this premium is larger for firms from countries with poor legal protections for minority shareholders. This finding is consistent with the idea that a cross-listing can act as a bonding mechanism because governance regulations are more stringent in the U.S.

Our model does not rule out these explanations but it identifies another channel through which a cross-listing could affect a firm value : a cross-listing improves stock price informativeness and thereby contributes to the efficiency of investment decisions. We show that many implications of the model are consistent with well-documented stylised facts regarding cross-listings. In particular, stock price volatility, a proxy for stock price informativeness in the model, should increase after a cross-listing. In line with this prediction, Fernandes and Ferreira (2005) find that firm-specific return variations increase after a cross-listing for firms from developed countries. The model generates additional predictions that can be used to distinguish it from other theories of cross-listings. The main testable implications are as follows:

1. For a given firm, the sensitivity of its investment decisions to stock price should increase when it becomes cross-listed.

2. The sensitivity of the cross-listing premium to the size of growth opportunities should increase when ownership becomes more evenly distributed between foreign and domestic retail investors or, equivalently in the theory, when trading becomes less concentrated in one market.

3. The cross-listing premium and the sensitivity of this premium to the size of growth

opportunities decrease with the quality of managerial information (as the informational benefit of a cross-listings becomes then relatively smaller)

4. The increase in stock price volatility after a cross-listing should be larger when trading becomes less concentrated in one market.

We also show that the informational benefit of a cross-listing vanishes when markets are informationnally integrated. This finding suggests to explain the dynamics of cross-listings (and delisting) decisions by the evolution of the level of informational integration among markets. In particular, increased informational integration between European stock markets could be the cause of the decline in the number of European cross-listings (documented by Pagano et al.(2002)).

We model multi-market trading as in Chowdry and Nanda (1991).[4] Our model extends their framework in two ways. First, we endogenize the number of informed traders (Chowdry and Nanda (1991) focus on the case with a single informed trader). This is important as, in the model, the benefit of a cross-listing is magnified by the entry of new informed traders when the firm cross-lists. Moreover, we explicitly model the decision to cross-list by a firm manager and we analyze in details the impact of a cross-listing on the firm value. In particular, we relate this impact to the *geography of ownership* (i.e. the holdings of foreign and domestic retail investors) and the distribution of trading activity between the domestic and the foreign market.

On this front, we find that cross-listed firms with relatively large (resp. small) growth opportunities experience an increase (resp. decrease) in their valuation when (a) ownership becomes more evenly distributed between foreign and domestic retail investors or (b) trading becomes more evenly distributed between the foreign and the domestic market. These findings suggest to relate time-series variations in the valuation of cross-listed firms (e.g. the cross-listing premium documented in Doidge et al.(2004)) to variations in the geography of their ownership or variations in the market share of, say, the domestic market. Second, they provide a rationale for the decision to cross-list when firms correctly anticipate that there will be little trading on the foreign market. This is important as recent studies (e.g. Halling et al.(2003)) indicate that trading in some cross-listed firms concentrates on the domestic market (so called "flow-back" phenomenon). In our model, this concentration is indeed optimal for firms with relatively small growth opportunities.

[4] Baruch, Karolyi and Lemmon (2003) also consider a model of multi-market trading. In contrast with Chowdry and Nanda (1991), they do not assume that some traders are captive in the foreign market or the domestic market. Other models of multi-market trading include Pagano (1989) and Gehrig, Stahl, Vives (1996). The purpose of these models is to explain the allocation of trading between markets, not the decision to cross-list as we do in this paper.

Our paper adds to the strand of literature relating cross-listing effects to changes in the informational environment of the firm. Cantale (1996) shows that a cross-listing acts a signaling device. By cross-listing on markets with more stringent disclosure requirements than their home market, firms signal that they have high quality projects. The role of disclosure requirements is also analyzed in Chemmanur and Fulghieri (2004).[5] In their model, firms cross-list to (i) take advantage of higher transparency induced by more stringent disclosure requirements on the foreign market and (ii) access investors with greater expertise ("skilled analysts") in evaluating their firm. In all these theories, managers are assumed to have more information than investors on the quality of their project. Rather, we consider a situation in which firm managers can learn additional information from stock prices.

Section 2 presents the model. Section 3 analyzes the cross-listing decision when exchanges are informationally segmented whereas section 4 consider the case in which exchanges are informationally integrated. Section 5 discusses the testable implications of the results and Section 6 concludes. The Appendix provides proofs and formal arguments.

2 The Model

The Firm

Following Subrahmanyam and Titman (1999), we consider a firm with assets in place and a growth opportunity. The final payoff on the assets in place is:

$$\widetilde{V} = \bar{V} + \tilde{\delta} + \tilde{\epsilon}, \tag{1}$$

where $\tilde{\delta}$ and $\tilde{\epsilon}$ are independent and normally distributed random variables with zero means. Their variances are respectively σ_{δ}^2 and σ_{ϵ}^2. The payoff of the growth opportunity is given by

$$G(K) = S((K_0^* + \tilde{\delta})K - 0.5K^2), \tag{2}$$

where K is the size of the investment in the growth opportunity and S is the size of the growth opportunity. Importantly, the payoff of the growth opportunity is correlated with the payoff on the assets in place as both payoffs depend on $\tilde{\delta}$ (e.g. the growth opportunity

[5] Huddart et al.(1999) also consider the role of disclosure requirements but their analysis focuses on the case in which firms must list on only one market. Firms listed in high disclosure environment are willing to cross-list in low disclosure environment since there is no additional cost (in terms of information revelation) for them. The reverse is not always true (see their section 5.1). Baruch and Saar (2005) and Foucault and Parlour (2004) analyze the determinants of the listing decision but, in these papers, firms cannot cross-list.

is an extension of the assets in place). All payoffs are realized in period 3. Figure 1 depicts the timing of the model.

INSERT FIG.1 ABOUT HERE

In period 0, the firm goes public and sells claims on the cash-flows of the assets in place but not on the cash-flows of the growth opportunity. As in Subrahmanyam and Titman (1999), this assumption is not key but necessary for tractability.[6] At this date, the firm's manager chooses to list on a single exchange or to dual-list on exchanges located in countries L and F where L designates the firm's home country and F designates a foreign country.[7] In period 1, the firm stock trades in one or two markets depending on whether the firm is cross-listed or not (the trading process is described below).

In period 2, the manager observes the stock price at the end of period 1 and receives an additional signal, $\widetilde{s}_2$ ("*managerial private information*"), on the value of the growth opportunities :

$$\widetilde{s}_2 = \widetilde{\delta} + \widetilde{\eta} \tag{3}$$

where $\widetilde{\eta}$ is normally distributed with mean zero and variance σ_η^2. Then, she chooses the size of the investment in the growth opportunity. The manager seeks to maximize the *total* expected value of the firm (including the value of the growth opportunity).

A dual listing involves larger direct costs than a single listing, as a dual listed firm must pay additional listing fees and investment-banking fees. It must also comply with a variety of listing and reporting requirements that can involve substantial costs for a firm (see Bancel and Mittoo (2001)). We denote by Σ the incremental cost of a dual-listing.

Shareholders and Ownership Structure

At date 0, the shares sold by the firm are purchased by two types of investors :

- *Sophisticated investors.* These investors can trade in markets L and F provided the firm is dual-listed. They can be viewed as financial intermediaries (e.g. mutual funds) who have the expertise and the technology required to engage into multimarket trading. For instance, they have relationships with brokerage firms in both markets.

- *Unsophisticated investors.* These investors exclusively trade in their home country.

[6] As an illustration, the firm can be seen as an holding with two distinct (a public and a private) subsiadiries. The managers of the holding learn information from the stock price of the publicly traded subsidiary and use it for investment decisions in the privately owned subsidiary .

[7] It is straightforward to extend the analysis to the case with N markets. This extension however increases the notational burden without providing additional intuitions.

The *ownership base* of the firm is characterized by two parameters α and $\Phi > 0$. Parameter Φ designates the fraction of outstanding shares owned by unsophisticated shareholders (sophisticated investors own a fraction $(1 - \Phi)$). When the firm is cross-listed, this fraction is split between unsophisticated investors located in countries L and F. Unsophisticated investors localized in country L owns a fraction $\Phi\alpha$ and those localized in country F owns a fraction $\Phi(1 - \alpha)$. For the exposition we assume that $\alpha \in [0.5, 1]$. The findings when $\alpha \in [0, 0.5]$ are symmetric to those obtained when $\alpha \in [0.5, 1]$ (e.g. trading concentrates in the domestic market when $\alpha = 1$ and the foreign market when $\alpha = 0$). If the firm is not cross-listed then $\alpha = 1$.[8] We refer to α as the *geography of ownership* as this parameter determines the distribution of ownership between unsophisticated foreign and domestic investors.

In period 1, initial shareholders are hit by liquidity shocks and trade in markets L and F. The total liquidity demand of initial shareholders in period 1, $\tilde{Z}$, is assumed to be normally distributed with mean zero and variance σ_Z^2. We have

$$\tilde{Z} = \tilde{Z}_L + \tilde{Z}_F + \tilde{Z}_s, \tag{4}$$

where $\tilde{Z}_j, j \in \{L, F\}$, is the liquidity demand of unsophisticated investors based in country j and $\tilde{Z}_s$ is the aggregate liquidity demand of sophisticated investors. Liquidity demands are normally and independently distributed with mean zero. We denote by σ_j^2 the variance of $\tilde{Z}_j$. This variance measures the average size of liquidity demand by a specific class of shareholders (since $E(\tilde{Z}_j^2) = \sigma_j^2$). Intuitively, the liquidity demand of a specific class of shareholders increases with the fraction of outstanding shares owned by this class. Thus, as in Holmstrom and Tirole (1993), we assume that :

$$\sigma_L^2 = \alpha\Phi\sigma_Z^2, \tag{5}$$

$$\sigma_F^2 = (1 - \alpha)\Phi\sigma_Z^2, \tag{6}$$

$$\sigma_s^2 = (1 - \Phi)\sigma_Z^2. \tag{7}$$

As shown below α determines the fraction of the total trading volume captured by the domestic market (its "market share") when the firm is cross-listed. There may be a variety of factors that determine α. For instance, firms with a large volume of sales abroad or large firms are more likely to be familiar or visible to foreign small investors. If investors

[8] Sophisticated foreign investors can hold shares of the firm even if it is not cross-listed. The important point is that a cross-listing attracts some unsophisticated investors. Thus, it should result in an increase in foreign investors' holdings. Ammer et al.(2005) show that this effect exists for cross-listings in the U.S.This effect could be due to familiarity effects as documented in Grinblatt and Kelohajru (2001) for instance.

are more willing to invest in familiar firms then we expect α to decrease with firm size or foreign sales. In this paper, we do not attempt to endogenize α as this is not necessary for our implications.

The Trading Process

We model multimarket trading as in Chowdry and Nanda (1991). The only difference with their approach is that the number of informed traders can be larger than 1 and is endogenous in our model. There are 3 types of participants: (i) liquidity traders, (ii) M risk-neutral informed traders who observe $\tilde{\delta}$ at cost C and (iii) competitive risk-neutral market-makers. As sophisticated investors do, informed traders can engage in multimarket trading.[9] Informed and sophisticated traders choose their trading strategy (order size in each market) to maximize their expected trading profit, under the constraint to trade $\widetilde{Z}_s$ shares for sophisticated investors. For simplicity, we assume that there is only one sophisticated liquidity trader. The geographical location of informed traders and the sophisticated trader is not important as they can trade in both markets.

We assume that the foreign and the domestic markets operate simultaneously. This case is relevant in many situations. For instance, trading hours for stocks cross-listed on European or North american markets overlap.

Informational Integration/Segmentation

In each market, dealers post prices such that they expect to earn zero expected profits conditional on all available public information. We will analyze two different environments: (i) markets are *informationally integrated* or (ii) markets are *informationally segmented*.

As in Domowitz et al. (1998), the level of integration between the two markets is defined with respect to the speed with which dealers obtain information on quotes or order flow prevailing in the competing market.[10] When markets are informationally integrated, dealers in one market can instantaneously reflect the information available in the competing market (e.g. order flow) into their quotes. Thus, with informational integration, the clearing price in either market is given by the following zero profit condition:

$$p(O_L, O_F) = E(\tilde{V} \mid \tilde{O}_L^i = O_L, \tilde{O}_F^i = O_F),$$

where $\tilde{O}_j^i$ is the net order flow in market j with informational integration (that is $\tilde{O}_j^i =$

[9] Menkveld (2002) studies trading in stocks cross-listed in NYSE and Amsterdam. He shows empirically that there are large traders, informed and uninformed, who strategically trade both in NYSE and Amsterdam when the two markets operate in parallel.

[10] In our model, information on prices is identical to information on order flow because, in equilibrium, there is a one-to-one mapping between prices and order flow.

$\sum_{k=1}^{k=M} Q_j^i(\tilde{\delta}) + \tilde{Z}_{js}^i + \tilde{Z}_j))$. Thus, trades take place at identical prices in each market.

Domowitz et al.(1998) study a sample of firms cross-listed in Mexico and in the U.S and reject the hypothesis of informational integration of the Mexican and the U.S. markets. Werner and Kleidon (1996) reach similar conclusions for a sample of firms cross-listed in the London stock Exchange and NYSE (see also Biais and Martinez (2003)). One reason for which markets are informationally segmented is that, at a given point in time, dealers in one market do not *immediately* observe trades occuring in the competing market at that point in time. This implies that dealers in a given market absorb order imbalances in their own market without knowing *concomitant* order imbalances in the competing market.[11] Formally, with informational segmentation, the price posted in market j is given by

$$p_j(O_j^s) = E(\tilde{V} \mid \tilde{O}_j^s = O_j^s),$$

where $\tilde{O}_j^s$ is the net order flow in market j with informational integration.

Thus, with informational segmentation, trades occuring simultaneously in the domestic and the foreign market can take place at different prices. This creates temporary differences between the reported transaction prices in each market. Of course, these divergences do not last as dealers in one market eventually get quote and trades information from the competing market or because cross-border arbitrage quickly aligns the prices in the two markets.[12] Hence, the price posted at the beginning of period 2, and observed by the manager, reflects all information available at this time (see Equation (13) below).

Remarks: Some authors (Gehrig (1993), Brennan and Cao (1997) or Kang and Stulz (1997)) assume that foreign investors are at an informational disadvantage compared to domestic investors. This informational asymmetry is also a source of market segmentation. A cross-listing overcomes this segmentation if it results in more abundant information for foreign investors. Moreover, Pagano et al.(2002) and Chemannur and Fulghieri (2003) argue that cross-listing could be a way to access investors with expertise in valuing firms in a specific industry. These effects are not present in our model because the precision of the private information or the cost of acquiring information are *not* country specific. In

[11] In practice, traders engaged in multimarket trading uses smart routing systems that give them the possibility to hit simultaneously quotes posted in different markets. Our definition of informational segmentation is common in the literature on multimarket trading (see Domowitz, Glen and Madhavan (1998), Chowdry and nanda (1991), Baruch and Saar (2005), Baruch, Karolyi and Lemmon (2003) for instance).

[12] Eun and Sabberwal (2003) estimate an error-correction model for stocks cross-listed in Canada and the U.S to study how U.S prices respond to price changes in Canada and vice-versa. Their findings show that prices adjust in each market so that the equality of prices between the two markets is maintained but that the adjustment is not immediate. Interestingly, they also find that prices in each market react to price changes in the competing market, which means that price discovery takes place both in the domestic (Canada) and the foreign (U.S) markets.

this way, we focus our analysis on a motivation for cross-listing that has not been analyzed in earlier studies.

Also, it has often been argued that a cross-listing is a way for firms to enlarge their shareholder base. This effect is not present in our model but it could easily be incorporated. Intuitively, an increase in the number of shareholders has the effect of reducing the number of shares held by each investor and to diversify liquidity shocks. Thus, an increase in the investor base after a cross-listing can be formalized by assuming that σ_Z^2 is *smaller* when the firm is cross-listed. Again, we prefer to hold σ_Z^2 fixed to better isolate the effects due to price informativeness on the cross-listing decision.

3 The Cross-Listing Decision with Informational Segmentation

In this section, we analyze the cross-listing decision when markets are informationally segmented. We proceed as follows. In section 3.1, we derive the equilibrium of the stock market when the firm is cross-listed and when it is not. Next, in Section 3.2, we study the cost and benefit of a cross-listing. We show that a cross-listing enhances the expected value of growth opportunities but results in larger expected trading costs for liquidity traders. In Section 3.3, we study under which conditions cross-listing is optimal for the manager. Throughout, we denote by M^c (resp. M^{nc}) the number of informed traders when the firm is cross-listed (resp. listed only in the domestic market).

3.1 Stock Market Equilibrium with and without a Cross-Listing.

We first consider the equilibrium of the stock market when the firm is cross-listed, for a given number of informed investors.

Lemma 1 *: In equilibrium, when the firm is cross-listed, dealers in market j post a price schedule:*

$$P(O_j) = \bar{V} + \lambda_j^*(\alpha)O_j \ for \quad j \in \{L, F\}.$$

The large sophisticated investor splits his order between the two markets so that:

$$Z_{js} = \omega_j^*(\alpha)Z_s, \ for \quad j \in \{L, F\}$$

and an informed trader's optimal order in market j is:

$$Q_j(\delta) = \beta_j^*(\alpha)\delta, \quad for \quad j \in \{L, F\}$$

with $\lambda_j^*(\alpha) = \frac{\sqrt{M^c}}{M^c+1}\sqrt{\frac{\sigma_\delta^2}{\omega_j^2\sigma_s^2+\sigma_j^2}}$, $\omega_j^*(\alpha) = \frac{\sigma_j}{\sigma_F+\sigma_L}$, *and* $\beta_j^*(\alpha) = \frac{1}{(M^c+1)\lambda_j^*}$ $\quad j \in \{L, F\}$.

The result is a straightforward extension of Lemma 1 in Chowdry and Nanda (1991) when there are several informed traders (Chowdry and Nanda (1991) focus on the case $M^c = 1$).[13] The equilibrium has the following properties. First, not surprisingly, the market with the largest proportion of unsophisticated investors turns out to be the most liquid in equilibrium because[14]

$$\frac{\lambda_F^*(\alpha)}{\lambda_L^*(\alpha)} = \frac{\sigma_L}{\sigma_F} = \sqrt{\frac{\alpha}{1-\alpha}} > 1 \quad \text{iff} \quad \alpha > \frac{1}{2}$$

Second, in order to minimize price impact, the sophisticated investor and informed investors split their order between the two markets and trades relatively more in the more liquid market (since $\frac{\omega_L}{\omega_F} = \frac{\beta_L}{\beta_F} = \frac{\lambda_F}{\lambda_L}$). Finally, the market with the largest proportion of unsophisticated investors has a greater trading volume because (a) the informed investor and the sophisticated investor trade relatively more in this market and (b) the size of the unsophisticated investor's liquidity demand is larger in this market. In order to formalize this observation, let consider the following measure of the trading volume in market j:

$$Vol_j = Var(\tilde{O}_j).$$

Lemma 1 implies :

$$\frac{Vol_L}{Vol_F + Vol_L} = \alpha. \tag{8}$$

Hence, the market shares of the domestic and the foreign markets are completely determined by the geography of ownership, α. Not surprisingly, the market share of the foreign market increases the fraction of outstanding shares owned by unsophisticated foreign investors. Trading will be highly concentrated in the local market if α is large. In the limiting case in which the firm is cross-listed and $\alpha = 1$, all the trading concentrates in the domestic market and the foreign market is completely inactive and illiquid ($w_F^* = 0$, $\beta_F^* = 0$ and $\lambda_F^* = \infty$). Several empirical studies document cross-sectional variations in the market shares (in terms of trading volume) of the domestic and foreign markets (e.g.

[13] The information received by the manager at date 2 does not affect the equilibrium of the stock market at date 1.

[14] As in Kyle (1985), λ_j is a measure of the liquidity of market j since it determines the price impact of a buy or a sell order. The larger is λ_j, the smaller is the liquidity of market j.

Baruch et al.(2003), Pulatkonak and Sofianos (1999) or Halling et al.(2003)). Consistent with Equation (8), Halling et al.(2003) find that cross-listed firms with a large fraction of U.S. ownership trade more heavily in the U.S.

Lemma 2 *: If the firm does not cross-list (it lists only in market L), the equilibrium is as described in Lemma 1 when* $\alpha = 1$ *(substituting* M^{nc} *with* M^c *in all formulae).*

In absence of cross-listing, trading takes place only in the domestic market and the equilibrium is as described in Lemma 1 when $\alpha = 1$, accounting for the fact that the number of informed traders may differ in the two cases.

In equilibrium, informed traders make profits at the expense of liquidity traders. Let $L_j(\alpha, \Phi, M^c)$ be the aggregate expected trading losses for unsophisticated shareholders localized in country j and $L_s(\alpha, \Phi, M^c)$ be the expected trading losses for the sophisticated shareholder. Liquidity traders' aggregate expected trading losses are :

$$\sum_{j\in\{L,F\}} L_j(\alpha, \Phi, M^c) + L_s(\alpha, \Phi, M^c)$$

$$= \sum_{j\in\{L,F\}} E((P_j - \tilde{V})\tilde{Z}_j) + \sum_{j\in\{L,F\}} E((P_j - \tilde{V})(\tilde{Z_{sj}})),$$

that is (using Lemma 1):

$$\sum_{j\in\{L,F\}} L_j(\alpha, \Phi, M^c) + L_s(\alpha, \Phi, M^c) = \lambda_L^*\sigma_L^2 + \lambda_F^*\sigma_F^2 + (\lambda_L^*(\omega_L^*)^2 + \lambda_F^*(\omega_F^*)^2)\sigma_s^2.$$

As dealers break-even, informed traders' aggregate expected profits, $\Pi^c(\alpha, \Phi, M^c)$, are equal to liquidity traders' aggregate expected losses. We deduce from the previous equation and the closed-form solutions for λ_j^* and ω_j^* that:

$$\Pi^c(\alpha, \Phi, M^c) = \frac{\sqrt{M^c}}{M^c + 1}[\sqrt{(2\Phi\sqrt{\alpha(1-\alpha)} + 1)\sigma_\delta^2\sigma_Z^2}]. \tag{9}$$

A trader acquires private information if his expected profit exceeds the cost of information, C. Observe that Π^c decreases with the number of informed traders. The number of informed traders in equilibrium, M^{c*}, is such that entry of an additional informed trader is unprofitable. In order to simplify the analysis, we treat the number of informed traders as a continuous variable. In this case, M^{c*} solves :

$$\Pi^c(\alpha, \Phi, M^{c*}) = CM^{c*}. \tag{10}$$

We obtain informed traders' aggregate expected profits when the firm is not cross-listed, Π^{nc}, by setting $\alpha = 1$ in Equation (9) and we obtain:

$$\Pi^{nc} \stackrel{def}{=} \Pi^{c}(1, \Phi, M^{nc}) = \frac{\sqrt{M^{nc}}}{M^{nc}+1}[\sqrt{\sigma_{\delta}^{2}\sigma_{Z}^{2}}]. \tag{11}$$

We deduce that the number of informed traders when the firm is not cross-listed solves :

$$\frac{\sqrt{M^{nc*}}}{M^{nc*}+1}[\sqrt{\sigma_{\delta}^{2}\sigma_{Z}^{2}}] = CM^{nc*}. \tag{12}$$

Using Equations (10) and (12), we obtain the following result.

Proposition 1 *: If $\alpha < 1$, the number of informed traders is larger when the firm is cross-listed than when it lists only in the domestic market (i.e. $M^{c*} > M^{nc*}$).*

- *Furthermore, the number of informed traders decreases with α (for $\alpha \in [0.5, 1]$) and increases in Φ when the firm is cross-listed.*
- *When $\alpha = 1$, the number of informed traders is identical when the firm is cross-listed and when it is not.*

When markets are informationnally segmented and the firm is cross-listed, informed traders can place orders in one market *without immediately* impacting the price in the other market. In this case, a cross-listing opens new profit opportunities for informed traders and they obtain a larger aggregate expected profit than when the firm has a single listing. Thus, a cross-listing triggers entry of additional informed traders compared to a single listing. Consistent with this result, Norhona et al.(1996) find that the level of informed trading has increased for firms listed on NYSE and AMEX following their dual-listing on the London Stock Exchange or the Tokyo Stock Exchange.

If $\alpha = 1$ the equilibrium is identical when the firm is cross-listed and when it is not. Hence, from now on, we say that the firm is cross-listed **iff** $\alpha < 1$. When markets are informationally segmented, concomitant transactions take place at different prices in the domestic and the foreign market. But prices in each market converge to a single value *once* dealers in one market observes the price innovation (or order flow) in the competing market. Hence, the price on markets F and L at the beginning of period 2 is :

$$P_{2}^{c} = \overline{V} + E(\widetilde{\delta} \mid P_{L}^{c}, P_{F}^{c}). \tag{13}$$

If the firm has a single listing, the price at the beginning of period 2 is :

$$P_2^{nc} = \overline{V} + E(\widetilde{\delta} \mid P_L^{nc}). \tag{14}$$

Let $I(P_2^k) \overset{def}{=} \sigma_\delta^2 - Var(\widetilde{\delta} \mid P_2^k)$ where $k = c$ if the firm is cross-listed and $k = nc$ if it is not. This variable measures the informativeness of the stock price observed at the beginning of period 2 in a given regime (cross-listed/not cross-listed). Actually, the larger is $I(P_2^k)$, the smaller is the residual uncertainty on $\widetilde{\delta}$ ($Var(\widetilde{\delta} \mid P_2^k)$) after observing the stock price.

Proposition 2 *: The informativeness of the stock price is larger when the firm is cross-listed than when it is not. The closed-form solutions for price informativeness are :*

$$I(P_2^c) = \frac{2M^{c*}\sigma_\delta^2}{(2M^{c*}+1) + \frac{(1-\Phi)}{1+2\Phi\sqrt{\alpha(1-\alpha)}}}, \tag{15}$$

and

$$I(P_2^{nc}) = \frac{M^{nc*}\sigma_\delta^2}{(M^{nc*}+1)}. \tag{16}$$

A cross-listing enhances price informativeness because it generates an increase in the number of informed traders (Proposition 1). The aggregate trade of informed investors (i.e. $M^{*c}(Q_L(\delta) + Q_F(\delta))$) is thereby more sensitive to their private information when the firm is cross-listed than when it is not.[15] Hence, the order flow is more informative with a cross-listing.[16]

Corollary 1 *: When the firm is cross-listed, the informativeness of the stock price increases with Φ and decreases with α for $\alpha \in [0.5, 1]$. It is maximal when $\alpha = 0.5$.*

The ownership structure of the firm (Φ) and its geography (α) determines the allocation of informed traders' orders between each market and thereby the informativeness of the price system. To see this point, observe that the total trade size of informed investors in market j is :

$$M^{c*}Q_j(\delta) = M^{c*}\beta_j^*(\alpha)\delta,$$

Now :

$$M^{c*}\beta_j^*(\alpha) = \frac{\sqrt{M^{c*}}w_j(\alpha)\sigma_Z}{\sigma_\delta}\sqrt{1+2\Phi\sqrt{\alpha(1-\alpha)}}$$

[15] Actually, it can be checked that $M^{c*}(\beta_L(\alpha) + \beta_F(\alpha)) > M^{nc*}(\beta_L(1))$ because $M^{c*} > M^{nc*}$.

[16] This result also holds if the number of informed traders is exogenous ($M^c = M^{nc}$). In this case, the result is due to the fact that a cross-listing induces *each* informed investor to trade more aggressively on his information.

An increase in Φ unambiguously enlarges informed traders' aggregate trade size in each market and, thereby, makes the order flow more informative in each market. An increase in α induces informed traders to trade more heavily in the home market and less heavily in the foreign market. Thus, a change in the geography of ownership contributes to make one market more informative and the competing market less informative. Given these countervailing effects, the impact of a change in α on price informativeness is unclear. Differentiation of equation (15) with respect to α, however, establishes that, overall, price informativeness is enhanced when the allocation of unsophisticated investors between the foreign and the domestic market becomes more even.

3.2 The Benefit and Cost of a Cross-Listing

In period 2, the manager chooses the size of the investment in the growth opportunity after observing (i) the stock price, P_2^k and (ii) managerial private information, s_2. It is straightforward that the optimal investment in the growth opportunity is:

$$K^* = K_0^* + E(\widetilde{V} \mid \widetilde{s}_2, P_2^k) \tag{17}$$

Assuming that, conditional on $\widetilde{\delta}$, $\widetilde{s}_2$ and P_2^k are independent[17], normal theory implies that

$$K^* = K_0^* + \frac{\tau_\eta}{\tau_\eta + \tau_k} s_2 + \frac{\tau_k}{\tau_\eta + \tau_k}(P_2^k - \overline{V}), \tag{18}$$

where $\tau_\eta = (\sigma_\eta^2)^{-1}$ (the precision of signal η) and $\tau_k = (Var(\widetilde{\delta} \mid P_2^k))^{-1}$. Thus, the investment in the growth opportunity depends both on (a) the stock price and (b) managerial information, as both signals are informative.

When informed traders receive a good signal ($\delta > 0$), they buy the stock and the stock price increases on average ($E(P_2^k \mid \delta > 0) - \overline{V}) > 0$). Thus, for a fixed value of s_2, an increase in the stock price is a positive signal about the value of the growth opportunity. Conversely, a decrease in price is a negative signal about the value of the growth opportunity. For this reason, there is a positive relationship between the size of the investment in the growth opportunity and the stock price. We analyze the determinants of this relationship in Section 5, when we discuss the implications of the model.

We normalize K_0^* to zero, which simplifies the derivations without affecting the results. The expected value of the growth opportunity at date 0 (denoted by EG^k) when the firm

[17] This assumption is innocuous. It means that the signal received by the manager at date 2 in addition to the stock prices is independent of the amount of liquidity trading in the stock market at date 1.

is in regime k is:

$$EG^k = S[E(K^*\tilde{\delta} - \frac{(K^*)^2}{2})], \qquad k \in \{c, nc\}$$

Using Equation (17), we rewrite this expression as:

$$EG^k = S[E(E(\tilde{\delta} \mid s_{2,}P_2^k)^2) - E(\frac{E(\tilde{\delta} \mid s_{2,}P_2^k)^2}{2})] = \frac{SE(E(\tilde{\delta} \mid s_{2,}P_2^k)^2)}{2}.$$

As $E(E(\tilde{\delta} \mid s_{2,}P_2^c)) = 0$, we deduce that the expected value of the growth opportunity is :

$$EG^k = \frac{SVar(E(\tilde{\delta} \mid s_{2,}P_2^k))}{2}, \qquad k \in \{c, nc\}. \tag{19}$$

Intuitively, the greater is $Var(E(\tilde{\delta} \mid s_{2,}P_2^k))$, the greater is the informativeness of the signals received by the manager at date 2.[18] Hence, the expected value of the growth opportunity increases with the the informativeness of the stock price. We establish this result in the next lemma.

Lemma 3 *: The expected value of the growth opportunity increases with the informativeness of the stock price, $I(P_2^k)$. Specifically, we have:*

$$EG^k = \frac{S}{2}(\frac{\sigma_\delta^4 + (\sigma_\eta^2 - \sigma_\delta^2)I(P_2^k)}{\sigma_\eta^2 + \sigma_\delta^2 - I(P_2^k)}) \ \textit{for } k \in \{c, nc\}. \tag{20}$$

Intuitively, a more informative stock price enables the manager to make more efficient investment decision (i.e. to invest more when the marginal return of the investment, δ, is large). This property holds whether the firm is cross-listed or not **but** the informativeness of the stock price is larger when the firm is cross-listed (Proposition 2). Thus, the expected value of the growth opportunity when the firm is cross-listed is larger than when it is not. We state this central result in the next proposition.

Proposition 3 *: **(benefit of a cross-listing)** For all values of α and Φ, the expected value of the growth opportunity is larger when the firm is cross-listed (i.e. $EG^c > EG^{nc}$). The incremental expected value of the growth opportunity, $\Delta EG \overset{def}{=} EG^c(\alpha, \Phi, \sigma_\eta^2) - EG^{nc}(\sigma_\eta^2)$, is maximal when $\alpha = 0.5$ and decreases with α. Furthermore, it increases with Φ and σ_η^2.*

[18] For any random variables X and Y for which the necessary expectations exist, $Var(Y) = E(Var(Y \mid X)) + Var(E(Y \mid X))$. Moreover, when X and Y are normally distributed, $Var(Y \mid X)$ is non random. In this case $Var(Y \mid X) = Var(Y) - Var(E(Y \mid X))$. This property holds also in the multi-dimensional case. This implies that the larger is $Var(E(Y \mid X))$, the more precise is the posterior of Y after observing X. Hence, $Var(E(Y \mid X))$ is a measure of the informational content of X about Y.

Interestingly, the impact of the cross-listing on the value of the growth opportunity depends on (i) the ownership of the firm and (ii) the quality of managerial information (s_2). Changes in ownership that enhances price informativeness (e.g. a more even allocation of shares between domestic and foreign investors) result in more efficient investment decisions and thereby a larger expected value for the growth opportunity. When the precision of managerial information declines, stock price information is more valuable for the manager. As a consequence, the impact of a cross-listing on the expected value of the growth opportunity becomes larger.

The informational benefit of a cross-listing must be balanced against the costs of a cross-listing. A cross-listing entails two costs in our model: (i) a direct cost, Σ (listing fees, compliance costs...) and (ii) an increase in expected trading losses for unsophisticated liquidity traders. To see this recall that unsophisticated traders' losses, L^k, are equal to aggregate informed traders' profits, Π^k. Hence, Equations (10) and (11) yield:

$$L^c - L^{nc} = \Pi^c(\alpha, \Phi, M^{c*}) - \Pi^{nc} = (M^{c*} - M^{nc*})C > 0,$$

where the inequality follows from Proposition 1. The increase in unsophisticated traders' losses is costly for the firm because the latter discount their valuation for the firm by the size of their expected trading loss (as in Hölmstrom and Tirole (1993)). We call this discount the *illiquidity premium.*

Corollary 2 *:* ***(cost of a cross-listing)*** *The illiquidity premium is larger when the firm is cross-listed than when it is not. Furthermore, in equilibrium, the illiquidity premium depends on the ownership structure of the firm : it decreases with α and it increases with Φ.*

The illiquidity premium depends on the ownership of the firm. Intuitively, changes in the ownership structure that induces more informed trading (i.e. enhances price informativeness) results in larger expected losses for liquidity traders (a greater illiquidity premium). Thus, the illiquidity premium becomes smaller as trading becomes more concentrated on the domestic market or when sophisticated investors hold a greater fraction of the issue. Overall, changes in ownership enhancing the expected value of the growth opportunity have an adverse impact on the illiquidity premium, for cross-listed firms. This tension is key for our analysis of the effect of a change in ownership on the value of a cross-listed firm (see next subsection).

Empirically, the effect of a cross-listing on liquidity is unclear. For Mexican companies, Domowitz, Glen and Madhavan (1998) find that, other things equal, trading costs are larger for cross-listed firms. In contrast, Noronha et al. (1996) or Foerster and Karolyi (2000) find an increase in trading activity and greater liquidity on both domestic and foreign markets following a cross-listing. This observation could come from phenomena that are not captured by our model. In this model, dealers earn zero expected profits whether the firm is cross-listed or not. In reality, maybe, market making is not completely competitive. In this case, a cross-listing could work to reduce domestic dealers' rents by increasing intermarket competition. In our set-up, this mechanism would simply reinforce the incentive to cross-list for a firm, by alleviating the impact of a cross-listing on the illiquidity premium.

3.3 The Value of a Cross-Listing with informational Segmentation

Now, we examine the conditions under which it is optimal for the firm to cross-list given the costs and benefit associated to this decision. For a given ownership structure, the expected value of the firm, $V^c(\alpha, \Phi, \sigma_\eta^2)$, if it is cross-listed is :

$$V^c(\alpha, \Phi, \sigma_\eta^2) \equiv \bar{V} + EG^c(\alpha, \Phi, \sigma_\eta^2) - L^c(\alpha, \Phi, M^{c*}) - \Sigma.$$

If the firm is not cross-listed, its expected value is :

$$V^{nc}(\sigma_\eta^2) \equiv \bar{V} + EG^{nc}(\sigma_\eta^2) - L^{nc}.$$

The firm should cross-list iff

$$\Delta V \equiv V^c(\alpha, \Phi, \sigma_\eta^2) - V^{nc}(\sigma_\eta^2) > 0.$$

We call ΔV the *cross-listing premium.* Using the expressions for V^c and V^{nc}, we obtain the following result.

Proposition 4 *: Growth opportunities and the cross-listing premium*

1. *Only firms with a sufficiently large growth opportunity chooses to cross-list. That is there exists a threshold S^*such that $\Delta V > 0$ if and only if $S > S^*$. Moreover S^* decreases when the manager's private information (s_2) is of lower quality (i.e. σ_η^2 increases).*

2. *The cross-listing premium increases with the size of the growth opportunity, that is ΔV increases with S.*

The contribution of the growth opportunity to the total value of the firm becomes larger as the size of the growth opportunity increases. For this reason, the positive impact of a cross-listing on the value of the growth opportunity dominates the cost of cross-listing when the size of the growth opportunity is large enough. Thus, firms with large growth opportunities are more likely to cross-list. Moreover, for a fixed size of the growth opportunity, the informational benefit of a cross-listing is greater when managerial information is poor. This yields the second prediction that firms with more uncertain growth opportunities (given the information available to managers) are more likely to cross-list. These predictions are supported by empirical findings on cross-listings. Pagano, Roëll and Zechner (2002) find that firms with high growth rates and large market-to-book values are more likely to cross-list. Furthermore, they observe that cross-listed firms have higher ratios of R&D expenses per employee. Presumably, the value of growth opportunities is more uncertain for these firms as the outcome of R&D is difficult to evaluate. Hence, the enhancement of price informativeness associated with a cross-listing is more valuable for these firms.

Doidge, Karolyi and Stulz (2004) find that firms cross-listed in the U.S. have a larger Tobin-q than firms that do not cross-list. They show that this cross-listing premium is positively related to indicators of growth opportunities. However, these indicators alone do not explain entirely the cross-listing premium. Rather, this is *the combination* of growth opportunities *and* the decision to cross-list that results in the premium. Subsequent empirical works have obtained similar conclusions with different samples and methodologies (e.g. Hail and Leuz (2005) or King and Segal (2005)). Our model is consistent with these observations. The cross-listing premium increases with the size of growth opportunities (second part of Proposition 4). Moreover, cross-listing is the act that enables the firm to enhance the expected value of its growth opportunity. That is, for given growth opportunities, the expected value of a cross-listed firm is larger than an otherwise comparable, but not cross-listed, firm. The model generates additional predictions regarding the determinants of the sensitivity of the cross-listing premium to the size of growth opportunities $(\frac{\partial V}{\partial S})$ that we discuss in Section 5.

Proposition 5 *: Other things equal, the cross-listing premium increases when the quality of managerial information decreases (i.e. σ_η^2).*

Intuitively, the informational benefit of a cross-listing is larger when managerial information is poor. Accordingly, the impact of a cross-listing on firm values is larger in this case. This finding suggests to use proxies for the quality of managerial information to explain cross-sectional variations in the cross-listing premium.

The model also implies that the cross-listing premium depends on ownership structure (Φ) and the geography of its ownership (α) (because these variables affect both the expected value of growth opportunities and the illiquidity premium for cross-listed firms; see previous section). King and Segal (2005) find indeed that the cross-listing premium for Canadian firms cross-listed in the US is positively related and, largely explained, by the fraction of shares hold by US investors. Moreover, Ammer et al.(2005) find that firms expecting a large increase in the fraction of shares owned by foreign investors are more likely to cross-list.

In our model, the effect of ownership variables on the cross-listing premium is ambiguous, because these variables affect the expected value of the growth opportunity and the illiquidity premium in opposite ways. In order to get more insights, we analyze the effect of a change in α on the cross-listing premium with the help of simulations (as it is difficult to obtain analytical results).

INSERT FIG2. ABOUT HERE

Figure 2 considers the impact of increasing α on the cross-listing premium (ΔV) for various sizes of the growth opportunity ($S = 30$, $S = 35$, $S = 40$ and $S = 45$). Given the baseline values of the parameters, the manager finds profitable to cross-list for any value of $\alpha < 1$. Thus, a firm can benefit from a cross-listing even if its trading activity mainly concentrates in the home market. Interestingly, in some cases, this concentration can even be optimal. Some studies (e.g. Karolyi (2003), Halling et al.(2003) or Baruch et al.(2003)) show that there is a tendency for trading activity to "flow back" to the domestic market. Our finding suggests that flow back can, paradoxically, enhance the value of a cross-listing. For instance, when $S = 30$, $\alpha^* = 99\%$ maximizes the cross-listing premium. The optimal value of α falls to $\alpha^* = 93.2\%$ and $\alpha^* = 77\%$ for $S = 35$ and $S = 40$, respectively. More generally, as the size of the growth opportunity increases, the optimal ownership structure becomes closer and closer to the ownership structure that maximizes the expected value of the growth opportunity (i.e. α^* goes to 50% as S increases, see Proposition 3). In fact for $S = 45$, Figure 2 shows that $\alpha^* = 50\%$.

Thus, the model suggests that the cross-listing premium of firms with relatively large growth opportunities will increase when trading becomes more evenly allocated between the foreign and the domestic market (i.e. when the proportion of foreign unsophisticated investors increases). In contrast, the cross-listing premium of firms with relatively small growth opportunities should increase when trading concentrates in the domestic market. We have checked that these conclusions were robust for a wide range of parameters. Thus, the model suggests to explain time-series variations in the cross-listing premium by intertemporal variations in the allocation of trading between the domestic and the foreign markets. We discuss this implication in more details in Section 5.

These findings also suggest that firms should endeavor to control the geography of ownership. Figure 2 reveals that the value of α that maximizes the cross-listing premium increases with the size of growth opportunities. Thus, if firms optimally control the geography of ownership, we should observe a positive correlation between (i) the size of growth opportunities and (ii) the fraction of global trading taking place in the foreign market for cross-listed firms (as this fraction is a proxy for α). Halling et al.(2003) find that this is indeed the case empirically.

How could firms control the geography of their ownership? Advertising campaigns can be one way to achieve this objective. Grullon et al. (2004) show that firms with greater advertising expenditures have a larger number of shareholders (institutional and retail). Interestingly they also find that the impact of advertising expenditures on retail investors is larger. These results suggest that a firm could increase its base of unsophisticated shareholders in a foreign market by advertising campaigns specifically targeted to foreign investors.[19] In fact, Grullon et al. (2004) describe the case of a Japanese firm listed on the NYSE which launched extensive advertising campaigns in the U.S. with the explicit goal of attracting new investors. Another possibility is to buy additional investment banking services, such as financial analysts coverage or market-making, that help to maintain the firm's visibility among foreign retail investors.

4 The Cross-Listing Decision with Informational Integration

Now we consider the polar case in which information linkages between markets L and F are perfect: dealers can instantaneously reflect into their prices information about the trading process in the other market. This case has not been formally analyzed in the literature on multi-market trading (e.g. Chowdry and Nanda (1991) only consider the case in which markets are segmented). In this section, we index all endogenous variables with superscript i as they take different values from those obtained when markets are informationally segmented. For instance, M^{ci*} denotes the number of informed investors when the firm is cross-listed *and* markets are informationally integrated.

[19]These advertising campaigns are also likely to boost sales abroad. This might explain why Halling et al.(2003) also find that the proportion of sales in the foreign market positively affects the fraction of global trading accounted by the foreign market.

We consider linear equilibria in which the price schedule writes

$$P^i(O_L, O_F) = E(\tilde{V} \mid \tilde{O}^i_L = O_L, \widetilde{O}^i_F = O_F) = \bar{V} + \lambda^{*i}_L O_L + \lambda^{*i}_F O_F.$$

We obtain the following result.[20]

Proposition 6 *: When there is informational integration and the firm is cross-listed, there is a linear equilibrium in which dealers post the price schedule*

$$P^i(O_L, O_F) = \bar{V} + \lambda^{*i}(O_L + O_F),$$

with $\lambda^{*i} = \frac{M^{ci*}}{(M^{ci*}+1)}\sqrt{\frac{\sigma^2_\delta}{\sigma^2_Z}}$. *An informed investor's trading strategy is:*

$$Q_F(\delta) = \beta^{*i}_F \delta = \left(\frac{\sigma^2_F}{\sigma^2_F + \sigma^2_L + \sigma^2_s}\right)\frac{\delta}{(M^{ci*}+1)\lambda^{*i}},$$

$$Q_L(\delta) = \beta^{*i}_L \delta = \left(\frac{\sigma^2_L + \sigma^2_s}{\sigma^2_F + \sigma^2_L + \sigma^2_s}\right)\frac{\delta}{(M^{ci*}+1)\lambda^{*i}},$$

and the sophisticated shareholder trades exclusively in Market L. Finally, in equilibrium, the number of informed investors is the same as when the firm is not cross-listed, $M^{ci*} = M^{nc*}$.

The properties of the market are identical to those obtained with a single listing. In particular, in equilibrium, the depth of each market is identical to the depth of the market with a single trading location since

$$\lambda^{*i} = \lambda^*(1) = \frac{M^{nc*}}{M^{nc*}+1}\sqrt{\frac{\sigma^2_\delta}{\sigma^2_Z}}.$$

This implies that the trading losses of liquidity traders are identical when the firm is cross-listed and when it is not. Moreover, with informational integration, the total trade size of informed investors does not depend on whether the firm is cross-listed or not as:

$$M^{c*i}(Q_L + Q_F) = M^{c*i}(\beta^{*i}_F + \beta^{*i}_L)\delta = M^{nc*}\beta^*(1)\delta.$$

Intuitively, with informational integration, dealers in each market reflect *instantaneously* into their prices the information contained in the order flow directed to the competing market. Hence, informed traders lose the possibility of exploiting "twice" their information

[20] We omit the proof of this result for brevity. It can be obtained upon request.

and behave as if trading was taking place in a single arena. But then a cross-listing has no effect on price informativeness. In fact it follows from Proposition 6 that:

$$I(P_2^c) = (\frac{M^{ci*}\sigma_\delta^2}{M^{ci*}+1}).$$

As $M^{ci*} = M^{nc*}$, we deduce that $I(P_2^c) = I(P_2^{nc})$. The next proposition follows directly from these remarks.

Proposition 7 *: With informational integration, the informativeness of the stock price is not affected by the cross-listing decision. Thus, it is never optimal for a firm to cross-list if* $\Sigma > 0$.

With perfect informational integration, firms have no incentives to cross-list at all. In reality, trading mechanisms often make it impossible for liquidity suppliers to condition their quotes on concomitant order flow in competing markets. Thus, the case with informational integration is best seen as a polar case. In reality, however, technological advances have accelerated the speed at which quote and trades data in one market are available in competing markets. The logic of the model suggests that this acceleration decreases the profitability for informed trading, price informativeness and thereby the benefits of a cross-listing. Pagano et al.(2002) point out that there has been a decline in the number of European cross-listings over the 90s'. They note:

"*When it comes to cross-listings, the most dynamic and outward-oriented European companies self-select U.S. exchanges. The main remaining puzzle is why European exchanges are judged to be less attractive by this group*"

The model suggests to consider increased informational integration among European equity exchanges as a possible cause for the decline in the number of European cross-listings. This hypothesis also implies that exchanges could oppose the process of informational integration. Actually, this process decreases their ability to attract cross-listings and thereby to generate revenues from cross-listings.[21]

[21] Interestingly, Pagano et al.(2002) find that European firms that cross-list in the U.S. appear to have higher growth rates compared to European firms that cross-list in Europe. This is consistent with our hypothesis as the model implies that informational benefits of a cross-listing in informationally integrated markets are small. Thus, getting more precise information from stock prices might not be the chief motivation of European firms that cross-list in Europe.

5 Testable Implications

We now discuss in more details the implications of our model for empirical works on cross-listings.

Cross-listings, Price Informativeness and Price Volatility. A key effect of a cross-listing in our model is to enhance price informativeness. Thus, following a cross-listing, the stock price should be more volatile as it reflects more information.[22] To formalize this intuition, observe that the volatility of close-to-close returns is (using Equations (13) and (14)):

$$Var(P_2^k - \overline{V}) = Var(E(\widetilde{\delta} \mid P_2^k)) = I(P_2^k), \tag{21}$$

where the second from the properties of normal variables. Thus, Proposition 2 implies that

$$Var(P_2^{nc} - \overline{V}) < Var(P_2^c - \overline{V}). \tag{22}$$

Jayaranan, Shastri and Tandon (1993), Domowitz, Glen and Madhavan (1998), Bailey, Karolyi and Salva (2005) find that price volatility increases when firms become cross-listed. Interestingly, Domowitz et al.(1998) show that the increase in volatility is unrelated to changes in liquidity and trading activity. They therefore conclude that the change in volatility reflects a change in information structure, in line with the logic of our model.

More recently, several authors (e.g. Durnev et al.(2004), Chen et al. (2005)) have used firm-specific stock return variations as a proxy for price informativeness (as initially suggested by Roll (1988)). This is consistent with Equation (21). Intuitively, incorporation of the information revealed during the trading process into prices raises price volatility. The model implies that measures of firm specific return variations should be larger after a firm cross-lists. This prediction is supported by the empirical findings of Fernandes and Ferreira (2005). For a large sample of firms cross-listed in the U.S., they show that a cross-listing results in larger idiosyncratic volatility for firms from developed countries.

The model further predicts a relationship between the change in idiosyncratic volatility after a cross-listing and the geography of ownership. Actually, Equation (21) implies that :

$$Var(P_2^c - \overline{V}) - Var(P_2^{nc} - \overline{V}) = I(P_2^c) - I(P_2^{nc}) \tag{23}$$

Corollary 1 implies that the change in price informativeness (the R.H.S of the last equation) is larger when α gets closer to 50%. Thus, the model implies that the change in price volatility following a cross-listing should increase when the allocation of ownership between

[22] See Freedman (1991) for a similar finding.

foreign and domestic unsophisticated shareholders becomes more even (or equivalently when the market share of, say, the foreign market gets closer to 50%).

Cross-listings and the sensitivity of investment decisions to stock price. In our model, a cross-listing enhances stock price informativeness and enables managers to make more efficient investment decision. Thus, the sensitivity of investment decisions to stock prices should be larger for cross-listed firms. Indeed, Equation (18) implies that the sensitivity of the investment decision to the stock price is :

$$\frac{\partial K^*}{\partial P_2^k} = \frac{\tau_k}{\tau_\eta + \tau_k},\ k \in \{c, nc\} \tag{24}$$

where τ_η is the precision of managerial information (s_2) and τ_k is the precision of the information contained in stock price in regime k. Thus the sensitivity of firms' investment decisions (i) increases with the informativeness of the stock price and (ii) is larger when the firm is cross-listed because the stock price is more informative in this case, i.e. $\tau_c > \tau_{nc}$. Chen et al.(2005) provide evidences supporting the first implication (they find that the sensitivity of investment to the stock price increases with measures of price informativeness). The second implication is specific our theory of cross-listings and could be used to test it (using, for instance, the methodology developed in Chen et al.(2005)).

The Sensitivity of the Cross-Listing Premium to Growth Opportunities. As discussed in Section 3, several studies have shown that the cross-listing premium increases with the size of growth opportunities (e.g. Doidge et al. (2004)). Our model has this property ($\frac{\partial \Delta V}{\partial S} > 0$) and yields several predictions regarding the determinants of the sensitivity of the cross-listing premium to the size of growth opportunities, as shown by the next proposition.

Proposition 8 *:The sensitivity of the cross-listing premium to the size of the growth opportunity ($\frac{\partial \Delta V}{\partial S}$) depends on :*

1. *The structure of ownership (Φ) and the geography of ownership (α). Specifically, this sensitivity decreases when α goes from 0.5 to 1 and it increases with Φ.*
2. *The precision of managerial information. Specifically, this sensitivity increases when σ_η^2 increases (i.e. when s_2 is less precise).*

A cross-listing in our model allows firm managers to exploit more efficiently their growth opportunities. Thus, any changes that reinforces the impact of the cross-listing on the efficiency of managerial decisions enhances the sensitivity of the cross-listing premium to the size of growth opportunities. A decrease in the quality of managerial information has this effect because it makes stock price information relatively more valuable. A more even allocation of ownership between foreign and domestic unsophisticated investors makes the impact of a cross-listing on price informativeness larger and is thereby conducive to more efficient investment decisions in their growth opportunities for cross-listed firms.

The implications of Proposition 8 could be tested by allowing the effect of growth opportunities (proxied by industry Tobin-q or past sales growth) on the cross-listing premium to interact with ownership variables and measures of the quality of managerial information. As they are specific to our theory, they offer a way to distinguish it from other explanations of the cross-listing premium (e.g. the bonding hypothesis).

Cross-listing premium and trading location dynamics. Some empirical studies (e.g. Doidge et al.(2004) and Levine and Schmukler (2004)) have studied the evolution of the cross-listing premium after the cross-listing date. Doidge et al. (2004) finds that this premium persists even years after the listing date while Levine and Schmukler (2004) obtain opposite findings.[23] find that the positive price effect of a cross-listing does not last. In fact, they even document a long run negative effect of cross-listing on stock valuations. Our model suggests to relate the evolution of the cross-listing premium to changes in the geography of ownership. In particular, for firms with large growth opportunities, the cross-listing premium should decrease when trading gravitates to only to one market (α gets closer to 1 in our model). In contrast, for firms with relatively small growth opportunities, the cross-listing premium should increase as trading concentration in one market gets larger.

6 Conclusion

This paper develops a new theory of cross-listings. We show that a cross-listing enhances price informativeness and thereby increases managers' ability to take advantage of their growth opportunities. Accordingly, firms with sufficiently large growth opportunities cross-list and the value of a cross-listed firm is larger than, otherwise similar, non-cross-listed firms. This cross-listing premium increases in the size of growth opportunities and is inversely related to the quality of managerial information.

The theory has a rich set of testable implications. In particular, it implies that the sensitivity of investment decisions to stock price should increase after a cross-listing. Moreover, it predicts that the sensitivity of the cross-listing premium to the size of growth opportu-

[23] Foerster and Karolyi (1999) find a negative long run abnormal performance for cross-listed stocks.

nities depends on the ownership base of cross-listed firms. In particular, this sensitivity should increase as ownership becomes more evenly distributed among foreign and domestic retail investors. Last, it suggests to explain time-series variations in the cross-listing premium by variations in the ownership base of the firm or the allocation of trading activity between the foreign and the domestic market. For instance, firms with relatively small growth opportunities should experience an increase in the cross-listing premium when (i) holdings become less evenly distributed between foreign and domestic retail investors or (ii) trading concentrates either in the domestic or the foreign market. Testing these implications could help to better understand the reasons for which firms choose to cross-list.

A cross-listing in U.S. markets obliges firms to additional disclosures, as they must reconcile their accounting statements with U.S GAAP. These disclosures can result in an increase in public information available to investors and thereby lower the profitability of acquiring private information. In our framework, this effect would lessen the increase in informed traders' profits following a cross-listing and could even outweight it for some firms. An interesting question is to identify the type of firms for which the disclosure effect is strong enough to reduce informed trading and thereby stock price informativeness.[24] This would help to better delineate the set of cross-listed firms for which our theory is most likely to apply.

7 Appendix

Proof of Lemma 1.

In a linear equilibrium, dealers' price schedules in exchanges L and F are given by

$$P(O_L) = \bar{V} + \lambda_L O_L,$$

$$P(O_F) = \bar{V} + \lambda_F O_F,$$

with $\lambda_j, j \in \{L, F\}$, finite and strictly positive (this is necessary and sufficient for both exchanges to be active). Informed investor k's trading strategy in market j is given by :

$$Q_{kj}(\delta) = \beta_{kj}\delta, \quad for \quad k \in \{1, ..., M^{c*}\} \quad and \quad j \in \{L, F\}. \tag{25}$$

[24] In the case of emerging countries, Fernandes and Ferreira (2005) find a reduction in idiosyncratic volatility following a cross-listing. One possibility (discussed by Fernandes and Ferreira (2005)) is that, for emerging markets, the disclosure effect is very strong because accounting standards are more lenient or not well enforced in emerging countries.

We define:

$$Q_{-kj} = \sum_{l \neq k} Q_l \quad j \in \{L, F\}. \tag{26}$$

and

$$\beta_{-kj} = \sum_{l \neq k} \beta_l \quad j \in \{L, F\}. \tag{27}$$

It is immediate that :

$$Q_{-kj} = \beta_{-kj}\delta \quad j \in \{L, F\}. \tag{28}$$

We proceed in 3 steps. First we derive the optimal trading strategies of the informed investors and the sophisticated investor (steps 1 and 2 respectively) for given values of λ_L and λ_F. Then (step 3), we derive the closed-form solution for λ_L and λ_F in equilibrium.

Step 1: Given dealers' price schedules in markets L and F and other informed traders' strategies, an informed investor chooses Q_{kL} and Q_{kF} in order to maximize his total expected profit. Thus his order placement strategy solves:

$$Max_{\{Q_{kL},Q_{kF}\}} E(Q_{kL}(\tilde{V} - p(O_L)) \mid \tilde{\delta} = \delta) + E(Q_{kF}(\tilde{V} - p(O_F)) \mid \tilde{\delta} = \delta),$$

which rewrites:

$$Max_{\{Q_{kL},Q_{kF}\}} Q_{kL}(\delta - \lambda_L(Q_{kL} + Q_{-kL})) + Q_{kF}(\delta - \lambda_F(Q_{kF} + Q_{-kF})).$$

The first order conditions yield

$$Q_{kj}(\delta) = \frac{\delta - \lambda_j Q_{-kj}}{2\lambda_j} = \frac{(1 - \lambda_j \beta_{-kj})\delta}{2\lambda_j} \quad for \quad j \in \{L, F\}.$$

The second order conditions are satisfied because $\lambda_j > 0$. Thus, in equilibrium, it must be the case that

$$\beta_{kj} = \frac{(1 - \lambda_j \beta_{-kj})}{2\lambda_j}. \tag{29}$$

This implies that :

$$\beta_{kj} = \beta_j, \quad \forall k, \quad for \quad j \in \{L, F\}.$$

Using Equation (29) and the definition of β_{-kj}, we deduce that in equilibrium :

$$\beta_j = \frac{(1 - (M^c - 1)\lambda_j \beta_j)}{2\lambda_j}.$$

Solving this equation for β_j, we obtain :

$$\beta_j = \frac{1}{(M^c+1)\lambda_j}, \quad for \quad j \in \{L, F\}.$$

Step 2: The sophisticated shareholder chooses his order in market j, Z_{js}, in order to maximize his total expected profit, under the constraint that he must trade Z_s shares. His order placement strategy solves:

$$Max_{\{Z_{Ls},Z_{Fs}\}} E(Z_{Ls}(\tilde{V} - p(O_L))) + E(Z_{Fs}(\tilde{V} - p(O_F))) = -\lambda_L Z_{Ls}^2 - \lambda_F Z_{Fs}^2,$$

$$u.c. : Z_{Ls} + Z_{Fs} = Z_s,$$

which is equivalent to

$$Min_{\{Z_{Ls},Z_{Fs}\}} \lambda_L Z_{Ls}^2 + \lambda_F Z_{Fs}^2,$$

$$u.c. : Z_{Ls} + Z_{Fs} = Z_s.$$

We deduce that the optimal trading strategy for the sophisticated investor is:

$$Z_{js} = \omega_j Z_s$$

with

$$w_j = \frac{\lambda_{-j}}{\lambda_L + \lambda_F} Z_s, \quad for \quad j \in \{L, F\}. \tag{30}$$

Step 3. In equilibrium, dealers' price schedules are such that:

$$p(O_j) = E(\tilde{V} \mid \tilde{O}_j = O_j).$$

Given the sophisticated investor strategy and informed traders' strategies, O_j is normally distributed. Hence :

$$E(\tilde{V} \mid \tilde{O}_j = O_j) = \bar{V} + \lambda_j O_j,$$

with

$$\lambda_j = \frac{Cov(\tilde{V}, \tilde{O}_j)}{Var(\tilde{O}_j)} = \frac{M^c \beta_j \sigma_\delta^2}{(M^c \beta_j)^2 \sigma_\delta^2 + \omega_j^2 \sigma_s^2 + \sigma_j^2}, \quad j \in \{L, F\}.$$

This yields (using the fact that $\beta_j = \frac{1}{(M^c+1)\lambda_j}$):

$$\begin{cases} \lambda_L = \dfrac{M^c \sigma_\delta^2}{\frac{(M^c)^2 \sigma_\delta^2}{(M^c+1)\lambda_L} + (M^c+1)\lambda_L(\omega_L^2 \sigma_s^2 + \sigma_L^2)}, \\ \lambda_F = \dfrac{M^c \sigma_\delta^2}{\frac{(M^c)^2 \sigma_\delta^2}{(M^c+1)\lambda_F} + (M^c+1)\lambda_F(\omega_F^2 \sigma_s^2 + \sigma_F^2)} \end{cases} \tag{31}$$

The linear equilibrium is completely characterized by the pairs (λ_L, λ_F) solving this system of equations. When $\alpha \in [0.5, 1)$, $\sigma_F^2 > 0$ and $\sigma_L^2 > 0$. In this case, it is straightforward to check that $(\lambda_L^*(\alpha), \lambda_F^*(\alpha))$, as given in Lemma 1, is the unique solution of the previous system of equations. It is easily shown that:

$$\frac{\lambda_{-j^*}}{\lambda_L^* + \lambda_F^*} = \frac{\sigma_j}{\sigma_L + \sigma_F}.$$

We then deduce that in equilibrium

$$Z_{js} = w_j^*(\alpha)\delta,$$

using Equation (30).

We now consider the case in which $\alpha = 1$ and the firm is cross-listed. In this case, $\sigma_F^2 = 0$ and $\sigma_L^2 = \Phi\sigma_Z^2 > 0$. The previous system of equations rewrites:

$$\begin{cases} \lambda_L^2(\omega_L^2\sigma_s^2 + \sigma_L^2) = \frac{M^c\sigma_\delta^2}{(M^c+1)^2}, \\ \lambda_F^2(\omega_F^2\sigma_s^2) = \frac{M^c\sigma_\delta^2}{(M^c+1)^2} \end{cases} \tag{32}$$

If $\omega_F^2 > 0$, it follows that:

$$\frac{\lambda_F^2}{\lambda_L^2} = \frac{\omega_L^2\sigma_s^2 + \sigma_L^2}{\omega_F^2\sigma_s^2}.$$

Now, Equation (30) implies that $\frac{\omega_F}{\omega_L} = \frac{\lambda_L}{\lambda_F}$, the previous condition imposes:

$$\sigma_L^2 = 0.$$

This is impossible since $\sigma_L^2 > 0$. Thus there is no equilibrium in which the two exchanges are active (λ_j is finite) and $\omega_F > 0$ when $\alpha = 1$. In this case, it is immediate to check that there is an equilibrium in which $\lambda_F^* = \infty$, $w_F^* = 0$, $\beta_F^* = 0$ and λ_L^* solves:

$$(\lambda_L^*)^2(\sigma_s^2 + \sigma_L^2) = \frac{M^c\sigma_\delta^2}{(M^c + 1)^2}.$$

The solution of this equation is $\lambda_L^* = \lambda_L^*(1)$. Thus, in this case, $\beta_L^* = \beta_L^*(1)$.■

Proof of Lemma 2

When the firm does not cross-list, all the trading necessarily takes place in market L. Thus we impose $w_F = 0$ and $\beta_F = 0$. This is in fact the outcome when the firm is cross-listed and $\alpha = 1$. Thus the equilibrium values for λ_L^* and β_L^* must be identical to those obtained when the firm is cross-listed and the number of informed traders is M^{nc}.■

Proof of Proposition 1

The equilibrium number of informed traders when the firm is cross-listed solves

$$\frac{\Pi^c(\alpha, \Phi, M^{c*})}{M^{c*}} = C.$$

$\Pi^c(.)/M^{c*}$ decreases with α, increases with Φ and decreases with M^{c*}. It immediately follows that the equilibrium number of informed traders decreases with α and increases with Φ when the firm is cross-listed. Furthermore, the number of investors when the firm is not cross-listed solves :

$$\frac{\Pi^{nc}(1, \Phi, M^{nc*})}{M^{nc*}} = C.$$

It follows that the equilibrium number of informed investors when the firm is not cross-listed is equal to the equilibrium number of informed investors when the firm is cross-listed and $\alpha = 1$, i.e. $M^{nc*} = M^{c*}(1)$. As $M^{c*}(\alpha) > M^{c*}(1)$, we deduce that the number of informed investors is larger when the firm is cross-listed than when it is not.■

Proof of Proposition 2

Case1 : the firm is cross-listed.

Using the fact that δ, P_L^c and P_F^c are normally distributed and standard results about multivariate normal distributions (see Anderson (1984), Chapter 2 for instance), we obtain after tedious computations:

$$P_2^c = \overline{V} + E(\delta \mid P_L^c, P_F^c) = \overline{V} + F * (\lambda_L^* O_L^c + \lambda_F^* O_F^c), \tag{33}$$

where F is a constant given by:

$$F = \frac{(M^{c*} + 1)}{(2M^{c*} + 1) + \frac{\sigma_s^2}{\sigma_s^2 + (\sigma_L + \sigma_F)^2}}.$$

We skip the formal derivation of this result for brevity. Clearly, P_2^c has a normal distribution as O_L^c and O_F^c are normally distributed. It follows from the definition of $I(P_2^c)$ and normal theory that:

$$I(P_2^c) = Var(E(\widetilde{\delta} \mid P_2^c))$$

We deduce from Equation (33) that

$$Var(E(\delta \mid P_2^c)) = F^2 * Var(\lambda_L^* O_L + \lambda_F^* O_F),$$

that is

$$Var(E(\widetilde{\delta} \mid P_2^c)) =$$

$$F^2[(M^c\lambda_L^*\beta_L + M^c\lambda_F^*\beta_F)^2\sigma_\delta^2 + \lambda_L^2((w_L^*)^2\sigma_s^2 + \sigma_L^2) + \lambda_F^2((w_F^*)^2\sigma_s^2 + \sigma_F^2) + 2\lambda_L^*\lambda_F^* w_F w_L \sigma_s^2].$$

Substituting λ_L^*, λ_F^*, β_L^*, β_F^*, w_L^* and w_F^* by their expressions given in Lemma 1 and simplifying, we obtain :

$$Var(E(\widetilde{\delta} \mid P_2^c)) = F^2 * [\frac{2M^{c*}\sigma_\delta^2}{(M^{c*}+1)F}] = F * [\frac{2M^{c*}\sigma_\delta^2}{(M^{c*}+1)}].$$

Then substituting F by its expression and simplifying we obtain :

$$I(P_2^c) = Var(E(\widetilde{\delta} \mid P_2^c)) = \frac{2M^{c*}\sigma_\delta^2}{(2M^{c*}+1) + \frac{\sigma_s^2}{\sigma_s^2 + (\sigma_L + \sigma_F)^2}}.$$

Using the definitions of σ_s^2, σ_L^2 and σ_F^2 (see Equations (5), (6) and (7)), we obtain finally

$$Var(E(\widetilde{\delta} \mid P_2^c)) = \frac{2M^{c*}\sigma_\delta^2}{(2M^{c*}+1) + \frac{(1-\Phi)}{1+2\Phi\sqrt{\alpha(1-\alpha)}}}. \tag{34}$$

Case 2 : the firm is not cross-listed.

In this case, we obtain :

$$I(P_2^{nc}) = Var(E(\widetilde{\delta} \mid P_2^{nc})) = \frac{M^{nc*}\sigma_\delta^2}{(M^{nc*}+1)} \tag{35}$$

Observe that, for a *fixed* M^{c*}, $Var(E(\widetilde{\delta} \mid P_2^c))$ (i) decreases with α (for $\alpha \in [0.5, 1]$) and increases with Φ. Thus, a lower bound for $I(P_2^c)$ is obtained by setting $\alpha = 1$ and $\Phi = 0$ in Equation (34). This lower bound is $\frac{M^{c*}\sigma_\delta^2}{(M^{c*}+1)}$. It is strictly larger than $\frac{M^{nc*}\sigma_\delta^2}{(M^{nc*}+1)}$ because $M^{c*} > M^{nc*}$. Thus, $I(P_2^c) > I(P_2^{nc})$.$\blacksquare$

Proof of Corollary 1

The expression of $I(P_2^c)$ as a function of α and Φ is given by Equation (34). Let this function be $I^c(M^{c*}, \alpha, \Phi)$. Differentiation of I^c with respect to α and Φ yields:

$$\frac{dI^c}{d\alpha} = \frac{\partial I^c}{\partial M^{c*}}\frac{\partial M^{c*}}{\partial \alpha} + \frac{\partial I^c}{\partial \alpha}.$$

It is immediate that $\frac{\partial I^c}{\partial M^{c*}} > 0$ and that $\frac{\partial I^c}{\partial \alpha} < 0$ for $\alpha \in [0.5, 1]$. Moreover, we know from

Proposition 1 that $\frac{\partial M^{c*}}{\partial \alpha} < 0$ for $\alpha \in [0.5, 1]$. We deduce that $\frac{dI^c}{d\alpha} < 0$. We also have:

$$\frac{dI^c}{d\Phi} = \frac{\partial I^c}{\partial M^{c*}} \frac{\partial M^{c*}}{\partial \Phi} + \frac{\partial I^c}{\partial \Phi}$$

As $\frac{\partial I^c}{\partial \Phi} > 0$ and $\frac{\partial M^{c*}}{\partial \Phi} > 0$ for $\alpha \in [0.5, 1]$, we deduce that $\frac{dI^c}{d\Phi} > 0$.■

Proof of Lemma 3

From normal theory, we obtain that:

$$Var(E(\widetilde{\delta} \mid \widetilde{s}_2, P_2^k)) = \sigma_\delta^2 - Var(\widetilde{\delta} \mid \widetilde{s}_2, P_2^k) = \sigma_\delta^2 - \frac{1}{\tau_\eta + \tau_k}, \text{ for } k \in \{c, nc\}, \tag{36}$$

where $\tau_\eta = (\sigma_\eta^2)^{-1}$ (the precision of signal η) and $\tau_k = (Var(\widetilde{\delta} \mid P_2^k))^{-1}$. Moreover,

$$\tau_k = (Var(\widetilde{\delta} \mid P_2^k))^{-1} = (\sigma_\delta^2 - I(P_2^k))^{-1}.$$

Substituting τ_k by this expression in Equation (36) and simplifying, we obtain:

$$Var(E(\widetilde{\delta} \mid \widetilde{s}_2, P_2^k)) = (\frac{\sigma_\delta^4 + (\sigma_\eta^2 - \sigma_\delta^2) I(P_2^k)}{\sigma_\eta^2 + \sigma_\delta^2 - I(P_2^k)}), \text{ for } k \in \{c, nc\} \tag{37}$$

The expression for the expected value of the growth opportunity directly follows from this equation and Equation (19). It is immediate that $\frac{\partial EG^k}{\partial I(P_2^k)} > 0$ if $\sigma_\eta^2 > 0$.■

Proof of Proposition 3

First, recall that $I(P_2^c) > I(P_2^{nc})$ (Proposition 2) and that $\frac{\partial EG^k}{\partial I(P_2^k)} > 0$ (Lemma 3). We deduce that $EG^c > EG^{nc}$. Moreover, $I(P_2^c)$ decreases with α, for $\alpha \in [0.5, 1)$ and increases with Φ. This implies that EG^c decreases with α, for $\alpha \in [0.5, 1)$ and increases with Φ as well. As EG^{nc} does not depend on these variables, we deduce that the effect of α and Φ on ΔEG is as described in the proposition. Finally, direct calculations show that $\frac{\partial \Delta EG}{\partial \sigma_\eta^2} > 0$.■

Proof of Proposition 2

Observe that

$$\Delta V = S(\frac{Var(E(\tilde{\delta} \mid \widetilde{s}_2, P_2^c)) - Var(E(\tilde{\delta} \mid \widetilde{s}_2, P_2^{nc}))}{2}) - C(M^{nc*} - M^{c*}). \tag{38}$$

Moreover, from Equation (37) in the proof of Lemma 3, we deduce that:

$$Var(E(\tilde{\delta} \mid \widetilde{s}_2, P_2^c)) - Var(E(\tilde{\delta} \mid \widetilde{s}_2, P_2^{nc}) = (\frac{\sigma_\delta^4 + (\sigma_\eta^2 - \sigma_\delta^2) I(P_2^c)}{\sigma_\eta^2 + \sigma_\delta^2 - I(P_2^c)}) - (\frac{\sigma_\delta^4 + (\sigma_\eta^2 - \sigma_\delta^2) I(P_2^{nc})}{\sigma_\eta^2 + \sigma_\delta^2 - I(P_2^{nc})})$$

Observe that $Var(E(\tilde{\delta} \mid \widetilde{s}_2, P_2^c)) - Var(E(\tilde{\delta} \mid \widetilde{s}_2, P_2^{nc})$ and $C(M^{nc*} - M^{c*})$ are determined by all exogenous parameter values, but S. Moreover, observe that $Var(E(\widetilde{\delta} \mid \widetilde{s}_2, P_2^c)) > Var(E(\widetilde{\delta} \mid \widetilde{s}_2, P_2^{nc}))$ because $I(P_2^c) > I(P_2^{nc})$ (Proposition 2). Therefore (i) ΔV increases with S, the size of the growth opportunity and (ii) there exists

$$S^*(\alpha, \Phi, \sigma_\delta^2, \sigma_Z^2, \sigma_\eta^2, C) \stackrel{def}{=} \frac{2C(M^{nc*} - M^{c*})}{Var(E(\tilde{\delta} \mid \widetilde{s}_2, P_2^c)) - Var(E(\tilde{\delta} \mid \widetilde{s}_2, P_2^{nc})}$$

such that $\Delta V \geq 0$ iff $S \geq S^*(\alpha, \Phi, \sigma_\delta^2, \sigma_Z^2, \sigma_\eta^2, C)$. Finally, we note that σ_η^2 does not affect the number of informed traders in equilibrium and that $(Var(E(\tilde{\delta} \mid \widetilde{s}_2, P_2^c)) - Var(E(\tilde{\delta} \mid \widetilde{s}_2, P_2^{nc}))$ increases with σ_η^2. We deduce that S^* decreases with σ_η^2.■

Proof of Proposition 7

The expected value of the growth opportunity is given by (see Equation (19)):

$$EG^{ki} = \frac{SVar(E(\tilde{\delta} \mid s_2, P_2^k))}{2}, \text{ for } k \in \{c, nc\}.$$

We deduce from Equation (37) in the proof of Lemma 3 that:

$$Var(E(\widetilde{\delta} \mid \widetilde{s}_2, P_2^c)) = (\frac{\sigma_\delta^4 + (\sigma_\eta^2 - \sigma_\delta^2)I(P_2^k)}{\sigma_\eta^2 + \sigma_\delta^2 - I(P_2^k)}), \text{ for } k \in \{c, nc\}.$$

Now, as $I(P_2^c) = I(P_2^{nc})$ (see text), we immediately deduce that, with informational integration, the expected value of the growth opportunity is identical when the firm is cross-listed or when it is not. Moreover

$$\Pi^i(\alpha, \Phi, M^{ci*}) = \lambda_i^*(\sigma_L^2 + \sigma_F^2 + \sigma_s^2) = \frac{\sqrt{M^{nc*}}}{M^{nc*} + 1}\sqrt{\sigma_Z^2 \sigma_\delta^2} = \Pi^{nc},$$

where the last equality follows from Equation (11). Thus, the expected trading losses of liquidity traders are identical whether the firm is cross-listed or not when markets are informationally integrated. We deduce that:

$$V^c - V^{nc} = -\Sigma < 0 \text{ if } \Sigma > 0.$$

Thus, it is never optimal to cross-list when markets are informationally integrated.■

Proof of Proposition 8

Using Equation (38) in the proof of Proposition 2, we obtain:

$$\frac{\partial V}{\partial S} = \frac{Var(E(\tilde{\delta} \mid \widetilde{s}_2, P_2^c)) - Var(E(\tilde{\delta} \mid \widetilde{s}_2, P_2^{nc}))}{2}$$

Using the expression for $Var(E(\tilde{\delta} \mid \widetilde{s}_2, P_2^k))$ (Equation (37) in the proof of Lemma 3), we obtain:

$$\frac{\partial V}{\partial S} = 0.5 * ((\frac{\sigma_\delta^4 + (\sigma_\eta^2 - \sigma_\delta^2)I(P_2^c)}{\sigma_\eta^2 + \sigma_\delta^2 - I(P_2^c)} - (\frac{\sigma_\delta^4 + (\sigma_\eta^2 - \sigma_\delta^2)I(P_2^{nc})}{\sigma_\eta^2 + \sigma_\delta^2 - I(P_2^{nc})})) \quad (39)$$

The first part of Proposition 8 obtains by differentiating Equation (39) with respect to α and Φ after substituting $I(P_2^c)$ by its expression given in Equation (15) ($I(P_2^{nc})$ does not depend on α and Φ). The second part of Proposition 8 is obtained by differentiating Equation (39) with respect to σ_η^2 (observing that $I(P_2^k)$ does not depend on σ_η^2).■

References

Allen, F.(1993) : "Stock Markets and Resource Allocation," in Capital Markets and Financial Intermediation, edited by C. Mayer and X. Vives, Cambridge, U.K.: Cambridge University Press, 81-108.

Ammer, J., Holland, S., Smith, D. and Warnock, F.(2005): "Look at me now : What attracts US Shareholders", mimeo, University of Virginia.

Bancel, F. and Mittoo, U. (2001) : "European Managerial perceptions of the Net Benefits of Foreign Stock Listings", *European Financial Management*, 213-236.

Bailey, R., Karolyi, A. and Salva, C. (2005) :"The economic consequences of increased disclosure: evidence from international cross-listings", forthcoming *Journal of Financial Economics*.

Baruch, S., Karolyi, A. and Lemmon, M. (2003) : "Multi-Market Trading and Liquidity : Theory and Evidence", Working Paper, Ohio State University.

Baruch, S. and Saar, G. (2004) : "Asset Returns and Listing Choice of Firms", mimeo, NYU and University of Utha.

Biais, B. and Martinez, I. (2001): "Price Discovery Across the Rhine", CEPR discussion paper series n°2878.

Blanchard, O., Rhee, C. and Summers, L. (1993):"The stock market, profit and investment", *Quarterly Journal of Economics*, **108**, 115-136.

Brennan, M. and H. Cao (1997): "International Portfolio Investment Flows", *Journal of Finance*, **52**, 1851-1880.

Chemmanur, T. and P. Fulghieri (2004): "Competition and co-operation among exchanges: a theory of cross-listings and endogenous listing standards", working paper, INSEAD.

Chen, Q., Goldtsein, I. and Jiang, W.(2005) : "Price Informativeness and Investment Sensitivity to Stock Price", mimeo, Duke University.

Chowdry, B and V. Nanda (1991): "Multimarket Trading and Market Liquidity", *Review of Financial Studies*, **4**, 483-511.

Coffee, J. (1999) : "The Future as History : The Prospect for Global Convergence in corporate Governance and its Implications", Northwestern University Law Review, 641-708.

Doidge,C., Karoly, A. and Stulz, R. (2004): "Why are foreign companies listed in the US worth more?", *Journal of Financial Economics*, **71**, 205-238.

Domowitz, I., J. Glen, A. Madhavan (1998): "International Cross-Listing and Order Flow Migration: Evidence from an Emerging Market", *Journal of Finance*, Vol. 53 (6). p 2001-27.

Dow, J. and Gorton, G. (1997): "Stock Market Efficiency and Economic Efficiency: Is there a Connection?", *Journal of Finance*, **52**, pp 1087–1129.

Durnev, A., Morck, R. and Yeung, B.(2004):"Value enhancing capital budgeting and firm-specific stock return variation", *Journal of Finance*, **59**, 65-105.

Fernandes, N. and Ferreira, M.(2005) : "Does International Cross-Listing Really Improve the Informational Environment?", mimeo, Universidade Catolica Portuguesa, Lisboa.

Foucault, T. and Parlour, C. (2004): "Competition for Listings", *Rand Journal of Economics,* Summer.

Foerster, S. and Karolyi, A. (2000): "Multimarket trading and liquidity : a transactions data analysis of Canada-US interlistings", *Journal of Financial and Quantitative Analysis*, **35**, 499-528.

Freedman, R. (1991): "A theory of the impact of international cross-listing", working paper, UBC.

Gehrig, T. (1993): "An Information Based Explanation of the Domestic Bias in International Equity Investment", *The Scandinavian Journal of Economics*, 97-109.

Gehrig, T. and Fohlin, C. (2005): "Price Discovery in Early Securities Markets: The Case of the Berlin Stock Exchange 1880-1910", mimeo, University of Freiburg.

Gehrig, T., K. Stahl and X. Vives (1996): "Competing Exchanges: Do Large Drive out Small?", mimeo.

Grullon, G., Kanatas, G. and Weston, J. (2002): "Advertising, Breadth of Ownership, and Liquidity," *Review of Financial Studies*, **17**, 439-461.

Grinblatt, M. and Keloharju, M. (2001):"How distance, language and culture influences stock holdings and trades", *Journal of Finance*, **56**, 1053-1073.

Hail, L. and Leuz, C.(2005):"Cost of capital and cash flow effects of U.S. cross-listings", working paper, Wharton School.

Halling, M., M. Pagano, O. Randl and J. Zechner (2003): "Where is the Market? Evidence from Cross-Listing", mimeo, Vienna University.

Hölmstrom, B. and J. Tirole (1993): "Market liquidity and performance monitoring", *Journal of Political Economy* **101**, 678-709.

Huddart J. ,S. Hughes and M. Brunnermeier (1999): "Disclosure Requirements and Stock Exchange Listing Choice in an International Context", *Journal of Accounting and Economics*, **26**, 237-269.

Karolyi, A. (1998): *Why do companies list their shares abroad? A survey of the evidence and its implications*, Blackwell Publishers, Boston.

Karolyi, A. (2003): "DaimlerChrysler AG, The First Truly Global Share", *Journal of Corporate Finance*, **9**, 409-430.

Karolyi, A.(2006), "The world of cross-listings and cross-listings of the world: challenging conventional wisdom", *Review of Finance*, **9**, 2-54.

King, M. and Segal, D.(2005), "The longer horizon importance of US investors and trading for cross-listed firms", mimeo, University of Toronto.

Levine, R. and Shmukler, S. (2005):"Migration, spillovers and trade diversion: the impact of stock market internationalization on stock market liquidity", World Bank, working paper.

Markovitch, D., Steckel, J. and Yeung, B. (2005): "Using Capital Market as Market Intelligence : Evidence from the Parmaceutical Industry", *Management Science*, **51**, 1467-1480.

Menkveld, A. (2002): "Splitting Orders in Fragmented Markets: Evidence from Cross-Listed Stocks", mimeo, Tibergen Institute Erasmus University Rotterdam.

Morck, Shleifer and Vishny (1990): "The stock market and investment: is the market a side-show?", *Brookings paper on Economic Activity.*

Noronha, G., Sarin, A., Saudagaran, S. (1996): "Testing for microstructure effects of international dual listings using intraday data", *Journal of Banking and Finance*, **20**, 965-983.

Pagano, M., A. Roell, J.Zechner (2002): The Geography of Equity Listings: Why do European Companies List Abroad?, *Journal of Finance*, **57**, 2651-2694.

Pulatkonak, M. and Sofianos, G. (1999): "The distribution of global trading in NYSE listed non, U.S. stocks", working paper, NYSE.

Stulz, R. (1999) Globalization of equity Markets and the Cost of Capital, *Journal of Applied Corporate Finance*, **12**, 8-25.

Sylla, R., J. Wilson, R. Wright (2004): "Trans-Atlantic Securities Market Integration 1790-1840", mimeo.

A. Subrahmanyam, S. Titman (1999): "The Going-Public Decision and the Development of Financial Markets", *Journal of Finance*, **54**, 1045-82.

Werner, I. and Kleidon (1996): "U.K. and U.S. Trading of British Cross-Listed Stocks: An Intraday Analysis of Market Integration", *Review of Financial Studies*, **9**, 620-664.

Yook, Y.(2005): "Stock Price informativeness and firm performance: evidence from corporate spinoffs", mimeo, University of North-Carolina.

FIGURE 1 : TIMING

Period 0

- Firm goes public and decides to cross-list or not.

Period 1

- Firm shareholders are hit by liquidity shocks
- Speculators acquire information
- Trading takes place.
- Closing price : P_2

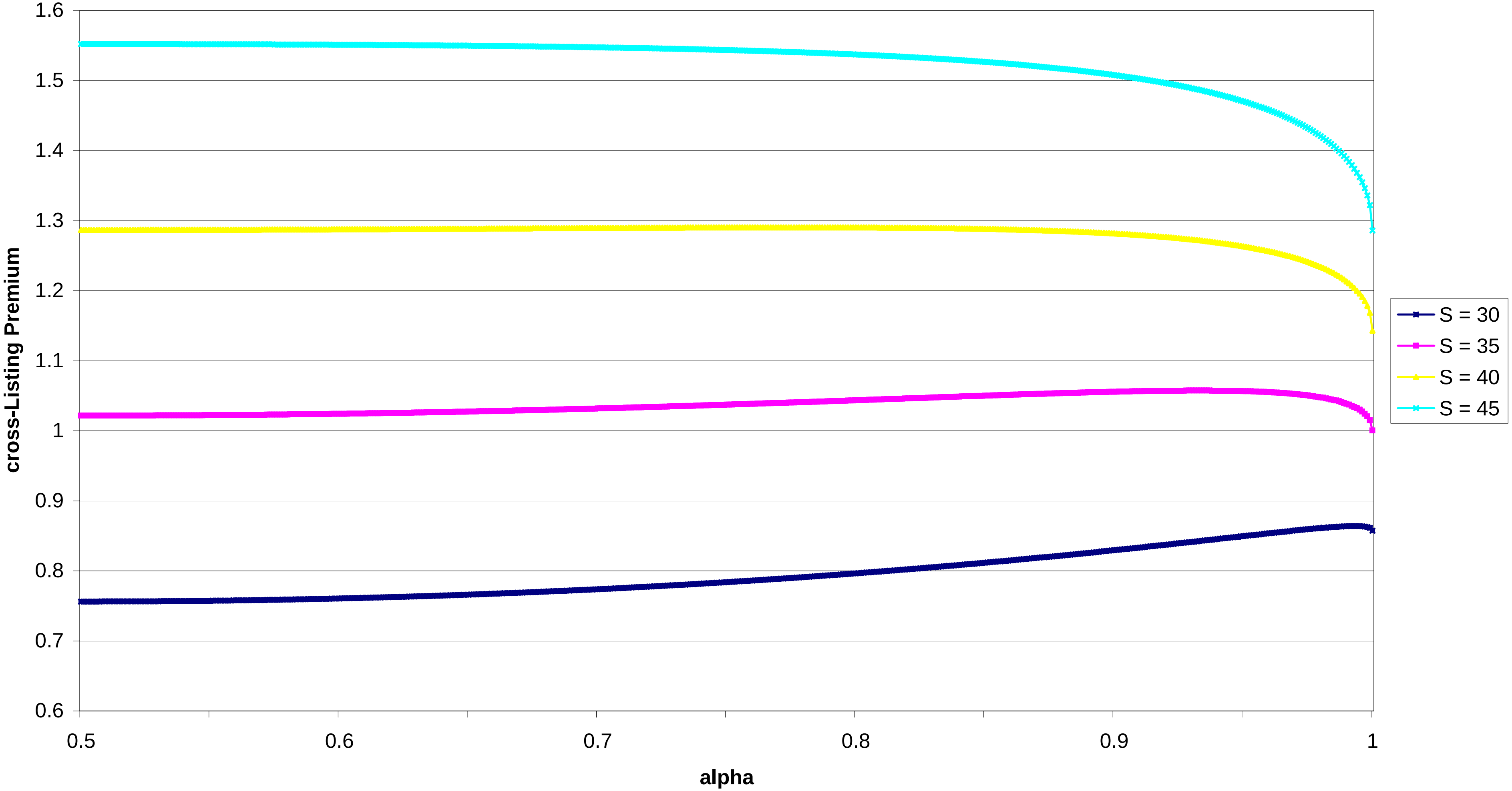
Period 2

- The firm's manager observes the stock price, P_2 and receives managerial information, s_2.
- The firm chooses the scale, K, of the investment in the growth opportunity.

Period 3

- Payoffs are realized.

Figure 2: Cross-listing Premium



Value of The Parameters : σ_δ=1, σ_z=10, ϕ=0.5,C=2, Σ=0 and no managerial information.