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THE MANY FACES OF INFORMATION DISCLOSURE

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ABSTRACT

We examine the effects of a variety of mandatory information disclosure regimes on the expected revenues of issuing firms and on their endogenously-arising incentives for financial innovation. The main question we ask is: what kind of information and how much of it should firms be asked to disclose? The analysis uses a noisy rational expectations model in which some investors can choose to become informed at their own expense. Information disclosure then potentially affects the information-advantage of these investors vis-a-vis uninformed (liquidity) investors in the market, and hence their information-acquisition incentives. Thus, asking managers to disclose more information is *not* obviously desirable for the shareholders of issuing firms.

Our main results are as follows. Mandating the disclosure of information about total firm value that would otherwise *not* have become available to any investor is always good for issuing firms. It increases their expected revenues and also strengthens financial innovation incentives. Mandating the disclosure of information about total firm value that would have been acquired anyway by informed investors but improves the quality of the information that uninformed investors have will benefit firms in emerging capital markets but hurt those in developed capital markets. In developed markets, the attention devoted to disclosure should thus shift from information that concerns total firm value to that which concerns the distribution of this value among claimants. Our conclusion is that disclosure requirements should be more stringent in less-developed capital markets, and that greater stringency in disclosure requirements on securities exchanges leads to a worsening of the borrower pool faced by banks. Our analysis also implies that competition among exchanges or securities regulators will not necessarily lead to a weakening of disclosure requirements.

I. INTRODUCTION

Along with the increased focus on public trading of securities in capital markets has been a resurgence of interest in information disclosure requirements. This is a reflection of the burgeoning interest in financial system design, both from a research and a policy standpoint [see, for example, Allen and Gale (1995, 1997), and Boot and Thakor (1997)]. As part of designing their financial systems, policymakers in emerging economies are asking how they should structure information disclosure requirements for firms that list on their securities exchanges. At the same time, they are also thinking about numerous banking issues, and the linkages between banks and capital markets. This leads naturally to a financial system design perspective, so that attention focuses on capital market growth, which is affected both by the trading volume of exchange-traded securities and the extent of financial innovation, both of which in turn may be influenced by disclosure requirements in public securities markets. The most compelling question regarding disclosure requirements, and one we confront in this paper, is: *what kind of information and how much of it should firms be required to disclose?*

The literature on information disclosure has primarily focused on *insider trading* and *market liquidity*, and *spillover effects* (proprietary information) in connection with this question. From the insider trading and market liquidity literature, the general result is that (mandatory) information disclosure is good. Fishman and Hagerty (1995) show that insider trading can discourage "outside" investors to become informed at a cost, so that it follows that mandatory disclosure of insiders' information can benefit market participants. Bhattacharya and Nicodano (1997) argue that mandatory disclosure of insiders' information can improve welfare by reducing payoff uncertainty in interim states that is of value to liquidity-seeking investors who may wish to sell their holdings in those states.

In the literature on spillover effects, the general result is that (mandatory) disclosure might be undesirable for competitive reasons. Bhattacharya and Chiesa (1995) and Yosha (1995) have shown that disclosure to investors also results in information spilling over to the firm's competitors. An important implication is that disclosure should be limited to information that does not have sensitive competitive implications.

We address the disclosure requirements question from a different perspective by looking beyond insider trading and spillover effects. If we ignore these two effects and ask how much information the shareholders of a good (undervalued) firm would like the manager to disclose to the market, it seems like the answer is obvious: as much as possible. This suggests the most stringent possible disclosure requirements. However, when one considers that disclosure diminishes the informational advantage that informed investors have and hence weakens their incentives to become informed at a cost, the answer becomes less obvious even from the standpoint of the issuing firm. Moreover, to the extent that an important goal of financial innovation is to improve informational transparency (e.g. Boot and Thakor (1997b)), disclosure that improves transparency could also have a chilling effect on financial innovation. These broad insights pave the way for a number of (smaller) questions that we seek to answer in this paper.

(1) Ignoring the insider trading and spillover effects, is greater information disclosure always better?

(2) Does the impact of disclosure requirements differ across developed and emerging economies? And if so, how?

(3) Does greater disclosure lead to stronger or weaker security design incentives?

(4) What are the different types of information disclosure and what are their effects? In particular, what difference does it make if the information being disclosed is about aggregate firm value as opposed to aspects of this value that have implications only for how the total value is distributed among different claimants?

To answer these questions, we start by precluding all voluntary disclosure, although we later examine the implications of relaxing this assumption. We assume that the decision of how much information disclosure to mandate is made in the best interest of (high-quality) issuing firms. We focus on the effects that disclosure has on trading and information acquisition incentives in the financial market ("Trading incentive" effect) and on security design incentives ("Security design" effect). In its impact on trading incentives, disclosure produces two counterveiling forces. On the one hand, greater disclosure means more information is impounded in prices *ceteris paribus*, and this benefits the high-quality issuers. On the other hand, greater disclosure means smaller benefits of information acquisition in financial markets, leading to reduced price transparency and lower expected revenues for the high-quality firms. Much of our analysis revolves around the tension between these two effects. On the security design effect, we follow Boot and Thakor (1993) and consider security design directed at altering trading incentives by changing the marginal return to investors from acquiring costly information. This is what links the trading incentive and security design effects.

Our analysis proceeds in the context of three different types of disclosure requirements. The first case deals with releasing new "aggregate value" information to the market that was previously private, so that its release improves the quality of the information processed by all traders, including informed traders. That is, in the absence of mandatory disclosure, the disclosed information would have otherwise remained exclusively with corporate insiders. We call this *complementary aggregate-value information*. The second case deals with disclosing aggregate-value information that would have been obtained anyway by informed traders on their own, but whose disclosure improves the quality of the information that uninformed traders have. We call this *substitute aggregate-value information*. Finally, the third case deals with disclosure of information that only affects the dispersion of aggregate value around its mean, so that with risk neutrality this does not affect total firm value, but does affect how value is divided among different securities. We call this *distribution-relevant information*. Thus, our analysis considers a fairly comprehensive set of information disclosure regimes. Our main results are as follows.

- Disclosure of complementary aggregate-value information is always good in that it has both positive trading incentive (enhances revenues of issuing firms) and security design (strengthens security design incentives) effects.
- From the standpoint of the trading incentive effect, the disclosure of substitute aggregate-value information is beneficial in emerging capital markets but may be counterproductive in more developed financial markets. In particular, we show that, in a more developed financial market, attention should

shift to disclosure of distribution-relevant information. Such disclosure will favorably affect security design incentives and thus also create a positive trading incentive effect.

While our formal analysis focuses on a single exchange or securities regulator determining disclosure requirements, it does have implications for competing exchanges. Contrary to the popular view that exchanges will compete by lightening the disclosure burden they place on firms, our analysis implies that competition will strengthen the stringency of disclosure for some types of information.

Our research is related to three strands of the literature. One is the literature on financial system design [e.g. Allen (1993) and the other references mentioned earlier]. This literature has focused on various issues, including the borrower's choice between bank and capital market financing, the implications of restricting the scope of (commercial) banking activities, and potential path-dependencies in the evolution of the financial system. Information disclosure requirements, although an important part of financial system design, have yet to be analyzed from that perspective. We take this perspective and focus on the impact of disclosure requirements on financial innovation incentives, and also discuss their impact on the borrower's financing source choice.

The other strand to which our paper is related is that on the market microstructure implications of differences between exchanges in accounting standards and listing requirements. This literature has examined questions like: how do differences in trade disclosure requirements across markets impact order flow migration, liquidity and trading costs? The focus is on policy issues related to the structure of securities markets; thus this literature is a close cousin of that on financial system design. Madhavan (1995) develops a model of trade disclosure in which investors have different motives for trade and dealers compete for order flow. He shows that the absence of trade disclosure benefits dealers and larger traders who place multiple orders, implying that market fragmentation cannot be eliminated without mandatory trade disclosure. Naik, Neuberger and Viswanathan (1996) also examine trade disclosure in the context of the welfare implications of price transparency. They find that higher mandatory disclosure lowers investors' ability to hedge endowment risk, although it also decreases the rents to informed investors. They thus argue that lower levels of mandatory trade disclosure may be worthwhile if the hedging of endowment risk is sufficiently important for welfare. Huddart and Hughes (1997) develop a rational-expectations trading model to examine the implications of international differences in accounting standards. They show that there are conditions under which exchanges compete for trade volume by increasing disclosure requirements.

The similarity between these papers and ours is that there are plausible conditions under which more stringent disclosure requirements are worthwhile, given a particular objective function. However, with the exception of Huddart and Hughes (1997), these papers focus on disclosure of *trade information* possessed by some investors. By contrast, we focus on disclosure of information possessed by issuing firms. Also, whereas Huddart and Hughes assume that listing decisions are made by corporate insiders who wish to maximize trading gains based on their private information, we assume that the goal is to maximize the expected revenues of listing firms. Moreover, unlike all the other papers, our analysis also examines the impact of disclosure requirements on financial innovation.

Finally, our work is also related to the literature on the firm's choice between bank and capital market financing [e.g. Diamond (1991), Rajan (1992), Bhattacharya and Chiesa (1995), and Yosha (1995)]. Much of this literature has assumed that capital market financing involves greater information disclosure than bank financing. Our contribution in this regard is to show that more stringent disclosure requirements in the capital market worsen the average credit quality of the firms borrowing from banks.

The rest is organized as follows. In Section II we describe the basic model. The analysis is contained in Section III. Extensions of the analysis, including the implications for interexchange competition, are discussed in Section IV. Section V discusses the implications of the analysis for emerging capital markets. Section VI concludes. All proofs are in the Appendix.

II. THE DIFFERENT TYPES OF INFORMATION DISCLOSURE

We first describe the model and then the key assumptions used in the analysis about what kind of information is disclosed by firms to investors and how this information is processed in the market.

A. The Model

A1) Information Structure, Firm Types and Preferences

We consider a four-date model. At date t=0, a firm seeks access to the capital market to raise \$1. Cash flows are realized at the final date t=3. The firm can be one of two types: high quality (good) and low quality (bad). The date-3 cash flow (value) of the good (G) firm is $\bar{x}$ and that of the bad (B) firm is $\tilde{y}$, a random variable uniformly distributed over $[\underline{x} - a, \underline{x} + a]$, where $a > 0$ and $0 < \underline{x} < \bar{x}$. At t=0, the firm knows its own type but no one else does. The commonly-known prior probability is $q \in (0,1)$ that the firm is G. At t=0 the firm is aware of the information it will be required to disclose at the next date (t=1), although this information will not reveal the firm's value noiselessly to all investors. Knowing this, it designs at t=0 the securities with which to raise capital. At t=1, the firm discloses to the market that information it is required to disclose. For simplicity, we consider only mandatory disclosure, precluding voluntary disclosure.[1] At t=2, some investors decide to become informed about the issuing firm at a cost, whereas the rest remain uninformed; this will be explained in greater detail in a moment. All investors submit their orders for the firm's securities to a market maker who then sets a price to clear the market. At t=3, the "true" value of the firm's securities becomes known to everybody and investors are paid off. *Figure 1* depicts the sequence of events. There is no discounting in this model and everybody is risk neutral.

Figure 1 goes here

A2) Types of Investors, Market Structure and Clearing

There are three types of investors in this market: liquidity/noise investors, uninformed discretionary investors (UDIs), and informed investors. The aggregate demand, ℓ, of the liquidity investors is random and exogenously given by the continuously differentiable probability density function $f(\ell)$ which has a support of $(0, \infty)$. We specify ℓ in terms of the number of dollars the liquidity investors wish to invest in the security. Like the liquidity investors, the UDIs are *a priori* unaware of the type of the firm whose securities they are buying. However, they condition their aggregate demand on their observation of the sum of the demands of the other two groups of investors. Each UDI can choose to either remain uninformed or acquire/process information at a cost $M_i \in \mathcal{M}$, for investor i. We assume that M_i varies cross-sectionally across investors. Investing that way in information transforms the UDI into an informed investor who knows precisely at t=2 whether the security he is buying is issued by a G or a B firm. This information pertains to aggregate (mean) firm value. Let D_I be the aggregate dollar demand from the informed investors.

The capital market is competitive in that, for the marginal informed investor, the *expected* net gain from buying a security is zero in equilibrium, net of the information cost M_i. Moreover, we assume that there is a competitive market-clearing mechanism called a "market maker" who receives market orders from the informed and liquidity investors. After observing the total demand from these two groups of investors, the market maker communicates it to the UDIs who absorb the net trade in the security. The market clearing price is one that produces zero expected profit for the UDIs. For simplicity, all traders other than UDIs are constrained to be unable to short sell.[2]

Let τ be the UDIs' demand (in terms of number of units) for the security, and let D be the aggregate dollar demand from the liquidity and informed investors, i.e., $D = D_I + \ell$. If P is the price of the security, then

$$\tau = 1 - [D/P]$$

since the supply of the security is \$1. For the UDIs, the end-of-period value of the security is a random variable $\tilde{x} \in \{\bar{x}, \tilde{y}\}$. Then, the market-clearing price of the security, P^e, is:

$$P^e = E(\tilde{x} \mid \tau). \tag{1}$$

Since prices are set by a risk-neutral and competitive market maker, and the riskless interest rate is zero, the equilibrium price is simply the expected value of the security, conditional on all the information contained in the order flow.

All individual investors are atomistic and appear observationally identical to the UDIs (and market maker). Thus, there is a continuum of investors of each type and the demand-relevant measure of each is zero. Security demand is positive only when integrated over a set of positive measure of investors.

A3) Informational and Wealth Endowments of Investors

Each potentially informed investors has $M_i + 1$ units of wealth, so that \$1 can be invested by each in the security after investing $\$M_i$ in information. There are only two consumption dates, t=2 and t=3, and consumption at both dates is equally valued. Thus, if the investor invests in the security, he consumes at t=3 and if he does not invest in the security, he consumes at t=2.

Upon investing M_i in information acquisition, each (informed) investor receives a signal θ that reveals the type of the firm issuing the security. Each informed investor receives the same signal. Although for now we assume that θ is a perfect (noiseless) signal, we will later permit θ to be noisy. Assume for the moment that each firm issues a composite security that is a claim against its total t=3 cash flow. Then, since each investor is risk neutral and θ perfectly reveals the issuer's type, the investor's individual demand will be as follows as long as he anticipates that the equilibrium price will only noisily reveal his information:

$$d_J = d_J(\theta) = \begin{cases} 1 & \text{if } \theta = G \\ 0 & \text{if } \theta = B \end{cases} \tag{2}$$

where d_I is in dollars.

Let Ω be the measure of those who become informed. Then

$D_I = D_I(\Omega, \theta) = \Omega d_I(\theta)$.

In the subsequent analysis, the equilibrium Ω is endogenously determined.

B. What Are the Different Faces of Disclosure?

Firms disclose different types of payoff-germane information. We thus need to make precise the *nature* of the information that is disclosed and how this disclosure interacts with what the informed investors do.

There are basically two assumptions we can make about the disclosure ϕ and how it compares to the signal θ that the informed investors generate. Under *Assumption I* (complementary), the information that is disclosed is complementary to the information that the informed investors receive in that the informed would not have had this information had it not been disclosed. This means that the disclosure does not undermine the value of the information that the informed could obtain. The alternative assumption, *Assumption II* (substitute), means that the information that is disclosed is a substitute for the information that informed traders could have obtained themselves.

The information signal θ of the informed can be either about the *aggregate value* of the firm or it could be "distributional" in nature. In our risk-neutral framework, a signal about aggregate value is essentially a signal about the mean of the value of the firm, whereas distributional information is essentially about the (idiosyncratic) variance of firm value. Similarly, the disclosure ϕ could either be about firm value or distributional in nature. If both ϕ and θ are of the same type (either "aggregate value" or "distributional"), disclosure can be either *complementary* to or a *substitute* for the information of the informed. This gives a total of *six* different cases:

***Table 1*: Possible Combination of Information Disclosure and Information Possessed by Informed Traders**

Information of Informed θ	**Type of Disclosure** ϕ	**"Synergy"**
1. Aggregate value	Aggregate value	Complementary
2. Aggregate value	Aggregate value	Substitute
3. Aggregate value	Distributional value	Complementary
NO: Aggregate value	Distributional value	Substitute
4. Distributional value	Aggregate value	Complementary
NO: Distributional value	Aggregate value	Substitute
5. Distributional value	Distributional value	Complementary
6. Distributional value	Distributional value	Substitute

Note that two cases have been excluded. We have assumed that a distribution-relevant disclosure cannot substitute for an aggregate-value signal of the informed. Nor can an aggregate-value disclosure substitute for a distribution-relevant signal of the informed.

In our analysis, we focus on informed traders who can obtain only "aggregate value" information.

This is somewhat arbitrary but not inconsistent with the existing literature (e.g. Admati and Pfleiderer (1987) and Boot and Thakor (1993)). We are then left with the cases 1, 2 and 3 that we will examine in what follows.

We could further highlight the importance of the different cases by making assumptions about the role of informed traders. If informed investors process publicly available information only that is costlessly available but costly to process, disclosure that releases otherwise private information will always help these investors, and hence could explain the complementarity in Case 1 and 3. In the alternative interpretation in which informed investors process privately-available information, disclosure could be either complementary to (as in Cases 1 and 3) or a substitute for the information of the informed (Case 2). In each of these three cases, our goal is to examine the impact of disclosure requirements on the trading incentive and security design incentive effects.

III. ANALYSIS

A. The Equilibrium Measure of Informed and Definition of Equilibrium

The condition determining the equilibrium measure of informed investors, Ω^*, says that for the marginal informed investor the *expected* net gain from becoming informed is zero. Let V be the investor's expected net gain to being informed, $P^e(\phi)$ the equilibrium price of the security as set by the market maker when the UDIs receive the noisy signal ϕ about the firm's type (only relevant for Case IA), and $P(\theta)$ the value of the security privately known to the informed investor who receives signal θ. Since D will be a function of θ and ℓ, we have $P^e(\phi) = P^e(\phi, D(\theta,\ell))$. An informed investor will submit a buy order (choose d_i=1) only when his signal reveals θ=G, in which case $D(\theta,\ell) = \Omega+\ell$. For investor i we have:

$$V_i = -M_i + q\int_0^{\infty}\{[\bar{x} - P^e(\phi,\Omega + \ell)][P^e(\phi,\Omega + \ell)]^{-1}\}f(\ell)d\ell \tag{3}$$

where we have substituted $P(\theta=G) = \bar{x}$ and $D(\theta,\ell) = \Omega + \ell$ for θ=G, and $[P^e(\phi,\Omega + \ell)]^{-1}$ is the number of units demanded (i.e., the number of units that can be substituted for 1). The equilibrium value of Ω, call it Ω*, is determined by the following marginal condition:

$V_i(\Omega^* \mid q, \phi, \underline{x}, \bar{x}, a, M_i, f(\ell)) = 0.$ (4)

Thus, V_i is zero for the marginal investor with information-acquisition cost M_i but positive for inframarginal investors with costs $M_j < M_i$.

***Definition of Equilibrium*:** A (noisy) rational expectations Nash equilibrium, given a set of disclosure requirements, is:

(1) A measure of informed investors, Ω^*, satisfying (4), in which each informed investor takes as given the equilibrium strategies of the other informed investors and the UDIs, but assumes that the impact of his own trade on the price is negligible.

(2) An aggregate security demand from informed and uninformed liquidity investors equal to $D^*(\theta,\ell) = \Omega^* d_I(\theta) + \ell$, with $d_I(\theta)$ given by (2).

(3) A market clearing price P^c given by (1), which is determined by the market maker (UDIs) to equate supply and demand and to yield a zero expected net profit to *a priori* uninformed security purchasers, conditional on the information contained in the order flow, $D^*(\theta,\ell)$, and (if applicable) the signal ϕ.

(4) A security design by the issuing firm which, taking as given the above behavior by traders and the UDIs, maximizes the issuer's total expected revenue.

This Nash equilibrium is a strategic game in which, subsequent to the determination of disclosure requirements, the informed issuer moves first with its security design, after which information disclosure occurs, followed by the decision of some investors to become informed, and then finally the UDIs respond with a price after observing total demand.

B. Analysis of Case 1

This is the case in which disclosure leads to the release of complementary-aggregate-value information. The practical situation to which this applies most transparently is that in which the informed investors are processing publicly-available information at a personal cost. This processing enables them to learn something about firm value that uninformed investors don't know even though the information *processed* by the informed was available to them as well. By releasing private information, mandated disclosure improves the quality of what the informed investors know. We will model this by assuming that θ is noisy and that disclosure improves the precision of θ. Let $\tilde{\theta}$ be this noisy signal, and it has the following distribution:

$$\Pr(\tilde{\theta}=G|G) = \Pr(\tilde{\theta}=B|B) = u\in(0.5,1)$$

$$\text{and } \Pr(\tilde{\theta}=G|B) = \Pr(\tilde{\theta}=B|G) = 1-u. \tag{5}$$

An increase in u then represents an increase in the precision of $\tilde{\theta}$. Recalling that $[\underline{x} - a, \underline{x} + a]$ is the interval of possible realizations of $\tilde{y}$, the value of the type-B firm, we set a=0 because it plays no role here.

Composite Security and No Disclosure: We now analyze the investor's incentive to acquire information and the type-G issuer's expected revenue. We continue to assume that all informed investors receive the same noisy signal on a given security. The aggregate demand for a security is given by $D = D(\tilde{\theta},\ell)$. Since the investor will only buy the security when $\tilde{\theta} = G$, the investor's net gain from being informed is:

$$V = -M + qu\int_0^\infty \{[\bar{x} - P^e(\Omega + \ell)][P^e(\Omega + \ell)]^{-1}\}f(\ell)d\ell$$
$$- [1 - q][1 - u]\int_0^\infty \{[P^e(\Omega + \ell) - \underline{x}][P^e(\Omega + \ell)]^{-1}\}f(\ell)d\ell. \tag{6}$$

Note that (6) differs from (3) because the informed investor's trading strategy is now driven by recognition of the noise in the signal. Although $\tilde{\theta}$ is noisy, the informed investor's information is a finer partition of the information available to the UDIs because the latter only observe $D(\tilde{\theta},\ell)$ which provides a noisy assessment of $\tilde{\theta}$. In (6), the informed investor submits a buy order when the security is truly type G (the probability of this is q) and $\tilde{\theta} = G$ (the conditional probability of this is u). The investor's expected gain is then $\bar{x} - P^e(\Omega + \ell)$, and the joint probability of this event is qu. The investor also submits a buy order when the security is truly type B (the probability of this is 1-q) and the signal reveals type G (with conditional probability 1-u). In this case the investor's loss is $P^e(\Omega + \ell) - \underline{x}$ and the joint probability of this event is [1 - q][1 - u].

The equilibrium value of Ω, call it Ω^{**}, is determined by the following marginal condition:

$$V(\Omega^{**} \mid q, \underline{x}, \bar{x}, M_i, f(\ell), u) = 0. \tag{7}$$

We can also define the market price of the composite security as:

$$P^e(D(\tilde{\theta},\ell)) = \Pr(G|D(\tilde{\theta},\ell)) \times [\bar{x} - \underline{x}] + \underline{x}, \tag{8}$$

where $\Pr(G|D(\tilde{\theta},\ell))$ is the probability that the true type is G, conditional on an aggregate demand of D. We next consider the impact of complementary aggregate-value information disclosure (Case 1).

Composite Security With Information Disclosure: It is relatively straightforward to establish that disclosure makes the type-G firm better off when this disclosure is interpreted as increasing u.

Proposition 1: *Disclosure increases the equilibrium measure of informed investors, Ω^{**}, and the expected revenue of the type-G issuer.*

The intuition for the positive trading incentive effect is as follows. The presence of noise in the informed investor's signal diminishes the expected gain to being informed, *ceteris paribus* (see (6)). Thus, the measure of informed investors is smaller, which in turn leads to a lower expected revenue for the type-G issuer because of lower price transparency. Disclosure reverses this by reducing the noise in the informed investors' signal. We now turn to the interaction between disclosure and security design.

Security Design With No Disclosure: Following Boot and Thakor (1993), we will model security design as splitting up the composite security into two securities: a senior security S that is not "information sensitive" and a junior security J which is more information sensitive than the composite security. "Information sensitivity" is defined as the percentage divergence between the "true" value of the security and its value based on the *prior* beliefs of the UDIs. S promises a sure date-3 payoff of $\underline{x}$, whereas J is a claim against all of the issuing firm's residual value after S is paid off. Since either type of issuer can pay off $\underline{x}$, the date-3 payoff to S is $\underline{x}$ with probability one. However, J will pay off $\bar{x} - \underline{x}$ if issued by the type-G firm (with probability q), and zero if issued by the type-B firm (with probability 1-q).

Although ℓ is exogenous in our model, it is reasonable to posit that the creation of a more information-sensitive security will cause some liquidity demand to migrate away from J [see, for example, Gorton and Pennacchi (1990)]. Suppose that a fraction $\alpha \in (0,1)$ of liquidity demand will migrate from J to S. Thus, the new liquidity demand for J is now given by the density $f_n(\cdot)$, and a realization ℓ^o of liquidity demand for the composite security (when it is the only security offered) "corresponds" to a realization of $[1 - \alpha]\ell^o$ of liquidity demand for J (when both S and J are offered in lieu of the composite security), i.e., $f_n([1 - \alpha]\ell^o) = f(\ell^o)[1 - \alpha]^{-1} \; \forall \; \ell^o$. We now have the following result.

Proposition 2: *As long as some liquidity demand remains in security J, the total equilibrium expected revenue of the type-G firm is higher by issuing securities S and J than by issuing only the composite security, whereas the total expected revenue of the type-B firm is lower in the equilibrium involving securities S and J than in the equilibrium involving only the composite security. However, in a universally divine sequential equilibrium [Banks and Sobel (1987)], both the type-G and type-B firms issue securities S and J. The off-the-equilibrium-path belief of the UDIs in this equilibrium is that any firm issuing the composite security is type-B with probability one.*

The intuition is as follows. By stripping away S from the composite security, the issuer separates out a component of firm value about which there is no informational asymmetry, and thereby concentrates informational sensitivity in J. The informed investor can now invest *all* of his wealth in J, rather than being implicitly compelled to invest some of it in S as in the composite security case. This informational leveraging up of the informed investor's wealth position leads to a greater expected profit for the informed *ceteris paribus*, and hence to a larger equilibrium measure of informed investors.[3] Since both types of firms obtain the first-best price for S, the increase in the equilibrium measure of informed for J leads to greater price revelation, and a higher total expected revenue for the type-G firm with split securities than with a composite security. Of course, by the same token, the type-B firm suffers an expected revenue decline, but it is forced to follow the lead of the type-G firm in equilibrium because otherwise it would be unambiguously identified as a type-B firm. We next consider the impact of complementary aggregate-value information disclosure on security design.

Information Disclosure and Security Design: We will once again consider the cash flow partitioning made possible by creating securities S and J, and the associated migration of liquidity demand from J to

S. The relevant expressions for the expected net gain to the informed and the prices of securities S and J are qualitatively similar to those used in proving Proposition 1. No unambiguous results can be proved about the security design effect. The greater informational efficiency of the "composite security" equilibrium implies that less is to be gained incrementally from security design. However, disclosure also facilitates security design, as it did in the "composite security" equilibrium. The net effect is ambiguous. It is unambiguously true, though, that the equilibrium expected revenues available to good firms are augmented by security design.

C. Analysis of Case 2

This is the case in which disclosure requirements result in the release of information to all investors that would otherwise have been available only to the informed investors. Thus, disclosure provides information that is a substitute for the information possessed by informed investors We assume that disclosure leads to a signal ϕ about firm type, and that ϕ obeys the following probability distribution:

$$\Pr(\phi=G \mid G) = \Pr(\phi=B \mid B) = r \in (0.5,1), \quad \Pr(\phi=G \mid B) = \Pr(\phi=B \mid G) = 1-r. \tag{9}$$

For simplicity, we will assume that a=0; because it plays no role in the analysis of this case.

Our plan in this subsection is as follows. First, we will characterize the equilibrium including the expected revenue of the issuing firm *without* the information disclosure that generates ϕ. We will then compare this equilibrium to the disclosure equilibrium in which the UDIs obtain ϕ. In each case, we will also compute the benefits of security design to the issuing firm. We will show that this type of information disclosure -- while increasing expected revenues -- diminishes the expected benefits of security design.

Composite Security With No Disclosure: Let us first compute the equilibrium price of the security. For a realization D of aggregate security demand $\ell + D_I$, the UDIs will set:

$$P^c(D(\theta,\ell)) = \Pr(\theta=G \mid D(\theta,\ell))\,\bar{x} + [1 - \Pr(\phi=G \mid D(\theta,\ell))]\underline{x}$$

$$= \Pr[(\theta=G \mid D(\theta,\ell)][\bar{x} - \underline{x}] + \underline{x}, \tag{10}$$

where $\Pr(\cdot|\cdot)$ is the conditional probability measure and (10) follows from the definition of equilibrium.

Using Bayes' rule we have

$$\Pr(\theta=G \mid D(\theta,\ell)) = \frac{f(D - \Omega)q}{f(D - \Omega)q + f(D)[1 - q]} \tag{11}$$

where we have recognized that an aggregate demand of $D = D(\theta,\ell)$ implies a liquidity demand of $D\text{-}\Omega$ if θ=G and D if θ=B. We will assume that $f'(\ell + \Omega) < 0 \;\forall\; \ell$. We can now use (10) and write the expected revenue, R, of an issuing firm of type G as:

$$R = \int_0^{\infty} P^e(\Omega + \ell)f(\ell)d\ell = \int_0^{\infty} \Pr(\theta=G \mid \Omega + \ell)[\bar{x} - \underline{x}]f(\ell)d\ell + \underline{x}. \tag{12}$$

Composite Security With Disclosure: In this case, the price of the security will depend on θ, ℓ *and* ϕ. Thus, (10) becomes

$$P^e(\phi,D|(\theta,\ell)) = \Pr_{\phi}[(\theta=G \mid D(\theta,\ell)][\bar{x} - \underline{x}] + \underline{x}. \tag{13}$$

Moreover, (11) becomes

$$\Pr_{\phi}(\theta=G \mid D(\theta,\ell)) = \frac{f(D - \Omega)q_{\phi}}{f(D - \Omega)q_{\phi} + f(D)[1 - q_{\phi}]} \tag{14}$$

where q_{ϕ} is the posterior belief of the UDIs that the firm is of type G, conditional on having received the signal ϕ but *before* observing D. Thus,

$$q_G = \Pr(G \mid \phi = G) = \frac{rq}{rq + [1 - r][1 - q]} \tag{15}$$

$$q_B = \Pr(G \mid \phi = B) = \frac{[1 - r]q}{[1 - r]q + r[1 - q]}. \tag{16}$$

Finally, we can write (12) as:

$$R = \sum_{i\in\{G,B\}} \Pr(\phi=i|G)\int_0^{\infty} P^e(\phi=i,\ \Omega+\ell)f(\ell)d\ell$$

$$= \int_0^{\infty}[r\Pr_G(\theta=G \mid \Omega+\ell) + [1-r]\Pr_B(\theta=G \mid \Omega+\ell)][\bar{x}-\underline{x}]f(\ell)d\ell + \underline{x}. \tag{17}$$

From (9), we see that $q_B < q < q_G$. We can now prove the following result about the trading incentive effect of disclosure in this case.

Proposition 3*: *The equilibrium measure of informed investors for the type-G firm with a composite security is lower with the disclosure ϕ than without. However, the equilibrium expected revenue of the type-G firm is lower with the disclosure ϕ than without as long as the cross-sectional heterogeneity in M_i is sufficiently low (e.g. cross-sectionally constant M). If this heterogeneity is sufficiently high, then the equilibrium expected revenue of the type-G firm is higher with the disclosure ϕ than without.

The intuition behind the first part of the proposition — that the type-G firm is worse off with the disclosure ϕ than without with sufficiently low heterogeneity in M_i — is straightforward. The disclosure ϕ lowers the value of information acquisition and thus the measure of informed investors, Ω. Hence, it makes prices less transparent and the type-G firm worse off. Things are a bit more tricky when M_i is very heterogeneous.

Since the signal ϕ is available to all investors, the equilibrium price, P^e, for a fixed Ω, is higher than before (without ϕ) for the type-G firm. Thus, the expected profit of an informed investor is lower, given the previous Ω, and the marginal informed investor's expected profit becomes negative. To restore the equilibrium equality in (4), the measure of Ω must decline. This means that the marginal investor in the new equilibrium has a lower M_i, which implies that the equilibrium expected ex post profit of the marginal informed investor (ignoring M_i) is lower (since M_i and the expected ex post profit must be equal in equilibrium). Hence, P^e must be closer to P^*, and the expected revenue of the type-G firm in this equilibrium is higher.

Security Design With Disclosure: We consider the same security design as in the earlier no-disclosure case. This leads to the following result about the security design effect.

Proposition 4*: *While security design elevates the type-G firm's expected revenue also with disclosure, the increase in expected revenue due to security design is smaller with information disclosure than

without. Thus, if security design imposes on the issuer a fixed cost, say $C > 0$, then it is possible for the imposition of disclosure requirements to eliminate security design even though it was optimal in the absence of disclosure requirements.

This result is intuitive. Mandating information disclosure improves price informativeness and expected revenues for type-G firms even without security design. Starting at this relatively high level of price informativeness, the enhancement in expected revenue due to security design is smaller. Since security design in practice could involve costs[4], it is possible that the benefits of security design to the type-G firm exceed the costs without disclosure but fail to do so with disclosure. In this case, information disclosure retards financial innovation. With homogeneous information acquisition costs, therefore, disclosure has only deleterious effects — it diminishes financial innovation and the expected revenues of issuers. However, if information acquisition costs are sufficiently heterogeneous, then the type-G firm, even though it may not innovate with disclosure, is nonetheless better off with disclosure than without. To summarize, the results of our analysis of Cases 1 and 2 indicate that the disclosure of aggregate-value information generally increases revenues but has a negative or ambiguous effect on security design incentives. We now show that disclosing distribution-relevant information improves security design incentives, and through this effect (only) it also indirectly produces a positive trading incentive effect.

D. Analysis of Case 3

We will now analyze a situation in which the information that is disclosed reveals information about the parameter a, i.e., the parameter that determines the support of and hence the variance in the value of the type-B firm, to all investors. Thus, we are now assuming that $a > 0$, and that the UDIs do *not* receive ϕ. Equations (3), (4), (10), (11) and (12) are relevant here.

Composite Security With and Without Disclosure: In this case, the analysis of the composite security case is particularly simple, as the following lemma shows.

Lemma 1: *If we limit all securities to be composite securities, then distribution-relevant information disclosure has no effect on the equilibrium, i.e., disclosure has no trading incentive effect.*

The intuition behind this result is straightforward. All investors are risk neutral and disclosure does *not* affect the expected value of either the type-G or the type-B firm; it only reduces the variance in the valuation of the type-B firm. Hence, firm valuation is unaffected by disclosure.

The Impact of Disclosure on Security Design: It will turn out that the irrelevance of distribution-relevant disclosure does not hold when we introduce security design. Once again, the promised payoff to security S is $\underline{x}$ and to security J the residual. However, security S is no longer riskless as was the case when a=0. The presence of the type-B firm makes S risky since the actual payoff on this security can fall below $\underline{x}$. Note that, despite this, J is more information sensitive than S, so that the informed investors will still prefer to invest all their wealth in J.[5] However, the order flow in security J will now provide the market maker with useful information about how to price security S issued by the same firm. What then is the value of S? This value, called P_S^e, is computed below.

$$P_S^e = \Pr(\theta = G | D_J(\theta,\ell)) \times \underline{x} + [1 - \Pr(\theta = G | D_J(\theta,\ell)] \times E(\min\{\underline{x},\tilde{y}\}), \tag{18}$$

where $D(\theta,\ell)$ is the total demand for security J issued by this firm and

$$E(\min\{\underline{x},\tilde{y}\}) = \int_{\underline{x}-a}^{\underline{x}} \tilde{y}h(\tilde{y})d\tilde{y} + \underline{x}\int_{\underline{x}}^{\underline{x}+a} h(\tilde{y})d\tilde{y}, \tag{19}$$

and $h(\tilde{y}) = 1/2a$ is the density function of $\tilde{y}$. We now have the following result.

Lemma 2: $\partial P_S^e/\partial a < 0$.

This lemma asserts that a reduction in the variance of the type-B firm due to information disclosure will increase the expected equilibrium price of security S. This is intuitive since it is this variance that makes S risky and lowers its value below $\underline{x}$.

We will assume again that the creation of securities S and J will cause a fraction α of the liquidity demand to migrate away from J to S. Using (3) we can now write an informed investor's expected gain from being informed when J is offered as:

$$V_J = -M + q \times \int_0^{\infty} \left(\frac{[\bar{x} - \underline{x}] - P_J^e(\ell + \Omega_J)}{P_J^e(\ell + \Omega_J)}\right) f_n(\ell)d\ell \tag{20}$$

where $f_n(\cdot)$ is the density function of ℓ after the liquidity demand migration, and Ω is the associated measure of informed investors. The equilibrium price of J can be written as:

$$P_J^e(D_J(\theta,\ell)) = \Pr(\theta=G|D_J(\theta,\ell)) \times [\bar{x}-\underline{x}]$$

$$+ [1-\Pr(\theta=G|D_J(\theta,\ell)] \times E(\max\{0, \tilde{y}-\underline{x}\}) \times \Pr(y\geq\underline{x}). \tag{21}$$

We now have the following result about the security design effect.

Proposition 5: *The equilibrium measure of informed investors and the equilibrium expected revenue of the type-G firm are both monotonically decreasing in a. Thus, information disclosure that reduces a should increase both the equilibrium measure of informed investors and the equilibrium expected revenue of the type-G firm. Moreover, since information disclosure had no impact on security valuation in the composite security case, distribution-relevant disclosure strengthens security design incentives.*

This proposition implies that security design is more likely with disclosure. Thus, if there is a cost C to security design that is borne by the issuer, then it is possible that there would be no security design without disclosure but there would be security design with disclosure. To see the intuition, suppose that b_o is the benefit of security design to the type-G firm when there is no disclosure. That is, let R_o be the expected revenue to the type-G firm with the composite security and R_0^1 the total expected revenue with split securities when there is no disclosure. Then $b_o = R_0^1 - R_o > 0$. Now introduce disclosure and let a hat on R delineate this case. By Lemma 1 we know that $\hat{R}_0 = R_0$. But by Proposition 5 we know that $\hat{R}_1 > R_1$. Thus, $\hat{b}_o > b_o$.

The intuition is that this type of disclosure increases the informational leveraging for the informed that is made possible by security design since the informed now know more of payoff relevance about the information-sensitive security than they did without the disclosure. This improves the *(ex post)* rents the informed earn on the investment in information. The marginal informed investor consequently earns a positive expected profit at the previous Ω. Thus, to restore the equilibrium equality in (4), Ω increases. This implies higher expected revenues for the type-G firm. These higher revenues available with security design lead to stronger security design incentives.[6]

IV. ADDITIONAL CONSIDERATIONS

In this section, we will deal with four issues not considered in the previous section. The first has to do with mandatory disclosure requirements versus voluntary disclosures, the second has to do with insider trading, the third has to do with the potential spillover effects of security design, and finally, the fourth has to do with the borrower's choice between bank and capital market financing.

A. Mandatory Versus Voluntary Information Disclosure

As global capital markets become increasingly integrated, it is reasonable to think that securities exchanges will compete more aggressively with each other. Will imposing more stringent information disclosure requirements improve or diminish the attractiveness of the exchange to listing firms? The answer to this question depends in part on the types of firms the exchange wants to attract.

We find it plausible that the objective function of the exchange is to increase the number of type G firms that list on the exchange.[7] Given this objective, one could just as easily recast our analysis in the context of the question: what information and how much of it should firms voluntarily disclose? Our results would then be interpreted as answering this question. In this case, it might appear at first blush that the less stringent the information disclosure requirements the better for the listing firms. After all, any information the firm may wish to disclosed to the market could just as well be voluntarily disclosed. Having a disclosure requirement reduces the flexibility the firm has in determining what to disclose.

This view ignores the potentially severe problems associated with voluntary disclosure. If the credibility of voluntary disclosure is either "certified" through the firm incurring a dissipative signaling cost or through multiple investors having to engage in duplicated costly verification, then the type-G firm may prefer to have the exchange impose disclosure requirements rather than voluntarily disclose that information. Consistent with the insights of the literature on financial intermediary existence, we can posit that the exchange develops certification expertise and exploits informational reusability advantages to certify the authenticity of disclosed information at lower cost than possible through other means.[8]

It is quite possible that the certification costs associated with voluntary disclosure are so large that in some instances such disclosure may not occur at all. The adverse-selection problem facing the type-G firm will be most severe in this case and the benefits of less costly mandatory disclosure the greatest.

A somewhat different approach to creating a value for disclosure appears in Bhattacharya and Nicodano (1997). They show that disclosure may induce the partial revelation of insider information through asset prices, thereby reducing the uncertainty of future payoffs in some interim states. With high liquidity needs on the part of some investors, this may create a value for disclosure.

There is, however, another factor driving the tradeoff between mandatory and voluntary disclosure. Any information disclosure suffers from the "two-audience signaling" problem that information revealed to the financial market also reaches the firm's product market competitors, and could consequently hurt the firm's cash flows. Bhattacharya and Chiesa (1995) and Yosha (1995) have explored the implications of this for the firm's choice between bank and capital market financing. Clearly, mandatory information disclosure creates a cost for the firm in this case that must be traded off against the earlier-mentioned benefits. This suggests that an interior optimum may exist in the stringency of mandatory information disclosure. We will say more on this later.

B. Insider Trading and Disclosure Requirements

Perhaps one of the most well-accepted justifications for disclosure requirements is that they limit the ability of corporate insiders to profit on their inside information.[9] Indeed, in many instances, rampant insider trading is the *motivation* for disclosure requirements. As Bhattacharya and Nicodano (1997) note, insider trading can be expected to improve welfare in two cases: when information revelation through prices guides interim investment choices, and when it creates additional incentives for effort choices by managers.

Introducing the possibility of insider trading opens up a new set of issues in our model. In particular, the existence of insider trading may provide a powerful *raison d'etre* for mandatory disclosure. That is, even if the verification of the reliability of voluntary disclosure is no more costly than that for mandatory disclosure, an agency problem arises between shareholders and managers that causes some types of voluntary disclosures to be eschewed although they are in the best interests of the firm's owners. In this case, voluntary and mandatory disclosure are no longer substitutes and the latter solves an agency problem. This leads to a rationale for mandatory disclosure that is similar to that provided for the corporate demand for insurance.[10]

While it has been asserted that insider trading can actually elevate the information content of prices by causing more of the insiders' information to be reflected in prices,[11] Fishman and Hagerty (1995) have shown that it can also discourage informed traders who are competitively disadvantaged relative to corporate insiders.[12] This sort of effect is most clearly seen in the context of our model in connection with the disclosures described in Case 1 and 3. The disclosure in Case 3 not only makes the type-G firm better off, but it also increases the measure of informed investors *and* incentives for financial innovation. Thus, in the absence of mandatory disclosure, insider trading could: (i) decrease the information content of prices by sufficiently reducing the measure of informed investors, (ii) make the higher quality firms worse off, and (iii) retard financial innovation.

The disclosure in Case 1 would also lower the benefits of insider trading and improve the competitiveness of informed investors *vis a vis* corporate insiders. Thus, insider trading possibilities also strengthen the rationale for this form of mandatory disclosure.

C. Spillover Effects of Security Design

We have not considered the possibility that financial innovation may have significant externalities. For example, Gale (1992) develops a model of financial innovation with adoption externalities. The success of a financial innovation in his model depends on how many firms adopt the innovation since a larger number of adopters permits (risk-averse) investors to diversify more effectively when they buy the new security and thus lowers the risk premium associated with the security.

Suppose that we were to assume that the fixed cost of financial innovation, C, to a given firm is a decreasing function of N, the number of firms adopting that innovation. Let N be a random variable with cumulative distribution function $\psi(N \mid \delta)$, where δ represents the stringency of mandated disclosure. Let $\bar{C}(\delta) = \int C(N)\ \psi(dN|\delta)$ be the expected cost of security design to a given firm, and assume that $\partial\bar{C}(\delta)/\partial\delta > 0$. The idea is that as disclosure requirements become more stringent (δ increases), the impact on different firms is different. For instance, for some firms the increased stringency may be related to Case 2 disclosure whereas for others it may be related to Case 1 or Case 3 disclosure. Thus, for some firms, more stringent requirements will lead to weaker security design incentives and for others to stronger incentives. Uncertainty about which firms will end up with stronger incentives and which with weaker incentives would make N a random variable. Since security design incentives are weakened by more stringent disclosure requirements for the disclosures in Cases 2 and possibly Case 1, a plausible assumption is that there are fewer firms on average adopting the innovation as they are required to disclose more, i.e., the effect of the partial substitutability between financial innovation and mandatory disclosure dominates overall. This means $\partial\psi(N \mid \delta)/\partial\delta > 0$.

Now suppose we consider two disclosure regimes, δ_1 and δ_2, with $\delta_1 > \delta_2$. Let $C(\delta_1)$ and $C(\delta_2)$ be the corresponding expected security design costs, derived from Nash equilibrium conjectures about $\psi(N \mid \delta)$, given δ_1 and δ_2. Let R_i and R_i^* be the expected total revenues of the type-G firm associated with the composite security equilibrium and the split-securities (security design) equilibrium respectively, when the information disclosure regime is δ_i, $i \in \{1,2\}$. Then, it is possible that

$$R_2^* - R_2 - \bar{C}(\delta_2) > 0, \tag{22}$$

$$\text{but } R_1^* - R_1 - \bar{C}(\delta_1) < 0, \tag{23}$$

$$\text{and } R_2 > R_1. \tag{24}$$

When (22) - (24) hold, more stringent disclosure requirements can make the type-G firm worse off due to the spillover effects of security design. In addition to the costs of inadvertently signaling proprietary information to product-market competitors identified in the previous subsection, this would be another cost of more stringent mandatory disclosure.

D. Competition Among Exchanges or Securities Regulators

Since our analysis has proceeded within the context of a single exchange/securities regulator, it is natural to wonder about its implications for competing regulators. In the U.S., firms do not have a choice — the SEC regulates securities markets and dictates disclosure requirements. Such a monopoly regulator is the norm in many countries. Romano (1998) has recently suggested that it may be better to give firms a choice between the SEC and other securities regulators (states or even foreign countries). The idea is that this would introduce competition among regulators that would benefit firms. Is such competition good for firms?

The "knee-jerk" reaction to this is that it would lead to a deterioration in the quality of disclosure since regulators would compete by lightening the disclosure burden they impose on firms (see, for example, *The Economist* (1998)). However, consistent with Romano's conjecture, our analysis implies the opposite. Since the high-quality firms are the ones that benefit from greater stringency in disclosure requirements for certain forms of information, regulators and/or exchanges will have to compete for these firms by *increasing* the stringency of their disclosure requirements. This is another way of justifying the regulatory objective function — maximizing expected revenues for high quality firms — that we have assumed. It is a natural outcome of competition among exchanges/regulators for the best issuers.

E. Disclosure Requirements and the Firm's Choice of Financing Source

Following the Bhattacharya and Chiesa (1995) and Yosha (1995) argument that one factor favoring the use of bank financing is the desire of borrowers to avoid the information disclosure to product-market competitors that is unavoidable with capital market financing, we could assume that the i^{th} type-G firm's value is $\bar{x}(\lambda_i(\delta))$ and the i^{th} type-B firm's mean value is $\underline{x}(\lambda_i(\delta))$, where $\partial\lambda_i(\delta)/\partial\delta \geq 0$ for some i and $\partial\lambda_i(\delta)/\partial\delta < 0$ for others. The idea is that if disclosing information hurts a particular firm's competitive position, it must help its competitors, so that they would realize value enhancements.

With this setup, an increase in mandatory disclosure in the capital market is seen to have two effects. First, those firms that have the most valuable confidential information — the firms with $\partial\lambda_i(\delta)/\partial\delta < 0$

— will find bank financing more attractive as disclosure requirements increase, regardless of whether the firm is type G or B. Second, our analysis indicates that an increase in capital market disclosure requirements augments price transparency, and this lowers the expected revenues of the type-B firms. Thus, these types of firms will gravitate more to bank financing. *This means that the borrower pool banks face will both worsen in quality and become more steeped in proprietary information as information disclosure requirements increase in the capital market.*

V. IMPLICATIONS FOR DISCLOSURE REQUIREMENTS IN EMERGING ECONOMIES

Our work has numerous implications for the design of disclosure requirements, particularly in emerging capital-market economies where these issues are being seriously debated. There are significant cross-jurisdictional differences in disclosure requirements and their enforcement. In the United States, the SEC mandates that firms comply with a prescribed set of accounting standards, periodic disclosure under Regulations S-K and S-X, and ongoing disclosure of material information under paragrapsh 13 and 15(d) of the 1934 Securities Exchange Act. The formulation of detailed rules regarding accounting disclosures is left to the Financial Accounting Standards Board (FASB), an independent, non-governmental body [see Alford, Jones, Leftwich and Zmijewski (1993)]. Insider trading is regulated under Rule 10(b)-5. The Market Surveillance Division of the NYSE monitors trading, and alerts the SEC about suspicious trades. The 1988 Insider Trading and Securities Fraud Enforcement Act specifies penalties for trading violations.

In stark contrast to this are countries like Austria, Germany and Brazil. Until recently, insider trading was not a criminal activity in these countries and they had not established standards for widespread dissemination of information relevant for stock prices. In Austria, actions on these issues were taken as recently as in 1993, whereas Germany set up its Federal Supervisory Agency as a governing body similar to the SEC only in 1994. Brazil's equivalent to the SEC, Comissao de Valores Mobiliarios, revised its securities laws on insider trading only in 1994.

Disclosure rules and their enforcement across countries remain heterogeneous elsewhere too. For example, despite reform undertaken in 1970, the disclosure prescriptions of Korea's Ministry of Finance and its SEC have been described as uninformative, whereas those of Italy's Commissione Nazionale per le Societa e la Borsa are characterized as conservative and secretive [see Haskins, Ferris and Selling (1996)]. In Romania, the main problem at present appears to be lax enforcement of disclosure requirements. Similarly, in Hungary, Poland and Czechoslovakia, the partial financial reforms of the 1980s did not impact the financial system much because of their tentative character [see Catte and Mastropasqua (1993)].

To understand the implications of our analysis for disclosure requirements, we need to first consider some examples of what we mean by different types of disclosure requirements. This information is provided in the table below.

***Table 2*: Examples of Different Types of Disclosure**

Type of Disclosure	Examples
Case 1	• Cost accounting method used. • Nature of reserve accounts. • Assets, revenues and profits by product line. • Growth projections. • Total cost structure breakdown. • Additional information on contingent liabilities. • Dependence of the business on a single or few customers. • R & D spending. • Importance to the business of material patents and franchises.
Case 2	• Information about (economic) free cash flow. • Sales figures compared to those of major competitors. • Information about weighted average cost of capital and Economic Value Added (EVA).
Case 3	• Estimates of uncertainty in future cash flows due to new investments. • Information disclosed to bond rating agencies about interest coverage strength. • Information related to acquisition plans. • Detailed information about composition of accounts receivables. • Plans to reduce cash balances through open market repurchases.

Consider Case 1 disclosure first. If one can ignore the harmful impact of information revelation to product market competitors in this case, our analysis implies that such disclosure should be as great as possible. Greater amounts of such disclosure will simultaneously increase the expected revenues of good firms *and* encourage financial innovation. Financial innovation and the development of the capital market are positively correlated [see, for example, Boot and Thakor (1997a,b)], so that initiatives that spur financial innovation also facilitate capital market growth.

Of course, it would be unreasonable to ignore informational spillovers to competitors altogether [Yosha (1995)]. Thus, our prescription should be tempered by the qualification that disclosures that seriously damage the firm's competitive position should be avoided. This is consistent with the Securities Exchange Act of 1934, which states [see Benston (1976), Yosha (1994), and Stevenson (1980)],

"In order to protect trade secrets and processes, the Act provides that such secrets and processes need not be revealed in any report. Furthermore, the issuer may object to the public disclosure of any information contained in any report, and such information must be withheld from publication unless the Commission considers that public interest requires its disclosure."

On the other hand, the Act requires the firm issuing securities to ". . . provide a description of the business during the past five years and future business to be done," including details such as whether a material part of the business is dependent on a single or a few customers, the importance to the business of material patents and franchises, and the "estimated amount spent during the last two years on research and development, indicating which activities were company-sponsored, describing substantial new products and number of employees engaged in research and new product development." Thus, it appears that while, sensitive technological information such as trade secrets and product designs can be withheld, sensitive strategic information (e.g. information related to innovative management techniques) cannot. This would seem to be a good approach for emerging capital markets to adopt, according to our analysis.

Consider Case 2 disclosure next. The issue of inadvertent information leakage to product market competitors is not likely to be much of an issue here. Our analysis suggests in this case that with relatively homogeneous information acquisition costs, both financial innovation and the expected revenues of issuers are hurt by greater disclosure. But with sufficient heterogeneity in investors' information acquisition costs, greater disclosure raises issuers' expected revenues, even though financial innovation continues to be adversely affected.

In emerging economies with relatively immature financial markets, there is likely to be a lot of heterogeneity in investors' information acquisition costs. Over time, competition among informed investors will tend to reduce this heterogeneity through a Darwinian survival process. Our analysis then prescribes stringent disclosure requirements for firms listed on the exchanges of emerging economies, with this stringency diminishing as the exchange matures. Of course, offsetting the revenue benefits of greater disclosure stringency is the cost of less financial innovation.

While distribution-relevant information disclosure (Case 3) leaves unaffected issuer revenues with security design, we find that stringency in such disclosure increases expected issuer revenues with financial innovation. The issue of information leakage to product market competitors is not of much concern here.

Our analysis does suggest a word of caution on this score, however. If the spillover effects of security design are significant, then asking companies to disclose more of Case 2 information could retard financial innovation and capital market growth. In emerging economies, these spillover effects will be significant only if innovation is largely *customized* to local conditions, i.e., takes the form of securities peculiar to that market. However, if financial innovations are "imported" from more well-developed capital markets, then the issue of "localized" security design being discouraged becomes relatively unimportant.

Let us now compare emerging and well-developed capital markets. From the standpoint of issuer revenues, we have argued that more well-developed markets are likely to have less cross-sectional heterogeneity in information acquisition costs, which suggests the desirability of greater stringency in disclosure requirements on less-developed exchanges. Moreover, we also believe that the deleterious impact of disclosure stringency on financial innovation with Case 2 disclosure is also less likely to be less of an issue on emerging exchanges because of the potential ease with which financial contracts from better developed exchanges can be adopted by the emerging exchanges. Thus, our overall conclusion is that disclosure requirements should be more stringent in less-developed markets.

Another issue of relevance in emerging economies is the *enforcement* of disclosure requirements in the capital market and credit screening discipline in commercial banking. If the enforcement of disclosure requirements is lax, then high-quality firms will be worse off as price transparency declines. But if at the same time, banks are derelict in credit screening, high-quality firms will find bank financing less attractive as well. Of course, low-quality firms will be better off, and if they account for a relatively high fraction of the total population of firms seeking financing, then there may end up being a perverse "competition" between banks and securities exchanges as each seeks to attract business by being more lax. For example, in Romania, this is an issue that the Central Bank is attempting to deal with.

VI. CONCLUSION

We have analyzed the issue of mandatory information disclosure assuming that the goal is to maximize the expected revenues of high-quality firms. Our analysis has focused on a variety of disclosure requirements with respect to their incentive trading and security design effects.

We find that the optimal stringency of disclosure requirements depends on the type of information being disclosed and the cross-sectional heterogeneity in investors' information acquisition costs. The disclosure of more complementary aggregate-value information is always desirable because it enhances issuers' revenues and also strengthens security design incentives. Greater stringency in the disclosure of substitute aggregate-value information has a positive trading incentive effect and is desired by (high-quality) issuers as long as there is sufficient heterogeneity in investors' information acquisition costs. Moreover, except in the case of substitute aggregate-value information, greater information disclosure always leads to more financial innovation. Thus, our analysis makes a strong case for a *selective* increase in mandated information disclosure in the capital market.

Our analysis also suggests *less stringent* substitute aggregate-value disclosure requirements on more well-developed exchanges, although this is predicted to worsen the average quality of the borrower pool in the banking sector. While it is difficult to generalize our recommendations to all markets, our paper does point to some of the key factors that should enter policy discussions of how to structure disclosure requirements.

APPENDIX

Proof of Proposition 1: First some preliminaries. Note that (6) can be written as:

$$V = -M - \{qu + [1-q][1-u]\} + \{qu\bar{x} + [1-q][1-u]\underline{x}\} \int_0^\infty [P^e(\Omega + \ell)]^{-1} f(\ell)\, d\ell. \tag{A1}$$

Moreover, we know that

$$\Pr(G \mid D(\tilde{\theta},\ell)) = \frac{\{uf(D-\Omega) + [1-u]f(D)\}q}{\{uf(D-\Omega) + [1-u]f(D)\}q + \{uf(D) + [1-u]f(D-\Omega)\}[1-q]}. \tag{A2}$$

Substitution of (A2) in (8) gives

$$[P^e(\Omega + \ell)]^{-1} = \frac{q\{uf(\ell) + [1-u]f(\ell+\Omega)\} + [1-q]\{[uf(\ell+\Omega) + [1-u]f(\ell)]\}}{q\{uf(\ell) + [1-u]f(\ell+\Omega)\}\bar{x} + [1-q]\{[uf(\ell+\Omega) + [1-u]f(\ell)]\}\underline{x}}. \tag{A-3}$$

We will now show that $\partial V/\partial u > 0 \ \forall \ \Omega > 0$. It is sufficient to show that the profits V to the informed in (A1) evaluated at u=1 strictly exceed those evaluated at u<1, and that the difference is decreasing in u. Substituting (A3) in (A1), we see that (A1) evaluated at u=1 exceeds that evaluated at u<1 if

$$q\bar{x}\left\{\frac{qf(\ell) + [1-q]f(\ell+\Omega)}{qf(\ell)\underline{x} + [1-q]f(\ell+\Omega)\bar{x}}\right\} - q$$

$$> -qu - [1-q][1-u] + \{qu\bar{x} + [1-q][1-u]\underline{x}\}\Gamma \ \forall \ \ell, \tag{A4}$$

where

$$\Gamma \equiv \frac{q\{uf(\ell) + [1-u]f(\ell+\Omega)\} + [1-q]\{uf(\ell+\Omega) + [1-u]f(\ell)\}}{q\{uf(\ell) + [1-u]f(\ell+\Omega)\}\bar{x} + [1-q]\{uf(\ell+\Omega) + [1-u]f(\ell)\}\underline{x}}.$$

Tedious algebra, involving premultiplication by

$$C \equiv q\{uf(\ell) + [1-u]f(\ell+\Omega)\}\bar{x} + [1-q]\{uf(\ell+\Omega) + [1-u]f(\ell)\}\underline{x} > 0,$$

gives

$$[1-u]\{[qf(\ell)+[1-q]f(\ell+\Omega)][q\bar{x}+[1-q]\underline{x}]\tau-[2q-1][q\bar{x}+[1-q]\underline{x}]\}>0 \tag{A5}$$

where

$$\tau \equiv 1-\frac{q\bar{x}[f(\ell)-f(\ell+\Omega)]}{[1-q]f(\ell+\Omega)\underline{x}+qf(\ell)\bar{x}}.$$

A little algebra shows that the left-hand side of (A5) is indeed strictly positive. Observe that the quantity on the left-hand side of (A5) is strictly decreasing in u. Since the premultiplication involved C, with $\partial C/\partial u > 0$, it follows that $\partial V/\partial u > 0$.

Now, from (7) we know that Ω^{**} solves

$$V(\Omega^{**} \mid q,\underline{x},\bar{x},M,f(\ell),u) = 0.$$

Given $\partial V/\partial u > 0$ and $\partial V/\partial \Omega < 0$, it follows that $\partial \Omega^{**}/\partial u > 0$, i.e., a higher value of u increases the expected revenue of the informed investors, and hence encourages informed trading. This proves the first part of the proposition. The type-G issuing firm's expected revenue is

$$R = u\int_0^\infty \Pr(G|D=\Omega+\ell)[\bar{x}-\underline{x}]f(\ell)d\ell + [1-u]\int_0^\infty \Pr(G|D=\ell)[\bar{x}-\underline{x}]f(\ell)d\ell$$

$$+[1-u]\left\{\frac{q[1-u]}{q[1-u]+[1-q]u}\right\}[\bar{x}-\underline{x}]\int_0^\infty f(\ell)d\ell+\underline{x}. \tag{A6}$$

The specification in (A6) takes into account the fact that there is a probability [1-u] that a type-G issuer does not face informed demand. If the total demand $D(\tilde{\theta},\ell)$ turns out to be less than Ω, then the absence of informed demand is perfectly revealed to the market maker. The proof involves first showing that, holding Ω fixed, R is increasing in u. Since R is increasing in Ω, and Ω^{**} is increasing in u, an increase in u will impact Ω in such a way as to further accentuate the increase in R. These details are not included here, but are available upon request. □

***Proof of Proposition 2*:** Define P_J^e as the equilibrium price of security J and $P_J(\theta)$ as the value of security J that is privately known to the informed trader who receives signal θ. The informed trader can gain nothing by purchasing security S, whereas there is a positive expected profit *ex post* from purchasing security J. Thus, an informed trader's optimal strategy is to invest his entire wealth endowment in security J. When security J is offered, the informed trader's expected net gain from being informed is (note that $f_n(\bullet)$ is the density function of liquidity demand in security J)

$$V_S = -M(\Omega_J) + q\int_0^\infty \left\{ \frac{[\bar{x} - \underline{x}] - P_J^e(\ell^o + \Omega_J)}{P_J^e(\ell^o + \Omega_J)} \right\} f_n(\ell)^o d\ell^o \tag{A-7}$$

where Ω_J is the measure of the set of traders who become informed, and $M(\Omega_J)$ is the cost of becoming informed for the marginally informed investor when the measure of informed traders equal Ω_J. In writing (A-7), we have used the fact that the informed trader will submit an order for security J only when $\theta = G$, and in that case the privately known (intrinsic) value of that security is $\bar{x} - \underline{x}$. For a realization $D^J = D^J(\theta, \ell^o)$ of aggregate demand $\ell^o + D_I^J$ in security J, the market will set

$$P_J^e(D^J(\theta,\ell^o)) = \Pr(\theta = G \mid D^J(\theta,\ell^o))[\bar{x} - \underline{x}]. \tag{A8}$$

Using Bayes rule, we have

$$\Pr(\theta = G \mid D^J(\theta,\ell)) = \frac{f_n(D^J - \Omega_J)q}{f_n(D^J - \Omega_J)q + f_n(D^J)[1-q]}. \tag{A-9}$$

Substituting (A-9) and (A8) in (A7) gives

$$V_J = -M(\Omega_J) + q\int_0^\infty \left\{ \frac{f_n(\ell^o)q + f_n(\ell^o + \Omega_J)[1-q]}{f_n(\ell)q} \right\} f_n(\ell^o)d\ell^o - q. \tag{A10}$$

Letting Ω_J^* be the equilibrium value of Ω_J, we have Ω_J^* being determined by the marginal condition,

$$V_J(\Omega_J^* \mid q, \bar{x}, \underline{x}, M, f_n(\ell^o)) = 0. \tag{A11}$$

We now wish to compare Ω_J^* to Ω^*. To do this, compare (A11) to (4) by writing (A11) as

$$0 = -M(\Omega_J^*) + q\int_0^\infty \left\{\frac{f_n(\ell^o)q + f_n(\ell^o + \Omega_J^*)[1-q]}{f_n(\ell^o)q}\right\} f_n(\ell^o)d\ell^o - q. \quad \text{(A-12)}$$

Noting that $\phi=0$ and a=0, we can write (4) as:

$$0 = -M(\Omega^*) + q\int_0^\infty \{\bar{x}/P^e(\ell + \Omega^*)\} f(\ell)d\ell - q. \quad \text{(A-13)}$$

Using (10) and (11), we can write (A13) as:

$$0 = -M(\Omega^*) + q\int_0^\infty \left\{\frac{f(\ell)q + f(\ell + \Omega^*)[1-q]}{f(\ell)q + f(\ell + \Omega^*)[1-q][\underline{x}/\bar{x}]}\right\} f(\ell)d\ell - q. \quad \text{(A-14)}$$

We now need to compare (A12) and (A-14). As we stated in the text above, $f_n([1-\alpha]\ell^o) = f(\ell^o)[1-\alpha]^{-1}\forall\ell^o$. Thus, a liquidity demand ℓ^o in security J corresponds to a demand $\ell = \{\ell^o/[1-\alpha]\}$ in the composite security. Now evaluate (A6) at $\tilde{\Omega}_I = [1-\alpha]\ \Omega^*$. Even ignoring $M(\tilde{\Omega}_J) < M(\Omega^*)$, we observe that informed trading in J is strictly profitable at $\Omega_J = \tilde{\Omega}_I$. Therefore, we have established $\Omega_J^* > [1-\alpha]\Omega^*$.

We show next that $\Omega_J^* > [1-\alpha]\Omega^*$ implies a strictly higher total expected revenue for a type-G issuer selling securities J and S. Define R_{JS} as the total expected outcome of the type-G issuer from selling securities J and S. Then we have,

$$R_{JS} = \underline{x} + E(P_J^e)$$

$$= \underline{x} + \int_0^\infty \left\{\frac{f_n(\ell^o)q}{f_n(\ell^o)q + f_n(\ell^o + \Omega_J)[1-q]}\right\}[\bar{x} - \underline{x}] f_n(\ell^o)d\ell^o. \quad \text{(A15)}$$

In deriving (A15) we used $D^J(\theta,\ell^o)) = \ell^o + \Omega_J$ (i.e., the firm is type G), and the expression for P_J^e in (A8). It is straightforward to show that, given $f_n'(\ell + \Omega_J) < 0$, we have $\partial R_{JS}/\partial\Omega_J > 0$. We now compare this to the expected revenue, R, with the composite security. We have (see (11) and (12)),

$$R = \underline{x} + \int_0^\infty \left\{\frac{f(\ell)q}{f(\ell)q + f(\ell + \Omega)[1 - q]}\right\}[\bar{x} - \underline{x}]f(\ell)d\ell. \tag{A-16}$$

Use $f([1-\alpha]\ell^o) = f(\ell^o)[1-\alpha]^{-1}\forall\ell^o$ to see that at $\Omega_J = [1 - \alpha]\Omega$, we have $R_{JS} = R$. However, we have established that $\Omega_J^* > [1 - \alpha]\Omega^*$. Hence, since $\partial R_{JS}/\partial\Omega_J > 0$, splitting the composite security enhances the type G's expected revenue.

Similar steps can be used to show that the type-B issuer's expected revenue declines when it splits the composite security. However, if it follows the conjectured equilibrium strategy of splitting the security, its total expected revenue (defined as $\bar{R}_{JS}$) is

$$\bar{R}_{JS} = \underline{x} + E_B(\bar{P}_J^e)$$

where $E_B(\bar{P}_J^e)$ is the expected equilibrium price of security J for the type-B issuer. And if it chooses not to split the composite security, its expected equilibrium price is $\underline{x}$, since the market maker believes with probability one that the defecting firm is of type-B. It can be easily checked that the Kreps and Wilson (1982) requirement that the equilibrium strategies and beliefs represent a "consistent assessment" is satisfied here. Thus, with this out-of-equilibrium (o.o.e.) belief, the equilibrium in which both firms choose to split their securities is a sequential equilibrium. Note that this o.o.e. belief survives the universal divinity refinement of Banks-Sobel (1987). To see this, let p be the probability belief of the market maker that the defecting issuer is of type-G. We will assume that the market maker prices the security to break even, conditional on his beliefs, even outside the equilibrium, i.e., his best response is fixed by his belief. Let p_G be the critical value of this probability such that $R_{JS} = R(p_G)$, where $R(p_G)$ is the type-G issuer's expected revenue if it defects from the equilibrium by issuing a composite security and the market maker believes with probability (w.p.) p_G that the defector is of type-G. Clearly, $R_{JS} < R(p)$ for $p > p_G$ and $R_{JS} > R(p)$ for $p < p_G$, i.e., R(p) is increasing in p. Similarly, define p_B through the equality $\bar{R}_{JS} = R(p_B)$. Since $\bar{R}_{JS} < R_{JS}$, it is clear that $R(p_G) > R(p_B)$. Hence, $[p_G, 1] \subset [p_B, 1]$, which means that, according to the universal divinity criterion, the market maker must attach zero probability to the defector being of type-G. Since $E_B(\bar{P}_J^e) > 0 \; \forall \; \ell^o \in (0,\infty)$, it is privately optimal for the type-B issuer to split the security. □

***Proof of Proposition 3*:**

Note from (10) and (11) that $P^e(\phi, \ell + \Omega) = \begin{cases} P^e = \bar{x} & \text{w.p. } \phi \\ P^e = P^e(\ell + \Omega) & \text{w.p. } 1 - \phi \end{cases}$ (A17)

Use (A17) and (4) to get (note a = 0)

$$0 = -M(\hat{\Omega}^*) + q\int_0^\infty \left\{ \frac{\bar{x} - \{\phi\bar{x} + [1 - \phi]P^e(\ell + \hat{\Omega}^*)\}}{\phi\bar{x} + [1 - \phi]P^e(\ell + \hat{\Omega}^*)} \right\} f(\ell)d\ell \tag{A18}$$

$$0 = -M(\hat{\Omega}^*) + q\int_0^\infty \left\{ \frac{\bar{x}}{\phi\bar{x} + [1 - \phi]P^e(\ell + \hat{\Omega}^*)} \right\} f(\ell)d\ell - q \tag{A19}$$

$$0 = -M(\hat{\Omega}^*) + q\int_0^\infty \left\{ \frac{f(\ell)q + f(\ell + \hat{\Omega}^*)[1 - q]}{f(\ell)q + f(\ell + \hat{\Omega}^*)[1 - q]\{[\phi\bar{x} + [1 - \phi]\underline{x}]/\bar{x}\}} \right\} f(\ell)d\ell - q. \tag{A20}$$

Compare (A20) to (A14) and note that at $\hat{\Omega}^* = \Omega^*$, informed investors make losses (i.e., the RHS of (A14) is negative). Therefore, we know $\hat{\Omega}^* < \Omega^*$.

We now show that with *homogenous* information production costs across UDI's (i.e., $M(\Omega) = \bar{M}$), the expected revenues (R) to a good firm are decreasing in ϕ: $\partial R/\partial\phi < 0$. In other words, disclosure requirements *reduce* expected revenues (due to the negative effect of disclosure on the equilibrium measure of informed $\hat{\Omega}^*$).

Note that ($E(\cdot)$ is the expectation operator)

$$= E\{\phi\bar{x} - [1 - \phi]P^e(\ell + \Omega)\}. \tag{A21}$$

From (3) and (4) we know

$$0 = -M + qE\left\{\frac{\bar{x}}{\phi\bar{x} + [1 - \phi]P^e(\ell + \hat{\Omega}^*)}\right\} - q$$

$$= E\left\{\frac{1}{\phi\bar{x} + [1 - \phi]P^e(\ell + \hat{\Omega}^*)}\right\} = \frac{\bar{M} + q}{q\bar{x}} = \text{constant (with homogenous } \bar{M}\text{)}. \tag{A22}$$

Since $\bar{x} > E(P^e(\ell + \hat{\Omega}^*))$ we see from (A22) and (10) that $\partial \hat{\Omega}^*/\partial\phi < 0$.

The following property can be proved.

Property: Let $\partial \hat{\Omega}^*/\partial\phi < 0$ be such that

$$\frac{\partial E\left\{\frac{1}{\phi\bar{x} + [1 - \phi]P^e(\ell + \hat{\Omega}^*)}\right\}}{\partial\phi} = 0, \text{ preserving the equality (A22)}$$

then $\dfrac{\partial E\{\phi\bar{x} + [1 - \phi]P^e(\ell + \hat{\Omega}^*)\}}{\partial\phi} \leq 0.$

This property shows that public disclosure ϕ discourages informed trading such that prices ultimately reflect less information, and good firms suffer: see (A21), $\partial R/\partial \phi < 0$.

Now introduce heterogeneous information production costs $M(\Omega)$. From (A22) we now observe

$$\frac{\partial E\left\{\frac{1}{\phi\bar{x} + [1 - \phi]P^e(\ell + \hat{\Omega}^*)}\right\}}{\partial\phi} = \frac{1}{qx}\left\{\frac{\partial M(\hat{\Omega}^*)}{\partial\phi}\right\} < 0. \tag{A23}$$

To see this, note that starting from the previous optimum $\hat{\Omega}^*$, the introduction of information disclosure generates a negative profit for the marginal informed investor. Thus, as before $\partial\hat{\Omega}^*/\partial\phi < 0$. The reduction in $\hat{\Omega}^*$ now helps restore equilibrium both from the LHS and the RHS of

(A22). That is, reducing $\hat{\Omega}^*$ increases the LHS, and through its effect on $M(\Omega)$, it decreases the RHS.

Consider now the *Property* and (A23) together. For $\dfrac{\partial E\left\{\dfrac{1}{\phi\bar{x} + [1-\phi]P^e(\ell - \hat{\Omega}^*)}\right\}}{\partial\phi}$

sufficiently negative (thus $\partial M(\Omega)/\partial\phi < -A$, where A is a strictly positive scalar), we have $\dfrac{\partial E\{\phi\bar{x} + [1-\phi]P^e(\ell + \hat{\Omega}^*)\}}{\partial\phi} > 0$. From (A21) we see that good firms may then benefit from the disclosure ϕ. Summarizing, the disclosure ϕ is good if investors are sufficiently heterogeneous in their information production costs. □

***Proof of Proposition 4*:** This proposition calls for a comparison between the incremental benefits of splitting (security design) *with* and *without* disclosure ϕ. Splitting gives (see (A10)),

$$V = -M(\Omega_J) + qE\left\{\frac{[\bar{x} - \underline{x}]}{\phi[\bar{x} - \underline{x}] + [1-\phi]P_J^e(\ell^o + \Omega_J)}\right\} - q \tag{A24}$$

where $P_J^e(\ell^o + \Omega_J) = \dfrac{f_n(\ell^o)q}{f_n(\ell^o)q + f_n(\ell^o + \Omega_J)[1-q]}[\bar{x} - \underline{x}]$. The optimum, $\Omega_J = \Omega_J^*$, is determined such that V = 0. The equilibrium revenues are given by

$$R_{JS}^* = \underline{x} + E(P_J^e(\phi, \ell^o + \Omega_J^*))$$

$$= \underline{x} + \phi[\bar{x} - \underline{x}] + [1-\phi]E(P_J^e(\ell^o + \Omega_J^*))$$

where $E(P_J^e(\ell^o + \Omega_J^*)) = E\left\{\dfrac{f_n(\ell^o)q}{f_n(\ell^o)q + f_n(\ell^o + \Omega_J^*)[1-q]}[\bar{x} - \underline{x}]\right\}$.

Thus,

$$R_{JS}^{*} = \phi\bar{x} + [1 - \phi]\left\{ \underline{x} + [\bar{x} - \underline{x}]E\left\{\frac{f_n(\ell^o)q}{f_n(\ell^o)q + f_n(\ell^o + \Omega_J^*)[1-q]}\right\}\right\}. \tag{A25}$$

Without splitting (see (A21) we have,

$$R^{*} = \phi\bar{x} + [1 - \phi]\left\{ \underline{x} + [\bar{x} - \underline{x}]E\left\{\frac{f(\ell)q}{f(\ell)q + f(\ell + \Omega^*)[1-q]}\right\}\right\}. \tag{A26}$$

The benefit of splitting is R_{JS} - R, and

$$R_{JS}^{*} - R^{*} = [1-\phi][\bar{x}-\underline{x}]\left\{ E\left\{\frac{f_n(\ell^o)q}{f_n(\ell^o)q + f_n(\ell^o + \Omega_J^*)[1-q]}\right\} - E\left\{\frac{f(\ell)q}{f(\ell)q + f(\ell + \Omega^*)[1-q]}\right\}\right\}. \tag{A27}$$

From expression (A27), it follows immediately that $\frac{\partial[R_{JS}^{*} - R^{*}]}{\partial\phi} < 0$. Thus, more public information disclosure reduces the benefits of splitting it (it is easy to verify formally that the second-order effects of ϕ on Ω^* and Ω_j^* are inconsequential). The result in Proposition 4 now follows immediately. (A27) shows lower benefits to security design. Therefore, there exists a range of fixed costs of security design to the issuing firms such that they opt for security splitting without disclosure, but abstain from it with disclosure. □

Proof of Lemma 1: Note that the value of the bad firm now equals $\tilde{y}$ with support ($\underline{x}$ - a, $\underline{x}$ + a) and expected value $\underline{x}$. It can easily be shown that — for the composite security equilibrium — the measure of informed Ω is independent of a (hence, as before, $\Omega = \Omega^*$). Moreover, the expected revenues to the good firm are not affected ($R = R^*$).

The proof is inductive. Adding "noise" (a) to the intrinsic value of the bad firm (or the good firm) does not effect its expected intrinsic value. The expected profit of the informed (=V) therefore does *not* change. Thus, neither Ω nor R is affected.

If the noise is confined to the bad firm's valuation, informed traders do not even face this noise (they only trade in the good firm's composite security). □

Proof of Lemma 2: From (19) we get,

$$E(P_J|\theta = B) = \underline{x} - 0.25a.$$

Thus (see (18)),

$$P_J^e = \underline{x} - [1 - \Pr(\theta = G \mid D_J(\theta,\ell^o))] \times 0.25a. \qquad \text{(A28)}$$

Note from (A28) that a reduction in "a" elevates the value of the safe security. □

Proof of Proposition 5: Note from (A28) that for any reduction of $D_J(\theta,\ell^o)$, the price $P_J^e(D_J(\theta,\ell^o))$ "benefits" from the noise "a" in the type-B firm's intrinsic value. More specifically, a type-B firm affects the value of a security of type J via the component $E(\tilde{y} - \underline{x} \mid \tilde{y} \geq x) \times \Pr(\tilde{y} \geq \underline{x})$; see (21). Note that given the distributional assumptions on $\tilde{y}$, we have $\Pr(y \geq \underline{x}) = 0.5$, and $E(\tilde{y} - \underline{x} \mid \tilde{y} \geq x)$

$$= \{1/[\Pr(\tilde{y} \geq \underline{x})]\} \times \int_{\underline{x}}^{\underline{x}+a} y g(y) dy.$$

$$= x + 0.5a.$$

Thus (use (21)),

$$P_J^e(D_J(\theta,\ell^o)) = \Pr(\theta = G \mid (D_J(\theta,\ell^o))[\bar{x} - \underline{x}]$$

$$+ [1 - \Pr(\theta = G \mid (D_J(\theta,\ell^o))] \times [0.25a]. \qquad \text{(A29)}$$

Substitute (A29) in (20) to get

$$V_J = -M + q\int_0^\infty \Big\{[\bar{x} - \underline{x}]/\{\Pr(\theta = G \mid \ell^o + \Omega_J)[\bar{x} - \underline{x}] + [1 - \Pr(\theta = G \mid \ell^o + \Omega_J)]0.25a\}\Big\} f_n(\ell^o) d\ell^o. \qquad \text{(A30)}$$

The expression for $\Pr(\theta = G \mid \ell^o + \Omega_J)$ is given in (A9). Observe from (A30) that $\partial V_J/\partial a < 0$. Given $\partial V_J/\partial \Omega_J < 0$, we now see that $\partial \Omega_J^*/\partial a < 0$.

Next we show that the equilibrium expected revenues to a type-G firm are decreasing in a. Note that the value of security S (promising $\underline{x}$) now equals (see (A28)):

$$E(P_S) = \underline{x} - \int_0^{\infty}\left\{[1 - \Pr(\theta=G \mid \ell^o + \Omega_J)] \times 0.25a\right\}f(\ell)d\ell,$$

whereas (see (A29))

$$E(P_J^e) = [\bar{x} - \underline{x}]\int_0^{\infty}\Pr(\theta=G \mid \ell^o + \Omega_J)f(\ell^o)d\ell^o + \int_0^{\infty}\left\{[1 - \Pr(\theta=G \mid \ell^o + \Omega_J)]0.25a\right\}f(\ell^o)d\ell^o.$$

Thus, $R_{JS} = E(P_J^e) + E(P_S)$

$$= \underline{x} + [\bar{x} - \underline{x}]\int_0^{\infty}\Pr(\theta=G \mid \ell^o + \Omega_J)f(\ell^o)d\ell^o.$$

We know that $\partial\Omega_J^*/\partial a < 0$ (see above), and $\partial R_{JS}/\partial\Omega_J > 0$. Therefore, we have established that $\partial R_{JS}/\partial a < 0$.

Observe that disclosure (reducing a) does not affect the composite-security revenue to the type-G firm (see Lemma 1), but it does have a positive effect on R_{JS} (see above). We therefore also have established that disclosure payments are benefits of security design. This completes the proof of the proposition. □

FOOTNOTES

1. One way to rationalize this is to assume that the *authenticity* of any disclosed information must be verified by an independent third party, and that the regulator who mandates information disclosure will provide the necessary verification for required disclosures but not for voluntary disclosures. One could justify a regulatory arrangement for mandatory disclosure and verification by appealing to the standard argument that having a single agency verify information authenticity minimizes duplicated verification by many [e.g. Diamond (1984) and Ramakrishnan and Thakor (1984)]. Alternatively, as in the spirit of the role of incentive contracts in motivating agents to work harder in principal-agent models, we can assume that we restrict attention to disclosures over and above those that firms would make voluntarily.
2. As shown in Boot and Thakor (1993), this assumption is pretty harmless. Limited short sales can be readily accommodated.
3. More precisely, in the absence of the migration of liquidity investors, the equilibrium measure of informed investors will exceed that in the case of the composite security, as stated in the text. Migration of liquidity investors will reduce the measure of informed investors, but in all cases *more* information will be revealed in prices with security splitting than with the composite security. Hence, security splitting will always lead to higher expected revenues for the type-G firm.
4. See, for example, Boot and Thakor (1997b).
5. This argument assumes that the information produced cost M is not trivial. Note also that the promised payoffs on S and J could be chosen differently. For example, S could be promised $\underline{x}$ - a, such that it is riskless. However, it is easy to show that this *reduces* the value of security splitting to the type-G firm. Similarly, a higher promised payoff to S is also suboptimal.
6. One might wonder what the effect is of heterogeneous information acquisition costs across investors. Our analysis implies that disclosure *always* leads to higher expected revenues. As information acquisition costs become more heterogeneous, informed trading diminishes and disclosure elevates expected revenues less.
7. For example, this is one of the goals of the Bucharest stock exchange in Romania.

8. See, for example, Bhattacharya and Thakor (1993).

9. See Fishman and Hagerty (1995).

10. See Mayers and Smith (1982)

11. See Roberts (1967), for example.

12. See also Hu and Noe (1997)

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Figure 1: **Sequence of Events**

t = 0

- Firm seeks access to market.
- Firm designs securities with which to access market.
- Firm knows disclosure requirements.

t = 1

- Firm discloses required information to the market.

t = 2

- Subset of investors become informed.
- Orders received by market maker.
- Price determined based on total order flow.
- Market clears.

t = 3

- True values of firms become known.
- Investors are paid off.