

Corporate Governance and Market Liquidity

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Abstract

In this paper I analyze how corporate governance affects the performance of financial markets. I model the interaction between a firm's manager and its shareholders, and highlight the role played by the dividend report in information revelation and information transmission. My model shows that corporate governance mechanisms such as investor protection laws and ownership dispersion affect the market liquidity of the firm's stock. Moreover, the effect of governance provisions that are aimed to improve financial transparency depends on the other corporate governance characteristics of the firm. Thus, disclosure of information by management associated with poor governance mechanisms may lead to an increase in the uncertainty about the liquidation value of the firm and therefore to a decrease in market liquidity.

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I Introduction

Corporate governance matters. It affects financial market development, firm value, concentration of ownership, and other dimensions of firm performance, such as profits, sales growth or capital expenditures (Shleifer and Vishny (1997), La Porta et al. (2000b), Gompers et al. (2003), Cremers and Nair (2005)). In this paper I develop a model that highlights a different channel through which corporate governance affects firm performance: liquidity. My model shows that corporate governance mechanisms such as investor protection laws, ownership dispersion or management's compensation scheme affect market liquidity of the firm's stock. Moreover, governance provisions that improve financial transparency by mitigating management's ability and incentive to distort information disclosure may have both a positive or a negative effect on liquidity. This contradicts the general view that disclosure is unambiguously good because it reduces the asymmetry of information. The interaction of the voluntary information disclosure with other corporate governance mechanisms in place may lead to the undesired outcome that the asymmetry of information in the financial market increases. The effect the quality of information disclosure has on market liquidity depends on the effectiveness of other corporate governance mechanisms. High disclosure requirements combined with poor shareholders protection mechanism or higher monitoring costs may increase the uncertainty about the liquidation value of the firm and therefore the asymmetry of information about liquidation value of the firm in the financial market.

In a model in which the manager of the firm is allowed to trade on the firm's stock I study how internal corporate governance (managerial compensation scheme, ownership concentration, large shareholder monitoring) or external corporate governance (shareholder protection laws, regulatory framework of stock exchanges) affect his dividend payout decision and therefore, the liquidation value of the firm to be traded in the financial market. The value of the firm to be traded in the financial market is endogenously determined and it is a result of the strategic interaction between the manager and the majority shareholder. Both the actions of the manager

and shareholder depend on the corporate governance characteristics of the firm. As a result, the model shows how corporate governance affects market performance in general, and market liquidity in particular, through the effect corporate governance has on dividend policy. According to agency theory, dividend policy is determined by agency costs arising from the divergence of ownership and control.¹ However, the agency problem becomes more complex when the manager has the possibility to trade using his private information in the financial market. This possibility to make profits from insider trading determines the manager to change his dividend payout decision in order to prevent that his private information is revealed to the market through the dividend report. Since the dividend report affects the liquidation value of the firm and its volatility, it affects also the market performance of its stock.

To show how a managerial decision, such as dividend payout, may be affected by corporate governance and how, on its turn, this decision affects both the liquidation value of the firm and the information to be revealed in the market about firm's performance, I develop a two-stage model. In the first stage, I model the strategic interaction between the manager and shareholders as a game with incomplete information. I analyze the optimal strategy of a manager who has private information about the firm's payoff, and the strategy of shareholders entitled to monitor. The manager of the firm has private information about the firm's payoff and uses this information strategically when setting the dividends. In addition, the manager trades in the financial market and makes use of his private information to increase his profits from insider trading. The fact that agents behave strategically becomes even more important in my model because the private information is used both in the interacting with shareholders and for trading in the stock market. Moreover, the dividend report plays an essential role in the mechanism through which information is transmitted. Firstly, the report affects the net payoff after dividends through the dividends paid out (honestly reported). Secondly, the report affects the monitoring effort chosen by shareholders and therefore, affects the profits seized by sharehold-

¹Dividend payout policy can also act as another important corporate governance device - a high payout policy pre-commits managers to generate sufficient cash flows and pay them out to shareholders. As such, the dividend may act as a substitute to the other corporate governance mechanisms.

ers in case of intervention. These are the two channels through which the dividend report affects the net payoff after dividends and consequently, the liquidation value of the firm when traded on the financial market. Nevertheless, there is one more channel through which the dividend report affects the price set by the market maker in the financial market, and, therefore, the demand and profits of the insider. Since the firm has to comply with disclosure regulation and therefore has to unveil the dividend payout to all market participants the market maker uses the dividend as a signal about the liquidation value of the firm.

The model permits also to analyse the role of regulation that imposes a minimum disclosure standard as a way of increasing shareholders' welfare. Regulatory proposals, like the Sarbanes-Oxley Act (SOX) and Fair Disclosure (FD) regulation called for increased accountability of management and directors, as well as more transparency and disclosure by firms. Specifically, SOX requires that firms disclose larger amounts of pertinent and material information to the public in a timely manner and that certify both the accuracy of the information and the quality of the financial-reporting systems used. FD regulation promotes full and fair disclosure i.e. opposes selective disclosure that takes place when non-public information is released to some specific market participants (analysts, institutional investors, stakeholders). This model reflects the effects of both regulation proposals. First, FD regulation requires that once the dividend report is paid and monitoring by shareholders takes place, the dividend report becomes public information and is then used correspondingly in the financial market. Note that the information structure in the trading stage of my model is different from Kyle (1985) because the value of the firm is endogenously determined in the first stage of the model. Endogenizing the liquidation value and disclosing the dividend report have significant consequences for the relationship between the riskiness of the firm's prospects and the performance of the financial market. Second, the SOX regulation asks for increased corporate transparency. In this model, the precision of the earnings report made by the manager can be viewed as a measure of corporate transparency.

The main findings of the model are that monitoring actions of the shareholders

can have a negative effect on market liquidity. The model shows firms with high shareholders' monitoring costs and high dispersion of ownership have high liquidity. The firm can also enhance its liquidity by offering the manager a compensation scheme that partially aligns his incentives with the ones of the shareholders. Finally, the model predicts that better shareholders protection laws and more effective disclosure regulation increase market liquidity when the other corporate governance mechanism in place ensure that the actions of the manager do not increase the uncertainty about the liquidation value of the firm. These theoretical results are in line with the recent empirical research of Chung et al. (2009), Bacidore and Sofianos (2002), Brockman and Chung (2003), Chung (2006) that show that better internal corporate governance, improved market transparency, strong insider trading laws and strong investor protection laws decrease bid-ask spreads. However, the analysis also shows that the interaction of the management's actions with poor governance mechanism may have a negative effect on liquidity. Moreover, the interaction between management's actions and the corporate governance mechanisms in place has also important effects when the manager can choose the precision of the information to disclose to other market participants. When disclosure is costless, the manager would like to introduce as much noise as possible in order to keep his informational advantage relative to shareholders and the market maker. However, when the monitoring costs of shareholders are high or there is not enough liquidity trading in the financial market, too much noise distorts all the information revealed in the market and it harms not only the shareholders but also the management.

This paper contributes to prior work on the effects of corporate governance on firm performance providing a theoretical explanation and identifying a channel through which corporate governance affects market liquidity.² The model unveils the link between a managerial decision, here the choice of dividend report, and market performance. It points out that the performance of the financial market might

²This paper is similar to Admati and Pfleiderer (2009) and Edmans (2009) in that the manager's actions affect the price and that his compensation is sensitive to the prices of its firm. They focus on "exit" as a form of shareholder activism while I focus on "voice" as a standard mechanism. Note that here, the management actions affect both the value of the firm and the asymmetry of information about the liquidation value of the asset.

be determined by interactions of the agents outside the financial markets - in this case corporate governance - and suggests that the implications of these interactions are very important both at quantitative and qualitative levels. Thus, firms may alleviate information-based trading and improve stock market liquidity by adopting corporate governance standards that mitigate information asymmetries. By improving stock market liquidity the firm lowers its cost of capital and therefore, increases its market value.

This paper studies how corporate governance affects market liquidity. The other direction of causality, how liquidity affects corporate governance, has been previously studied in the literature. Market liquidity may affect corporate governance in several ways. First, liquidity may lead investors to increase or reduce their holdings, so liquidity can affect their ability to influence corporate policies. On the one hand, Admati et al. (1994) and Bolton and von Thadden (1998) find a trade-off between liquidity and control, as the hold-up problem may induce the large shareholders to dispose of their shares easily if they disagree with management's actions rather than incur the cost of intervention. Also, Kahn and Winton (1998) show that market liquidity can decrease large shareholders' monitoring incentives by giving them incentives to trade on private information rather than intervene. On the other hand, in a liquid market, shareholders may benefit from increasing their stake as the monitoring cost per share decreases. Thus, Maug (1998) finds that liquidity can help overcome the free-rider problem by facilitating the appearance of block holders or by increasing their holdings (and therefore their intervention probability). In a more liquid market, large shareholders can make more capital gains on the shares they purchase and these gains from the new purchase help cover the costs of their monitoring activities. Second, as Holmstrom and Tirole (1993) show, higher market activity encourages information acquisition, which, in turn, increases the information content of stock prices. Faure-Grimaud and Gromb (2004) also highlight the role of a liquid and informative public market in increasing the activism incentives of a large shareholder. Finally, more informative stock prices in liquid markets facilitate the monitoring of management and the implementation of incentive-based compensation

designed to align management's interests with those of outside shareholders.

The remainder of this paper is organized as follows. Section 2 presents the model. I define the payoffs, describe the information structure as well as disclosure and trading strategies. Section 3 characterizes the equilibrium. Section 4 proceeds with the calculation of some market indicators: volatility of prices, informativeness of prices, expected profits and performs comparative statics for the market indicators. Section 5 analyses the shareholders' welfare. Finally, Section 6 summarizes the results. All the proofs appear in the Appendix.

II The Model

I consider a publicly-owned full-equity firm that has a single project. I assume that the firm is controlled by a manager (with no significant equity stake) unless shareholders intervene to reclaim their control rights. The firm's ownership structure is summarized by the parameter $\phi \in (0, 1]$, which denotes the ownership share of the largest shareholder or group of shareholders. The firm's earnings, \tilde{y} , are determined by a random technological or demand component.³ I assume that \tilde{y} is normally distributed with mean $\bar{y} > 0$ and variance V_y , $\tilde{y} \sim N(\bar{y}, V_y)$. The firm offers and signs a contract with the manager, which specifies the salary to be received by the manager. I assume that it is not possible to write an optimal compensation contract and make the simplifying assumption that the contract promises the manager a fixed salary W .

³A tilde distinguishes a random variable from its realization. Thus, v denotes a particular realization of \tilde{v} .

Monitoring Game		Trading Game
$t = 0$		$t = 1$
<ul style="list-style-type: none"> · Nature chooses y · Manager observes y 	<ul style="list-style-type: none"> · Manager announces earnings and pays dividends · Shareholders decide whether to intervene or not · Manager receives wage · Value of the firm is realized 	<ul style="list-style-type: none"> · Dividends are made public · Traders submit their orders · Market maker sets the price · Payoffs accrue

Figure 1: Timing of Events

The sequence of events, summarized in Figure 1, is as follows:

1. The firm's payoff, y , is realized and observed privately by the manager.
2. The manager makes the earnings announcement $\tilde{v} = \tilde{y} + \tilde{\varepsilon}$, with $\tilde{\varepsilon} \sim N(0, V_\varepsilon)$, decides the amount of dividends to be paid to shareholders \tilde{z} and receives the fixed salary W .
3. After receiving dividends z , the largest shareholder, or group of shareholders, decides how much effort to exert to intervene and gain control over the firm. If the largest shareholder exerts effort π , he regains control with probability π . The cost of intervention is assumed to be $\frac{\xi}{2}\pi$, where $\xi > 0$ is a parameter that describes the firm's corporate governance arrangement. For example, in a firm with a staggered board (i.e. a firm in which it is not possible to replace the whole board of directors at once), ξ would be high, reflecting the difficulties that shareholders would have to overcome to replace the incumbent management team. Thus ξ could be considered as a measure of shareholders power. If intervention succeeds, the manager is fired. Otherwise, the manager

diverts a fraction of total net earnings after dividends and wage payment. In both cases the liquidation value of the firm is realized and the game continues as follows:

4. The dividends are made public.
5. The manager submits an order \tilde{d} of shares of the firm to a market maker, who is in charge of setting prices in the stock market.
6. The market maker observes the total order flow, $\tilde{u} = \tilde{d} + \tilde{\omega}$ which consists of the manager's order, \tilde{d} , and the order made by the noise traders, $\tilde{\omega}$, but cannot observe \tilde{d} or $\tilde{\omega}$ individually. I assume that noise traders' order, $\tilde{\omega}$, is a random variable normally distributed with mean 0 and variance V_ω , $\tilde{\omega} \sim N(0, V_\omega)$. Upon observing the total order flow, the market maker sets a price, p , for the firm's shares and trading takes place.
7. After trading takes place, payoffs are distributed between shareholders and the manager and the firm is liquidated.

Before solving the model, I describe in greater detail payoffs, strategies and some of the model's assumptions.

A Payoffs

Shareholders select the governance standards to maximize the value of the firm weighing the benefits of greater liquidity against the cost associated with the ability of the manager to expropriate firm value. They have two mechanisms to mitigate the adverse selection problem. First, they can monitor to verify the dividend report provided by the manager. Second, they can design the compensation of the managers to provide them with incentives to report truthfully. Here, their decision to monitor is contingent on the dividend report they receive, while the compensation scheme is assumed for simplicity to be exogenously given. I assume that the manager is guaranteed a fixed salary W , which is independent of the firm's earnings and of whether or not intervention takes place. In the case the shareholder

decide to intervene, the manager is fired and he does not receive any compensation. In the case intervention does not take place, the manager receives a compensation that is a fraction a of the net earnings, earnings obtained after dividends and the contractually set wage W are paid. Thus, the manager obtains in this case a total pay of $W + aR$, where $R = v - z - W$. The parameter $a \in [0, 1]$ characterizes the managerial compensation scheme and reflects the quality of the investor protection laws, when a is low the manager is not able to appropriate the firm's resources. It should be emphasized that the additional pay aR is perfectly legal as it may result from a pay increase (a bonus) approved by a manager-controlled board. Finally, in both cases, the manager may further profit from trading the firm's shares based on his private information. The manager's trading profit equals to $\Pi_T = (V(\tilde{y}, \tilde{z}) - p)d$, where V is the value of the firm's equity, which is equal to the firm's liquidation value. Therefore, if there is no intervention the manager's payoff is:

$$\tilde{U}_{NI} = W + a(\tilde{v} - \tilde{z} - W) + ((\tilde{y} - \tilde{z} - W) - \tilde{p})\tilde{d}.$$

I assume here for simplicity that the discount factor is equal to 1.

The largest shareholder, in turn, obtains the fraction ϕ of the dividends paid out by the manager plus the corresponding fraction of value of the stock and minus the earnings ε .⁴ The largest shareholder's payoff if there is no intervention is, thus:

$$\tilde{S}_{NI} = \phi(\tilde{z} + (1 - a)(\tilde{v} - W - \tilde{z}) - \tilde{\varepsilon}).$$

If there is intervention, the manager earns:

$$U_I = W + ((\tilde{y} - \tilde{z} - W) - \tilde{p})\tilde{d}$$

⁴Note that the large shareholder cannot trade in the financial market based on the signal he receives because this signal becomes public at the trading stage. Our model differs from Admati and Pfleiderer (2009) and Edmans (2009) where the blockholders have private information and use exit as a disciplining mechanism. Here the shareholders can use the private information only to decide whether to fire the management or not.

and the largest shareholder obtains

$$\tilde{S}_I = \phi(\tilde{z} + (\tilde{v} - W - \tilde{z}) - \tilde{\varepsilon}) - \frac{\xi\pi}{2}.$$

Manager and shareholders choose their dividend payout policy and intervention probability, respectively, to maximize their expected profits conditional on the information they possess. I emphasize here the link between dividend changes and market performance and the role played in reducing the information asymmetry and agency problems.⁵ Notice that the managerial compensation scheme characterized by a and the monitoring costs ξ are two internal corporate governance mechanisms through which shareholders affect both the liquidation value of the firm and the performance of the stock in the financial markets.

B Financial Market

The exchanges impose strict disclosure requirements on listed firms to ensure that they comply with disclosure standards. Firms are required to inform the stock exchange of any action affecting the rights of existing shareholders, as well as to provide a timetable for all dividends and interest payments. At this stage, after the manager chooses the dividends to be paid, z , and the largest shareholder chooses the intervention probability, π , the amount of dividends paid out is learned by the market. Despite of the regulation, the manager can still use his private information about the firm's liquidation value to obtain profits from trading in the financial market in the case the earnings announced are different from the real earnings, because the report does not fully reveal his private information.

I model the financial market as in Kyle (1985). However, my model departs from Kyle (1985) in the fact that the liquidation value of the firm depends on the dividend payment made by the manager, and therefore it is not exogenously given.

⁵Extent literature shows that dividends are used as a signal to convey information about future profitability (Bhattacharya (1979), Miller and Rock (1985), John and Williams (1985)) or as an instrument to mitigate the agency problem (Jensen and Meckling (1976), Easterbrook (1984), Jensen (1986), Ruiz-Verdú (2008)).

The market maker sets the price using the information about the order flow but also the dividend report, z . The total order flow consists of the order of the insider and the order of the noise traders, $\tilde{\omega}$. The amount traded by the insider is contingent on the firm's value and depends on the dividend report the manager made previously. The manager conditions the quantity to trade on his signal about the payoff, y .

I assume that in the financial market the market maker sets the price so as to satisfy the semi-strong efficiency condition

$$p(\tilde{u}, z) = E_z [V(\tilde{y}, z) | \tilde{u}] = \mu(z) + \lambda(z) \tilde{u}, \quad (1)$$

where $\tilde{u} = d(\tilde{y}) + \tilde{\omega}$ is the total order flow.

C Strategies and Information Structure

Since the market maker sets a price to satisfy the semi-strong efficiency condition, the relevant players in the model are the manager and the large shareholder. The large shareholder's strategy, $\pi(z)$, determines his intervention effort as a function of the dividend paid by the manager, z . The manager's strategy is more complex, as it describes two choices: first, the manager sets the dividends to be paid to shareholders; and then, the manager picks an order to place with the market maker. Therefore, the manager's strategy is $(z(y, \varepsilon), d(y))$, where $z(y, \varepsilon)$ is the optimal dividend payout policy and $d(y)$ is the optimal demand strategy. The manager understands that dividends reveal information about the firm's earnings and, since he wants to keep some informational advantage for the trading stage, he adds a stochastic bias to the earnings that he would have declared in the absence of insider trading opportunities $\tilde{v} = \tilde{y} + \tilde{\varepsilon}$, where $\tilde{\varepsilon}$ is a normally distributed random variable with mean zero and variance V_ε , $\tilde{\varepsilon} \sim N(0, V_\varepsilon)$. Earnings manipulation can be done through accounting actions (discretionary accruals) but also through economic actions (early liquidation of long-run investments). The manipulation can affect both the level and the variance of earnings. Since the manager is risk neutral, I assume that the manipulation affects only the variance of the report. I follow

Admati and Pfleiderer (1986, 1990), Fischer and Verrecchia (2000) and Huddart et al. (2001) who introduce exogenous noise that precludes the investors from fully recovering the information of the manager out of his report. Market microstructure literature shows that voluntarily disclosure can reduce the asymmetry of information. However, completely unbiased disclosure is not optimal if managers can add some noise at a small cost. If it is known that all managers wish to bias disclosure in the same direction and if disclosure is costly, a “lemon” equilibrium can occur in which no firm discloses. However, if the shareholders are uncertain about the direction of managers’ incentives to bias disclosure, a pooling equilibrium exists in which there is disclosure and some disclosure-contained bias (see Dye (1998), Fischer and Verrecchia (2000)).⁶ Therefore, the theory predicts that even though disclosure contains some bias, in equilibrium it is still credible.

In my model the manager’s ability to introduce noise in the report in order to prevent the revelation of his private information - measured by the variance of the noise V_ε - can be considered as a measure of corporate transparency. In a first step I assume that it is exogenously given. Notice however, that the corporate transparency is a direct consequence of the legal and regulatory environment and the manager can influence the level of disclosure of information, and therefore it can be chosen endogenously by any firm.⁷ On the one hand, between state incorporation laws and the stock exchange governance regulation, most firms are required to have a board that meets a number of requirements: it must have at least a given number of members, it must meet with specified regularity, it may need to have various committees (audit, compensation and executive committees), and a fraction of the directors may be obligated to be independent from management. Thus, board com-

⁶The bias is defined there as the difference between the realization of earnings and manager’s actual report. For other models on earnings manipulation where managers introduce endogenous noise in their reporting, see Guttman et al. (2006) and Kedia and Philippon (2007).

⁷ In his speech delivered on September 28, 1998, the Chairman of the Securities Exchange commission, Arthur Levitt pointed out five ways in which firms can alter the integrity of their financial reporting: “big bath” restructuring charges, creative acquisition accounting, “cookie jar” reserves, “immaterial” misapplications of accounting principles, and the premature recognition of revenue.

mittee structure and composition may likely impact management's willingness and ability to manage earnings - the variance of the noise introduced by the manager, V_ε - in that an effective protection of shareholders' interests would hinder the managers from distorting information on earnings. If they are diligent, they will first exert a closer monitoring of the manager's actions (especially on the integrity and quality of the financial statements and the appropriateness of their disclosure), and second, they will evaluate ex-post the manager's performance and approve their compensation. On the other hand, regulators should ensure that monitoring and enforcement systems for listed companies are effective, so they prevent financial misstatements and preclude earnings manipulation in order to avoid industry regulation (for example minimum capital requirement) or anti-trust regulation. Consequently, the ability of the manager to manipulate earnings could be also interpreted as a measure of effectiveness of the regulation.

The manager chooses the dividends to be paid out to shareholders to maximize his total expected payoff

$$z^*(y, \varepsilon) = \arg \max_z E \left(\tilde{U} \mid y, \varepsilon \right).$$

When the manager takes his decision he has rational expectations about the strategy of the shareholders, so he bears in mind that the intervention probability, π , depends on the dividend payment made. The dividend payment affects shareholders' strategy, and consequently, there are two channels through which the voluntary dividend payment affects the net payoff of the firm after dividends (the direct channel through which the payoff is affected by paying out the dividends and the link between dividends payment and intervention probability). Moreover, it affects the information used by market maker to set the price of the firm's shares traded in the financial market. Therefore, it affects both the expected profit from wages and from trading. Consequently, the manager has to take into account all these effects.

As I have explained, shareholders choose the probability to intervene so as to maximize their total expected payoff and conditioning on the dividends voluntarily paid z . Thus, the total expected payoff amounts to voluntarily paid dividends,

z , the share of profits seized in case of intervention and the value of the stock. The intervention takes place at a fixed cost, ξ , this cost being observable both by shareholders and manager. As a result, shareholders choose the intervention probability to maximize the expected revenue

$$\pi^*(z) = E \left(\phi(z + ((1-a) + a\pi(z))(\tilde{y} - W - z) - \varepsilon) - \frac{\xi\pi^2(z)}{2} \middle| z \right).$$

I look for equilibria in which the manager's demand is linear in the value of the project: $d(y) = \theta(z) + \rho(z)y$ since the manager conditions the quantity to trade on his signal y . He knows the dividend report z and therefore his optimal choice is

$$d^*(y) = \arg \max_d E_z [\Pi_T | y] = \arg \max_d E_z ((V(\tilde{y}, z) - p)d | y).$$

III Equilibrium

An equilibrium with rational expectations is the manager's dividend payout strategy, $z(y, \varepsilon)$, his trading strategy, $d(y)$, the shareholder's intervention strategy, $\pi(z)$, and the market maker's pricing strategy, $p(u, z)$. I look for a linear equilibrium and therefore, I restrict the attention to strategies that are linear. The manager's dividend payout strategy, $z = \alpha + \beta y + \eta\varepsilon$, and his demand, $d(y) = \theta(z) + \rho(z)y$, are linear in the earnings, y . The shareholders intervention policy, $\pi(z) = \delta + \gamma z$, is linear in the dividend received, z , and the price policy, $p(u, z) = \mu(z) + \nu(z)u$, is linear in the total order flow, u .

To simplify, I define $C \equiv \frac{\phi a}{\xi}$. I solve for a linear equilibrium and given that the equilibrium conditions are satisfied I obtain the following:

Proposition 1 *There is a unique linear equilibrium where the optimal dividend payout policy is*

$$z(v) = \alpha + \beta y + \eta\varepsilon$$

and shareholder's intervention strategy is

$$\pi(z) = \delta + \gamma z,$$

where

$$\begin{aligned}\alpha &= (1 - \beta)\bar{y} - W - \frac{1}{C(2 - A)} \\ \beta &= \frac{AV_\varepsilon}{V_y(A - 2)^2 + V_\varepsilon A^2} \\ \eta &= \frac{(2 - A)V_y}{V_y(A - 2)^2 + V_\varepsilon A^2} \\ \delta &= \frac{1}{(2 - A)} - C(A - 1)\left(\bar{y} - W - \frac{1}{C(2 - A)}\right) \\ \gamma &= C(A - 1),\end{aligned}$$

where A is a solution of the equation (4) in the Appendix.

The demand of the manager in financial markets is

$$d(y) = \rho(z)(y - \bar{y})$$

where

$$\rho = \sqrt{\frac{V_\omega}{\text{Var}(y|z)}}$$

and the equilibrium price is

$$p(u, z) = \mu(z) + \lambda(z)u$$

where

$$\begin{aligned}\mu(z) &= \bar{y} + A(z - \bar{z}) \\ \lambda(z) &= \frac{1}{2}\sqrt{\frac{\text{Var}(y|z)}{V_\omega}}.\end{aligned}$$

Using the coefficients I have previously obtained, I calculate the firm's expected dividend report and the expected intervention probability of shareholders.

Corollary 2 *The expected dividend payment equals*

$$E(z) = \bar{y} - W - \frac{1}{C(2-A)}$$

and the expected intervention probability is

$$E(\pi(z)) = \delta + \gamma E(z) = \frac{1}{(2-A)}.$$

As it can be seen from Corollary 2, the manager always underreports and there are two reasons to do so. First, since the variable component of his compensation is proportional to the net payoff of the firm net of the fixed wage and the dividend, the manager prefers to declare a lower dividend. Moreover, since monitoring is costly, the shareholders never intervene with probability 1. As a result, the manager underreports whenever there is asymmetry of information between him and the majority shareholder. Second, the manager has incentives to underreport because in this way he affects the liquidation value of the firm to be traded on the financial market. Thus, he can exploit his informational advantage over the liquidation value of the firm and make profits at the expense of the noise traders. A low report z is associated with more aggressive trading on the private information (higher $\rho(z)$) and therefore, with a higher profit from insider trading.

There are two sources of uncertainty: about the riskiness of the payoff of the project, V_y and uncertainty introduced by manager through earnings manipulation, V_ε . The higher is the asymmetry of information with respect to the payoff of the project, V_y , the lower the expected report is (see Figure 2). This is explained by the fact that the adverse selection problem between manager and shareholders is more acute when the riskiness of the firm's payoff is higher, and therefore the manager has more incentives to underreport.

If the manager's ability to appropriate resources in the first stage is poor, or the monitoring of the shareholders is inefficient, he may prefer to increase the report since as the variance of the noise V_ε increases, the asymmetry of information in the trading stage increases; and therefore, the manager increases his profits from

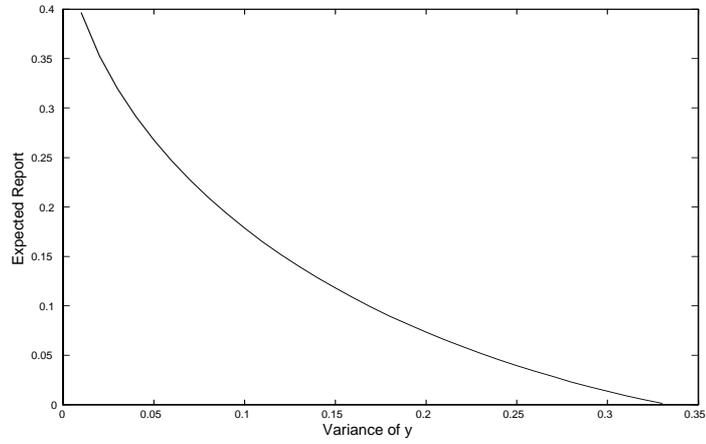


Figure 2: Expected Report. Comparative statics with respect to the riskiness of the firm's payoff, V_y . Parameter Values: $V_\varepsilon = 1, V_\omega = 4, \phi = 0.5, \xi = 0.25, a = 0.5, b = 1, \bar{y} = 2, W = 0$.

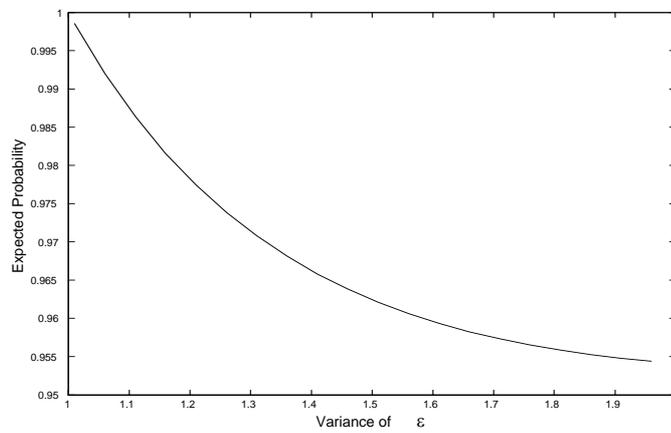


Figure 3: Expected Report. Comparative statics with respect to the manager's ability to manage earnings, V_ε . Parameter Values: $V_y = 1, V_\omega = 4, \phi = 0.5, \xi = 0.5, a = 0.5, b = 1, \bar{y} = 2, W = 0$.

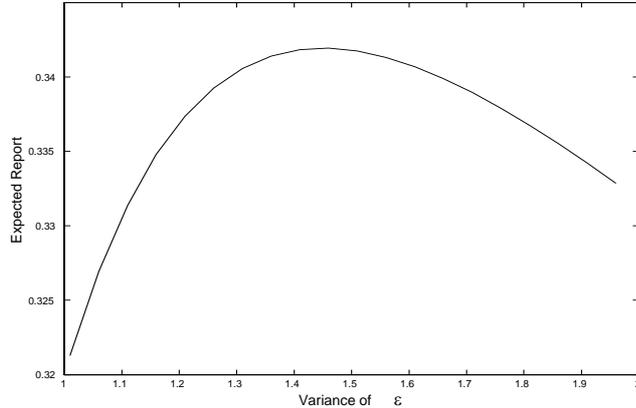


Figure 4: Expected Report. Comparative statics with respect to the manager's ability to manage earnings, V_ε . Parameters Values: $V_y = 1$, $V_\omega = 4$, $\phi = 0.5$, $\xi = 0.42$, $a = 0.5$, $b = 1$, $\bar{y} = 2$, $W = 0$.

trading (see Figure 3). However, if shareholders have better monitoring abilities or the manager receives a high payment in the first period, the manager faces a trade-off between a higher profit from trading and a higher first period payment (see Figure 4).

In addition to the manager's ability to manipulate earnings, the magnitude of the asymmetry of information between manager and the majority shareholder depends also on other three corporate governance characteristics: the monitoring abilities of the majority shareholder, ownership concentration and manager's bonus scheme. First, the asymmetry of information depends on the majority shareholder's costs of monitoring, ξ . Weak investor protection laws, that imply low shareholder power, make replacing the manager (in case he does not perform well) very costly. In case shareholders want to replace the manager, they have to set a proxy fight, which is usually very expensive. Therefore, in the case of high monitoring costs, the adverse selection problem is more acute and the manager has more incentives to underreport. This is consistent with the empirical findings of La Porta et al. (2000a) who show that better minority shareholder protection is associated with higher dividend pay-outs. Second, dispersion of ownership (low ϕ) makes it more difficult for the shareholders to control the manager. It is more difficult for them in this case to agree

and take common action and therefore, since they monitor less often, the manager acts in his own interest. Finally, the managers's bonus scheme alters his incentives to report correctly. On the one hand, since his bonus is proportional to the value of the firm net of dividends he has incentives to underreport. On the other hand, since the dividend report is used by the market maker in setting the price in the financial market, he has incentives to overreport. The second effect, dominates always the first, and therefore we obtain that the higher is the manager's bonus ratio a the higher is the dividend report.

In addition, the expected report also depends on the noise in the financial market, since the manager takes into account his expected profits from trading in choosing his optimal report. Thus, the higher the variance of noise traders' demand V_ω , the higher their informational advantage and therefore their incentives to underreport. Therefore, the manager's possibility of trading in the financial markets affects both directly and indirectly his optimal choice of dividend payout.

The effects of all these characteristics on shareholders' expected intervention probability is similar but exactly the opposite; a higher expected report corresponding to a lower expected intervention probability.

IV Market Performance

I now turn to the implications of the manager's choice of dividend payout on the liquidation value of the firm and financial market performance. I consider a few market indicators: market depth; price volatility; information content of prices; the expected profit of different market participants and characterize their variation with respect to different corporate governance devices.

As it can be seen from Proposition 1, the demand of the insider is

$$d(y) = \rho(z) (y - \bar{y})$$

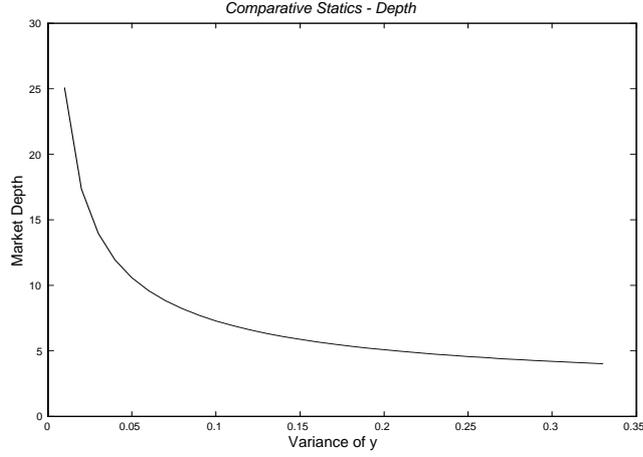


Figure 5:

and the equilibrium price equals

$$p(\tilde{u}, z) = \mu(z) + \lambda(z) \tilde{u} = \bar{y} + A(z - \bar{z}) + \frac{1}{2} \sqrt{\frac{\text{Var}(y|z)}{V_\omega}} \tilde{u}.$$

I use the market depth as a measure of liquidity, as defined by Kyle (1985), which represents the volume of trading needed to move prices by one unit. As can be seen from the price, the market depth equals to

$$\frac{1}{\lambda(z)} = 2 \sqrt{\frac{V_\omega}{\text{Var}(y|z)}}$$

There are some similarities to Kyle (1985) in the sense that the lower the noise traders' demand variance, V_ω and the higher the asymmetry of information generated by the riskiness of the firm's project, V_y , the lower expected market depth (see Figure 5).

Next, I calculate the volatility of prices measured as the variance of price conditional on the report made by the manager.

Corollary 3 *The price volatility is*

$$\text{Var}(\tilde{p}|z) = \frac{1}{4}\text{Var}(y|z) = \frac{1}{4} \frac{(A-2)^2 V_y^2}{4V_y(1-A) + A^2(V_y + V_\varepsilon)}.$$

I characterize also the amount of private information that is revealed through prices. I define the informativeness (or the information content) of prices as the difference between the prior variance of the payoff conditional on the report and the variance conditional on prices and the report. This measure gives us the decrease in variance due to revelation of private information, after conditioning on the private signal. Using normality assumptions I obtain the expression presented in the following Corollary:

Corollary 4 *The price informativeness is*

$$\text{Var}(V(\tilde{y}, z)|z) - \text{Var}(V(\tilde{y}, z)|\tilde{p}, z) = \text{Var}(y|z) = \frac{(A-2)^2 V_y^2}{4V_y(1-A) + A^2(V_y + V_\varepsilon)}.$$

As in Kyle (1985), I obtain that the price reveals half of the insider's information and both the expected volatility of prices and expected price informativeness increase with the asymmetry of information, V_y .

Finally, I calculate the expected insider trading profit.

Corollary 5 *The manager's expected insider profit is*

$$E\left((V(\tilde{y}, z) - \tilde{p})\tilde{d}|z\right) = \frac{1}{2}\sqrt{\text{Var}(y|z)V_\omega} = \frac{(A-2)V_y}{2}\sqrt{\frac{V_\omega}{4V_y(1-A) + A^2(V_y + V_\varepsilon)}}.$$

Similar to Kyle (1985), I obtain that the higher the asymmetry of information, V_y and the higher the noise in the market, V_ω , the higher is the trading profit.

Consequently, the effect of the asymmetry of information between manager and market maker on market performance it is exactly the same as in Kyle (1985), but this source of asymmetry is not exogenously imposed. It can be due either to the uncertainty about the project's payoff but can be also endogenously created in the manager-shareholders interaction. Since the manager and the shareholders interact

in the first stage, the liquidation value of the firm is endogenous and therefore, the market performance depends on the corporate governance characteristics of the firm. I study next how external corporate governance (disclosure regulation) and internal corporate governance (monitoring by majority shareholder, ownership concentration and manager's bonus scheme) affect market performance.

A Regulation and Impact on Market Performance

Fair Disclosure Regulation was adopted by the Securities and Exchange Commission in August 2000. Its main goal was to stop the selective disclosure of material non-public information by issuers to analysts and institutional investors. FD Regulation requires that when an issuer discloses material information, all the information is publicly disclosed. In this model the firm complies with this regulation in sense that the dividend payment becomes public information in the trading stage. The effects on market performance of the release of this signal is the same as of any other public signal i.e. it improves market performance. However, the manager can affect the informational content of this signal simply by manipulating the earnings. Despite of the fact that the firm should comply to SOX regulation, the managers may have incentives not to disclose information in order to be able to use this private information for their own benefit. Regulators cannot always monitor and enforce full disclosure and moreover cannot anticipate the actions of the managers to avoid the regulation. Thus, Cohen et al. (2008) empirically show that after the implementation of SOX Act the accrual-based earnings management decreased while real earnings management increased. Consequently, the manager can manipulate earnings in the case the disclosure regulation or shareholders' protection laws cannot be perfectly implemented.

To see how regulation affects manager's dividend payout decision and the effect this one has on market performance I study how the manager's ability to manage earnings, V_ε , affects market performance.

The ability of the manager to manage earnings, V_ε , has a different effect on market liquidity and insider trading profits depending on the other corporate gover-

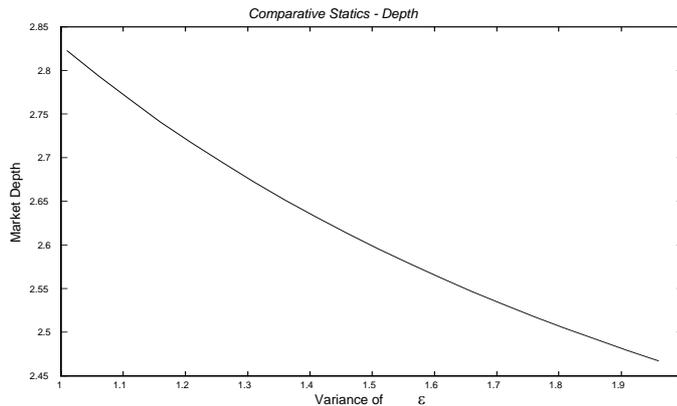


Figure 6: Expected Market Depth. Comparative statics with respect to the manager's ability to manage earnings, V_ε . Parameters Values: $V_y = 1$, $V_\omega = 4$, $\phi = 0.5$, $\xi = 1.5$, $a = 0.5$, $b = 1$, $\bar{y} = 2$, $W = 0$.

nance mechanisms in place. When the shareholder protection mechanisms are good, we still obtain the expected result that market liquidity decreases with manager's ability to manipulate earnings. The intuition for this is simple. When the shareholders' protection mechanisms are good, the manager's actions do not increase the uncertainty about the firm's liquidation value. As a result, by disclosing more precise information about earnings, the manager reduces indeed the uncertainty about the liquidation value of the asset in the financial market. Consequently, when the asymmetry of information is low, an additional order does not lead to a large price impact and therefore the market is very liquid (see Figure 6). Moreover, since his informational advantage decreases when the variance of the liquidation value decreases, his profit from insider trading also decreases.

However, when the shareholders' protection mechanisms are weak, and therefore the manager is able to appropriate a lot of resources, the manager may, through his actions and shareholders' response to his actions, increase the uncertainty about the liquidation value of the asset. Therefore he may increase the asymmetry of information despite of an increase in the precision of the signal he release. In this case, the market liquidity either increases with the variance of the noise introduced in corporate disclosure, V_ε or it has an inverted U-shape (see Figures 7 and 8). Similarly,

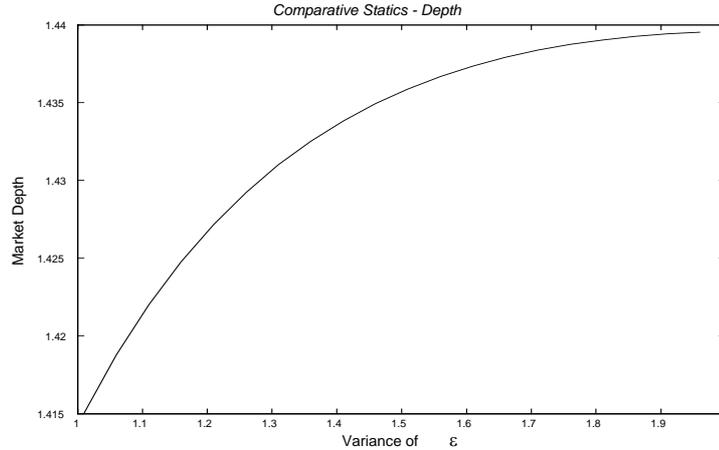


Figure 7: Expected Market Depth. Comparative statics with respect to the manager's ability to manage earnings, V_ε . Parameters Values: $V_y = 1$, $V_\omega = 1$, $\phi = 0.5$, $\xi = 1.5$, $a = 0.25$, $b = 1$, $\bar{y} = 4$, $W = 0$.

the insider trading profit decreases or has a U-shape with respect to variance of the noise.

Similarly, the volatility of prices, the informativeness of prices increase with the manager's ability to manage earnings. Thus, we obtain that market participants in the financial market respond in the same way to different sources of uncertainty. As a result, to improve market performance we need to reduce the asymmetry of information by imposing more effective disclosure rule and better shareholders' protection laws. These results are consistent with Brockman and Chung's (2003) and Chung's (2006) empirical findings that show that markets where securities laws require more disclosure than in other countries, where the investor protection mechanism are better and the quality of law enforcement is higher are characterized by higher market liquidity.

In this model the precision of the signal about realized earnings is exogenous. However, in practice the management has the ability to choose the quality of information to disclose. If the decision is delegated to the manager he would choose the precision of the signal to maximize his total wealth. His total wealth increases with the noise he introduces in the earnings announcement despite of the fact that there

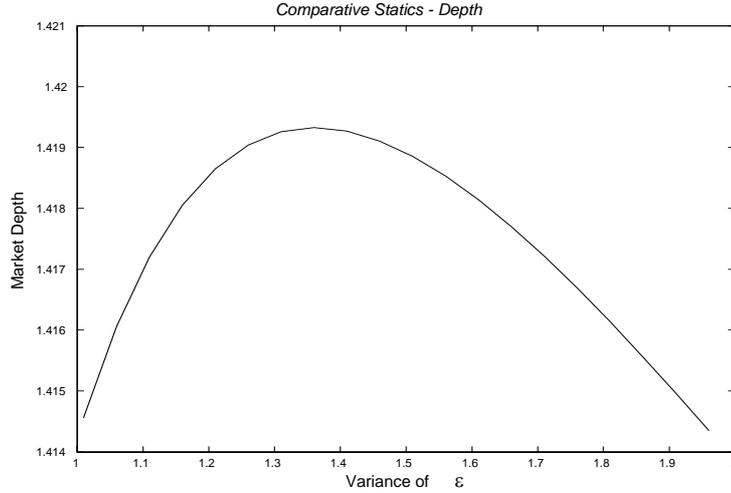


Figure 8: Expected Market Depth. Comparative statics with respect to the manager's ability to manage earnings, V_ε . Parameters Values: $V_y = 1$, $V_\omega = 1$, $\phi = 0.5$, $\xi = 1.5$, $a = 0.35$, $b = 1$, $\bar{y} = 4$, $W = 0$.

are cases when the profit from trading does not necessarily increase with the noise in the earnings. Notice also that due to the shareholders' monitoring, the manager can increase the noise only till a certain level. This level is determined by the corporate governance characteristics of the firm. So even in the case when there is no direct cost associated with disclosure, the manager has an indirect cost of being fired and therefore he does not increase the noise above a certain level.

B Corporate Governance Firm's Characteristics and Market Performance

Since the manager and shareholders interact in the first stage, the liquidation value of the firm is endogenous and therefore the expected market depth and the other measures of market performance depend also on the corporate governance characteristics of the firm.

I study first the effect of quality of investor protection laws on market performance. In the case of firms fully financed by equity, the investor protection reflects company law and other legislation governing minority-shareholder protection. The relevant investor protection here consists of the legislation allowing shareholders to

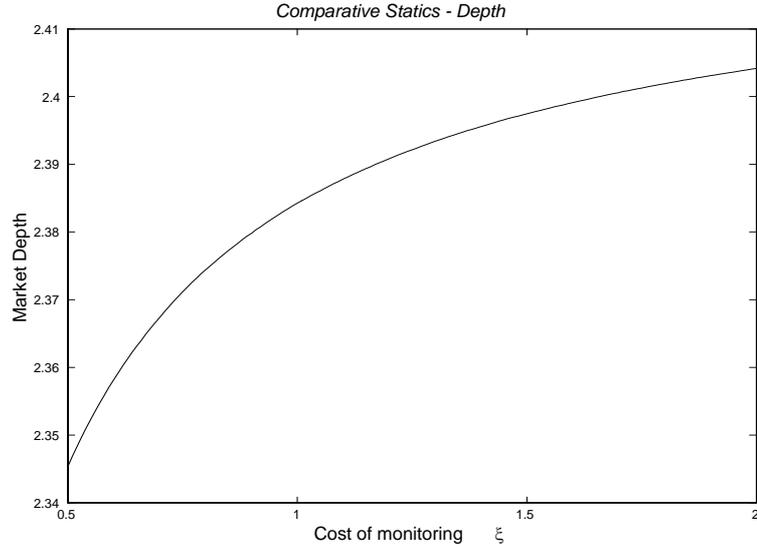


Figure 9: Expected Market Depth. Comparative statics with respect to the monitoring cost, ξ . Parameter Values: $V_y = 1$, $V_\varepsilon = 2$, $V_\omega = 1$, $\phi = 0.5$, $a = 0.5$, $b = 1$, $\bar{y} = 2$, $W = 0$.

bind the hands of managers or to monitor the project returns. As a result, investor protection can be quantified through monitoring costs because enhancing investor protection lowers both the manager's private benefits and the monitoring costs. I obtain that the higher the monitoring cost, the higher the market depth (see Figure 9). As we have seen above, higher control costs lead to lower expected report and lower expected intervention probability. The high control costs reduce both the liquidation value of the firm and the variance of the liquidation value of the asset. Thus the higher the monitoring costs, the lower is the variance of the liquidation value of the asset and therefore the lower the information asymmetry in the financial market. Consequently, when the monitoring costs are high, the manager has low informational advantage when trading in the financial market and therefore his trading has a low price impact. Similarly, the volatility and informativeness of price decrease with the monitoring costs since the asymmetry about the liquidation value of the firm decreases when the monitoring costs increase.

Second, I study the impact of the ownership concentration on market perfor-

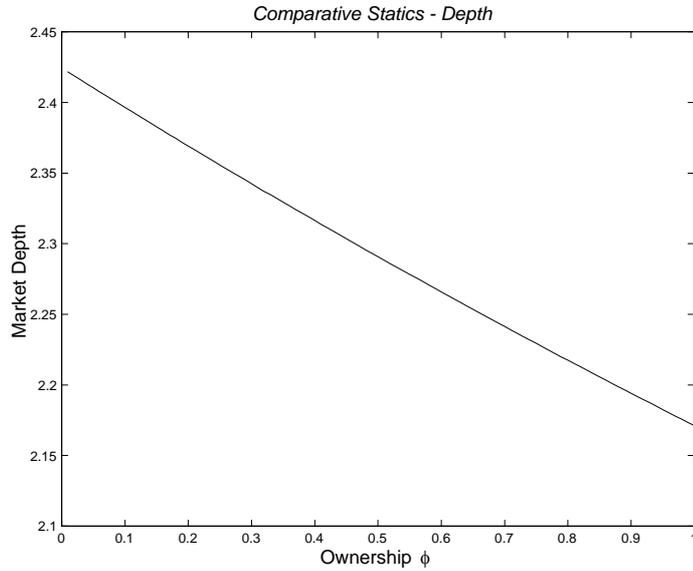


Figure 10:

mance. The adverse selection problem between the manager and market maker becomes more severe when ownership is more concentrated. This is due to the fact that in the first stage the shareholders are able to induce the manager to increase the report since he fears to be fired. However, since the monitoring costs per share decrease with the shareholdings, the shareholders increase their monitoring probability despite of the fact that they receive a high report. Their action increases the value of the firm but also increases the variance of the liquidation value of the firm, creating therefore, more asymmetry of information in the financial market. Consequently, I find a negative relationship between market liquidity and ownership (see Figure 10) despite of the fact that shareholders do not trade on private information. Thus, the concentration of ownership reduces the agency problem between manager and shareholders, increases the firm value, but reduces the market liquidity because increases the agency problem between manager and market maker. Chiang and Venkatesh (1998), Heflin and Shaw (2000) and Rubin (2007) empirically find that firms with higher concentration of ownership have lower market liquidity and they suggest that this effect is due to the fact that the blockholders can acquire

private information and use it when trading (the adverse selection hypothesis). In the present model this does not happen. The dividend payment is private information for the shareholders but becomes public before the trading takes place and therefore, they cannot use it for trading. However, the negative relationship between ownership concentration and liquidity is still due to the fact that ownership concentration increases the information asymmetry.⁸ Holmstrom and Tirole (1993) obtain also this negative relationship between liquidity and ownership concentration by assuming that by decreasing the insider's ownership more shares are available for trading. Therefore, the liquidity trading increases and consequently market liquidity also increases. Notice that in this model, the effect the ownership has on liquidity is not due to the trading of the main shareholder, but due to his intervention. By monitoring the manager he increases the asymmetry of information and therefore reduces liquidity.

Similarly, since the ownership concentration increases the asymmetry of information about the liquidation value of the firm, both price informativeness and price volatility increase with ownership concentration. In this sense, Boehmer and Kelley (2009) obtain empirical evidence that institutional investors improve the informational efficiency of prices.

Finally, I study how the fraction bonus to net value after dividends and wages, a , affects the expected market performance. On the one hand, the higher the bonus fraction a , the higher the expected intervention probability. On the other hand, the higher the bonus fraction, a , the higher the report and the lower the liquidation of the firm in case the shareholders do not intervene. Consequently, there is a trade-off between higher intervention probability and lower firm value in case of no intervention that determines this inverted U-shape for market depth (Figure 11). If the manager is supposed to receive a high compensation in the first period, then the shareholders monitor him more, to reduce as much as they can his expected compensation and increase the liquidation value of the firm. However, the manager

⁸Bhide (1993) describes the U.S. policies aimed to protect shareholders and show that shareholders who reduce agency costs through monitoring also reduce stock liquidity by creating information asymmetry problems.

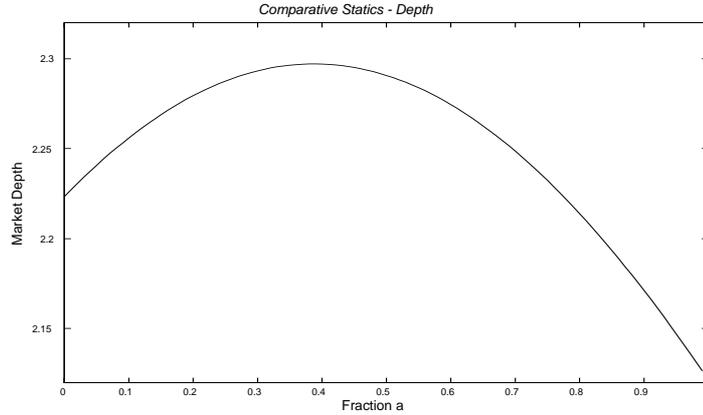


Figure 11: Expected Market Depth. Comparative statics with respect to the fraction a . Parameter Values: $V_y = 1$, $V_\varepsilon = 2$, $V_\omega = 1$, $\phi = 0.5$, $\xi = 0.5$, $b = 1$, $\bar{y} = 2$, $W = 0$.

anticipates it and increases his report and consequently decreases the liquidation value of the firm. These actions, have an effect also on the risk of the firm and this effect depends critically on the other corporate governance mechanisms in place. Note that due to the possibility of insider trading, the manager incentives are to increase the risk of the firm.⁹ However, the riskiness of the firm and therefore, his trading profit, is non-monothonical in a . However, since there are two ways the compensation scheme affects the total profit of the manager- through the first period compensation and through the profit from trading - and since the first one always dominates, even when the riskiness of the firm is reduced, he still obtains higher profits. Due to the same trade-off we obtain that the price volatility and price informativeness are U-shaped with respect to the bonus fraction, a . The consequences of these results are that the effectiveness of the compensation scheme depends on other characteristics of the firm since the ability of the insider trading, the shareholders' power, the managerial incentives shape the risk profile of the firm to be traded in the financial market.

The implications of these results are that by adopting investor protection laws that facilitate the monitoring role of the investors has a positive effect on the value

⁹Prendergast (2002) obtains also that in the case of risk neutrality, there is positive relationship between risk and incentives and points out that most of the empirical studies support this view.

of the firm but a negative effect on its market performance. It is clear that the ownership concentration is endogenously determined, but as La Porta et al. (1997) point out, the concentration of ownership is the response of investors to inadequate regulation since they seek to protect their investments with the direct exercise of control through large share blocks. Consequently, better investor protection laws can also discourage concentration of active stockholding and improve thus market liquidity.

V Conclusions

In this paper I present an insider trading model where I study the effect of corporate governance on market liquidity. I study how the choice of dividend report - result of interaction between manager and shareholders - affects trading in the financial market and show that uncertainty regarding a firm's payoff together with the bias introduced during the reporting stage, have a significant effect on the reporting strategy of the firm and the intervention strategy of the large shareholder. Allowing for this interaction between the firm and shareholders permits me to endogenize the value of the firm. As a result, the uncertainty and the agents' decisions made at the initial stage affect the value of the firm and therefore, trading in the financial market. I find that corporate governance brings about substantial changes in the behavior of market depth, volatility of prices, informativeness of prices and profits of market participants.

Thus, the model explains how differences in liquidity can be explained by differences in internal corporate governance characteristics: monitoring cost of shareholders; ownership concentration; manager's bonus pay for performance scheme or external corporate governance as shareholder's protection laws and disclosure regulation. This has important implications since firms characterized by high liquidity have higher value (high liquidity implies lower cost of capital). The model shows that higher liquidity can be obtained by firms with low shareholder power (high monitoring costs) and low concentration of ownership. The firm can also enhance its liquidity by adopting a manager's pay-for-performance scheme that ensures max-

imum liquidity. Since the market liquidity has an inverted U-shape with respect to the bonus ratio, this means that the firm should offer an intermediate bonus ratio. Finally, firms in countries with better protection shareholders laws and more effective disclosure regulation have higher market liquidity and therefore, lower cost of capital. However, the disclosure regulation interacts with the other corporate governance mechanisms in place and better disclosure leads to higher market liquidity only in the presence of other effective corporate governance mechanisms.

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VI Appendix

Proof of Proposition 1. I solve the problem backwardly. At this stage z is known and the manager observes y and ε . As a result, at this stage $V(y, z) \equiv (\tilde{y} - W - z)$ is normally distributed conditional on z .

The manager chooses his demand when trading in the financial markets such that to maximize his profits from trading in the second stage

$$d^* = \arg \max E(\Pi_T | y, \varepsilon, z) = \arg \max E_z((V(y, z) - p)d | y, \varepsilon).$$

Market maker sets the price

$$p(u, z) = E(V(y, z) | u, z).$$

Since $V(y, z)$ does not depend on ε , the manager ignores this signal. The conjecture of the market maker is that the demand of the manager is

$$d(y) = \theta(z) + \rho(z)y,$$

and the conjecture of the manager about the price schedule set by the market maker is

$$p(u, z) = \mu(z) + \lambda(z)u.$$

The first order condition for the manager in the second stage is

$$\frac{\partial}{\partial d} E_z((y - w - z - p)d | y) = 0,$$

or equivalently,

$$\begin{aligned} \frac{\partial}{\partial d} E_z((y - w - z - (\mu(z) + \lambda(z)(d + \omega)))d | y) &= 0 \\ E_z(y - w - z - \mu(z) - 2\lambda(z)d + \lambda(z)\omega | y) &= 0, \end{aligned}$$

and from here I get that

$$d^*(y) = \frac{E_z(y - w - z|y) - \mu(z)}{2\lambda(z)} = \frac{y - w - z - \mu(z)}{2\lambda(z)}.$$

The second order condition for the manager's problem in the second stage is $\lambda(z) > 0$. I identify the coefficients and obtain that

$$\begin{aligned}\theta(z) &= -\frac{w + z + \mu(z)}{2\lambda(z)} \\ \rho(z) &= \frac{1}{2\lambda(z)}.\end{aligned}$$

On the other hand, the market maker sets the price

$$p(u, z) = E(y - w - z|u, z) = E_z(y) - w - z + \frac{\text{Cov}(y, u|z)}{\text{Var}(u|z)}(u - E(u|z)).$$

Since

$$\begin{aligned}\text{Cov}(y, u|z) &= \text{Cov}(y, d + \omega|z) = \text{Cov}(y, \theta(z) + \rho(z)y + \omega|z) \\ &= \rho(z)\text{Var}(y|z),\end{aligned}$$

the price equals to

$$\begin{aligned}p(u, z) &= E_z(y) - w - z + \frac{\rho(z)\text{Var}(y|z)}{\rho^2(z)\text{Var}(y|z) + V_\omega}(u - E(u|z)). \\ &= E_z(y) - w - z + \frac{\rho(z)\text{Var}(y|z)}{\rho^2(z)\text{Var}(y|z) + V_\omega}(u - (\theta(z) + \rho(z)E_z(y))).\end{aligned}$$

Consequently,

$$\begin{aligned}\mu(z) &= E_z(y) - w - z - \frac{\rho(z)\text{Var}(y|z)}{\rho^2(z)\text{Var}(y|z) + V_\omega}(\theta(z) + \rho(z)E_z(y)) \\ \lambda(z) &= \frac{\rho(z)\text{Var}(y|z)}{\rho^2(z)\text{Var}(y|z) + V_\omega}.\end{aligned}$$

Solving the following system

$$\begin{aligned}\mu(z) &= E_z(y) - w - z - \frac{\rho(z) \text{Var}(y|z)}{\rho^2(z) \text{Var}(y|z) + V_\omega} (\theta(z) + \rho(z) E_z(y)) \\ \lambda(z) &= \frac{\rho(z) \text{Var}(y|z)}{\rho^2(z) \text{Var}(y|z) + V_\omega} \\ \theta(z) &= -\frac{w + z + \mu(z)}{2\lambda(z)} \\ \rho(z) &= \frac{1}{2\lambda(z)}\end{aligned}$$

implies

$$\begin{aligned}\mu(z) &= E_z(y) \\ \lambda &= \frac{1}{2} \sqrt{\frac{\text{Var}(y|z)}{V_\omega}} \\ \theta &= -\sqrt{\frac{V_\omega}{\text{Var}(y|z)}} \bar{y} \\ \rho &= \sqrt{\frac{V_\omega}{\text{Var}(y|z)}},\end{aligned}$$

where

$$\text{Var}(y|z) = V_y - \frac{\text{Cov}^2(y, z)}{\text{Var}(z)} = V_y - \frac{\beta^2 V_y^2}{\beta^2 V_y + \eta^2 V_\varepsilon} = \frac{\eta^2 V_y V_\varepsilon}{\beta^2 V_y + \eta^2 V_\varepsilon}.$$

In order to satisfy the second order condition for the manager's problem in the second stage I need to have $\lambda(z) > 0$, which is always satisfied.

Next, I write further, $\mu(z) = \bar{y} + A(z - \bar{z})$, where $A = \frac{\beta V_y}{\beta^2 V_y + \eta^2 V_\varepsilon}$, the demand as

$$d(y) = \theta + \rho y = \rho(z)(y - \bar{y}) = \sqrt{\frac{V_\omega}{\text{Var}(y|z)}} (y - \bar{y})$$

and the price as

$$p(u, z) = E_z(y) + \frac{1}{2} \sqrt{\frac{\text{Var}(y|z)}{V_\omega}} (u - \bar{u}) = E_z(y) + \frac{1}{2} \sqrt{\frac{\text{Var}(y|z)}{V_\omega}} u.$$

Once I have determined the profit I go to the first stage. The manager takes into account that his choice of dividends z affects the intervention probability, π , because the shareholders' strategy is $\pi(z) = \delta + \gamma z$. The manager's problem in the first stage is

$$\begin{aligned} \max_z E(U|y, \varepsilon) &= E(W + a(1 - \pi(z))(v - W - z) + (y - p)d|y, \varepsilon) \\ &= E\left(W + a(1 - \pi(z))(v - W - z) + \frac{1}{4\lambda}(y - \mu(z))^2 \middle| y, \varepsilon\right) = \\ &= E\left(W + a(1 - \pi(z))(v - W - z) + \frac{\rho}{2}(y - \bar{y} - A(z - \bar{z}))^2 \middle| y, \varepsilon\right). \end{aligned}$$

The first order condition for manager's problem when choosing the dividends is

$$\begin{aligned} \frac{\partial}{\partial z} E(U|y, \varepsilon) &= 0 \Leftrightarrow \\ a(-(1 - \delta - \gamma z) + (-\gamma)(y + \varepsilon - W - z)) - A\rho(y - \bar{y} - A(z - \bar{z})) &= 0 \\ z &= \frac{1}{2a\gamma + A^2\rho} (a(1 - \delta) + \gamma a(y + \varepsilon - W) + A\rho(y - \bar{y}) + A\bar{z}) \\ z &= \frac{a(1 - \delta)}{2a\gamma + A^2\rho} - \frac{\gamma a}{2a\gamma + A^2\rho} W - \frac{A\rho\bar{y} - A^2\rho\bar{z}}{2a\gamma + A^2\rho} + \frac{\gamma a + A\rho}{2a\gamma + A^2\rho} y + \frac{\gamma a}{2a\gamma + A^2\rho} \varepsilon. \end{aligned}$$

Second order condition for this problem is $2a\gamma + A^2\rho < 0$.

Let us solve next the problem of shareholders

$$\pi^*(z) = \arg \max_{\pi} E(S|z) = E\left(\phi(z + ((1 - a) + a\pi(z))(v - W - z)) - \varepsilon - \frac{\xi\pi^2}{2} \middle| z\right).$$

First order condition for the shareholders' problem is

$$E(\phi(a(y - W - z)) - \xi\pi|z) = 0$$

and therefore, the probability to intervene is

$$\pi(z) = \frac{\phi a}{\xi} (E(y - W - z|z)).$$

The second order condition for this problem is $\xi > 0$ and is satisfied by assumption

(positive intervention costs). The shareholders' strategy is $\pi(z) = \delta + \gamma z$ and they conjecture that the manager's strategy is $z(y, \varepsilon) = \alpha + \beta y + \eta \varepsilon$. As a result,

$$\begin{aligned}
\pi(z) &= \frac{\phi a}{\xi} (E(y - W - z | z)) \\
&= \frac{\phi a}{\xi} \left(\left(\bar{y} + \frac{Cov(y, z)}{Var(z)} (z - E(z)) \right) - W - z \right) \\
&= \frac{\phi a}{\xi} ((\bar{y} + A(z - \alpha - \beta \bar{y})) - W - z) \\
&= \frac{\phi a}{\xi} ((\bar{y} - \alpha A - A\beta \bar{y} - W) + z(A - 1)).
\end{aligned}$$

I identify the coefficients and I find that $\alpha, \beta, \eta, \delta, \gamma$ are solution of the following system

$$\begin{aligned}
\alpha &= \frac{a(1 - \delta)}{2a\gamma + A^2\rho} - \frac{\gamma a}{2a\gamma + A^2\rho} W - \frac{A\rho\bar{y} - A^2\rho\bar{z}}{2a\gamma + A^2\rho} \\
\beta &= \frac{a\gamma + A\rho}{2a\gamma + A^2\rho} \\
\eta &= \frac{a\gamma}{2a\gamma + A^2\rho} \\
\delta &= \frac{\phi a}{\xi} (\bar{y} - \alpha A - A\beta \bar{y} - W) \\
\gamma &= \frac{\phi a}{\xi} (A - 1),
\end{aligned}$$

and therefore,

$$\alpha = (1 - \beta)\bar{y} - W - \frac{1}{C(2 - A)} \quad (2)$$

$$\beta = \frac{AV_\varepsilon}{V_y(A - 2)^2 + V_\varepsilon A^2}$$

$$\eta = \frac{V_y(2 - A)}{V_y(A - 2)^2 + V_\varepsilon A^2}$$

$$\begin{aligned} \delta &= - \left(\frac{A}{A - 2} - \gamma W + \frac{(2a\gamma + A^2\rho)(A\beta - 1)}{a(A - 2)} \bar{y} \right) \\ &= \frac{1}{(2 - A)} - C(A - 1) \left(\bar{y} - W - \frac{1}{C(2 - A)} \right) \end{aligned} \quad (3)$$

$$\gamma = C(A - 1),$$

where $C = \frac{\phi a}{\xi}$, and A is a solution of

$$f(A) = 0, \quad (4)$$

where

$$\begin{aligned} f(A) &= (-V_\omega V_y - V_\omega V_\varepsilon + V_y^2 a^2 C^2 + 2V_\varepsilon V_y a^2 C^2 + V_\varepsilon^2 a^2 C^2) A^4 \\ &\quad + (4V_\omega V_y - 2V_\varepsilon^2 a^2 C^2 - 6V_y^2 a^2 C^2 - 8V_\varepsilon V_y a^2 C^2) A^3 \\ &\quad + (13V_y^2 a^2 C^2 + V_\varepsilon^2 a^2 C^2 - 4V_\omega V_y + 10V_\varepsilon V_y a^2 C^2) A^2 \\ &\quad + (-4V_\varepsilon V_y a^2 C^2 - 12V_y^2 a^2 C^2) A + 4V_y^2 a^2 C^2 \\ &= (V_y + V_\varepsilon) (C^2 a^2 (V_y + V_\varepsilon) - V_\omega) A^4 + (4V_\omega V_y - 2C^2 a^2 (3V_y + V_\varepsilon) (V_y + V_\varepsilon)) A^3 \\ &\quad + (C^2 a^2 (13V_y^2 + V_\varepsilon^2 + 10V_y V_\varepsilon) - 4V_\omega V_y) A^2 - 4C^2 a^2 V_y (3V_y + V_\varepsilon) A + 4V_y^2 a^2 C^2. \end{aligned}$$

Notice that since $f(0) = 4V_y^2 a^2 C^2 > 0$ and $f(1) = -V_\omega (V_y + V_\varepsilon) < 0$, it implies that there exists at least one solution in the interval $(0, 1)$.

The second order condition for manager's problem is $2a\gamma + A^2\rho < 0$. If this is not the case, all the manager's private information is disclosed through reporting and trading and therefore, no equilibrium exists. ■

Proof of Corollary 2. I calculate first the expected dividend payment $E(z)$

$$\begin{aligned}
E(z) &= \alpha + \beta \bar{y} = \\
&= -\frac{1}{aC(A-2)} (a + (A\rho + Ca)(A\beta - 1)\bar{y}) + W + \beta \bar{y} = \\
&= \bar{y} - W - \frac{1}{C(2-A)}.
\end{aligned}$$

Then the expected probability equals to

$$\begin{aligned}
E(\pi(z)) &= \delta + \gamma E(z) = \\
&= -\left(\frac{A}{A-2} - \gamma W + \frac{(2a\gamma + A^2\rho)(A\beta - 1)\bar{y}}{a(A-2)}\right) \frac{1}{(2-A)} + \gamma \left(\bar{y} - W - \frac{1}{C(2-A)}\right) \\
&= \frac{1}{(2-A)}.
\end{aligned}$$

■

Proof of Corollary 3. I define the volatility of prices as the variance of the price

$$\begin{aligned}
Var(p|z) &= Var(\mu(z) + \lambda(z)u|z) = \\
&= Var(\mu(z) + \lambda(z)(\rho(z)(y - \bar{y}) + \omega)|z) \\
&= \lambda^2(z)(\rho^2(z)Var(y|z) + Var(\omega|z)) \\
&= \lambda^2(z)\rho^2(z)Var(y|z) = \frac{1}{4}Var(y|z) \\
&= \frac{1}{4} \frac{(A-2)^2 V_y^2}{4V_y(1-A) + A^2(V_y + V_\varepsilon)}.
\end{aligned}$$

■

Proof of Corollary 4. I compute now the informativeness of prices defined as the reduction in the variance of the liquidation value conditional on observing the price

$$Var(y|z) - Var(y|p, z) = (Var_z(p))^{-1} (Cov_z(y, p))^2.$$

First, I compute the covariance of the firm's liquidation value with the price

$$\begin{aligned}
Cov_z(y, p) &= Cov_z(y, \mu(z) + \lambda(z)(\rho(z)(y - \bar{y}) + \omega)) \\
&= Cov_z(y, \lambda(z)(\rho(z)(y - \bar{y}))) \\
&= \lambda(z)\rho(z)Var_z(y) = \frac{1}{2}Var(y|z).
\end{aligned}$$

Therefore,

$$Var(V(\tilde{y}, z)) - Var(V(\tilde{y}, z)|\tilde{p}) = \frac{\frac{1}{4}(Var(y|z))^2}{\frac{1}{4}Var(y|z)} = Var(y|z).$$

■

Proof of Corollary 5 . Since the demand of the manager is linear in y it results that also $d(y)$ is a normal variable with mean $\mu_d = 0$ and $Var(d)$

$$\begin{aligned}
V_d &= Var(d) = Var(\rho(z)((y - \bar{y}))) = \rho^2(z)Var(y) \\
&= \frac{V_\omega V_y}{Var(y|z)}.
\end{aligned}$$

Then since d is $\mathcal{N}(\mu_d, V_d)$ it results that the expected volume of trade by the manager is

$$E(|d|) = \int_{-\infty}^{+\infty} |d| \frac{1}{V_d \sqrt{2\pi}} \exp\left(-\frac{d^2}{2V_d}\right) = \mu_d + \sqrt{\frac{2}{\pi}} Var(d) = \frac{V_\omega V_y}{Var(y|z)}.$$

Let us compute now the unconditional expected profit of the manager from insider trading,

$$\Pi_T = E\left((y - W - z - \tilde{p})\tilde{d}\right).$$

Since I have a zero-sum game, the profit of the insider is equal to the loss made by

the noise traders

$$\begin{aligned} E\left((y - W - z - \tilde{p}) \tilde{d}\right) &= -E\left((y - W - z - \tilde{p}) \tilde{\omega}\right) \\ &= -E\left(y - W - z - \mu(z) - \lambda(z) (\rho(z) (y - \bar{y}) + \omega) \omega\right) \\ &= \lambda(z) V_{\omega} = \frac{1}{2} \sqrt{\text{Var}(y|z) V_{\omega}}. \end{aligned}$$

■