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Hidden Ownership, Monitoring, and the Value of the Firm

Roy Shashua

University of Pennsylvania, dinovo@gmail.com

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Hidden Ownership, Monitoring, and the Value of the Firm

Abstract
This paper analyzes the effect of market transparency on firm value and social surplus.

I investigate the incentives of large investors to publicly disclose their economic interests, as well as to monitor management. I find that when markets are sufficiently liquid, large investors will tend to forgo share ownership in favor of "hidden ownership" - alternative forms of economic exposure not subject to disclosure regulations. The resulting uncertainty regarding the extent of investor exposure to firm performance can better align management’s incentives with shareholder interests, thereby increasing firm value and social surplus, even when management displays risk neutral preferences. A transparent market may therefore become a liability from both the shareholder and social planner perspectives.

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HIDDEN OWNERSHIP, MONITORING,
AND THE VALUE OF THE FIRM

Roy Shashua

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in

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Supervisor of Dissertation

Co-Supervisor of Dissertation

Itay Goldstein, Professor of Finance

Bilge Yilmaz, Associate Professor of Finance

Graduate Group Chairperson

Eric T. Bradlow, Professor of Marketing, Statistics, and Education

Dissertation Committee

Itay Goldstein, Professor of Finance

Bilge Yilmaz, Associate Professor of Finance

Alex Edmans, Assistant Professor of Finance
To my parents and loving family,
whose support made this work possible.
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This paper analyzes the effect of market transparency on firm value and social surplus. I investigate the incentives of large investors to publicly disclose their economic interests, as well as to monitor management. I find that when markets are sufficiently liquid, large investors will tend to forgo share ownership in favor of “hidden ownership” - alternative forms of economic exposure not subject to disclosure regulations. The resulting uncertainty regarding the extent of investor exposure to firm performance can better align management’s incentives with shareholder interests, thereby increasing firm value and social surplus, even when management displays risk neutral preferences. A transparent market may therefore become a liability from both the shareholder and social planner perspectives.
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CHAPTER 1: Introduction

Is transparency a desirable quality of the market for corporate control? The prevailing doctrine asserts that a transparent market protects investors by providing them the relevant information required to accurately assess the effect of a firm’s ownership structure on its share price.\(^1\) This rationale has prompted regulators in the U.S. and abroad to enact rules requiring investors holding a significant stake in a firm to disclose their ownership.\(^2\) Similarly, on a theoretical level, Fama’s (1970) taxonomy of financial markets based on their level of transparency has in effect made transparency synonymous with efficiency. In recent years, however, mounting evidence suggests that investors are increasingly employing novel strategies in an effort to sidestep disclosure regulations.\(^3\) Non-disclosure provides an informational advantage to its practitioners, and the recent trend alludes to the profit potential this advantage confers. As regulators are scrambling to plug what they consider to be loopholes by extending the scope of existing disclosure regulations, it may be worthwhile to pause and ask whether the enduring pursuit of absolute transparency is in fact improving shareholder and total welfare, or are astute investors on to a tactic that can benefit more than just their personal worth.

This paper provides an analytical framework in which to evaluate the claim that transparency promotes the efficiency of corporate governance and argues that it may in fact become a liability from both the shareholder and social planner perspectives. The model presented analyzes the decision making process of an activist investor (with regard to ownership disclosure and monitoring) as well as that of the firm’s management (concerning expropriation of funds for private benefit) and compares firm value and social surplus under two scenarios: one in which the ownership structure is fully transparent and the other

---

\(^1\)“In general terms, the ideal is a market...in which...investors can choose among the securities that represent ownership of firms’ activities under the assumption that security prices at any time fully reflect all available information”. Fama (1970)


\(^3\)See Hu and Black (2007) and Brav and Mathews (2011)
in which investors can choose to disguise their interest in the firm (henceforth referred to as the “hidden ownership” regime). The analysis shows that the information asymmetry introduced by hidden ownership can act in two distinct dimensions to alleviate frictions inherent to the corporate governance mechanism, thereby improving firm value and even social surplus. The first dimension concerns the dynamic between the activist investor and other shareholders: Grossman and Hart (1980) have shown that in a fully transparent market, value-enhancing initiatives will be hampered due to the free-rider problem. Hidden ownership can provide the required incentive that will make such an undertaking worthwhile: it allows activist investors to trade and augment their interest in the firm without conceding the rewards for their actions to other shareholders. The second dimension revolves around the ever present agency problem at the heart of the investor - management dynamic: One of the main results of the paper is that in the face of uncertainty regarding the scale of investor activism it faces, even a risk-neutral management will tend to better-align its actions with the interests of its shareholders.

The paper also examines the role and effect of liquidity in this setting. The analysis shows that liquidity and hidden ownership create a complementarity in which each enables the other to contribute to firm value and social surplus. Liquidity combines with hidden ownership to facilitate gains from informed trading, mitigating the free-rider problem. In this role, it acts to make the hidden ownership regime a more likely equilibrium outcome. Under this regime, the informed trading that liquidity enables increases the uncertainty management faces regarding activism even further, making its effect even more dominant. Thus, the hidden regime provides liquidity an additional channel through which it can have a positive impact on firm value and social surplus.

One of the primary channels by which shareholders can mitigate the agency problems and

---

4 Following Hu and Black (2005) I employ the term "hidden ownership" to refer to the array of investor strategies involving non-disclosure.

5 Maug (1998) Presents a somewhat similar result in which liquidity mitigates the free-rider problem. This model adds a new source of information asymmetry that works together with liquidity towards the same end.
conflicts of interest inherent to public companies is often termed in the literature as “monitoring”.6 This term is generally used to describe a combination of costly efforts exerted by shareholders, directed at some form of information acquisition, and the exercise of their mandate - in light of this information - to affect the course charted by management and hold it accountable for its actions. Monitoring is perhaps the principal mechanism with which management is kept in check, and can be extremely efficient if its application is credible, since the implications of its use are taken into account by management before any decisions concerning the firm are made. Recognized for its importance, it has been a prominent feature in much of the literature, and as such has been modeled in many different variations. In virtually all those variations one implicit assumption is always present: monitoring is performed solely by shareholders, as they alone have the incentive to exert effort in order to exercise their voting power well. While Stock ownership is composed of both economic exposure and voting power, only the former ingredient is necessary in order to induce its bearer to exert an effort directed at improving firm value. The obvious example for such a setup is the derivatives market: an investor holding a significant 'long' position in derivative instruments has an incentive to exert an effort (such as monitoring) if that effort is likely to increase the value of the underlying asset.

One might argue that an investor holding only derivatives of public company shares lacks the authority to affect change. However, in many cases, it may be enough to share information with legitimate shareholders in order to motivate them to take action. In other cases, a position comprised of derivatives can be quickly and discretely morphed into an equivalent position in actual shares, conferring the required authority to the investor.7 This 'de-facto' ownership is typically not disclosed under large shareholder disclosure rules. These rules focus on voting power rather than economic interest, and so allow investors to plausibly deny

---

7A common practice for the the broker taking the short side of the derivatives contract (vis-à-vis the investor) is to hedge its exposure using the underlying asset. It is often willing to accommodate its client by voting the shares used as a hedge according to the client’s wish. The investor can also gain access to voting rights by ending its derivatives contract at any time and buying these shares from the broker, as the latter no longer needs them. This transaction can be done off the market, without affecting the market price and without revealing any information.
the voting power that would trigger disclosure. The derivative markets supply investors, therefore, with an opportunity to disguise their specific interests while conveying virtually all of the advantages of share ownership. Investors are now coming to realize this, making this form of 'hidden ownership' increasingly popular.

Since this practice is covert by nature, gauging its prevalence is a challenging task. Hu and Black (2006a) compiled a list containing dozens of recent examples, but perhaps the most compelling evidence regarding the expanding scale of this phenomena can be found in the response of regulators around the world: In 2011, the Financial Times reported that the SEC began to take a stricter stance on derivatives disclosure. Also, in 2012, the French Parliament voted to extend the scope of existing shareholding disclosure rules to include positions held through derivative instruments which give rise to a long position on the economic performance of underlying shares.

While the practice of hidden ownership has been documented before, this is the first paper employing a well defined theoretical framework to examine its effects. At a period when increased regulation is frequently mentioned as a cure to many of the financial system’s shortcomings, I offer a somewhat contrasting view, bringing to light a practice novel to the corporate governance financial literature. The literature closest in nature to my own includes Kalm and Winton (1998) and Maug (1998). I follow the methodology presented in the latter, with obvious departures in order to accommodate the introduction of the emerging hidden ownership phenomena.

---

8SEC takes stricter line on derivatives disclosure, Financial Times, November 6, 2011.

9My contribution also includes an arguably more realistic representation of firm value as a continuous function of monitoring intensity, whereas related papers have employed a binary variable. This adds a dynamic dimension to the analysis.
Consider a single firm, with one share outstanding. The firm has no assets in place but the projects it is currently undertaking are expected to produce a net positive cash flow normalized to one. Atomistic shareholders collectively own all of the firm. The firm’s manager (\(M\)) can choose to divert a fraction \(0 \leq b \leq 1\) of this cash flow for private benefit, at the expense of all shareholders. An Investor (\(D\)) initially holds a position (determined exogenously) in derivatives that gives her an economic exposure equivalent to the ownership of a fraction \(0 \leq \alpha \leq 1\) of the firm’s outstanding shares. \(D\)’s exposure to the firm’s value motivates her to exert a monitoring effort \(0 \leq e \leq 1\), at a cost of \(\frac{1}{2}ce^2\).

Because the disclosure of hidden ownership is voluntary, public filings regarding the firm’s ownership structure no longer provide an accurate reflection of its potential monitors. In order to capture the uncertainty management faces regarding monitoring intensity, I assume \(M\) believes that \(D\) is of one of two possible, equally likely investor types \(i \in \{1, 2\}\), differing only with respect to their (publicly known) monitoring cost parameter \(c_i\). W.l.o.g., assume \(c_1 < c_2\). Also assume that \(D_1\), facing a lower cost of monitoring, has an initial hidden ownership at least as large as that of \(D_2\) (generally, \(\alpha_1 \geq \alpha_2\)). The mechanism enabling hidden ownership is discussed in the introduction - here I simply assume \(D\) has the privilege of choosing whether to disclose her position or not. Disclosure of investor position is assumed to be verifiable, and reveals not only the investor’s position but also their identity and in effect their type. All agents are risk-neutral and the risk-free rate is normalized to zero.

There are four periods, summarized in Figure 1. At \(t = 1\), Nature randomly chooses \(D\)’s type \((i)\) to be 1 or 2 with equal probability. At this point, \(D_i\) has the option of voluntarily disclosing her position (and implicitly - her type). At \(t = 2\), \(M\) chooses the fraction \(b\) of the firm’s cash flow to divert for private benefit. \(M\)’s marginal utility from diverted funds is assumed to be decreasing in the magnitude of \(b\). When choosing \(b\), \(M\) takes into account the expected monitoring effort exerted by the investor he faces. At \(t = 3\) markets open,
t=1
Nature chooses investor type \( i \in \{1, 2\} \).
Investor chooses whether to hide/disclose her ownership.

\[ t=2 \]
Manager diverts fraction \( b \) of cash flow.

\[ t=3 \]
Market opens.
Liquidity shock hits.
Trading takes place.

\[ t=4 \]
Investor monitors with intensity \( e \).
Firm value is realized.

Figure 1. Timeline of the model.

and a liquidity shock that is correlated across households hits the atomistic shareholders.\(^1\) In particular, there is a probability of \( \frac{1}{2} \) that a fraction \( 0 < \eta < 1 \) of households will be subject to such a shock and sell their shares as a result. Therefore:

- with probability \( \frac{1}{2} \), no households will sell their shares.
- with probability \( \frac{1}{2} \), a fraction \( \eta \) of households will sell their shares.

Note that there is an ex-ante probability of \( \eta/2 \) for any household to be affected by the shock. At this time, \( D_i \) can also submit a long/short trade to try and capture some of the potential gains stemming from her private information regarding her type.\(^2\) All orders are submitted to a competitive market maker who then sets a price \( P \) at which to fulfill the orders. \( P \) reflects the market maker’s expectation of firm value conditional on the aggregate order flow he observes. At \( t = 4 \), \( D_i \) monitors at her chosen intensity \( e_i \), incurring a cost \( \frac{1}{2} c_i e_i^2 \).

Monitoring is defined as a directed effort to detect misappropriation of funds by \( M \), as well as the recovery of those funds when detection is successful. The choice of monitoring intensity \( e \) is directly affected by the magnitude of \( D_i \)'s position (measured by \( \alpha_i \)), as well

---

\(^1\)The structure of the market is similar to that in Kyle (1985). See Dow and Gorton (1994) and Bernhardt et al. (1995) for a discrete version of the model. Also see Krishnan (1992) regarding the equivalence of the Kyle and Glosten and Milgrom (1985) models.

\(^2\)The informational advantage gained from hidden ownership can encourage investors to trade and increase their economic exposure, providing an incentive for further information gathering and thus mitigating the free-rider problem to the benefit of all shareholders.
as by the monitoring cost $c_i$ she faces and her beliefs about the magnitude $b$ of misappropriation. Higher monitoring intensity implies a higher probability of detection, and $e$ is also interpreted to be the probability with which detection is successful (if in fact $M$ engaged in misappropriation of funds). If monitoring is successful, the diverted funds are recovered and $M$ faces a pecuniary penalty equal to $\frac{1}{2}b^2$. Finally, firm value is realized.
CHAPTER 3: Analysis

In order to assess the effects of hidden ownership on firm value and social welfare, consider two scenarios: one in which hidden ownership is not possible (“Transparent Regime”), and the other in which it is (“Hidden Regime”). With sub-game perfection as a solution concept, I use backward induction to first solve for the equilibrium levels of $e$ and $b$ under each regime, assuming an exogenously determined initial position (in derivatives) for the investor. To examine the effect liquidity has on firm value, the analysis includes a baseline scenario in which no trading takes place at time $t = 3$. Next, I analyze the investor’s initial decision regarding choice of regime. Finally, I compare the effects each regime has on aggregate welfare loss, and derive the optimal distribution of investor positions from a social planner’s perspective.\(^1\)

3.1. Transparent regime

The investor’s portfolio allocation at the initial stage is taken as given. When there is no possibility\(^2\) for $D_i$ to hide her position, or if she chooses to disclose it voluntarily, $M$ can correctly deduce her type, and therefore the level of monitoring effort $e_i$ he will face. As a result, $M$’s response to $e_i$ will be the optimal response $b_i$ where generally $b_1 \neq b_2$.

$M$’s utility specification involves only two straightforward assumptions: (i) The marginal utility derived from private benefits is decreasing in the size of the benefits. (ii) The penalty for misappropriation of company funds is commensurate with (squarely proportional to) the amount diverted. This specification results in an optimality condition for $b_i$ that is linear in $e_i$. A desirable characteristic of such a specification is that the results obtained throughout this analysis continue to hold for any specification resulting in an optimality condition for $b$ that is weakly concave in $e$ (a linear relation being the limiting case). $M$’s program is

\(^1\)Regime choice affects (and is affected by) the agency and free-rider related frictions that are inherent to corporate governance.

\(^2\)The transparent regime can be enforced by regulations requiring disclosure of derivative positions conferring significant economic exposure. Alternatively, limiting investors to holding only shares (which are already subject to ownership disclosure regulations) achieves the same effect.
given by:

\[ U_{trans}^M = \max_{b_i} (1 - e_i) \cdot (b_i - \frac{b_i^2}{2}) - e_i \cdot \frac{b_i^2}{2} \]  

(3.1)

where the monitoring intensity \( e_i \) can be interpreted as the probability of successful monitoring, \((b_i - \frac{b_i^2}{2})\) is \( M \)'s (marginally decreasing) utility from successfully diverting a fraction \( b \) of the firm’s cash flow, and \( \frac{b_i^2}{2} \) is the pecuniary equivalent of the penalty he faces in case monitoring is successful.

This specification yields the following optimality condition:

\[ b_i = 1 - e_i . \]  

(3.2)

As expected, higher monitoring intensity exerted by \( D_i \) will result in a smaller fraction of funds being diverted. Since the diversion of \( b_i \) will only go undetected a fraction \((1 - e_i)\) of the time, the expected firm value loss \((L_{trans})\) under each type is \((1 - e_i)^2\). Assuming both types are equally likely, expected firm value loss firm value under this regime is:

\[ E[L_{trans}] = \frac{(1 - e_1)^2 + (1 - e_2)^2}{2} . \]  

(3.3)

When deciding on the optimal monitoring intensity, \( D_i \) takes into account her exposure to the firm’s value, as well as the monitoring cost she faces:

\[ U_{trans}^{D_i} = \max_{e_i} \alpha_i ((1 - e_i)(1 - b_i) + e_i \cdot 1) - \frac{c_i e_i^2}{2} \]  

(3.4)

where \( \alpha_i \) denotes the measure of exposure (equivalent to ownership of a fraction \( \alpha_i \) of the
firm’s shares) \( D_i \) has to firm value.

Eq. 3.4 yields the following optimal monitoring intensity:

\[
e_i = \frac{\alpha_i b_i}{c_i}.
\]  

(3.5)

The intuition in eq. 3.5 is straightforward: \( D_i \) will monitor with a higher(lower) intensity as her economic exposure to firm value grows(shrinks). She will monitor with a higher(lower) intensity the larger(smaller) the attempted misappropriation is. Finally, \( D_i \) will monitor with a higher(lower) intensity as her cost of monitoring \( c_i \) decreases(increases). Combining eq. 3.2 and eq. 3.5 allows us to express the optimal monitoring intensity under the transparent regime in terms of the model’s parameters:

\[
e_i = \frac{\alpha_i}{\alpha_i + c_i}.
\]  

(3.6)

**Lemma 1.** Under the transparent regime, expected firm value under \( D_1 \) is always higher than under \( D_2 \).

**Proof of Lemma 1:** Expected firm value loss under type \( i \) is given by \((1 - e_i)b_i = (1 - e_i)^2\). Since \( c_1 < c_2 \) and \( \alpha_1 \geq \alpha_2 \), eq. 3.6 implies \( e_1 > e_2 \). Therefore, firm value loss under type 1 is lower, and firm value is higher.

Substituting eq. 3.6 into eq. 3.3, expected value loss under the transparent regime when both types are equally can be expressed as:

\[
E[L^\text{trans}] = \left( \frac{c_1}{\alpha_1 + c_1} \right)^2 + \left( \frac{c_2}{\alpha_2 + c_2} \right)^2
\]  

(3.7)
It is important to note that under the transparent regime, $D$ has no incentive to trade at time $t = 3$ and will therefore withdraw from the market. Since all information regarding her identity is public and therefore impounded into the share price, she can not derive any trading gains stemming from an informational advantage. This is a manifestation of the free-rider problem, where a potentially value increasing equilibrium cannot be achieved. As I will now show, the free rider problem along with other value reducing frictions are mitigated once hidden ownership is introduced.

3.2. Hidden regime

When both investor types choose to keep their position hidden, $M$ cannot deduce which type he is facing and therefore cannot adapt his choice of $b$ accordingly. $M$ will therefore choose a single value of $b$ regardless of $D_i$’s identity. This choice is bound to be sub-optimal when facing any one type: it will be too low when facing the (relatively) inattentive type 2, and too high when facing (a relatively more vigilant) type 1:

$$U_{hid}^M = \max_b \frac{1}{2} \left[ (1 - e_1) \cdot (b - \frac{b_2^2}{2}) - e_1 \cdot \frac{b_2^2}{2} \right] + \frac{1}{2} \left[ (1 - e_2) \cdot (b - \frac{b_2^2}{2}) - e_2 \cdot \frac{b_2^2}{2} \right]$$

(3.8)

giving the optimum:

$$b = 1 - \frac{e_1 + e_2}{2}.$$  

(3.9)

As is evident from eq. 3.9, since $M$ is risk-neutral, his optimal choice depends only on the average level of monitoring he faces. In other words, if monitoring intensities $e_1, e_2$ are constant, $M$’s average choice of $b$ will be identical across the different regimes. The expected firm value loss in this case is given by:

$$E[L_{hid}] = \frac{1}{2} \left[ (1 - e_1) b_{hid} \right] + \frac{1}{2} \left[ (1 - e_2) b_{hid} \right] = \left( 1 - \frac{e_1 + e_2}{2} \right)^2.$$  

(3.10)
As long as $e_i^{trans} = e_i^{hid}$, and $e_1 \neq e_2$, we have that $E[L^{hid}] < E[L^{trans}]$. The assumption that each type’s monitoring intensity is unchanged between the different regimes is unfounded, however: $M$’s choice of $b$ under the hidden regime is higher (lower) than it is when facing type 1(2) under the transparent regime. As a result, type 1 will monitor with greater intensity under the hidden regime than under the transparent regime, while type 2 will monitor with a lower intensity than under the transparent regime. This is because regardless of the regime, $D_i$’s monitoring intensity is determined by the same relation as in eq. 3.5.

An insight into to exact mechanism at work here can be obtained by combining eq. 3.5 and eq. 3.9 to arrive at the following condition:

$$e_i^{hid} = \frac{\alpha_i(2 - e_{-i})}{2c_i + \alpha_i}$$  \hspace{1cm} (3.11)

where the subscript $-i$ denotes the type other than $i$ (if $i = 1$ then $-i = 2$ and vice-versa). Eq. 3.11 highlights a distinctive feature stemming from the introduction of hidden ownership: When choosing her optimal monitoring effort under the hidden regime, the investor must now take into account $M$’s beliefs regarding other possible investor types. In other words, $D_i$’s monitoring decision depends on the beliefs $M$ holds regarding $D_{-i}$’s choice. Specifically, an increase (decrease) in monitoring effort by one type will induce a decrease (increase) in effort from the other. Substituting in $e_{-i}^{hid}$ into eq. 3.11 allows us to express $e_i^{hid}$ only in terms of the model’s parameters $\alpha_1, \alpha_2, c_1, c_2$:

$$e_i^{hid} = \frac{2\alpha_i c_{-i}}{\alpha_1 c_2 + \alpha_2 c_1 + 2c_1 c_2}.$$  \hspace{1cm} (3.12)

\(^3\)As far as the investor is concerned, there is no qualitative difference between the regimes. Since her utility function is the same, so is the relation defining her optimal choice of monitoring intensity.
Finally, plugging eq. 3.12 into eq. 3.10 yields the required expression for expected value loss under the hidden regime.

**Proposition 1.** When trading is prohibited, and as long as \( c < c_1 < c_2 \) and \( \alpha_1 > \alpha_2 \), the hidden ownership regime strictly dominates the transparent ownership regime, as it pertains to firm value.\(^4\) Formally, \( \forall \alpha_1, \alpha_2 \ s.t. \ \alpha_2 < \alpha_1 \) and \( \forall c_1, c_2 \ s.t. \ c < c_1 < c_2 \):

\[
E[L_{hid}] < E[L_{trans}] .
\] (3.13)

A full proof is in the appendix. The intuition behind this result is as follows: Expected firm value under each type is affected by two factors: the fraction \( b \) that \( M \) tries to divert, and the monitoring effort \( e_i \) exerted by \( D_i \). Under \( D_1 \), who exerts a higher monitoring effort, \( M \)'s choice of \( b \) makes relatively little difference to expected firm value, since for a large fraction of the time monitoring will be successful and the funds will be recovered. Under \( D_2 \), who exerts less monitoring effort, \( M \)'s choice of \( b \) has a stronger effect since those funds are less likely to be recovered.

Since \( b_1^{trans} < b_{hid} < b_2^{trans} \), the hidden regime causes \( M \) to divert less than he would have when facing \( D_2 \) under the transparent regime (when a change in \( b \) has a large effect) and more than he would have when facing \( D_1 \) under the transparent regime (when a change in \( b \) has a small effect).

When nature selects \( D_1 \), expected firm value is actually lower under the hidden regime. Information asymmetry prevents \( D_1 \)'s 'reputation' from attenuating the fraction of funds \( M \) will try to divert. The opposite effect occurs when nature selects \( D_2 \) - now the information asymmetry masks \( D_2 \)'s relatively ineffective monitoring and causes \( M \) act too cautiously. While \( D_1 \) makes up for the loss of deterrence by monitoring more intensely, expected firm value under \( D_2 \) depends primarily on the reputation effect, as her monitoring is not very

\(^4\)In order to maintain tractability, I will assume the cost of monitoring \( c_i \) is always above a minimum level \( c \). This will ensure that \( \forall i, 0 < c_i^{hid} < 1 \). In other words, I assume the cost of monitoring is never so low as to allow an investor to monitor with absolute accuracy.
effective. In other words, firm value is more sensitive to \( M \)'s choice of \( b \) when \( D_2 \) is in charge. The aggregate effect is of a smaller expected loss under the hidden regime.

3.3. The effect of trading

At time \( t = 3 \), the market opens and \( D_i \) has an opportunity to adjust her total economic exposure by buying/selling shares on the market. The market maker observes the aggregate order flow, and sets a price \( P_e \) which represents his expectation of firm value conditional on the order flow observed. Regardless of the market maker’s beliefs about the type he is facing, this price will always fall somewhere between the expected price under type 1, \( P_1 \), and the expected price under type 2, \( P_2 \). Since \( e_1 > e_2 \), expected firm value under type 1 is higher than it is under type 2 and therefore \( P_1 \geq P_e \geq P_2 \).

In order for \( D_i \) to gain from informed trading, her strategy must be twofold:

(i) **Direction of trade:** since \( P_1 \geq P_e \), \( D_1 \) can only profit by submitting a 'buy' order, profiting from the fact that the price set by the market maker may undervalue the firm. A similar argument compels \( D_2 \) to submit a 'sell' order.

(ii) **Size of trade:** Because trading gains stem from information asymmetry, \( D_i \)'s order size is bounded only by the requirement that her order divulges no information pertaining to her identity. In other words, both types will trade (although is opposite directions) the maximum fraction of shares that allows their trade to be disguised by the presence of liquidity trading.

As mentioned in the introduction, the exact mechanism by which the derivatives position of the investor is achieved is not the focus of this paper. When considering available liquidity, however, I make the conservative assumption that the broker taking the other side of the derivative position may in fact be holding an equivalent stake in the underlying asset in order to hedge its position. In that case, households susceptible to the liquidity shock may only be holding a fraction \( 1 - \alpha_i \) of the firm’s shares. Thus, any assertions regarding the
effect of liquidity become stronger still when this assumptions is discarded.

Following the liquidity shock, households will sell a fraction $\eta(1 - \alpha_i)$ or 0 with equal probability. Define $x_1, x_2$ as the respective fractions type 1 and 2 will trade. There are four possible combinations of investor type and shock size, all occurring with equal probability:

Case 1: $D_1$ buys $x_1$ and households sell 0: aggregate flow is $x_1$

Case 2: $D_1$ buys $x_1$ and households sell $\eta(1 - \alpha_1)$: aggregate flow is $x_1 - \eta(1 - \alpha_1)$

Case 3: $D_2$ sells $x_2$ and households sell 0: aggregate flow is $-x_2$

Case 4: $D_2$ sells $x_2$ and households sell $\eta(1 - \alpha_2)$: aggregate flow is $-x_2 - \eta(1 - \alpha_2)$

**Lemma 2.** Under the hidden regime, when markets open, both types will choose to trade equal amounts:

$$x_1 = x_2 = \frac{\eta}{2}(1 - \alpha_1)$$ (3.14)

where $\eta$ is the fraction of households affected by the liquidity shock and $\alpha_1$ is the fraction of shares required to achieve an economic exposure equivalent to that of $D_1$’s initial derivatives position. $D_1$ will submit an order to buy a fraction $\frac{\eta}{2}(1 - \alpha_1)$ of the firm’s shares, while $D_2$ will attempt to (short) sell the same fraction.

**Proof of Lemma 2:** Define $F_i$ to be the aggregate order flow in case $i$ (see cases 1-4 above) and $P_i$ to be the price the market maker sets after observing $F_i$. For any values $0 < x_1, x_2 < 1$, the only two aggregate order flows that can in fact equate are $F_2, F_3$. Therefore in equilibrium it must be that: $-x_2 = x_1 - \eta(1 - \alpha_1)$, or equivalently that $x_1 + x_2 = \eta(1 - \alpha_1)$. This conditions implies that there are infinitely many combinations of $x_1, x_2$ such that $0 \leq x_1, x_2 \leq \eta(1 - \alpha_1)$ resulting in $F_2 = F_3$. Also note that $-\eta(1 - \alpha_1) \leq F_2 = F_3 \leq 0$. Equilibrium uniqueness can be guaranteed by specifying the following off-the-equilibrium-path beliefs for the market maker:

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Table 1
Order Flows and Market Prices

This first column lists all possible equilibrium outcomes of aggregate order flow. The second column specifies the ingredients of each aggregate order flow. As is evident, identical order flow can result from different combinations of orders submitted by the households (HH) and the investor (Di) (column 2). η is the liquidity parameter (fraction of households affected by the liquidity shock). α1 is the fraction of shares required to achieve an economic exposure equivalent to that of Di’s initial derivatives position. L is the expected firm value under Di. H is the expected firm value under D1. Intrinsic firm value (depending on the type of investor involved) is shown in the second to last column. The market maker, observing only aggregate order flow, sets the price (last column). Note that P2 < Pe < P1 always.

<table>
<thead>
<tr>
<th>Order flow</th>
<th>Transactions</th>
<th>Probability</th>
<th>Intrinsic Value</th>
<th>Market Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{\eta}{2}(1 - \alpha_1) )</td>
<td>D1 buys ( \frac{\eta}{2}(1 - \alpha_1) )</td>
<td>1/4</td>
<td>H</td>
<td>P1</td>
</tr>
<tr>
<td></td>
<td>HH sell 0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( -\frac{\eta}{2}(1 - \alpha_1) )</td>
<td>D1 buys ( \frac{\eta}{2}(1 - \alpha_1) )</td>
<td>1/4</td>
<td>H</td>
<td>Pe</td>
</tr>
<tr>
<td></td>
<td>HH sell ( \eta(1 - \alpha_1) )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( -\frac{\eta}{2}(1 - \alpha_1) )</td>
<td>D2 sells ( \frac{\eta}{2}(1 - \alpha_1) )</td>
<td>1/4</td>
<td>L</td>
<td>Pe</td>
</tr>
<tr>
<td></td>
<td>HH sell 0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( -\frac{\eta}{2}(1 - \alpha_1) - \eta(1 - \alpha_2) )</td>
<td>D2 sells ( \frac{\eta}{2}(1 - \alpha_1) )</td>
<td>1/4</td>
<td>L</td>
<td>P2</td>
</tr>
<tr>
<td></td>
<td>HH sell ( \eta(1 - \alpha_2) )</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If \( F_i > -\frac{\eta}{2}(1 - \alpha_1) \) then \( P_i = P_1 \) where \( P_1 \) is the expected share price when the investor is of type 1.

If \( F_i < -\frac{\eta}{2}(1 - \alpha_1) \) then \( P_i = P_2 \) where \( P_2 \) is the expected share price when the investor is of type 2.

These beliefs guarantee that type 1 will never submit a buy order where \( x_1 > \frac{\eta}{2}(1 - \alpha_1) \) and similarly that type 2 will never submit a sell order where \( x_2 > \frac{\eta}{2}(1 - \alpha_1) \). Since each type strives to maximize order size, equilibrium can only be achieved when \( x_1 = x_2 = \frac{\eta}{2}(1 - \alpha_1) \).

Table 1 summarizes the possible order flows the market maker observes, and the prices set in each instance.

The implication of lemma 2 is that the expected change in economic exposure caused by trading in period \( t = 3 \) is symmetric about its previous mean (both types trade the same...
amount, albeit in different directions). In other words, trading does not change the expected mean economic exposure of the investor, but rather its variance. While the effect of a change in mean economic exposure on the manager’s decision and on firm value is clear cut\(^5\), it is less obvious what effect a change in variance alone (keeping the mean constant) would have, given that the manager is assumed to be risk neutral.

Eq. 3.12 implies that \(D_1\)’s decision regarding monitoring intensity under the hidden regime is more sensitive to a change in her economic exposure than \(D_2\)’s decision is. Moreover, \(D_1\)’s decision is also more sensitive to a change in the other type’s exposure than \(D_2\)’s decision is. This difference in sensitivity between investor types is driven by the difference in monitoring costs \(c_i\) the two types face. As a result, the symmetric equilibrium trade described in lemma 2 will tend to increase the expected monitoring intensity \(M\) faces, and compel \(M\) to choose a lower value for \(b\) than he would have chosen in the absence of trading. The aggregate affect of the trading has on firm value is therefore a positive one.

**Proposition 2.** Under the hidden regime, the effect of trading on expected monitoring intensity and on firm value \(V^{hid}\) is always positive. Furthermore, an increase in the liquidity parameter \(\eta\) will always result in increased expected monitoring, decreased fund diversion, and increased firm value. Formally: \(\forall \alpha_1, \alpha_2 \ s.t. \ \alpha_2 \leq \alpha_1\), and \(\forall c_1, c_2 \ s.t. \ \zeta < c_1 < c_2\):

\[
\frac{\partial E[V^{hid}]}{\partial \eta} > 0, \quad \frac{\partial h^{hid}}{\partial \eta} > 0, \quad \frac{\partial E[e^{hid}]}{\partial \eta} > 0.
\]

(3.15)

A full proof is in the appendix. This result may seem counter intuitive at first: in the presence of convex monitoring costs, the marginal change in monitoring intensity as a function of economic exposure tends to decrease as exposure increases. This effect is evident from equation 3.6 describing monitoring intensity under the transparent regime. Had this effect retained its dominance when switching to the hidden regime, the introduction of

---

\(^5\)A higher mean economic exposure for the investor directly translates to a higher mean monitoring intensity. This increase in mean monitoring intensity will in turn cause \(M\) to choose a lower value for \(b\), all else being equal. The aggregate effect will result in an increase in firm value.
trading as described in lemma 2 could - at least for part of the parameter space - cause a decrease in expected monitoring intensity. However, the hidden regime introduces a new set of considerations for the investor: each type now has to consider the manager’s beliefs regarding the *other* type. For instance, if \( M \) believes \( D_2 \) decreased her exposure (and therefore decreased her monitoring intensity) he steals more, driving \( D_1 \) to increase her monitoring effort. Thus, having a higher economic exposure and a lower cost of monitoring, \( D_1 \) is more sensitive to changes in \( D_2 \)’s exposure (and resulting monitoring intensity) than vice-versa. Therefore, a small decrease in \( e^{hid}_2 \) will result in a relatively larger increase in \( e^{hid}_1 \). On aggregate, the effect trading imparts on firm value under the hidden regime is positive over the entire parameter space.

To conclude, hidden ownership can mitigate the free-rider problem by allowing investors access to gains from informed trading. It then serves to magnify this effect by compelling larger investors to ‘compensate’ (monitoring-wise) for the partial or complete withdrawal of smaller ones, in effect increasing the average monitoring intensity the manager faces, thereby further increasing firm value.

3.4. Choice of regime

When faced with the decision of whether to disclose her economic interest in the firm or keep it hidden, the investor first compares the effect each contingency (sub-game) has on her personal welfare. I now turn to focus on characterizing the conditions leading the investor to choose one regime over the other.

Disclosure of economic interest has two immediate effects on investor welfare. The first is the forfeit of any trading gains: once the magnitude of her interest is made public and her type subsequently deduced, the share price will immediately adjust to accurately reflect this information, and the opportunity to trade on this information will be lost. Therefore, this effect has negative consequences for both investor types and would compel both to hide their ownership. The second channel through which the decision to disclose economic interest
effects investor welfare is the ‘signaling’ channel: by disclosing her economic interest, the
investor is in effect signaling her type, thereby influencing the manager’s choice of $b$. Unlike
the previous effect, this one presents opposite incentives to each type of investor. Because
$b_1^{\text{trans}} < b_1^{\text{hid}} < b_2^{\text{trans}}$, $D_2$ would prefer to hide her interest (and type), and $D_1$ would prefer
to disclose it. While it is easy to see that disclosure of economic interest will never be
optimal for $D_2$, the decision becomes a little less clear cut in the case of $D_1$: on one hand,
disclosing her interest in the firm will cause an increase in expected firm value due to the
signaling effect. On the other hand, disclosure also implies the investor will have to forgo
the benefits of informed trading. The choice of optimal strategy for $D_1$ must therefore
involve weighing these gains and losses and determining what the net effect of disclosure on
$D_1$’s welfare would be.

**Proposition 3.** A pooling equilibrium where both investor types choose to hide their eco-
nomic interest will occur whenever market liquidity is large enough relative to the initial
economic exposure of $D_1$. Formally:

$$\forall \alpha_1, \alpha_2 \text{ s.t. } \alpha_2 < \alpha_1, \text{ a pooling equilibrium where both investor types hide their ownership}$$

$$\text{stakes will occur whenever}$$

$$\eta > \frac{\alpha_1}{1 - \alpha_1}.$$  \hspace{1cm} (3.16)

**Furthermore,** for a given liquidity level $\eta$ satisfying eq. 3.16, firm value will increase as the
initial uncertainty regarding economic interest $(\alpha_1 - \alpha_2)$ grows.

A full proof appears in the appendix. The reasoning behind this result is straightforward:
gains from trading increase in liquidity. The gains (and therefore the liquidity) required to
offset the decline in expected firm value resulting from hiding her type depends mostly on
$D_1$’s exposure $\alpha_1$ to this decline. Therefore if the available liquidity is large enough relative
to the initial economic exposure of $D_1$, she will prefer to keep her interest in the firm hidden
and force a pooling equilibrium.

Two components are necessary for the opportunity of informed trading to arise: information
asymmetry - in order to create mispricing, and sufficient liquidity - in order to exploit it. Hidden ownership introduces information asymmetry in two separate dimensions: It creates the asymmetry between the informed investor and other market participants, mitigating the free-rider problem and driving informed investors to trade. Informed trading can lead to better governance by increasing the investor’s incentives to monitor. More importantly, hidden ownership creates an information asymmetry between the investor and the firm’s management by injecting noise into the information management has regarding the monitoring intensity it faces, thus mitigating agency related frictions. Liquidity’s effect does not end once the hidden regime is selected: under the hidden regime, an increase in liquidity translates into an increase in firm value. The analysis therefore reveals an interesting complementarity involving hidden ownership and liquidity: Liquidity enables the practice of hidden ownership, and hidden ownership for its part provides liquidity with a novel channel through which it can have a positive effect on governance and firm value.
CHAPTER 4: Total Surplus

So far, the case has been made for the positive effects of hidden ownership on firm value. In order to determine the circumstances, if any exist, under which the practice of hidden ownership can be beneficial from a social planner’s perspective, the analysis must extend to include its effects on the aggregate welfare of all involved.

The model contains three sources of surplus loss: the first is the specification attributing decreasing returns to scale to a successful diversion of cash flow by $M$. This specification is given in eq. 3.1 to be $\frac{b^2}{2}$. The second source of surplus loss stems from the penalty imposed on $M$ when monitoring is successful. This loss is also given by eq. 3.1 to be $\frac{b^2}{2}$. Combining these two sources, we can therefore expect $M$ to contribute a fraction $\frac{b^2}{2}$ to total surplus loss regardless of whether monitoring is successful or not. The third and final source of surplus loss is the monitoring cost borne by $D$, given in eq. 3.4 to be $\frac{c^2}{2}$. This loss is also incurred regardless of the outcome of the monitoring effort. I define the surplus loss attributed to $M$ as $\psi_M$ and the loss attributed to $D$ as $\psi_D$. Total surplus loss is defined as $\psi = \psi_M + \psi_D$.

*Transparent regime*

It is straightforward to show that for both investor types, monitoring intensity $e$ decreases in the monitoring cost parameter $c$. As $\psi_D$ is an increasing function of both $c$ and $e$, the effect of $c$ on $\psi_D$ is not as obvious. The monitoring cost parameter $c$ affects $\psi_D$ both directly and indirectly (through its effect on $e$). The two channels affect $\psi_D$ in opposite directions, and the overall influence of $c$ on $\psi_D$ therefore depends on which of the two channels is dominant.

**Lemma 3.** Under the transparent regime, and for all $c < c_1 < c_2$, $0 \leq \alpha_2 \leq \alpha_1 < \frac{1}{2}$, an increase in the monitoring cost parameter $c_i$ always reduces the surplus loss attributed to monitoring $\psi_{D_i}$.

A full proof is in the appendix. Since monitoring costs are linear in $c$ but quadratic in $e$,
the indirect effect of $c$ on $\psi_D$ is the dominant one. In other words, as the 'unit cost' of monitoring increases, the investor scales down her monitoring effort such that the overall cost she incurs is lower than before.

Under both regimes, $M$’s contribution $\psi_M$ to expected surplus loss is increasing in $c$, as $b$ is increasing in $c$. Thus, although $\psi_D$ is decreasing in $c$, total welfare loss under the transparent regime is increasing as monitoring becomes increasingly expensive.

**Lemma 4.** Under the transparent regime, and for all $c < c_1 < c_2$, $0 \leq \alpha_2 \leq \alpha_1 \leq 1$, an increase in the monitoring cost parameter $c_i$ always increases total surplus loss $\psi$.

A full proof is in the appendix. Because $e_i$ and $b_i$ are linearly related under the transparent regime, $c_i$’s effect on each is all but canceled out, and what remains as a decisive factor of total surplus is $c_i$’s direct effect on $\psi_D$.

The investor’s initial economic interest $\alpha_i$ on total surplus also has opposite effects in each channel: larger exposure to firm value implies increased expected monitoring effort and therefore increased expected monitoring costs. On the other hand, more monitoring compels $M$ to act in a more prudent manner, thereby reducing his contribution to welfare loss. Once again, any assertion as to the identity of the dominant channel requires a closer examination.

**Lemma 5.** Under the transparent regime, and for all $c < c_1 < c_2$, $0 \leq \alpha_2 \leq \alpha_1 < 1$, an increase in the investor’s economic interest $\alpha_i$ always decreases total surplus loss $\psi$.

A full proof is in the appendix. An increase in investor economic interest linearly increases her monitoring costs $\psi_{Di}$, but at the same time decreases manager related costs $\psi_M$ quadratically. the aggregate effect of an increase in $\alpha_i$ on $\psi$ under the transparent regime is therefore negative.
Hidden regime

Under the hidden regime, changes to $c_i$ and $\alpha_i$ produce the same effect (qualitatively) on total surplus as they did under the transparent regime.

Proposition 4. For all $c < c_1 < c_2$, $0 \leq \alpha_2 \leq \alpha_1 \leq \frac{1}{2}$ s.t. $c_2 > \lambda c_1$ and $\lambda \geq \lambda$, total surplus is always higher under the hidden regime. Formally:

$$\forall \alpha_L, \alpha_H, c_L, c_H \ s.t. \ 0 \leq \alpha_L \leq \alpha_H \leq \frac{1}{2} \ and \ c < c_H < c_L,$$

$$\psi^{hid} < \psi^{trans} \quad (4.1)$$

A full proof is in the appendix. The intuition for this result is as follows: $M$’s contribution to surplus loss is $\psi^{2}/2$ regardless of whether monitoring is successful or not. Therefore surplus loss will be smaller when $M$ is better deterred from diverting firm funds for personal use. This formulation has the desirable quality that not unlike the real world, prevention is cheaper and more efficient than corrective action after the fact. As for the investor, as long as $D_2$ monitoring cost parameter $c_2$ is high enough when compared to $c_1$, the increased costs of monitoring borne by $D_1$ will be largely offset by the decreased monitoring costs borne by $D_2$. One particular case where proposition 4 and all other propositions still apply is when the cost of monitoring is prohibitively high for $D_2$, causing her to withdraw from the market.
CHAPTER 5 : Conclusion

This paper presents a model of investor intervention where investors employ a two-fold strategy: (i) monitor the firm’s management in order align its interests with those of shareholders and increase firm value, and (ii) Create information asymmetry and then trade on private information in public markets. To those ends, the means include disguising their engagement using different trading strategies and an increasingly accessible derivatives market. The analysis yields the following results:

1. If stock markets are liquid, hidden ownership is likely to become more prevalent as it allows investors to create information asymmetry and benefit from informed trading that would be otherwise impossible. Informed trading, in turn, mitigates the free rider problem thus indirectly contributing to better governance and higher firm value.

2. As the practice of hidden ownership becomes more prevalent, the firm’s management faces increased uncertainty regarding the its potential monitors. This uncertainty is further amplified by market liquidity, and can enforce a better alignment of interests between the firm’s management and its shareholder constituency, resulting in higher firm value and in some cases even increased total surplus.

3. For a given level of market liquidity, higher dispersion of (and therefore uncertainty about) the monitoring cost parameter of potential investors can lead to higher efficiency and lower surplus loss due to frictions.

Informed trading in this model drives an increase in firm value not only through increased expected monitoring (as discussed in previous literature) but also (and mainly) through increasing the uncertainty management faces, better aligning its interests with those of shareholders. In this setting, a liquid stock market not only contributes to firm value through making hidden ownership more likely, but also continues to have a positive effect on firm value conditional on hidden ownership already being in effect. For its part, hidden
ownership contribution is two fold: it allows for the mitigation of the free rider problem, as well as supplies a new channel through which liquidity can positively affect the corporate governance mechanism, over and beyond evidence provided in previous literature. Contrary to the popular opinion advocating complete transparency as a cure to all matters pertaining to corporate governance, this paper shows that under the right circumstances, hidden ownership is one case where opacity can alleviate inherent frictions and benefit shareholders as well as total surplus.
APPENDIX

Proof of Proposition 1: Expected firm value loss $E[L^{\text{trans}}]$ is given by eq. 3.7 to be:

$$E[L^{\text{trans}}] = \frac{\left(\frac{c_1}{\alpha_1 + c_1}\right)^2 + \left(\frac{c_2}{\alpha_2 + c_2}\right)^2}{2}$$

and expected firm value loss under the hidden regime $E[L^{\text{hid}}]$ is found by substituting eq. 3.12 into eq. 3.10 to be:

$$E[L^{\text{hid}}] = \frac{4c_1^2c_2^2}{(\alpha_1c_2 + \alpha_2c_1 + 2c_1c_2)^2}$$

To show that $E[L^{\text{trans}}] > E[L^{\text{hid}}]$, define:

$$x = \frac{c_1}{\alpha_1 + c_1}, \quad y = \frac{c_2}{\alpha_2 + c_2}, \quad z = \frac{2\sqrt{2}c_1c_2}{\alpha_1c_2 + \alpha_2c_1 + 2c_1c_2}.$$

Therefore, it suffices to show that $x^2 + y^2 > z^2$, or equivalently that: $y^2 - z^2 > z^2 - x^2$.

Applying the simple polynomial identity $a^2 - b^2 = (a + b)(a - b)$ yields:

$$\left(y + \frac{z}{\sqrt{2}}\right)\left(y - \frac{z}{\sqrt{2}}\right) > \left(\frac{z}{\sqrt{2}} + x\right)\left(\frac{z}{\sqrt{2}} - x\right) \quad (A.1)$$

First, to establish that both sides of eq. A.1 are always positive, I show that $y > \frac{z}{\sqrt{2}} > x$ always.

To show:

$$y = \frac{c_2}{\alpha_2 + c_2} > \frac{2c_1c_2}{\alpha_1c_2 + \alpha_2c_1 + 2c_1c_2} = \frac{z}{\sqrt{2}}$$
divide by $c_2$ and multiply diagonally to get:

$$\alpha_1 c_2 + \alpha_2 c_1 + 2c_1 c_2 > 2c_1 \alpha_2 + 2c_1 c_2$$

or equivalently:

$$\alpha_1 c_2 > \alpha_2 c_1$$

Which always holds under the model assumptions $\alpha_1 \geq \alpha_2$ and $c_1 < c_2$.

To Show:

$$x = \frac{c_1}{\alpha_1 + c_1} < \frac{2c_1 c_2}{\alpha_1 c_2 + \alpha_2 c_1 + 2c_1 c_2} = \frac{z}{\sqrt{2}}$$

divide by $c_1$ and multiply diagonally to get:

$$\alpha_1 c_2 + \alpha_2 c_1 + 2c_1 c_2 < 2c_2 \alpha_1 + 2c_1 c_2$$

yielding the same inequality as before:

$$\alpha_1 c_2 > \alpha_2 c_1$$

Which again always holds under the stated model assumptions.

Since lemma 1 already states that $y > x$, it follows that $\left(y + \frac{z}{\sqrt{2}}\right) > \left(\frac{z}{\sqrt{2}} + x\right)$, and since I have already established that $y > \frac{z}{\sqrt{2}} > x$, all that is required to complete the proof is to show that $\left(y - \frac{z}{\sqrt{2}}\right) > \left(\frac{z}{\sqrt{2}} - x\right)$, or equivalently that $x + y > \sqrt{2} \cdot z$:

W.T.S.

$$x + y > \sqrt{2} \cdot z$$

27
\[
\frac{c_1}{\alpha_1 + c_1} + \frac{c_2}{\alpha_2 + c_2} > \frac{4c_1c_2}{\alpha_1c_2 + \alpha_2c_1 + 2c_1c_2}
\]

\[
\frac{1}{\alpha_1 c_1} + 1 + \frac{1}{\alpha_2 c_2} + 1 > \frac{4}{\alpha_1 c_1 + \alpha_2 c_2 + 2}
\]

Change of variables (for simplification) yields:

\[
\frac{1}{m} + \frac{1}{n} > \frac{4}{m + n}
\]

\[
\frac{m + n}{m} + \frac{m + n}{n} > 4
\]

\[
2 + \frac{n}{m} + \frac{m}{n} > 4
\]

Which always holds since \(\frac{n}{m} + \frac{m}{n} > 2\) \(\forall m > 0, n > 0\) s.t. \(m \neq n\). And \(m \neq n\) always since \(c_1 < c_2\) and \(\alpha_1 \geq \alpha_2\).

\[\blacksquare\]

Proof of Proposition 2: Eq. 3.12 implies that the expected monitoring intensity under the hidden regime is given by:

\[
E[e^{hid}] = \frac{e_1^{hid} + e_2^{hid}}{2} = \frac{\alpha_2 c_1 + \alpha_1 c_2}{\alpha_2 c_1 + \alpha_1 c_2 + 2c_1c_2} \quad (A.2)
\]
Define \( x = \frac{\eta}{2}(1 - \alpha_1) \) the fraction of shares traded by the investor in equilibrium (see Lemma 2). Since \( \alpha_1 \) is a constant, any change to \( x \) is coming from \( \eta \), and it is also obvious that \( \frac{\partial x}{\partial \eta} > 0 \). Therefore, we can consider changes in \( x \) to be a perfect proxy changes in \( \eta \) and use \( x \) instead of \( \eta \) in our sensitivity analysis.

After trading, type 1 will have an economic exposure equivalent to holding a fraction \( \alpha_1 + x \) of the shares while type 2 will have exposure equivalent to a fraction \( \alpha_2 - x \) of the shares. By eq. A.2 the expected level of monitoring will then become:

\[
E[e^{hid}] = \frac{(\alpha_2 - x)c_1 + (\alpha_1 + x)c_2}{(\alpha_2 - x)c_1 + (\alpha_1 + x)c_2 + 2c_1c_2}
\]

Taking a FOC with respect to \( x \) yields:

\[
\frac{\partial E[e^{hid}]}{\partial x} = \frac{2c_1c_2(c_2 - c_1)}{(\alpha_2 - x)c_1 + (\alpha_1 + x)c_2 + 2c_1c_2)^2}
\]

And since \( c_2 > c_1 \) we get:

\[
\frac{\partial E[e^{hid}]}{\partial x} > 0 \tag{A.3}
\]

Since the average level of monitoring increases in liquidity, and since the optimal amount the \( M \) diverts \( b^{hid} \) decreases in the average level of monitoring (see eq. 3.9), it follows that \( b^{hid} \) is decreasing in liquidity:

\[
\frac{\partial b^{hid}}{\partial x} < 0 \tag{A.4}
\]

From eq. 3.9 and eq. 3.10 we can see that the expected value loss under the hidden regime
is

\[ E[L^{hid}] = \left( 1 - \frac{e_1 + e_2}{2} \right)^2 = (b^{hid})^2 \]

Therefore eq. A.4 implies that

\[ \frac{\partial E[L^{hid}]}{\partial x} < 0 \]  \hspace{1cm} (A.5)

and since expected firm value can be expressed as \( 1 - E[L^{hid}] \), we arrive at the desired result.

\[ \square \]

Proof of Proposition 3: I have already established that \( D_2 \) will always prefer to hide her ownership (disclosure results in the loss of gains from informed trading as well as a loss of “deterrence” stemming from being identified as a relatively ‘weak’ monitor).

For \( D_1 \) to prefer hidden ownership, I must show her utility is higher when hiding than when choosing to disclose. \( D_1 \)'s disclosure decision revolves around comparing potential gains from informed trading (under the hidden regime) to the value lost from decreased deterrence (\( M \) would divert less if \( D_1 \) were to disclose her ownership).

When \( D_1 \) chooses to (verifiably) disclose her ownership, \( M \) can infer her type and therefore optimize the fraction \( b \) diverted to be \( b^{\text{trans}}_1 = 1 - e^{\text{trans}}_1 \) as in eq. 3.2. Under this transparent regime, \( D_1 \) optimizes her monitoring intensity according to eq. 3.6 to be \( e^{\text{trans}}_1 = \frac{\alpha_1}{\alpha_1 + c_1} \).

Note that under this regime, no trading will occur as the market price will be fully revealing. \( D_1 \)'s utility is then given by:

\[ U^{\text{trans}}_{D_1} = \alpha_1 (1 - b^{\text{trans}}_1 (1 - e^{\text{trans}}_1)) - \frac{c_1 (e^{\text{trans}}_1)^2}{2} = \frac{\alpha_1^2 (2\alpha_1 + 3c_1)}{2(\alpha_1 + c_1)^2} \]  \hspace{1cm} (A.6)
When $D_1$ instead elects to keep her interest in the firm hidden, she will have the opportunity to buy an additional fraction $x$ of shares (where $x$ is given by lemma 2) over and above her initial stake $\alpha_1$, in effect giving her a total economic exposure equivalent to holding a fraction $\alpha_1 + x$ of all outstanding shares.

I will first derive the required result under the assumption that $\alpha_2 > x$, and later for the case where $\alpha_2 \leq x$. (when $\alpha_2 \leq x$, $D_2$ will not engage in monitoring at all $e_2^{hid} = 0$).

**Case 1** When $\alpha_2 > x$:

$e_1^{hid}$ is given by eq. 3.12 to be:

$$e_1^{hid} = \frac{2(\alpha_1 + x)c_2}{(\alpha_1 + x)c_2 + (\alpha_2 - x)c_1 + 2c_1c_2} \quad (A.7)$$

and similarly $e_2^{hid}$ is

$$e_2^{hid} = \frac{2(\alpha_2 - x)c_1}{(\alpha_1 + x)c_2 + (\alpha_2 - x)c_1 + 2c_1c_2} \quad (A.8)$$

Following eq. 3.9, $b^{hid}$ can then be expressed as

$$b^{hid} = \frac{2c_1c_2}{(\alpha_1 + x)c_2 + (\alpha_2 - x)c_1 + 2c_1c_2} \quad (A.9)$$

The price $P_e$ set by the market maker under the hidden regime is a price reflecting the expected firm value, taking into account the fact that both investor types are equally likely:

$$P_e = \frac{(1 - b^{hid}(1 - e_1^{hid}))(1 - b^{hid}(1 - e_2^{hid}))}{2}$$

Therefore, $D_1$’s utility under the hidden regime can be expressed as:
\[ U_{D_1}^{\text{hid}} = (\alpha_1 + x)(1 - b_{D_1}^{\text{hid}}(1 - e_1^{\text{hid}})) - \frac{c_1(e_1^{\text{hid}})^2}{2} - x \cdot P_e = \]
\[ = \left\{ \alpha_1^3 c_2^2 + 2c_1^2 c_2 x(x - \alpha_2) + 2\alpha_1^2 c_2 (\alpha_2 c_1 + 2c_1 c_2 + x(c_2 - c_1)) + \right. \]
\[ + \left. \alpha_1 [a_2^2 c_1^2 + 2\alpha_2 c_1 (c_1 c_2 + x(c_2 - c_1)) + x(2c_1 c_2 (2c_2 - x) + c_2^2 x - c_1^2 (2c_2 - x))] \right\} / ((\alpha_2 - x)c_1 + (\alpha_1 + x)c_2 + 2c_1 c_2)^2 \]

W.T.S.

\[ U_{D_1}^{\text{hid}} > U_{D_1}^{\text{trans}} \quad \forall \alpha_1, \alpha_2, c_1, c_2, x \quad s.t. \quad \alpha_1 \geq \alpha_2, \quad c_2 > c_1 \geq \frac{1}{2}, \quad x \geq \frac{\alpha_1}{2}. \quad (A.10) \]

Multiplying both sides of eq. A.10 by \(2(\alpha_1 + c_1)^2(\alpha_2 c_1 + \alpha_1 c_2 + 2c_1 c_2 - c_1 x + c_2 x)^2\), expanding both sides and then subtracting the following common elements:

\[
\begin{align*}
(2\alpha_1^3 a_2^2 c_1^2 + 3\alpha_1^2 a_2^2 c_1^3 &+ 4\alpha_1^4 a_2 c_1 c_2 + 4\alpha_1^3 a_2 c_1 c_2 x + 12\alpha_1^2 a_2 c_1^2 c_2 + 18\alpha_1^3 c_1^2 c_2^2 + 12\alpha_1^3 a_2 c_1^2 c_2 \\
+14\alpha_1^3 c_1 c_2^2 x - 12\alpha_1^3 c_1^2 c_2 x + 12\alpha_1^2 c_1 c_2^2 x + 12\alpha_1^2 c_1^2 c_2^2 x - 4\alpha_1^3 c_1^2 c_2 x &+ 8\alpha_1^2 c_1^3 c_2^2 + 11\alpha_1^4 c_1 c_2^2 \\
-4\alpha_1^4 c_1 c_2 x + 2\alpha_1^5 c_2 &- 4\alpha_1^2 c_1^2 c_2^2 x - 4\alpha_1^3 c_1 c_2 x^2 + 4\alpha_1^4 c_2 x + 3\alpha_1^2 c_1^2 c_2^2 + 3\alpha_1^2 c_1 c_2 x^2 \\
+2\alpha_1^3 c_2^2 x^2 &+ 2\alpha_1^3 c_1^2 x^2 - 6\alpha_1^2 a_2 c_1^3 x + 4\alpha_1^2 a_2 c_1^2 c_2 x 
\end{align*}
\]

from both sides yields:

\[
\begin{align*}
\alpha_1^2 a_2^2 c_1^3 &+ 2\alpha_1 a_2^2 c_1^4 + 4\alpha_1 a_2 c_1^4 c_2 + a_2^4 c_1^2 c_2 - 2\alpha_1^2 a_2 c_1^3 x - 4\alpha_1 a_2 c_1^4 x - 4\alpha_1 a_2 c_1^3 c_2 x \\
-4\alpha_1 c_1 c_2 x - 4\alpha_2 c_1 c_2 x &+ 2\alpha_1^2 c_1^2 c_2^2 x + 8\alpha_1^2 c_1^2 c_2 x + 8\alpha_1 c_1^3 c_2^2 x + a_2^2 c_1^3 x^2 + 2\alpha_1^4 c_1^2 x^2 \\
+4\alpha_1^3 c_2^2 x &+ 4c_1^2 c_2 x^2 + a_1^2 c_1^2 c_2^2 x + 2\alpha_1^2 c_1^2 c_2^2 x^2 &> \quad (A.11)
\end{align*}
\]

\[ 2\alpha_1^3 a_2 c_1^2 c_2 + 2\alpha_1^3 c_1^2 c_2 + 4\alpha_1^3 c_1^3 c_2 - 2\alpha_1^3 c_1^2 c_2 x + 2\alpha_1^2 a_2 c_1^2 c_2 x - 2\alpha_1^2 c_1^2 c_2 x^2 \]

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Dividing eq. A.11 by \( c_1 \) and moving all elements to LHS yields:

\[
\begin{align*}
\alpha_1^2 \alpha_2 c_1^2 + 2 \alpha_1 \alpha_2 c_1 + 4 \alpha_1 \alpha_2 c_1^3 c_2 + \alpha_1^4 c_2^2 - 2 \alpha_1^2 \alpha_2 c_1^2 x - 4 \alpha_1 \alpha_2 c_1^3 x - 4 \alpha_1 \alpha_2 c_1^2 c_2 x \\
-4 \alpha_1 c_1^3 c_2 x - 4 \alpha_2 c_1^3 c_2 x + 2 \alpha_1^3 c_1^2 x + 8 \alpha_1 \alpha_2 c_1^2 x + 8 \alpha_1 \alpha_2 c_1^2 x + \alpha_1^2 \alpha_2 c_1^2 x^2 + 2 \alpha_1 c_1^3 x^2 \\
+4 \alpha_1^2 c_1^2 c_2 x^2 + 4 c_1^3 c_2 x^2 + \alpha_1^2 c_1^2 x^2 - 2 \alpha_1 \alpha_2 c_1 c_2 - 2 \alpha_1^3 c_1 c_2 \\
-4 \alpha_1^2 c_1^2 c_2 + 2 \alpha_1^3 c_1 c_2 x - 2 \alpha_1 \alpha_2 c_1 c_2 x + 2 \alpha_1^2 c_1 c_2 x^2 > 0
\end{align*}
\]

Eq. A.12 can be re-written as:

\[
\begin{align*}
\alpha_1 (-\alpha_2 c_1 + \alpha_1 c_2)(\alpha_1^2 c_2 - \alpha_1 c_1(\alpha_2 + 2 c_2)) - 2 c_1^2 (\alpha_2 + 2 c_2) \\
+2(-\alpha_1 \alpha_2 c_1^2(\alpha_1 + 2 c_1) = c_1(\alpha_1^2(-\alpha_1 + \alpha_2) + 2 \alpha_1 \alpha_2 c_2 \\
+2(\alpha_1 + \alpha_2) c_1^2) c_2 + \alpha_1(\alpha_1 + 2 c_1)^2 c_2^2 x \\
+(2 c_1^2 + \alpha_1(c_1 + c_2))(2 c_1 c_2 + \alpha_1(c_1 + c_2))^2 x^2 > 0
\end{align*}
\]

(A.13)

I will now show that the sum of the terms multiplied by \( x \) in eq. A.13 is positive:

The sum of elements multiplied by \( x \) in eq. A.13 is:

\[
2(-\alpha_1 \alpha_2 c_1^3(\alpha_1 + 2 c_1) = c_1(\alpha_1^2(-\alpha_1 + \alpha_2) + 2 \alpha_1 \alpha_2 c_2 + 2(\alpha_1 + \alpha_2) c_1^2) c_2 + \alpha_1(\alpha_1 + 2 c_1)^2 c_2^2)
\]

and can be rewritten as:

\[
\begin{align*}
2(-\alpha_1^2 \alpha_2 c_1^2 - 2 \alpha_1 \alpha_2 c_1^3 + \alpha_1^3 c_1 c_2 - \alpha_1^2 \alpha_2 c_1 c_2 - 2 \alpha_1 \alpha_2 c_1^2 c_2 - 2 \alpha_1 c_1^3 c_2 \\
-2 \alpha_2 c_1^3 c_2 + \alpha_1^3 c_2^2 + 4 \alpha_1^2 c_1 c_2 + 4 \alpha_1 c_1^2 c_2)
\end{align*}
\]

(A.14)

Using the constraints \( c_2 > c_1 \) and \( \alpha_1 \geq \alpha_2 \) it is straightforward to show that:

\[
4 \alpha_1 c_1^2 c_2^3 - 2 \alpha_1 c_1^3 c_2 - 2 \alpha_2 c_1^3 c_2 \geq 0 \text{ and}
\]

\[
\alpha_1^3 c_1 c_2 - \alpha_1^2 \alpha_2 c_1^2 \geq 0 \text{ and}
\]
\[4\alpha_1^2c_1c_2^2 - 2\alpha_1\alpha_2c_1^3 - 2\alpha_1\alpha_2c_1^2c_2 \geq 0 \text{ and} \]

\[\alpha_1^3c_1c_2 - \alpha_1^2\alpha_2c_1^2 \geq 0 \]

and therefore that the sum of terms multiplied by \(x\) is non-negative.

It is also evident from eq. A.13 that the sum of terms multiplied by \(x^2\) is non-negative.

Therefore, \(x\) and \(x^2\) in eq. A.13 can be replaced by \(\frac{\alpha_1}{2}\) and \(\frac{\alpha_2}{4}\) respectively since this will only make LHS smaller (remember that \(x \geq \frac{\alpha_1}{2}\) is one of the original constraints).

Eq. A.13 can therefore be expressed as:

\[
\frac{\alpha_1}{4}[(\alpha_1 - 2\alpha_2)^2c_1^2(\alpha_1 + 2c_1) + 2(\alpha_1 - 2\alpha_2)c_1(3\alpha_1^2 + 2\alpha_1c_1 - 2c_1^2)c_2 + \alpha_1^2(9\alpha_1 + 10c_1)c_2^2] > 0
\]

(A.15)

Multiplying eq. A.15 by \(\frac{4}{\alpha_1}\) and expanding yields:

\[
\alpha_1^3c_1^2 - 4\alpha_1^2\alpha_2c_1^2 + 4\alpha_1\alpha_2^2c_1^2 + 2\alpha_1^2c_1^3 - 8\alpha_1\alpha_2c_1^3
\]

\[
+ 8\alpha_2^2c_1^2 + 6\alpha_1^3c_1c_2 - 12\alpha_1^2\alpha_2c_1c_2 + 4\alpha_1^2c_1^2c_2 - 8\alpha_1\alpha_2c_1^2c_2
\]

\[
- 4\alpha_1c_1^3c_2 + 8\alpha_2c_1^3c_2 + 9\alpha_3^2c_1c_2 + 8\alpha_1c_1^2c_2 + 2\alpha_1^2c_1c_2^2 \geq 0
\]

(A.16)

Once again, using the original constraints \(c_2 > c_1\) and \(2\alpha_2 \geq 2x \geq \alpha_1 \geq \alpha_2\) it is straightforward to show that:

\[8\alpha_1^2c_1c_2^2 - 8\alpha_1\alpha_2c_1^2c_2 \geq 0 \text{ and} \]

\[2\alpha_1^2c_1^3 + 8\alpha_2^2c_1^2 + 4\alpha_1^2c_1^2c_2 - 8\alpha_1\alpha_2c_1^3 \geq 0 \text{ and} \]

\[8\alpha_2c_1^3c_2 - 4\alpha_1c_1^3c_2 \geq 0 \text{ and} \]

\[9\alpha_3^2c_1^2 + 6\alpha_1^3c_1c_2 + 2\alpha_1^2c_1c_2^2 - 12\alpha_1^2\alpha_2c_1c_2 - 4\alpha_1\alpha_2c_1^2 \geq 0. \text{ Therefore, eq. A.16 holds.} \]
Case 2: When $x \geq \alpha_2$:

In this case, $D_2$ will monitor with intensity zero ($e_2^{hid} = 0$), as her position after trading will be either neutral or short.

$e_1^{hid}$ is given by eq. 3.11 to be:

$$e_1^{hid} = \frac{2\alpha_1}{2c_1 + \alpha_1}$$ (A.17)

Following eq. 3.9, $b^{hid}$ can then be expressed as

$$b^{hid} = 1 - \frac{e_1}{2} = 1 - \frac{\alpha_1}{2c_1 + \alpha_1} = \frac{2c_1}{2c_1 + \alpha_1}$$ (A.18)

The price $P_e$ set by the market maker under the hidden regime is a price reflecting the expected firm value, taking into account the fact that both investor types are equally likely:

$$P_e = \frac{(1 - b^{hid}(1 - e_1^{hid}))(1 - b^{hid}(1 - e_2^{hid}))}{2}$$

Therefore, $D_1$’s utility under the hidden regime can be expressed as:

$$U_{D_1}^{hid} = \frac{\alpha_1(\alpha_1 + x)(\alpha_1 + x + 4c_1)}{(\alpha_1 + x + 2c_1)^2}$$ (A.19)

W.T.S.

$$U_{D_1}^{hid} > U_{D_1}^{trans}$$

$$\forall \alpha_1, \alpha_2, c_1, c_2, x \quad s.t. \quad \alpha_1 \geq \alpha_2, \quad c_2 > c_1 \geq \frac{1}{2}, \quad x \geq \frac{\alpha_1}{2}. \quad (A.20)$$

Multiplying both sides of eq. A.20 by $\frac{2}{\alpha_1} (\alpha_1 + c_1)^2(\alpha_1 + 2c_1 + x)^2$, expanding both sides
and then subtracting

$$2\alpha_1^4 + 11\alpha_1^3 c_1 + 20\alpha_1^2 c_1^2 + 12\alpha_1 c_1^3 + 4\alpha_1^3 x + 14\alpha_1^2 c_1 x + 12\alpha_1 c_1^2 x + 2\alpha_1^2 x + 3\alpha_1 c_1 x^2$$

from both sides yields:

$$\alpha_1^3 c_1 + 2\alpha_1^2 c_1 x + 8\alpha_1 c_1^2 x - 2\alpha_1^2 c_1^2 + 8c_1^3 x - 4\alpha_1 c_1^3 + \alpha_1 c_1 x^2 + 2c_1^2 x^2 > 0 \quad \text{(A.21)}$$

Under the assumption of $x > \frac{\alpha_1}{2}$, it is straightforward to show

$$8\alpha_1 c_1^2 x - 2\alpha_1^2 c_1^2 > 0$$

and

$$8c_1^3 x - 4\alpha_1 c_1^3 \geq 0.$$ 

The rest of LHS is non-negative.

---

Proof of Lemma 3: W.T.S.: Under the transparent regime, and for all $c_i < c_1 < c_2$, $0 \leq \alpha_2 \leq \alpha_1 < \frac{1}{2}$, an increase in the monitoring cost parameter $c_i$ always reduces the surplus loss attributed to monitoring $\psi_{D_i}$. In other words, $\frac{\partial \psi_{D_i}}{\partial c_i} < 0$.

By definition, $\psi_{D_i} = \frac{c_i e_i^2}{2}$. Furthermore, under the transparent regime, $e_i = \frac{\alpha_i}{\alpha_i + c_i}$.

Therefore, $\psi_{D_i} = \frac{1}{2} c_i \left( \frac{\alpha_i}{\alpha_i + c_i} \right)^2$. 

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Taking a first order condition with respect to $c_i$:

$$
\frac{\partial \psi_D}{\partial c_i} = \frac{1}{2} \left( \frac{\alpha_i^2(c_i + c_i)^2 - c_i\alpha_i^2(2\alpha_i + 2c_i)}{(\alpha_i + c_i)^4} \right).
$$

Since the denominator is always positive, it is sufficient to show that:

$$
\alpha_i^2(\alpha_i + c_i)^2 - c_i\alpha_i^2(2\alpha_i + 2c_i) < 0.
$$

Dividing by $(\alpha_i + c_i)$ yields:

$$
\alpha_i^2(\alpha_i + c_i) - 2c_i\alpha_i^2 < 0,
$$

or equivalently

$$
\alpha_i^3 - c_i\alpha_i < 0.
$$

Dividing by $\alpha_i^2$ leaves $\alpha_i - c_i < 0$ which always holds since by assumption: $\alpha_i < \frac{1}{2} \leq c_i$.

Proof of Lemma 4: W.T.S.: Under the transparent regime, and for all $c_1 < c_2$, $0 \leq \alpha_2 \leq \alpha_1 \leq 1$, an increase in the monitoring cost parameter $c_i$ always increases expected total surplus loss $\psi$. In other words, $\frac{\partial \psi}{\partial c_i} > 0$.

Under the transparent regime,

$$
\psi = \psi_D + \psi_M = \frac{1}{2} \left[ \frac{c_i}{(\alpha_i + c_i)^2} + \frac{c_i^2}{(\alpha_i + c_i)^2} \right] = \frac{1}{2} \left[ \frac{c_i\alpha_i^2 + c_i^2}{(\alpha_i + c_i)^2} \right],
$$

and therefore:

$$
\frac{\partial \psi}{\partial c_i} = \frac{1}{2} \left[ \frac{(\alpha_i^2 + 2c_i)(\alpha_i + c_i)^2 - (2\alpha_i + 2c_i)(c_i\alpha_i^2 + c_i^2)}{(\alpha_i + c_i)^4} \right].
$$

Since the denominator is always positive, it is sufficient to show that:
\[(\alpha_i^2 + 2c_i)(\alpha_i + c_i)^2 - (2\alpha_i + 2c_i)(c_i\alpha_i^2 + c_i^2) > 0.\]

Dividing by \((\alpha_i + c_i)\) and expanding:

\[\alpha_i^3 + 2c_i\alpha_i - c_i\alpha_i^2 > 0.\]

Dividing by \(\alpha_i\) yields

\[\alpha_i^2 + 2c_i - c_i\alpha_i > 0,\]

or equivalently

\[\alpha_i^2 > c_i(\alpha_i - 2).\]

Since \(\alpha_i \leq 1\), the RHS is negative and the required result is obtained. ■

**Proof of Lemma 5:** W.T.S.: Under the transparent regime, and for all \(\underline{c} < c_1 < c_2\), \(0 \leq \alpha_2 \leq \alpha_1 < 1\), an increase in the investor’s economic interest \(\alpha_i\) always decreases expected total surplus loss \(\psi\).

Equivalently, need to show that \(\frac{\partial \psi}{\partial \alpha_i} < 0\).

Under the transparent regime,

\[\psi = \psi_D + \psi_M = \frac{1}{2} \left[ c_i \alpha_i^2 \left( \frac{\alpha_i}{\alpha_i + c_i} \right)^2 + \frac{c_i^2}{(\alpha_i + c_i)^2} \right] = \frac{1}{2} \left[ \frac{c_i\alpha_i^2 + c_i^2}{(\alpha_i + c_i)^2} \right],\]

and therefore:

\[\frac{\partial \psi}{\partial \alpha_i} = \frac{1}{2} \left[ 2c_i\alpha_i(\alpha_i + c_i)^2 - (2\alpha_i + 2c_i)(c_i\alpha_i^2 + c_i^2) \right] \left( \frac{1}{(\alpha_i + c_i)^4} \right).\]

Since the denominator is always positive, it is sufficient to show that:
\[2c_i \alpha_i (\alpha_i + c_i)^2 - (2\alpha_i + 2c_i)(c_i \alpha_i^2 + c_i^2) < 0.\]

Dividing by \(2(\alpha_i + c_i)\) and expanding yields:

\[c_i \alpha_i^2 + c_i^2 \alpha_i < c_i \alpha_i^2 + c_i^2.\]

or equivalently;

\[\alpha_i < 1.\]

Proof of Proposition 4: W.T.S.: For all \(c < c_1 < c_2\), \(0 \leq \alpha_2 \leq \alpha_1 \leq \frac{1}{2}\) s.t. \(c_2 > \lambda c_1\) and \(\lambda \geq \lambda_i\), expected total surplus is always higher under the hidden regime.

I first derive the expressions for expected surplus loss under each regime and then show that it is always smaller under the hidden regime. Surplus loss stems from \(M\)'s socially inefficient diversion of funds, and from \(D\)'s costly monitoring effort.

**Transparent regime**

Eq. 3.1 gives \(M\)'s utility under the transparent regime. It is straightforward to see that regardless of whether monitoring is successful or not, \(M\) contributes \(b_i^2\) to surplus loss, either through decreasing returns to scale when diversion is successful, or through the penalty he receives when it is not. Therefore, when facing \(D_i\),

\[\psi_{M_i} = \frac{b_i^2}{2} = \frac{c_i^2}{2(\alpha_i + c_i)^2}.\]
Since both investor types are equally likely,

\[
\psi_M = \frac{1}{2} \left[ \frac{b_1^2}{2} + \frac{b_2^2}{2} \right] = \frac{1}{2} \left[ \frac{c_1^2}{2(\alpha_1 + c_1)^2} + \frac{c_2^2}{2(\alpha_2 + c_2)^2} \right].
\]

D’s contribution to surplus loss comes only from the costly monitoring she undertakes, therefore

\[
\psi_D = \frac{c_i c_i^2}{2} = \frac{\alpha_i^2 c_i}{2(\alpha_i + c_i)^2}.
\]

And since both investor types are equally likely,

\[
\psi_D = \frac{1}{2} \left[ \frac{\alpha_1^2 c_1}{2(\alpha_1 + c_1)^2} + \frac{\alpha_2^2 c_2}{2(\alpha_2 + c_2)^2} \right].
\]

Therefore, the expected total surplus loss under the transparent regime can be expressed as

\[
\psi = \psi_M + \psi_D = \frac{1}{4} \left[ \frac{c_1(\alpha_1^2 + c_1)}{(\alpha_1 + c_1)^2} + \frac{c_2(\alpha_2^2 + c_2)}{(\alpha_2 + c_2)^2} \right].
\]

\(\text{(A.22)}\)

**Hidden regime**

Using eq. 3.9 and 3.12 and taking the trading period into account, we can express M’s contribution to surplus loss, \(\frac{b^2}{2}\) as

\[
\psi_M = \begin{cases} 
\frac{2c_1 c_2^2}{(\alpha_1 c_2 + \alpha_2 c_1 + 2c_1 c_2 - c_1 x + c_2 x)^2} & \text{When } x < \alpha_2 \\
\frac{2c_1^2}{(\alpha_1 + x + 2c_1)^2} & \text{When } x \geq \alpha_2
\end{cases}
\]
Using eq. 3.12 and keeping in mind both investor types are equally likely, the expected surplus loss directly attributed to the investor is:

\[
\psi_D = \begin{cases} 
    \frac{c_1c_2(\alpha_1^2c_2 + \alpha_2^2c_1 + 2\alpha_1c_2x - 2\alpha_2c_1x + (c_1 + c_2)x^2)}{(\alpha_1c_2 + \alpha_2c_1 + 2c_1c_2 - c_1x + c_2x)^2} & \text{when } x < \alpha_2 \\
    \frac{c_1(\alpha_1 + x)^2}{(\alpha_1 + x + 2c_1)^2} & \text{when } x \geq \alpha_2.
\end{cases}
\]

Therefore,

\[
\psi = \psi_M + \psi_D = \begin{cases} 
    \frac{c_1c_2(\alpha_1^2c_2 + \alpha_2^2c_1 + 2\alpha_1c_2x - 2\alpha_2c_1x + (c_1 + c_2)x^2)}{(\alpha_1c_2 + \alpha_2c_1 + 2c_1c_2 - c_1x + c_2x)^2} & \text{when } x < \alpha_2 \\
    \frac{c_1(\alpha_1 + x)^2 + 2c_1^2}{(\alpha_1 + x + 2c_1)^2} & \text{when } x \geq \alpha_2.
\end{cases}
\]

(A.23)

**Case 1:** \( x \geq \alpha_2 \)

W.T.S.

\[
\frac{1}{4} \left[ \frac{c_1(\alpha_1^2 + c_1)}{(\alpha_1 + c_1)^2} + \frac{c_2(\alpha_2^2 + c_2)}{(\alpha_2 + c_2)^2} \right] \geq \frac{c_1(\alpha_1 + x)^2 + 2c_1^2}{(\alpha_1 + x + 2c_1)^2} \tag{A.24}
\]

Multiplying both sides by \( 4(\alpha_1 + c_1)^2(\alpha_2 + c_2)^2(\alpha_1 + x + 2c_1)^2 \) and moving all terms to LHS, we get:
\[-3\alpha_1^4\alpha_2^2 c_1 - 7\alpha_1^2\alpha_2^2 c_1^2 - 4\alpha_1^3\alpha_2^2 c_1^3 - 12\alpha_1\alpha_2^2 c_1^4 - 4\alpha_2^4 c_1 \]
\[+\alpha_1^4\alpha_2^2 c_2 - 6\alpha_1^4\alpha_2 c_1 c_2 + 6\alpha_1^3\alpha_2^2 c_1 c_2 - 14\alpha_1^2\alpha_2 c_1^2 c_2 - 8\alpha_1\alpha_2^2 c_1^3 c_2 \]
\[+13\alpha_1^3\alpha_2^2 c_1^2 c_2 - 24\alpha_1\alpha_2^2 c_1^3 c_2 + 12\alpha_1\alpha_2^2 c_1^4 c_2 - 8\alpha_2^4 c_1^2 c_2 + 4\alpha_2^4 c_1^2 c_2 \]
\[+\alpha_1^4 c_2 + 6\alpha_1^3 c_1 c_2 - 3\alpha_1^4 c_1^2 + 6\alpha_1^2 c_1^2 c_2 - 4\alpha_1^4 c_1^2 \]
\[-6\alpha_1^3\alpha_2^2 c_1 + 2\alpha_1\alpha_2^2 c_1 x - 12\alpha_1^2\alpha_2^2 c_1 x + 4\alpha_2^3 c_1 x - 8\alpha_1\alpha_2^3 c_1 x \]
\[+2\alpha_1^3\alpha_2^2 c_2 x - 12\alpha_1^3\alpha_2 c_1 c_2 x + 8\alpha_1^2\alpha_2^2 c_1 c_2 x + 4\alpha_1\alpha_2^2 c_2 c_2 x \]
\[-24\alpha_1^{2} \alpha_2 c_1 c_2 x + 10\alpha_1^{2} \alpha_2 c_1 c_2 x + 8\alpha_2^3 c_1 c_2 x - 16\alpha_1\alpha_2 c_1^3 c_2 x \]
\[+4\alpha_2^3 c_1 c_2 x + 2\alpha_1^3 c_1^2 x + 8\alpha_1\alpha_2^2 c_1^2 x - 6\alpha_1^2 c_1^2 x + 12\alpha_1 c_1^2 c_2 x \]
\[-12\alpha_1^{2} \alpha_2 c_1^2 c_2 x + 8\alpha_1\alpha_2 c_1^2 c_2 x - 8\alpha_1\alpha_2^2 c_1 c_2 x - 3\alpha_1^2 \alpha_2^2 c_1 x^2 + \alpha_2^2 c_1^2 x^2 \]
\[-8\alpha_1^2 \alpha_2^2 c_1^2 x^2 - 4\alpha_1^2 \alpha_2 c_1^2 x^2 + 2\alpha_1^2 \alpha_2 c_1 c_2 x^2 - 6\alpha_1\alpha_2 c_1^2 c_2 x^2 + 2\alpha_1\alpha_2 c_1 c_2 x^2 \]
\[+2\alpha_2 c_1^2 c_2 x^2 - 16\alpha_1\alpha_2^2 c_2 c_2 x^2 + \alpha_2^2 c_1^2 c_2 x^2 - 8\alpha_2^2 c_1^2 c_2 x^2 + \alpha_1^2 c_2^2 x^2 \]
\[+2\alpha_1 c_1^2 c_2 x^2 - 3\alpha_1^2 c_1^2 c_2 x^2 + \alpha_1^2 c_1^2 c_2 x^2 - 8\alpha_1\alpha_2^2 c_1^2 c_2 x^2 - 4\alpha_1^2 c_1^2 x^2 \geq 0 \]

Note that the highest power of \(c_2\) in eq. A.25 is 2. I will now show that the sum of elements multiplying \(c_2^2\) in eq. A.25 is strictly positive:

W.T.S.

\[\alpha_1^4 + 6\alpha_1^3 c_1 - 3\alpha_1^4 c_1 + 6\alpha_1^2 c_1^2 - 4\alpha_1^3 c_1^2 \]
\[+2\alpha_1^3 c_1 x + 8\alpha_1^2 c_1 x - 6\alpha_1 c_1 x + 12\alpha_1 c_1^2 x \]
\[-12\alpha_1^2 c_1 x + 8\alpha_1^3 x - 8\alpha_1^3 c_1 x + \alpha_1^2 x^2 \]
\[+2\alpha_1 c_1 x^2 - 3\alpha_1^2 c_1 x^2 + 2c_1^2 x^2 - 8\alpha_1 c_1^2 x^2 - 4c_1^2 x^2 > 0 \]

Using the constraints \(0 < \alpha_1 \leq \frac{1}{2}\), \(x \leq 1\), it is straightforward to show that:
8c_1^2x - 8\alpha_1 c_1^3x - 4c_1^3x^2 \geq 0 \text{ and}

6\alpha_1 c_1^2x - 12\alpha_1^2 c_1^2x \geq 0 \text{ and}

6\alpha_1 c_1^2x + 2c_1^2x^2 - 8\alpha_1 c_1^3x^2 \geq 0 \text{ and}

2\alpha_1^2 c_1^2 - 4\alpha_1^3 c_1^2 \geq 0 \text{ and}

6\alpha_1^3 c_1 - 3\alpha_1^4 c_1 \geq 0 \text{ and}

3\alpha_1^2 c_1x - 6\alpha_1^3 c_1x \geq 0 \text{ and}

2\alpha_1 c_1x^2 - 3\alpha_1^2 c_1x^2 \geq 0

Subtracting these 7 equations from eq. A.26 leaves:

\[
\alpha_1^4 + 4\alpha_1^2 c_1^2 + 2\alpha_1^3 x + 5\alpha_1^2 c_1x + \alpha_1^2 x^2 > 0
\]

Which always holds under the constraints \(0 < \alpha_1 \leq \frac{1}{2}, x \leq 1\).

Now that I’ve shown that the sum of multipliers of \(c_2^2\) in eq. A.25 is strictly positive, it follows that there is always \(c_2\) large enough to make eq. A.25 hold under proposition 4’s constraints. Formally, \(\forall \alpha_1, \alpha_2, c_1 \text{ s.t. } \frac{x}{2} \leq c_1 < c_2, \ 0 \leq \alpha_2 \leq \alpha_1 \leq \frac{1}{2}, \ \alpha_1 > 0, \text{ there always exists a } c_2 \text{ s.t. eq. A.25 holds.}

Case 2: \(x < \alpha_2\)

W.T.S.

\[
\frac{1}{4} \left[ \frac{c_1(\alpha_1^2 c_1 + c_1)}{(\alpha_1 + c_1)^2} + \frac{c_2(\alpha_2^2 c_2 + c_2)}{(\alpha_2 + c_2)^2} \right] \geq \frac{c_1 c_2(\alpha_1^2 c_2 + \alpha_2^2 c_1 + 2c_1 c_2 + 2\alpha_1 c_2 x - 2\alpha_2 c_1 x + (c_1 + c_2)x^2)}{(\alpha_1 c_2 + \alpha_2 c_1 + 2c_1 c_2 - c_1 x + c_2 x)^2}
\]  

(A.27)
Using the same method as in case 1, I start by multiplying both sides by $4(\alpha_1 + c_1)^2(\alpha_2 + c_2)^2(\alpha_1 c_2 + \alpha_2 c_1 + 2c_1 c_2 - c_1 x + c_2 x)^2$ and moving all elements to LHS. In this case the highest power of $c_2$ is 4. I will now show that the sum of elements multiplying $c_2^4$ is strictly positive under the constraints, and therefore that eq. A.28 holds.

Isolating only the elements that multiply $c_2^4$, we get:

$$
\begin{align*}
\alpha_1^4 + 6\alpha_1^3 c_1 - 3\alpha_1^2 c_1 + 6\alpha_1^2 c_2^2 - 4\alpha_1^3 c_1^2 + 2\alpha_1^3 x + 8\alpha_1^2 c_1 x \\
-6\alpha_1^3 c_1 x + 12\alpha_1 c_2^2 x - 12\alpha_1^2 c_2^2 x + 8c_1^3 x - 8\alpha_1 c_1^3 x \\
+\alpha_1^2 x^2 + 2\alpha_1 c_1 x^2 - 3\alpha_1^2 c_1 x^2 + 2c_1^2 x^2 - 8\alpha_1 c_1^2 x^2 - 4c_1^3 x^2 > 0
\end{align*}
$$

(A.28)

Using the constraints $0 < \alpha_1 \leq \frac{1}{2}$, $x \leq 1$, it is straightforward to show that:

$8c_1^3 x - 8\alpha_1 c_1^3 x - 4c_1^3 x^2 \geq 0$ and

$6\alpha_1 c_1^2 x - 12\alpha_1^2 c_1^2 x \geq 0$ and

$6\alpha_1^2 c_1^2 x + 2c_1^2 x^2 - 8\alpha_1 c_1^2 x^2 \geq 0$ and

$6\alpha_1^2 c_1^2 - 4\alpha_1^3 c_1^2 \geq 0$ and

$6\alpha_1^3 c_1 - 3\alpha_1^4 c_1 \geq 0$ and

$2\alpha_1 c_1 x^2 - 3\alpha_1^2 c_1 x^2 \geq 0$ and

$8\alpha_1^2 c_1 x - 6\alpha_1^3 c_1 x \geq 0$.

Subtracting these 7 equations from eq. A.28 leaves:

$$
\alpha_1^4 + 2\alpha_1^3 x + \alpha_1^2 x^2 > 0
$$

Which always holds under the constraints $0 < \alpha_1 \leq \frac{1}{2}$, $x \leq 1$. ■


