# Speculation with Information Disclosure[*]

Paolo Pasquariello[†] and Yifei Wang[‡]

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### Abstract

Sophisticated financial market participants frequently choose to disclose private information to the public—a phenomenon inconsistent with most theories of speculative trading. In this paper, we propose and test a model to bridge this gap. We show that when a speculator cares about both the short-term value of her portfolio and her long-term profit, information disclosure is incentive compatible: Disclosure in the form of a mixture of fundamental information and the speculator's position induces competitive dealership to revise prices in the direction of the speculator's position. Using mutual fund disclosure through newspaper articles, we find that when fund managers have stronger estimated short-term incentives, the frequency of strategic disclosures about stocks in their portfolios increases and those stocks' liquidity improves, consistent with our model.

**Keywords:** Liquidity, Market Depth, Trading, Disclosure, Private Information, Mutual Funds.

**JEL Classification Numbers:** D82, G14, G23.

# 1 Introduction

Private information is valuable. Much research in financial economics over the last three decades illustrates both its benefits to speculators and its impact on financial market quality through their trading activity. For instance, Kyle (1985) shows that speculators trade cautiously with private information to minimize its disclosure to less informed market participants. Importantly, in this model and many others, since speculators' trading profits monotonically depend on their informational advantage, protecting information leakage ensures maximal extraction of the rent of being informed.

Yet in reality, we also observe speculators strategically giving away their supposedly valuable information. These disclosures may take a variety of forms. Portfolio managers share perspectives on their covered firms through media interviews or public commentaries; activist investors have their opinions posted through Twitter feeds or blogs; etc. In a recent paper, Ljungqvist and Qian (2016) document an interesting phenomenon whereby some boutique hedge fund managers reveal evidence of questionable business activities by possibly overvalued firm—which they have gone through considerable trouble (and incurred great costs) to discover. Barring irrationality, this suggests that (cautious) disclosure of private information may indeed be optimal. For instance, Ljungqvist and Qian (2016) suggest that these hedge funds' voluntary disclosures may minimize the noise trader risk they face after taking short positions in those troubled firms (e.g., De Long et al. 1990; Kovbasyuk and Pagano 2015). Intuitively, for fear that market prices may further deviate from (poor) fundamentals, therefore forcing them to liquidate prematurely, fund managers disclose some private information to expedite convergence of prices to fundamentals.

The goal of this paper is to shed further light on the strategic disclosure of information in financial markets. Using a model of speculative trading based on Kyle (1985), we show that if an informed speculator's objective function includes not only long-term profit but also the short-term value of her portfolio, disclosure of information may naturally arise. This short-term objective captures parsimoniously a variety of forms of short-termism among

sophisticated market participants: a hedge fund manager with a short position may be concerned about forced liquidation because of a sharp drop in portfolio value (as in Ljungqvist and Qian 2016); a mutual fund manager may care about her fund's NAV, upon which her compensation is often contingent; financial derivatives holders have their gains or losses hinge on the price movements of the underlying asset before the expiration date; liquidity constraint or risk-aversion in general can also lead to concerns over short-term values. A recent literature on "portfolio pumping" examines the impact of similar incentives for speculators on their trading activity and resulting market outcomes. For instance, Bhattacharyya and Nanda (2012) argue that fund managers may "pump" the short-term value of their portfolios by trading "excessively" in the direction of their initial holdings—i.e., away from what is warranted by long-term profit maximization. Consequently, equilibrium prices are distorted in the short term, the more so the larger weight the fund manager places on her short-term NAV or when she has a larger initial position. We refer to this pumping strategy as "pumping by trading" (PBT).

In our model, we show that public disclosure of private information is an additional tool to achieve portfolio pumping. A sophisticated speculator may optimally reveal private information about her holdings and asset fundamentals at the same time, but in a mixed fashion. Unable to distinguish between the two, uninformed market participants (market-makers) may revise their priors about asset fundamentals in response to such disclosures when clearing the market. Accordingly, short-term equilibrium prices are pumped in the direction of the speculator's holdings. We refer to this pumping strategy as "pumping by disclosing" (PBD).

PBT hurts the speculator's long-term profit as she deviates from her long-term profit-maximizing strategy. When available, PBD reduces the adverse effects of PBT by limiting the equilibrium extent of "excessive" trading. Disclosure, however, is also costly, as it compromises the speculator's informational advantage, which in turn deteriorates the speculator's long-term profits. Nonetheless, we show that, in equilibrium, the benefits from alleviating

3

PBT and boosting the speculator's short-term value always outweigh the costs of compromising her informational advantage. Strategic disclosure, therefore, optimally arises in our model.

PBD has important implications for our understanding of the determinants of financial market quality. Disclosure has two opposite effects on market liquidity. On the one hand, as more private information is revealed, market-makers face less adverse selection risk and so lower the price impact of order flow, increasing market depth. On the other hand, as speculators refrain from PBT, a larger fraction of the aggregate order flow is driven by information-based trading, decreasing market depth. We show that when disclosure is incentive compatible, the former effect dominates the latter such that PBD improves market liquidity. We further show that with optimal disclosure, equilibrium prices are more informative (and at the same time more volatile) in the sense that they reflect a larger proportion of speculators' private information, even though speculators trade more cautiously with their private information and aggregate order flow carries less fundamental information.[1]

Our empirical analysis provides support for the model's implications. Our model suggests that strategic disclosure may be commonplace: Given a reasonably low cost, any partly-short-term-oriented speculator should find it optimal to disclose. Anecdotal evidence broadly supports this implication. For instance, portfolio managers "talk their book", i.e., discuss their positions in order to create or reduce interest and therefore promote buyers or sellers of the securities.[2] Yet, with the noteworthy exception of Ljungqvist and Qian (2016), empirical

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[1]In related work, Kovbasyuk and Pagano (2015) argue that when uninformed investors have limited attention, price-taking arbitrageurs in several undervalued assets may optimally choose to overweight and advertise their private payoff information about only one such asset to expedite convergence to fundamentals. When studying bilateral transactions with imperfect competition, Glode et al. (2017) also show that a privately informed agent facing a counterparty endowed with market power may find it optimal to voluntarily disclose his *ex post* verifiable information in order to mitigate the counterparty's inefficient screening, leading to socially efficient trade. However, Han and Yang (2013) postulate that social communication may hinder information production and worsen market efficiency by enabling traders to free-ride on better informed friends or prices. Others investigate the notion that firm managers have discretion to disclose information that investors do not observe (e.g., Shin 2003; Goto et al. 2009). The focus of our study is on the interaction between speculators' strategic trading and strategic disclosure of private information about asset payoffs and endowments in the presence of competitive dealership, and its implications for the process of price formation in the affected markets.

[2]This phenomenon has received ample coverage in the media. See, for instance, *"Every-*

4

evidence on this issue remains scarce. To that end, we focus on strategic disclosures made by mutual fund families through three major newspapers: the Wall Street Journal, the Financial Times and the New York Times. We then show that likely stronger short-term incentives of mutual fund managers are associated with increased occurrence of strategic disclosures and greater liquidity improvement for the disclosure targets. This evidence is both consistent with our model and (to our knowledge) novel to the literature on mutual fund management (e.g., surveyed in Elton and Gruber 2013).

The rest of the paper proceeds as follows. Section 2 introduces our model and derives its implications. Section 3 describes our data sources, while Section 4 presents the empirical results. We conclude in Section 5.

# 2   The Theory

In this section, we show how strategic disclosure may naturally arise in a standard Kyle (1985) setting, in contrast with the conventional wisdom in market micro-structure that information leakage hurts speculation. As we show, the key ingredient leading up to this result is that speculators face a trade-off between maximization of long-term profit and short-term portfolio value. As we discuss next, this stylized trade-off captures parsimoniously a variety of real-life conflicting incentives for sophisticated financial market participants.

We begin by describing a baseline model of speculative trading based on Kyle (1985) and Bhattacharyya and Nanda (2012), which gives rise to PBT. Next, we enrich this model by allowing for informative disclosure and derive novel implications of PBD for the equilibrium quality of the affected market. All proofs are in the Appendix.

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*body Talks Their Book, Everybody"* on Abnormal Returns, available at http://abnormalreturns.com/2010/02/18/everybody-talks-their-book-everybody/, or *"New Investing Strategy: Talk Your Book"* on BloombergView, available at https://www.bloomberg.com/view/articles/2014-03-07/new-investing-strategy-talk-your-book.

## 2.1 The Baseline Model

Our basic setting is a batched-order market as in Kyle (1985), with three periods, $t = 0, 1$ and 2, and one risky asset. At date $t = 2$, the payoff of the risky asset—a normally distributed random variable $v$ with mean $P_0$ and variance $\sigma_v^2$—is realized. Three types of risk neutral market participants populate the economy: An informed trader (the speculator), a competitive market making sector (MM), and liquidity traders. The structure of the economy and the decision processes leading up to order flow and prices are common knowledge among all market participants.

**Figure 1: Time Line**
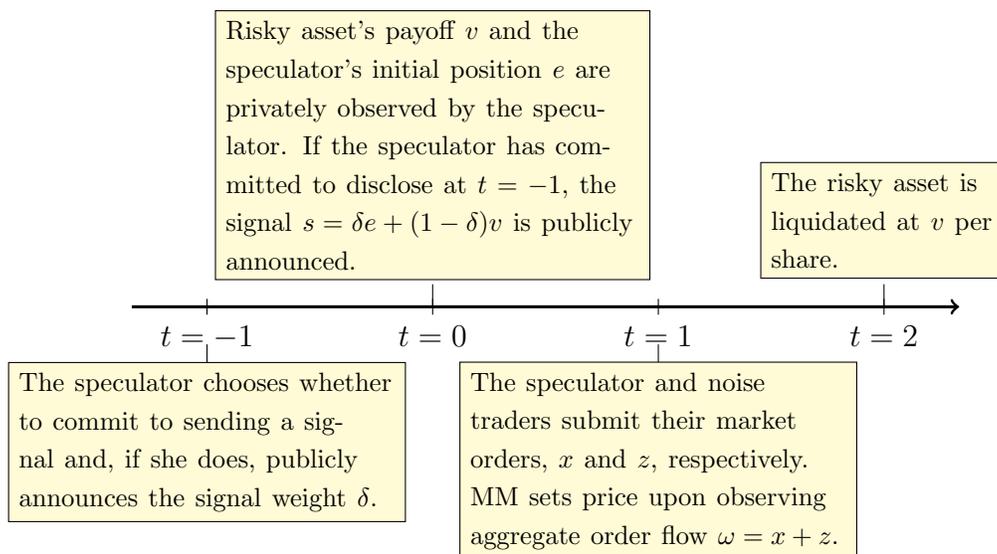


This figure depicts the time line of the baseline model (starting from period $t = 0$) and the signaling model (starting from period $t = -1$).

At date $t = 0$, the speculator privately observes the liquidation value of the risky asset $(v)$, as well as receives an initial endowment $(e)$ of the risky asset, also unobservable to all others. Throughout this paper, we use the terms "initial position", "initial endowment" and "initial holding" interchangeably, all referring to the speculator's position in the risky asset before the model's single round of trading. Individual allocations are endogenous in a

6

number of models.[3] This paper takes as given the level of information asymmetry (regarding both endowments and fundamentals) to study the speculator's strategic behavior thereafter. Hence we parsimoniously assume that $e$ is normally distributed with $\mathbb{E}(e) = \bar{e}$ and $\mathbb{V}(e) = \sigma_e^2$, as well as independent of $v$ ($\mathbb{C}(v, e) = 0$).

At date $t = 1$, both the speculator and liquidity traders submit market orders, $x(v, e)$ and $z$, respectively, to the MM, where $z \sim N(0, \sigma_z^2)$ is independent of all other random variables. The MM observes the aggregate order flow $\omega = x(v, e) + z$ and sets the equilibrium price $P_1 = P_1(\omega)$ that clears the market.

The departure we take from Kyle (1985) lies in the speculator's objective function. In Kyle (1985) as well as many other theoretical studies of price formation, long-term profit maximization is the sole objective of the speculator. In reality, however, many sophisticated market participants are found to be short-term oriented, or at least partly so. For instance, mutual fund managers are compensated on the basis of the funds' current net asset value (NAV). A fund's recent performance is crucial to its competition for fund flows as well as the success of its fund managers in the job market. Short-term performance also concerns activist investors as many of them choose to exit from their block holdings after carrying out interventions in a firm; the firm's valuation at the time of the exit would therefore largely affect the return to the activist investors.[4] More broadly, any investor with liquidity constraints or preferring early resolutions of uncertainty (e.g., under Epstein and Zin 1989 preferences) may wish all or part of her investment to pay off early. Lastly, the short-term performance of an asset may be relevant to investors holding both the asset and options on it. Following Bhattacharyya and Nanda (2012) and Pasquariello and Vega (2009), we capture these short-term incentives parsimoniously by assuming that the speculator's value function is separable in her short-term (i.e., date $t = 1$) value $W_1 = e(P_1 - P_0)$, and long-term (i.e.,

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[3]See, for instance, Back and Zender (1993).

[4]Accordingly, Greenwood and Schor (2009) associate abnormal returns surrounding hedge funds' announcements of activist intentions about a target to their ability to induce a take-over for that target.

date $t = 2$) profit $W_2 = x(v - P_1)$, such that:

$$W = \gamma W_1 + (1 - \gamma)W_2 \tag{1}$$

where $\gamma \in [0, 1]$ can be interpreted as the speculator's rate of substitution between short-
and long-term objectives. Finally, at date $t = 2$, the risky asset is liquidated at price $v$.

Consistent with Kyle (1985), we define a Bayesian Nash Equilibrium of this economy
as a trading strategy $x(v, e)$ and a pricing rule $p(\omega)$, such that the following conditions are
satisfied:

1. Utility Maximization: $x(v, e) = \arg \max \mathbb{E}[W | v, e]$;

2. Semi-strong form market efficiency: $P_1 = \mathbb{E}[v | \omega]$.

The following proposition characterizes the unique linear equilibrium of this economy.

**Proposition 1 (Baseline)** *The unique equilibrium in linear strategies of this economy is
characterized by the speculator's demand strategy*

$$x^*(v, e) = \beta \bar{e} + \frac{v - P_0}{2\lambda^*} + \frac{\beta}{2}(e - \bar{e}), \tag{2}$$

*and the MM's pricing rule*

$$P_1 = P_0 + \lambda^*(\omega - \beta \bar{e}), \tag{3}$$

*where*

$$\lambda^* = \frac{\sigma_v}{2(\beta^2 \frac{\sigma_e^2}{4} + \sigma_z^2)^{\frac{1}{2}}}, \tag{4}$$

*and*

$$\beta = \frac{\gamma}{1 - \gamma}. \tag{5}$$

In this model, $\beta$ captures the relative importance the speculator attaches to her short-term
objective ($W_1$). When $\beta = 0$, the speculator reduces to a long-term profit maximizer and

8

the ensuing equilibrium to the one in Kyle (1985): $x^k = \frac{v-P_0}{2\lambda^k}$ and $\lambda^k = \frac{\sigma_v}{2\sigma_z}$. As $\beta$ increases, the speculator's trading strategy deviates from long-term profit maximization ($x^* \neq x^k$) to pump up/down the equilibrium price in the direction of her initial position in the risky asset ($\mathbb{C}(P_1, e) = \frac{1}{2}\lambda^*\beta\sigma_e^2 > 0$), a behavior that we call portfolio pumping by trading (PBT). In particular, PBT improves market liquidity ($\lambda^* < \lambda^k$) by alleviating market makers' adverse selection risk. Further insights on PBT can be found in Bhattacharyya and Nanda (2012).

## 2.2  Equilibrium with Disclosure

We now extend the baseline model of Section 2.1 by allowing the speculator to publicly disclose information before trading.

Sophisticated market participants often make public announcements on asset fundamentals in a variety of forms. For instance, Ljungqvist and Qian (2016) document that some small hedge funds, after spending considerable resources to discover that a target firm is overpriced, not only take short positions in that firm but also publicly disclose that information in detailed reports (e.g. alluding the target firm of fabricating accounting figures or inflating productive capacity). Other disclosures are less aggressive. For instance, portfolio managers and financial analysts often make media appearances (on such outlets as CNBC, WSJ, etc.) discussing recent corporate events or market outlook. These talks may allow the involved speculator to reveal her private knowledge of asset fundamentals.

Importantly, however, these disclosures may reveal information not only about asset fundamentals, but also the speculator's own stake in that asset. To begin with, U.S. law mandates that the speculator be explicit about the conflict of interest in her disclosures such that the reader or audience should realize that the speculator stands to gain once her suggestions are followed.[5]

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[5]The Securities Exchange Commission (SEC) imposes fiduciary duty on financial advisors, which is made enforceable by Section 206 of the U.S Investment Advisers Act of 1940. Under the Act, an adviser has an affirmative obligation of utmost good faith and full and fair disclosure of all facts material to the clients engagement of the adviser to its clients. This is particularly pertinent whenever the adviser is faced with a conflict—or potential conflict—of interest with a client. The SEC has stated that the adviser must disclose

Even without conflict of interest, investors may rationally perceive public disclosures by speculators as tainted. After all, a speculator may be inclined, if she holds a long (short) position in an asset, to use her disclosures about that asset to induce investors to buy (sell) it. Current regulations, albeit stringent, may leave the information provider sufficient wiggling room for toning her message. The speculator may, for instance, disclose evidence with selective emphasis, but without crossing the line between truthful revealing and misrepresentation. Consequently, upon seeing a strongly negatively-toned disclosure about an asset by a speculator, a reader has every reason to suspect that the speculator is intentionally tilting her tone and that she is likely to hold a short position in that asset.[6]

Lastly, information on asset fundamentals and speculator's holdings are likely indistinguishable to an uninformed investor. On the one hand, any bias in a speculator's disclosure about asset fundamentals will likely depend on the speculator's stake in that asset. On the other hand, speculators are often not entirely transparent about their holdings. Many studies find that institutional investors disguise their portfolio holdings, e.g., by window dressing (e.g., Lakonishok et al. 1991, Musto 1999, and Agarwal et al. 2013). How much the speculators hide their positions may in turn depend on the fundamental information they want to keep private.

In short, speculators' disclosures are likely to reflect both their private fundamental information and their unobservable holdings; accordingly, uninformed market participants are likely to view any public disclosure by speculators as a function of both their private fundamental information and their unobservable holdings. We capture this observation in

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all material facts regarding the conflict such that the client can make an informed decision whether to enter into or continue an advisory relationship with the adviser. Additionally, the Act also applies to prospective clients. The SEC has adopted rule 206(4)1, prohibiting any registered adviser from using any advertisement (that includes notice through radio or television) that contains any untrue statement of material facts or is otherwise misleading. Accordingly, Ljungqvist and Qian (2016, p. 1989) note that each of the stock reports prepared by boutique hedge funds in their sample "prominently discloses that the arb[itrageur] has a short position in the target stock."

[6]Relatedly, Banerjee et al. (2016) show that in an investment game in which two players endowed with noisy private fundamental information have an incentive to coordinate, both the sender and the receiver may prefer strategic communication—in the form of only partially informative cheap-talk—to the sender's commitment to perfect disclosure.

the model by assuming that the speculator has the option to disclose a signal $s$ that is a convex combination of $e$ and $v$:

$$s(v, e) = \delta e + (1 - \delta)v, \tag{6}$$

where the coefficient $\delta \in [0, 1]$ represents the extent to which the signal is informative about speculators' holdings $(e)$ versus asset fundamentals $(v)$. The speculator may freely choose which $\delta$ to use, but she must commit to disclosing at the chosen $\delta$ at $t = 0$. Eq. (6) is a parsimonious characterization of the speculator's reporting strategy. More detailed discussions about the plausibility of this assumption is in Section 2.5.

To model strategic disclosure, we introduce a date $t = -1$, in which the speculator can choose either (1) to do nothing and proceed to date $t = 0$ (yielding the baseline equilibrium of Proposition 1), or (2) to commit to the following reporting strategy: She first chooses and commits to a particular $\delta$ at $t = -1$; then, at $t = 0$, after observing $v$ and $e$, she discloses the resulting signal $s$ of Eq. (6) to the public. Each reporting strategy thus corresponds to a choice of the weight $\delta$. When the speculator commits to disclose, the ensuing model has a unique equilibrium in linear strategies, in which the price schedule is a linear function of the signal and the order flow and the speculator's trading strategy is linear in the asset's liquidation value, initial position, and the signal.

**Proposition 2 (Equilibrium with Disclosure)** *If the speculator chooses to send a signal $s$ of Eq. (6) with publicly known weight $\delta$ (PBD), the ensuing linear equilibrium of the economy is characterized by the speculator's demand strategy*

$$x(v, e) = \frac{\beta}{2}(e + \bar{e}) + \frac{v - P_0}{2\lambda_1} - \frac{\lambda_2}{2\lambda_1}(s - \bar{s}) = \beta\bar{e} + \frac{\beta\lambda_1 - \delta\lambda_2}{2\lambda_1}(e - \bar{e}) + \frac{1 - (1 - \delta)\lambda_2}{2\lambda_1}(v - P_0), \tag{7}$$

*and the MM's pricing rule*

$$P_1 = P_0 + \lambda_1(\omega - \bar{\omega}) + \lambda_2(s - \bar{s}), \tag{8}$$

11

*where*

$$\lambda_1 = \frac{1}{\sqrt{\alpha^2 \beta^2 + 4\frac{\sigma_z^2}{\sigma_v^2} + 4\alpha^2 \frac{\sigma_z^2}{\sigma_e^2}}} > 0, \tag{9}$$

$$\lambda_2 = -\frac{\lambda_1}{\delta}(\beta - \frac{4\lambda_1 \sigma_z^2}{(\frac{1}{\alpha} - \beta\lambda_1)\sigma_e^2}), \tag{10}$$

*and*

$$\alpha = \frac{1 - \delta}{\delta}. \tag{11}$$

The coefficients $\lambda_1$ and $\lambda_2$ represent the equilibrium price impact of the order flow and public signal, respectively. In particular, it can be shown that for any $\delta$ such that disclosure is *ex ante* optimal (as discussed next), $\lambda_2 > 0$. Relative to the baseline equilibrium, and for any given level of market liquidity $\lambda'$, the speculator trades "less" both on private fundamental information ($\frac{1-(1-\delta)\lambda_2}{2\lambda'} < \frac{1}{2\lambda'}$) and her endowment ($\frac{\beta\lambda'-\delta\lambda_2}{2\lambda'} < \frac{\beta}{2}$). Intuitively, because the signal partly resolves fundamental uncertainty, information-based trading is less profitable; this captures the "cost" of PBD. However, PBD both alleviates the need for PBT and makes it less effective (by improving market depth, i.e., lowering $\lambda_1$). As we show shortly, the former effect of PBD translates into a reduction in long-term profit, whereas the latter yields an increase in long-term profit because of the reduced scale of PBT.

The MM incorporates the signal's information content about fundamentals in the market clearing price of Eq. (8). However, since the MM is unable to disentangle the signal's fundamental-related component and endowment-related component, both components have a positive impact on the equilibrium price. The fact that the signal moves prices in the direction of the endowment is especially desirable to a speculator who is at least partly short-term-oriented. The equilibrium price is high/low exactly when a high/low price is desirable—i.e., when her initial holdings of the asset are large ($e > \bar{e}$)/small ($e < \bar{e}$).

As we noted earlier, the equilibrium in Proposition 2 is conditional on the speculator committing to disclose a signal $s$. We now discuss when such a commitment is optimal. As we show in the following proposition, there always exist suitable choices of signal weight $\delta$,

at which committing to disclosure is *ex ante* optimal.

**Proposition 3 (Optimality of Disclosure)** *Let $D$ be the indicator variable for disclosure: $D = 1$ if the speculator commits to sending signal $s(v, e)$ and $D = 0$ otherwise. The following results hold:*

1. *The ex ante ($t = -1$) payoff to the speculator of committing to sending a signal with weight $\delta$ is given by*

$$\mathbb{E}\big[W(v, e, z)\big|D = 1, \delta\big] = (1 - \gamma)\lambda_1\sigma_z^2\frac{1 + \alpha\beta\lambda_1}{1 - \alpha\beta\lambda_1}, \tag{12}$$

   *where $\lambda_1$ is defined in Eq. (9).*

2. *The ex ante ($t = -1$) payoff to the speculator of not disclosing a signal is given by*

$$\mathbb{E}\big[W(v, e, z)\big|D = 0\big] = \frac{1 - \gamma}{4\lambda^*}(\sigma_v^2 + \beta^2\lambda^{*2}\sigma_e^2), \tag{13}$$

   *where $\lambda^*$ is defined in Eq. (4).*

3. *Disclosing is incentive compatible. Let $\delta^*$ be the optimal signal weight with disclosure:*

$$\delta^* = \arg\max_{\delta} \mathbb{E}\big[W(v, e, z)\big|D = 1, \delta\big], \tag{14}$$

   *then*

$$\mathbb{E}\big[W(v, e, z)\big|D = 1, \delta^*\big] > \mathbb{E}\big[W(v, e, z)\big|D = 0\big], \quad \forall\sigma_v^2 > 0, \sigma_e^2 > 0, \sigma_z^2 > 0, \gamma > 0. \tag{15}$$

The intuition for this result is that even with disclosure, the speculator can still replicate the equilibrium outcome in the baseline model by carefully choosing the signal weight $\delta$. If the speculator sends a signal with no information content above and beyond that of the aggregate order flow, then such a signal is redundant and the equilibrium reduces to the

baseline equilibrium. It can be shown that such a redundant signal is one with the weight $\hat{\delta} = \frac{1}{1+\lambda^*\beta\frac{\sigma_\epsilon^2}{\sigma_v^2}} \in (0,1)$, where $\lambda^*$ is given by Eq. (4).[7] Thus the action set of the speculator in the signaling equilibrium of Proposition 2 is $\delta \in [0,1]$ versus $\delta \in \{\hat{\delta}\}$, which is effectively her action set in the baseline equilibrium of Proposition 1. With a strictly larger action set, optimality of disclosure follows.

It might be counterintuitive that it is suboptimal for the speculator not to disclose. It is an established notion that (more) private information yields (more) trading profit. For instance, in Kyle (1985), the greater her informational advantage, the more profit the speculator could reap from trading. Releasing a signal of her private information is thus tantamount to (at least partly) giving away expected trading profits. Accordingly, most existing models in the micro-structure literature do not leave room for voluntary disclosure. In our model, however, the speculator is not a pure long-term profit maximizer. The loss of long-term profit caused by information revelation is compensated by gains in the short-term value of her portfolio; and the gains outweigh the losses—as shown in Proposition 3. By incorporating short-termism in the speculator's objective function, our model has the potential to explain the frequently observed voluntary disclosures in financial markets.

The following example may shed further light on the intuition behind Proposition 3. Assume that a speculator has the intention to "pump" price by disclosing a signal. In order for that signal to have any price impact, it must contain at least some fundamental information. Thus, in general, the signal should be a function of $v$ and possibly some noise $\epsilon$. Consider for simplicity the class of linear signals $s = v + \epsilon$. If the speculator follows a "naïve" strategy by setting $\epsilon$ to be purely random noise, such a disclosure would move prices in the desired direction only when the speculator's endowment shock happens to be

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[7]Specifically, under $\hat{\delta}$, the MM's two sources of information are: (a) The order flow $\omega - \bar{\omega} = \frac{1}{2\lambda^*}(v - P_0) + \epsilon_\omega$, where $\epsilon_\omega = \frac{\beta}{2}(e - \bar{e}) + z$, is the noise about fundamentals; and (b) the (scaled) signal $\frac{s - \bar{s}}{2\hat{\delta}\lambda^{*2}\beta\frac{\sigma_\epsilon^2}{\sigma_v^2}} = \frac{1}{2\lambda^*}(v - P_0) + \epsilon_s$, where $\epsilon_s = \epsilon_\omega + \eta$ with $\eta = \frac{2\sigma_z^2}{\beta\sigma_e^2}(e - \bar{e}) - z$. Since $\epsilon_\omega$, $\eta$ and $v - P_0$ are mutually independent, the signal is just the order flow plus uninformative noise. This implies that $v \perp s|\omega$, i.e., that given the order flow, a signal with weight $\hat{\delta}$ is redundant in learning about asset fundamentals. Thus, $\lambda_1 = \lambda^*$, $\lambda_2 = 0$, and the equilibrium reduces to the baseline equilibrium of Proposition 1.

in the same direction as the fundamental shock; otherwise the signal may backfire. The net effect of such a signal is that the speculator obtains no short-term gain on average but only long-term losses due to a compromised informational advantage.

Consider now a disclosure strategy that sets $\epsilon \propto e$. Since from a Bayesian perspective, how the noise is constructed is irrelevant to the inference of $v$, a signal with $\epsilon \propto e$ has the same impact on the MM's fundamental priors as a signal with purely random noise (given the same noise variance). But now the signal has an added benefit of leading the MM to interpret, e.g., a "large" endowment shock as a high fundamental shock, potentially leading to a "large" price change. Note that when $\epsilon = \frac{1}{\alpha}e$, this is effectively the signal in Eq. (6). Hence, pumping by disclosing is most effective exactly when the speculator cares most about it—when her endowment is "large".

## 2.3  Pumping by Trading and Pumping by Disclosing

In order to achieve her short-term objective, the speculator may either trade "excessively" in the direction of her initial endowment (PBT) or disclose a mixed signal (PBD). Our earlier discussion suggests that the speculator optimally uses both tools in equilibrium. In this section, we isolate the two tools and examine separately their effect on the speculator's short-term and long-term objectives ($W_1$ and $W_2$, respectively).

To that end, it is useful to take a closer look at the process by which information is used by the MM and the speculator. In the signaling equilibrium of Proposition 2, the MM receives the signal and the order flow simultaneously (Eq. (8)). Alternatively, one could think of the MM as separately absorbing the information in two steps. First, the MM observes the signal and updates his priors about $v$ and $e$. Second, the MM observes the order flow, and, together with his updated priors, sets the price. One could also think of the speculator as acting in two steps. First, she observes $v$ and $e$, discloses the signal according to Eq. (6), and forms belief about the MM's updated priors. Second, she trades in the updated information environment.

15

While both approaches yield the same equilibrium outcomes, the two-step approach allows for a more intuitive interpretation: The first step involves no trading and the second step represents a baseline equilibrium without disclosure. This helps isolate the effects of PBT and PBD.

### 2.3.1   A Two-step Formulation of the Signaling Equilibrium

We begin by formally describing an alternative approach to construct the signaling equilibrium of Proposition 2. Consider a two-stage game. In the first stage, the speculator privately observes $v$ and $e$ and then announces her signal $s$ of Eq. (6) at a predetermined weight $\delta$. In the second stage, trading takes place (as the baseline equilibrium).

We consider the Perfect Bayesian Equilibrium of this two-stage game. Note that with the *ex ante* commitment to disclose and a predetermined signal weight, no optional action occurs in the first step: Nature draws $v$ and $e$, publicly reports $s$, the speculator observes $v$ and $e$ directly and the MM updates her priors about $v$ and $e$ according to $s$. Thus we only need to study the equilibrium in the second step. We start with the information environment in the continuation game after Nature's draw - the common prior in the second step. Since the speculator is fully informed, the updated common prior is the MM's perceived distribution of $(v, e)$ conditional on $s$:

$$\begin{pmatrix} v \\ e \end{pmatrix} \Big| s \sim N \left[ \begin{pmatrix} \tilde{v} \\ \tilde{e} \end{pmatrix}, \begin{pmatrix} \tilde{\sigma}_v^2 & -\tilde{\sigma}_v \tilde{\sigma}_e \\ -\tilde{\sigma}_v \tilde{\sigma}_e & \tilde{\sigma}_e^2 \end{pmatrix} \right] \tag{16}$$

where

$$\tilde{v}(v, e) = P_0 + \frac{(1 - \delta)\sigma_v^2}{\delta^2 \sigma_e^2 + (1 - \delta)^2 \sigma_v^2} (s - \bar{s}) \tag{17}$$

$$\tilde{e}(v, e) = \bar{e} + \frac{\delta \sigma_e^2}{\delta^2 \sigma_e^2 + (1 - \delta)^2 \sigma_v^2} (s - \bar{s}) \tag{18}$$

$$\tilde{\sigma}_v^2(v, e) = \frac{\delta^2 \sigma_v^2 \sigma_e^2}{\delta^2 \sigma_e^2 + (1 - \delta)^2 \sigma_v^2} \tag{19}$$

and

$$\tilde{\sigma}_e^2(v, e) = \frac{(1-\delta)^2 \sigma_v^2 \sigma_e^2}{\delta^2 \sigma_e^2 + (1-\delta)^2 \sigma_v^2} \tag{20}$$

Proposition 1 can be applied to fully characterize the second stage equilibrium by replacing the prior distribution with the updated posteriors of Eqs. (16) to (20). The entire game is therefore a set of baseline equilibriums, one for each realization of $(v, e)$. Our next result shows that this two-stage approach yields the same equilibrium outcome as the single-stage signaling equilibrium.

**Proposition 4 (Equivalence)** *The Perfect Bayesian Equilibrium of the two-step game is identical to the single-step signaling equilibrium: For any realization of $v$, $e$, and $z$, the speculator submits the same market order, and the MM sets the same price.*

This two-step approach emphasizes the role of disclosure as reshaping the information environment before trading takes place. Effectively, price is formed in two steps: First, information in the signal is incorporated in the form of the MM's updated posteriors about $v$ and $e$; second, information in the order flow is incorporated through trading. This is a convenient result as it allows to separate the effects of PBT and PBD on the equilibrium.

### 2.3.2 Decomposing the Effects of PBD

Following the two-step approach, we decompose the speculator's value function in equilibrium as:[8]

$$\mathbb{E}[W(v,e,z)|D=1,\delta] = \mathbb{E}\Big\{ \overbrace{\gamma e(\tilde{v} - P_0)}^{\text{Short-term}} \Big\} + \underbrace{\mathbb{E}\Big\{ \overbrace{\gamma e(P_1 - \tilde{v})}^{\text{Short-term}} + \overbrace{(1-\gamma)x(v - P_1)}^{\text{Long-term}} \Big| s \Big\}}_{\text{Trading (second stage)}} \tag{21}$$

$$\underbrace{\phantom{\mathbb{E}\Big\{ \gamma e(\tilde{v} - P_0) \Big\}}}_{\text{Signaling (first stage)}}$$

Only trading can generate long-term profit, whereas both disclosure and trading serve to the speculator's short-term objective. The signal firstly shifts the price via updating the

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[8]Note that the expectation of $W$ given the speculator's period $t = -1$ information set is $\mathbb{E}[W(v,e,z)|D = 1, \delta] = \mathbb{E}\{\gamma e(\tilde{v} - P_0)\} + \mathbb{E}\{\mathbb{E}[\gamma e(P_1 - \tilde{v}) + (1-\gamma)x(v - P_1)|s]\}$, where the outer expectation in the second term drops because the expected payoff conditional on period $t = 1$ information is independent of s.

MM's inference of $v$; then this inference (and the market clearing price) is further affected by the speculator's trading in the aggregate order flow. The effect of the signal persists through the trading stage, as it shifts the prior mean of the MM's valuation. By construction, the signal positively depends on both $v$ and $e$. The first dependence means that the MM adjusts his inference ($\tilde{v}$) of $v$ upward on seeing a positive signal, whereas the second dependence means that a positive endowment shock $e$ leads to a positive signal. This feature serves to the speculator's short-term objective as it implies a positive correlation between $e$ and $\tilde{v}$ ($\mathbb{C}(e, \tilde{v}) = \frac{(1-\delta)\delta\sigma_v^2\sigma_e^2}{\delta^2\sigma_e^2 + (1-\delta)^2\sigma_v^2}$).

**Table 1: Decomposition of Speculator's Value Function**

|         | Actions | Short-term Objective | | Long-term Objective | |
|---------|---------|---------|---------|---------|---------|
|         |         | D=0 | D=1 | D=0 | D=1 |
| **Stage 1** | PBD | 0 | $\frac{1}{2}\gamma\tilde{\sigma}_v\tilde{\sigma}_e$ | 0 | 0 |
| **Stage 2** | PBT | $\frac{\gamma\beta}{2}\lambda^*\sigma_e^2$ | $\frac{\gamma\beta}{2}\lambda_1\tilde{\sigma}_e^2$ | $(1-\gamma)\lambda^*\sigma_z^2$ | $(1-\gamma)\lambda_1\sigma_z^2$ |

Table 1 decomposes the speculator's value function by PBT and PBD and their contributions to her long-term and short-term objectives. Comparing each component of the value function under disclosure ($D = 1$) versus no disclosure ($D = 0$) reveals that: (1) The direct effect (first step) of PBD is a boost to the speculator's short-term objective ($\frac{1}{2}\gamma\tilde{\sigma}_v\tilde{\sigma}_e$) but there is no direct effect on the long-term objective; (2) PBD allows the speculator to optimally cut back on her PBT such that the effect of PBT on her short-term objective is reduced ($\frac{\gamma\beta}{2}\lambda^*\sigma_e^2 > \frac{\gamma\beta}{2}\lambda_1\tilde{\sigma}_e^2$);[9] (3) PBD has two opposing effects on the speculator's long-term objective: First, the signal gives away part of the speculator's private information about $v$; second, less PBT means less information leakage about $v$ by the order flow; the net effect is a loss in long-term profit, as reflected by the improved price impact ($(1-\gamma)\lambda_1\sigma_z^2 < (1-\gamma)\lambda^*\sigma_z^2$).[10]

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[9]We later show that in equilibrium $\lambda_1 < \lambda^*$.

[10]Note that since the equilibrium price is semi-strong form efficient, the speculator's expected long-term profit is just noise traders' loss, and therefore depends solely on the price impact $\lambda$. Using Eqs. (16) to (20), the expression for price impact with disclosure ($\lambda_1$ in Eq. (9)) can be rewritten as:

$$\lambda_1 = \frac{\tilde{\sigma}_v}{2\sqrt{(\frac{\beta}{2})^2\tilde{\sigma}_e^2 + \sigma_z^2}}.$$

Proposition 3 shows that, after aggregating these effects, the speculator's value function is improved by PBD.

## 2.4 Equilibrium Properties and Comparative Statics

*A. Comparative Statics*

The optimal signal weight ($\delta^*$) depends on the model's primitives. In Figure 2, for different combinations of $(\sigma_v^2, \sigma_e^2, \sigma_z^2)$, we plot $\delta^*$ as a function of $\gamma$—the relative importance of the speculator's short-term objective.[11] For all combinations, optimal signal weight decreases monotonically in $\gamma$. Intuitively, when $\delta$ is smaller, the signal becomes more informative about $v$, leading to a larger loss of the speculator's informational advantage and long-term profit. Of course, if the speculator only cared about the long run ($\gamma = 0$), she would choose never to disclose valuable private information (i.e., $\delta = 1$). On the other hand, when the speculator values the short run ($\gamma > 0$), she wants the signal to have a large price impact; thus she needs the signal to be informative about both $v$ and $e$. It can be shown that a $\delta = \frac{\sigma_v}{\sigma_e + \sigma_v}$ induces the largest price impact of the signal in the direction of the speculator's endowment; in other words, this is the signal weight the speculator would choose if she cared only about the short-run.[12] Correspondingly, as $\gamma$ increases, the optimal choice of $\delta$ decreases from 1 to $\frac{\sigma_v}{\sigma_e + \sigma_v}$.

Figures 3 and 4 plot $\delta^*$ against $\sigma_v^2$ and $\sigma_e^2$, for different choices of $\gamma$ while holding all other parameters fixed. These plots show that the optimal choice of $\delta$ increases in $\sigma_v^2$ but

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Intuitively, the numerators and denominators of both the above expression and the one for price impact without disclosure ($\lambda^*$ of Eq. (4)) reflect the amount of information and non-information-based trading, respectively. With PBD, there is less information-based trading as the signal compromises the speculator's informational advantage, improving the price impact and reducing the speculator's profit. However, with PBD, non-information-based trading (PBT) is also reduced; this leads to the opposite effects on price impact and long-term profit. The net effect is that the speculator loses long-term profit.

[11]There is, unfortunately, no analytically tractable solution for $\delta^*$. Therefore, we derive its comparative statics numerically.

[12]Note that $\mathbb{C}(\tilde{v}, e) = \frac{\delta(1-\delta)\sigma_v^2 \sigma_e^2}{\delta^2 \sigma_e^2 + (1-\delta)^2 \sigma_v^2}$, which is maximized at $\delta = \frac{\sigma_v}{\sigma_v + \sigma_e}$. Note also that when the speculator cares only about the short-run, order flow would have zero price impact as the speculator's trades would have no information content. Thus only the signal can move the price and her short-run value would be given by $\mathbb{E}\{\gamma e(\tilde{v} - P_0)\} = \gamma \mathbb{C}(\tilde{v}, e)$, implying that optimal $\delta$ is $\frac{\sigma_v}{\sigma_v + \sigma_e}$.

decreases in $\sigma_e^2$. There are two forces driving this result. First, as noted earlier, the direct effect of PBD is maximized at $\delta = \frac{\sigma_v}{\sigma_e + \sigma_v}$, which is increasing in $\sigma_v^2$ and decreasing in $\sigma_e^2$. Second, since the indirect effect of disclosure involves reduction in long-term profit, a larger $\delta$ means a smaller weight on $v$, and therefore a smaller information loss. Thus the speculator optimally increases $\delta$ when the cost of information loss is larger, i.e., when $\sigma_v^2$ is large.

**Conclusion 1** *The optimal signal weight $\delta^*$ increases in $\sigma_v^2$, decreases in $\sigma_e^2$, and decreases in $\gamma$.*

We turn next to the size of disclosure gains. In particular, we examine how large a cost to disclosure would a speculator be willing to bear while still preferring PBD. Such a cost can be thought of as the opportunity cost to the manager of spending time in a TV studio, of composing and publishing a report, or the monetary cost of making an advertisement. For simplicity, we assume this cost to be a fixed amount $c$ paid by the speculator if she commits to send a signal at $t = -1$.

Proposition 3 suggests that disclosure is always optimal when it is costless. Given a fixed cost $c$ to disclose, we ask the following questions: For what range of $\gamma$ would the speculator still find it optimal to disclose? How does this range depend on the information environment ($\sigma_v^2$ and $\sigma_e^2$)?

To answer these questions, let

$$I^\gamma(c, \sigma_v^2, \sigma_e^2, \sigma_z^2) = \{\gamma \in [0,1] | \max_\delta \mathbb{E}\big[W|D=1,\delta\big] - c > \mathbb{E}\big[W|D=0\big]\}.$$

Intuitively, $I^\gamma$ is the set of $\gamma$ such that the speculator prefers costly disclosure to no disclosure *ex ante*. Figures 5 and 6 then plot the relation between $I^\gamma$ and $\sigma_v^2$ and $\sigma_e^2$, respectively. The two dashed lines represent upper and lower bounds of $I^\gamma$, while the solid line represents the width of the interval $[\inf I^\gamma, \sup I^\gamma]$. Note that the direct effect of PBD is to boost the short-term objective by $\gamma \mathbb{C}(e, \tilde{v}) = \gamma \frac{\delta^*(1-\delta^*)\sigma_v^2 \sigma_e^2}{\delta^{*2}\sigma_e^2 + (1-\delta^*)^2 \sigma_v^2}$, suggesting that the direct gains to disclose is increasing in both $\sigma_v^2$ and $\sigma_e^2$. This is consistent with Figure 5 and 6. Intuitively, both larger

$\sigma_v^2$ and larger $\sigma_e^2$ increase the scope of the speculator's value function (i.e., short-termism and pumping become more important for it), and therefore can support a larger range of $\gamma$ for a given fixed disclosure cost $c$.

**Conclusion 2** $(\sup I^\gamma - \inf I^\gamma)$ *is decreasing in $c$, increasing in $\sigma_v^2$ and increasing in $\sigma_e^2$.*

*B. Disclosure and Market Liquidity*

We now turn to the effect of PBD on market liquidity. As a benchmark, consider first the effect of a public signal of $v$ on the equilibrium depth of an economy where the speculator maximizes exclusively her long-term profit ($\gamma = 0$). Intuitively, any signal of $v$ would reduce the uncertainty about the asset's payoff, hence lowering adverse selection risk and equilibrium price impact (e.g., Pasquariello and Vega 2007, Kahraman and Pachare 2017)—the more so the greater is the initial uncertainty about $v$. Next, consider the effect of PBT alone on market liquidity, PBT also lowers equilibrium price impact since it induces the speculator to deviate from long-term profit maximization to increase the short-term value of her portfolio— the more so the greater is endowment uncertainty (Bhattacharyya and Nanda 2012).[13] The release of a signal may not only alleviate information asymmetry about $v$ but also reduce uncertainty about $e$ (and PBT), leading to opposing effects on liquidity. Accordingly, we show that disclosing can either increase or decrease the price impact depending on the signal weight $\delta$; yet, price impact is always smaller if PBD is *ex ante* optimal. Equivalently, the effect of $s$ on fundamental uncertainty prevails upon its effect on endowment uncertainty.

**Corollary 1** *(1) $\lambda_1$ increases with $\delta$; (2) $\lambda_1 < \lambda$ if and only if $\delta < \hat{\delta}$, where $\hat{\delta}$ is given by Eq. (A.16); (3) In particular, if $\delta$ is such that $\mathbb{E}\big(W(v, e, z | D = 1, \delta)\big) > \mathbb{E}\big(W(v, e, z) | D = 0\big)$, then $\lambda_1 < \lambda$.*

*C. Price Efficiency*

Our last result concerns price informativeness. We show that the equilibrium price is more efficient in the presence of PBD. Intuitively, to the extent that the signal conveys

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[13]Accordingly, the speculator becomes in effect a partial noise trader.

information regarding asset fundamentals, one would expect that a greater proportion of the speculator's private information will be incorporated into prices; this is indeed the case when a signal is optimally disclosed, as summarized in the following corollary.

**Corollary 2** *Denote by $\mathbb{V}(v|P_1, D = 0)$ the portion of the speculator's private information that is not incorporated into prices in the baseline PBT equilibrium of Proposition 1, and by $\mathbb{V}(v|P_1, D = 1, s(\delta))$ the portion of unincorporated information when the speculator sends a signal with weight $\delta$. (1) $\mathbb{V}(v|P_1, D = 0) = \frac{1}{2}\sigma_v^2$. (2) In the second step, less than half of the speculator's remaining private fundamental information is impounded into the price: $\mathbb{V}(v|P_1, D = 1, s(\delta)) > \frac{1}{2}\tilde{\sigma}_v^2$. (3) $\mathbb{V}(v|P_1, D = 1, s(\delta))$ increases with $\delta$. (4) $\mathbb{V}(v|P_1, D = 1, s(\delta)) \leq (<)\frac{1}{2}\sigma_v^2$ if $\delta$ is such that the speculator ex ante (strictly) prefers disclosure to no disclosure, or equivalently, if $\mathbb{E}\big(W(v, e, z|D = 1, \delta)\big) \geq (>)\mathbb{E}\big(W(v, e, z)|D = 0\big)$.*

Corollary 2 implies that, in the presence of PBD, the equilibrium price incorporates more of the speculator's private information, despite her more cautious trading activity (and less informative order flow).

In Kyle (1985), there is an equivalence between the volatility of price and the amount of private information being impounded.[14] This equivalence is preserved under both the PBT and PBD equilibriums:.

$$\mathbb{V}(P_1|D) = \sigma_v^2 - \mathbb{V}(v|P_1, D), \tag{22}$$

where $\sigma_v^2 - \mathbb{V}(v|P_1, D)$ measures the amount of information incorporated into the price. Therefore optimal PBD implies both greater price informativeness and greater price volatility.

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[14]To see this, note that $\sigma_v^2 = \mathbb{V}(\mathbb{E}(v|P_1, D)) + \mathbb{E}(\mathbb{V}(v|P_1, D))$, where we can drop the outer expectation because $\mathbb{V}(v|P_1, D)$ is constant across all realization of $P_1$ and $s$, and $\mathbb{E}(v|P_1, D) = P_1$ because price is semi-strong form efficient.

## 2.5 Discussion of Model Assumptions

In delivering our theoretical results, we made two important assumptions: (1) The speculator commits not to deviate, on observing her private information, from her disclosing strategy (which is determined *ex ante*) and (2) the speculator's signal is a linear combination of endowment ($e$) and fundamentals ($v$).

In our model, it is crucial that the speculator commits both to disclose and to a predetermined form of disclosure. Were the speculator not bound to disclose exactly $s = \delta e + (1-\delta)v$ *ex post*, she would have a strong incentive to deviate—given the significant gains from signal manipulation when the MM takes the signal at its face value. We discuss the plausibility of these two assumptions below.

On the theoretical side, most existing models in the information transmission literature rely on some commitment by the sender. For instance, Grossman and Stiglitz (1980), when modeling an economy in which market participants endogenously become informed by acquiring a signal, abstract from the information producer's problem, taking as a given that all information is the true fundamental up to an independent noise term. Admati and Pfleiderer (1988) study how an informed party sells information to the rest of the market in a model in which the seller can choose signal precision but not signal form and is bounded away from manipulation. Our paper closely resembles Admati and Pfleiderer's (1988) setting in that the informed agent not only transfers her private information, but also trades on her own account. Our paper is also closely related to Kamenica and Gentzkow (2011), in which an information sender is granted the ability to commit to both the form of the signal and truthful revelation of the signal. Kamenica and Gentzkow (2011) derive in their setting the optimal signal that would induce the receiver to take the most favorable actions to the sender. Our model adds to their setting an additional level of complication in that the speculator (the sender) can not only communicate information (disclose a signal), but also take action herself (trade directly on information).

On the empirical side, we note that, in financial markets, *ex post* deviation often entails

large penalties. As we argue, either one of the following costs may serve as a commitment device to deter deviation.

The first one is reputation cost. Although our model is a static one, a real-world speculator—be it a fund manager, venture capitalist, or specialist company—is most likely a repeated player. As reputation is generally believed to be of vital importance for any type of financial institution, the gains from "deviation" must be traded-off against the cost of reputation damage when the speculator decides what signal to provide. Reputation concerns, therefore, arguably constrain the extent to which the speculator may deviate from the committed (agreed-upon) signal disclosure process.[15]

A second commitment device is financial regulation. Regulators often impose and enforce stringent rules regarding disclosure made by fund managers and other key market participants. For instance, in regulating disclosure of financial asset fundamentals, the U.S. Investment Advisor Act of 1940 requires that an advisor has an obligation of "full and fair disclosure of all facts material to the client's engagement of the advisor to its clients, as well as a duty to avoid misleading them". In addition, the SEC prohibits any advisor from "using any advertisement that contains any untrue statement of material fact or is otherwise misleading". Similarly, in regulating any disclosure about a speculator's holdings, the SEC mandates that investment advisors with discretion over $100 million must file a Form 13(F) on a quarterly basis containing her positions in detail. Although the SEC gives hedge funds the option of delaying reporting on the basis of confidentiality, this confidential treatment is neither trivial nor guaranteed (Agarwal et al. 2013).

Since violating these regulations entail possibly significant punishment ranging from fines

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[15]For instance, one could apply the Folk Theorem to a repeated version of our model where (1) on the equilibrium path, the signaling equilibrium is reached in every stage and (2) once mis-reporting is detected at any time, the players switch to the baseline equilibrium in all subsequent stages. There is only one caveat: In our model, the one-shot gain from deviating could be arbitrarily large. Therefore, one must modify the stage equilibrium to fit in the Folk Theorem framework. One possible modification is as follows. Let $\underline{s}$ and $\bar{s}$ be two threshold values of the signal. If the signal is realized such that $\underline{s} \leq s \leq \bar{s}$ the same equilibrium is reached in the ensuing subgame as before. On the other hand, if $s$ is realized such that $s < \underline{s}$ or $s > \bar{s}$, then the MM will suspect that manipulation is in play and refuse to update his beliefs. Therefore, the ensuing continuation game proceeds with the same common prior as the original one.

to imprisonment, regulations leave the fund manager with little flexibility in her choice of disclosure. In the context of our model, this means the signal weight $\delta$ is effectively imposed (or restricted) by the regulators. If the speculator optimally chooses to disclose, she is constrained by regulation to stick to pre-specified signal weights.

Interestingly, this also implies that under some regulatorily imposed signal weights, a speculator may not find it incentive compatible to disclose. Regulation in effect puts the speculators through a screening process; only those who happen to have the right $\sigma_v^2$ and $\sigma_e^2$ choose to be vocal. To illustrate this observation, Figure 8 plots the speculator's value function in the signaling (solid line) and baseline (dashed line) equilibriums as functions of signal weight $\delta$. Figure 8 shows that, although for the optimal $\delta$ releasing a signal is always better than staying silent, there is only a narrow range of $\delta$ for which the speculator prefers the signaling equilibrium to the baseline equilibrium. For some speculators/firms, regulatorily imposed $\delta$ may be out of that range.

# 3    Data and Sample Selection

Our model argues that a speculator who cares about the short-term value of her holdings may voluntarily disclose some of her private information. Consistent with our model, Ljungqvist and Qian (2016) show that small hedge fund managers make public their findings about problematic firms after taking large short positions in those companies. Anecdotally, activist investors such as Carl Icahn or Bill Ackman frequently communicate their perspectives to the public through media interviews, Twitter feeds or blogs.[16] Our theory suggests that the use of strategic disclosure may be even more widespread than what currently reported in the literature, especially among (at least partly) short-term oriented sophisticated financial market participants.

Accordingly, we set to test our model by studying the effect of all voluntary disclosures

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[16]See, for instance, *"Carl Icahn Takes 'Large' Apple Stake"* on CNN Money, available at http://money.cnn.com/2013/08/13/technology/mobile/carl-icahn-apple/.

by mutual funds in the Wall Street Journal (WSJ), the Financial Times (FT), and the New York Times (NYT) on the U.S. stock market. Four observations motivate our choice. First, mutual funds arguably are among the most sophisticated financial market participants (e.g., Wermers 2000, Huang et al. 2011, Kacperczyk et al. 2008). Second, many studies show that mutual fund managers are subject to short-term concerns. For instance, numerous papers find that mutual fund flows are sensitive to past performance (e.g., Ippolito 1992, Sirri and Tufano 1998, Del Guercio and Tkac 2002). Additionally, mutual fund managers exhibit tournament-like behavior (e.g., Brown et al. 1996, Chevalier and Ellison 1999), consistent with short-term objectives. Third, the large reader base of those three newspapers and their broad coverage of the financial sector grants speculators broad access to investors at large, consistent with our model's notion of the disclosed signal being common knowledge. Fourth, newspaper disclosures leave traceable records, and mutual funds are required by law to regularly report their portfolio compositions; both ensure adequate availability of data to test our theory.[17]

## 3.1 Data and Identification Criteria

*A. Mutual Fund Holding Data*

Our sample spans from 2005 to 2014. We obtain mutual fund holdings data from the CRSP mutual fund database. The database provides portfolio compositions, including both long and short positions, of all open-end mutual funds in the United States. Holdings data is available at the monthly frequency. We use only quarter-end-month data as reporting of portfolio composition is only mandatory quarterly; non-quarter-end month data is missing for most funds. CRSP provides holdings data at the portfolio level. For our tests, however, we consolidate all data to the fund holding company level for two reasons. First, our empirical study involves linking a speculator's disclosure behavior to her incentives to disclose and (as

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[17]Investigating strategic disclosure and trading by hedge funds is significantly more challenging in light of severe data limitations on their managers' identity and portfolio holdings. Accordingly, the unreported analysis of a much smaller sample of hedge funds with viable such data yields qualitatively similar, yet noisier inference.

we observe next) most disclosures are only identifiable at the fund holding company level.[18] Second, it is plausible that funds within the same family may coordinate their disclosing strategy to serve the same family-level objective. The fund holding family, therefore, fits more closely with our notion of a sophisticated speculator in the model. We also collect from CRSP the names of all portfolio managers who have worked at each of the fund holding families during our sample period.[19]

For each quarter, we consider as potential disclosure targets all firms that are in the S&P 1500 universe as of the end of the previous quarter. We exclude all financial companies, as most of them are often also classified as speculators in our mutual fund sample. We obtain firm-level balance sheet information from Compustat.

## B. Mutual Fund Disclosure Data

Our disclosure data comes from two sources. We obtain WSJ articles from ABI/INFORM and FT and NYT articles from LexisNexis. For each newspaper, we obtain all articles published between 2005 and 2014. We then drop articles that are published in a non-business-related section, letters from readers, or corrections. We parse the news by paragraph to filter out strategic disclosures. Specifically, a paragraph is defined as a (potentially) strategic disclosure by fund holding company $j$ about target firm $i$ if either one of the following criteria is met:

1. Both names of the target company $i$ and the fund management company $j$ are found. Investment banks are frequently covered in the media together with other firms for reasons unrelated to strategic information disclosure (equity/bond underwriting, market making, mergers/acquisitions, rating assignments, etc.). To avoid confounding our analysis, we exclude investment banks (e.g., Goldman Sachs, Merrill Lynch, Wells

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[18]For example, it is much more likely for a news article to report a quote from "a portfolio manager with T. Rowe Price" rather than a quote from "a portfolio manager at T. Rowe Price Blue Chip Growth Fund".

[19]CRSP reports fund manager names with varying levels of precision. For the majority of fund managers, CRSP reports their first and last names; sometimes all first, middle and last names are available; sometimes CRSP either only reports the last name or states that the fund is "team-managed".

Fargo, etc.) from fund management companies, unless one of the following is true:

- Key words such as "analyst", "portfolio manager", or "strategist" appear in the same sentence as the mention of the fund holding company;

- Key words such as "securities", "holdings" or "asset management"—which indicate that the disclosure may come from a non-investment banking branch of financial institution $j$—closely follow the mention of the fund management company (i.e., with no more than one word in between);

- Name (first name followed by last name) of a portfolio manager associated with fund holding company $j$ is also found in the same paragraph.

2. The name of the target company $i$ is found and either one of the following is true:

- All first, middle, and last names of any portfolio manager at fund holding company $j$ are found;

- First and last names of any portfolio manager at fund holding company $j$ are found, and, in the same sentence, there are such key words as "analyst", "portfolio manager", etc.

Importantly, in applying these screenings, we do not separately search for information disclosures about fundamentals ($v$) versus the speculator's endowment ($e$), since, as noted earlier, the two are likely indistinguishable. Plausibly, speculators may provide information to the media with selective emphasis. Upon seeing a disclosure about fundamentals, a reader may rationally infer that the information provider has such a position that she stands to gain if her disclosure is impounded into the price. Second, as sophisticated investors choose their positions endogenously, information about their positions is also likely to be suggestive about fundamentals.

Table 2 reports, for each newspaper, the number of articles so identified as disclosures, as well as the number of articles that are in business-related and non-business-related sections.

28

Out of the 820,812 articles published in business-related sections, 10,473 are identified as strategic disclosures, amounting to a plausible 1.3% of all articles. Visual inspection of the identified articles shows that they capture the notion of "strategic disclosure" with reasonable accuracy. Table 3 reports four such paragraphs as examples.

*C. Liquidity*

We use stock price and trading data to compute a measure that is both commonly used in the literature and broadly consistent with the notion of Kyle's (1985) lambda in the model: Amihud's (2002) price impact. For stock $i$ on day $t$, it is computed as a rolling average of daily price impact:

$$Amihud_{i,t} = \frac{1}{90} \sum_{h=t-90}^{t-1} \frac{|r_{i,h}|}{vol_{i,h}}, \tag{23}$$

where $r_{i,h}$ is the return of stock $i$ on day $h$ and $vol_{i,h}$ is the dollar volume of trading of stock $i$ on day $h$, obtained by multiplying the number of shares traded by the closing price on that day.

*D. Summary Statistics*

Table 4 provides summary statistics for our sample. All reported variables are winsorized at the 2% and 98% levels to remove extreme realizations. Panel (A) of Table 4 summarizes the sample at holding company-quarter level. Each statistic is reported for the full sample, and for each of the five subsamples for which we restrict the number of disclosures made by the holding company in a quarter to be equal to zero or at least 1, 5, 10 or 15 over the sample period 2005-2014. Disclosing fund holding companies tend to be larger in size and hold less of their assets in equity and cash but more in bonds. There appears to be little variation in the funds' expense ratios.

Summary statistics at the firm-quarter and firm-fund-quarter levels are in Panels (B) and (C) of Table 4, respectively, for the full sample as well as for subsamples defined by the number of strategic disclosures associated with firm-quarters over 2005-2014. On average,

disclosure targets tend to be larger in size and hold more intangible assets. There is, however, no clear pattern in firm-level stock market liquidity and return volatility across disclosure subsamples.[20]

# 4    Empirical Results

## 4.1    Strategic Disclosure and Incentives to Disclose

Our theory implies that PBD is optimal for any at least partially short-term oriented speculator. Empirically, we argue that, *ceteris paribus*, fund holding families with stronger short-term incentives disclose more aggressively. The reason is two-fold. First, relative to long-term profit maximizers ($\gamma = 0$) who do not find it optimal to disclose, those with short-term incentives ($\gamma > 0$) clearly disclose more often. Second, even among partially short-term oriented financial market participants, some may not find the gains from PBD large enough to justify the cost of doing so. Consequently, we should observe more disclosures being made by those who, *ceteris paribus*, may benefit more from it—i.e., those who have a stronger short-term orientation (larger $\gamma$).[21]

We construct two proxies for a fund's short-termism.[22] Our first measure (denoted as

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[20]Because large numbers of disclosures are rare, the winsorized number of disclosures made about a firm in each quarter is capped at 5 throughout all subsamples in Panel (B). Accordingly, we do not winsorize the number of disclosures at the firm-fund-quarter level in Panel (C), since that number is zero in most firm-fund-quarters.

[21]Note that in our model, the gains from PBD are not monotonic in $\gamma$. Figures 5 and 6 suggest that *ex ante* disclosure gains first increase but then decrease as $\gamma$ increases. Intuitively, as the speculator places less weight on her long-term profit (when $\gamma$ grows larger), she is less concerned about the cost of PBT; thus she can achieve her short-term objective efficiently enough by PBT alone. As a result, PBD is less valuable to the speculator when $\gamma$ is sufficiently large. For our empirical tests, however, we ignore the decreasing portion of the gains from PBD (as a function of $\gamma$) because a so-behaving speculator would have to trade aggressively to take advantage of PBT. Such overt PBT is, however, unfeasible over our sample period (2005–2014) due to the sharp increase in investor attention and SEC enforcement about portfolio pumping since 2001 (e.g., Gallagher et al. 2009; SEC 2014; Duong and Meschke 2016). With PBT constrained by regulation, it is plausible that speculators would turn to PBD as a substitute, and the more so the more short-term oriented they are. Consequently, it is plausible that the gains from PBD are increasing for the entire feasible range of $\gamma$.

[22]Since our empirical tests aggregate fund information to the fund holding company level, throughout this section we use the terms "fund", "fund holding family/company" and "fund manager" interchangeably—all referring to a fund holding company and its management team. We also use the terms "short-termism",

$\hat{\gamma}^1_{j,t}$) captures a fund's flow-return sensitivity. As discussed earlier, an important reason mutual funds value their short-term performance is the competition for fund flows (Ippolito 1992, Sirri and Tufano 1998, Chevalier and Ellison 1997). Flow-performance sensitivity reflects the extent to which such competition matters to a fund manager. Additionally, limits to arbitrage also induce short-term concerns (Shleifer and Vishny 1997)—the significance of which arguably depends on a fund's flow-performance sensitivity as well. Accordingly, we argue that funds with greater flow-return sensitivity may be more responsive to their portfolio's short-term valuation. We compute flow-return sensitivity for each fund holding company $j$ in each quarter-end month $t$ in two steps. First, we estimate the following rolling regression of fund flows on contemporaneous and lagged fund returns—for each individual fund $k$ under holding company $j$—using monthly fund return and flow data over the past year (i.e., from month $m = t - 11$ to $m = t$):

$$\text{Flow}_{k,m} = \alpha_{k,t} + \sum_{h=0}^{2} \zeta^h_{k,t} \text{Ret}_{k,m-h} + \epsilon_{m,t}, \tag{24}$$

where $Flow_{k,m}$ are fund inflows or outflows, and $Ret_{k,m-h}$ are fund portfolio returns.[23] Second, we sum the resulting contemporaneous and lagged estimates of fund-specific flow-performance sensitivity:

$$\hat{\zeta}_{k,t} = \hat{\zeta}^0_{k,t} + \hat{\zeta}^1_{k,t} + \hat{\zeta}^2_{k,t}. \tag{25}$$

for each fund $k$ at each quarter-end month $t$. We then define our first measure of short-termism from these estimates as the NAV-weighted average of $\hat{\zeta}_{k,t}$ across all individual funds $k$ under holding family $j$.

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"incentives to disclose/PBD" and "short-term incentives" interchangeably—all referring to the empirical counterpart of our model parameter $\gamma$.

[23]So-estimated fund-specific flow-performance sensitivity from time-series data allows us to quantify each fund's potential return to PBT and PBD (i.e., the relative importance of short-termism, $\gamma$, in the speculator's value function of Eq. (1)). In the literature on fund flow-performance dependence, this relation is instead typically established in the cross-section (Sirri and Tufano 1998, Gruber 1996), and is found to be strongest among top-performing funds (Sirri and Tufano 1998, Chevalier and Ellison 1997). Unreported tests proxying for flow-performance sensitivity using dummy variables for top-performers in the cross-section of mutual funds based on past performances yield qualitatively similar results as those reported in this paper. Our analysis is also robust to using CAPM- or Fama-French three factor-adjusted returns—instead of raw returns—as measures of fund performance.

Our second measure of a fund's incentives to disclose ($\hat{\gamma}_{i,j,t}^2$) exploits the deviation of a fund's portfolio composition from the market portfolio. Practitioners typically evaluate fund managers by benchmarking their returns to, e.g., the market portfolio. Additionally, PBD in a stock may improve a fund's performance relative to the market only if that fund's percentage holdings in that stock differ from those of the market portfolio; hence the greater is that difference, the more "pivotal" is that stock for the fund's pumping activity. Similarly, a fund manager competing for fund flows would only benefit from PBD in a stock if her percentage holdings in that stock differ from her competitors' holdings. We use that stock's market share as a proxy for its benchmark holdings. To compute $\hat{\gamma}_{i,j,t}^2$, let $H_{i,j,t}^f$ be fund $j$'s percentage holdings of firm $i$ as of the end of quarter $t$:[24]

$$H_{i,j,t}^f = \frac{\text{Market Value of Firm } i \text{ Shares Held by Fund } j \text{ at the End of Quarter } t}{\text{Market Value of All S\&P 1500 Shares Held by Fund } j \text{ at the End of Quarter } t}, \quad (26)$$

and let $H_{i,t}^m$ be firm $i$'s representation in the S&P 1500 universe:

$$H_{i,t}^m = \frac{\text{Firm } i\text{'s Market Capitalization at the End of Quarter } t}{\text{Market Capitalization of the S\&P 1500 Universe at the End of Quarter } t}; \quad (27)$$

then we define $\hat{\gamma}_{i,j,t}^2$ as:

$$\hat{\gamma}_{i,j,t}^2 = \begin{cases} H_{i,j,t}^f/H_{i,t}^m, & \text{if } H_{i,j,t}^f > H_{i,t}^m, \\ H_{i,t}^m/H_{i,j,t}^f, & \text{otherwise.} \end{cases} \quad (28)$$

Importantly, $\hat{\gamma}_{i,j,t}^2$ does not distinguish the direction of the deviation in a fund's portfolio holdings—e.g., a percentage position in firm $i$ that is 50% less than the market portfolio results in the same $\hat{\gamma}_{i,j,t}^2$ as one that is twice the market's share. In our model, it is the *ex ante* intensity of short-termism ($\gamma$) to affect both the equilibrium extent of PBD and equilibrium price formation; the specific content of any resulting pre-committed strategic disclosure (e.g., its "direction") depends on specific, unobservable realizations of fundamental ($v$) and endowment ($e$) shocks. Therefore, both $\hat{\gamma}_{j,t}^1$ and $\hat{\gamma}_{i,j,t}^2$ measure exclusively a fund's unsigned incentives to disclose.

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[24]In a few instances, funds hold short stock positions yielding $H_{i,j,t}^f < 0$. Eliminating these positions from our sample does not affect our empirical analysis.

Summary statistics for $\hat{\gamma}^1_{j,t}$ and $\hat{\gamma}^2_{i,j,t}$ are in Panel (A) and Panel (C) of Table 4. Fund-flow sensitivity across fund families is non-trivial—e.g., an average standardized change in fund flows of about 0.42 in response to a cumulative one standard deviation shock in current and past fund performance. However, no clear pattern of fund flow-return sensitivity emerges across subsamples of different disclosure intensities. Disclosing funds, however, tend to have larger deviations in their portfolio holdings compared to non-disclosing funds.

To test the dependence of strategic disclosure on mutual fund manager short-termism, we estimate the following OLS model at the firm-fund-quarter level:

$$\#\text{Discl}_{i,j,t} = \beta_0 + \beta_1 \hat{\gamma}^s_{(i,)j,t} + \beta_2 \#\text{Discl}_{-i,j,t} + \beta_3 \#\text{Discl}_{i,-j,t} + \delta_y + \delta_q + \epsilon_{i,j,t}, \quad s = 1, 2 \qquad (29)$$

where $\#\text{Discl}_{i,j,t}$ is the number of articles in WSJ, FT and NYT identified as strategic disclosures about firm $i$ by fund $j$ during quarter $t$. All variables in our empirical analysis are standardized to adjust for differences in scale within and across variables and to facilitate the interpretation of the corresponding coefficients of interest; our inference is unaffected by this normalization.

Eq. (29) allows us (1) to test if funds with stronger short-term incentives disclose more frequently, as well as (2) to test if stocks that are more "pivotal" to fund managers become disclosure targets more often. Both (1) and (2) imply that $\beta_1 > 0$. Some fund managers may make more frequent media appearances for reasons unrelated to PBD (e.g., stronger media connections); we control for this possibility by including $\#\text{Discl}_{-i,j,t}$, the number of disclosures made by fund $j$ about all firms except firm $i$ during quarter $t$; this variable also controls for any fund-level characteristics that induce the fund to disclose about all firms. Some firms may become disclosure targets for reasons unrelated to PBD; for instance, a firm may become more newsworthy in correspondence with important, newsworthy corporate events—e.g., CEO turnover or merger talks. To control for this possibility, we also include $\#\text{Discl}_{i,-j,t}$, the number of disclosures made about firm $i$ by all funds except fund $j$ during quarter $t$. This variable also captures firm-level characteristics that may make a stock more newsworthy to all funds. We further include year fixed effects ($\delta_y$) and quarter fixed effects

($\delta_q$) to control for macroeconomic trends as well as seasonality in disclosure patterns. Lastly, to avoid the confounding effects caused by media-initiated disclosures, we exclude, for each firm in each quarter, funds with the largest holdings in that firm's stock from the analysis.[25]

We report estimates of Eq. (29) for both $\hat{\gamma}^1_{j,t}$ and $\hat{\gamma}^2_{i,j,t}$ in Columns (1) and (5), respectively, of Table 6. For ease of interpretation, we standardize all variables. Consistent with our model, in both cases $\hat{\beta}_1$ is positive and statistically significant—i.e., stronger short-term incentives are associated with higher frequency of disclosures. When proxying for short-termism with $\hat{\gamma}^2_{i,j,t}$, this effect is also economically large—e.g., a one standard deviation increase in short-term incentives corresponds to more than 20% standard deviation increase in the number of strategic disclosures. Estimates of $\beta_1$ are smaller for $\hat{\gamma}^1_{j,t}$. Since $\hat{\gamma}^1_{j,t}$ is a fund-quarter level variable, its effect on disclosure may be subsumed by the control variable $\#\mathrm{Discl}_{-i,j,t}$.

Next, we investigate whether the effect of short-termism on disclosure is more pronounced for subsets of firms whose characteristics may render PBD about them more effective. These tests may enhance our interpretation of the identified disclosures as PBD. We explore three such firm-level characteristics: size, tangibility and return volatility. Intuitively, stock prices may be more sensitive to information disclosure when the issuing firms are smaller, more intangible, or display greater fundamental uncertainty.[26] Plausibly, sophisticated fund managers may also have greater informational advantage about firms with these characteristics (larger $\sigma_v^2$), making (costly) PBD optimal for a larger number of funds (Figure 5). To examine these effects, we amend the baseline regression of Eq. (29) as follows:

$$\#\mathrm{Discl}_{i,j,t} = \beta_0 + \beta_1\hat{\gamma}^s_{(i,)j,t} + \beta_2\mathrm{Suit}_{i,t} + \beta_3\hat{\gamma}^s_{(i,)j,t} \times \mathrm{Suit}_{i,t} \tag{30}$$

$$+ \beta_4\#\mathrm{Discl}_{-i,j,t} + \beta_5\#\mathrm{Discl}_{i,-j,t} + \delta_y + \delta_q + \epsilon_{i,j,t}, \quad s = 1, 2,$$

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[25]Journalists often contact financial practitioners—typically one of the largest shareholders—for comments when reporting about a firm. Because such reporting involves both the speculator and the firm, it is likely picked up by our screening algorithm but may not represent a strategic disclosure.

[26]For instance, under the two-step formulation of the signaling equilibrium in Section 2.3.1, the revision in MM's prior is larger in correspondence to the release of a signal when *ex ante* fundamental uncertainty is larger, as shown by Eq. (17).

where $Suit_{i,t}$ is the inverse of firm size ($Size_{i,t}$), firm intangibility ($Intan_{i,t}$), or return volatility ($Stdev(Ret)_{i,t}$). Precise definitions of all variables are in Table 5. Since larger realizations of $Suit_{i,t}$ are associated with greater potential gains from PBD, rendering the firms more "suitable" as disclosure targets. we expect that the interaction term $\beta_3 > 0$ for all specifications.

We report estimates of Eq. (30) for $\hat{\gamma}^1_{j,t}$ and $\hat{\gamma}^2_{i,j,t}$ in Columns (2) to (4) and (6) to (8) of Table 6, respectively. As conjectured, $\hat{\beta}_3$ is positive under all specifications and, as earlier, these estimates are statistically significant when $\hat{\gamma}^2_{i,j,t}$ is used, yet not for $\hat{\gamma}^1_{j,t}$. As noted above, this may be due to $\hat{\gamma}^1_{j,t}$ not being firm-specific and so being subsumed by the control variable #Discl$_{-i,j,t}$ in Eq. (30). The economic significance of these estimates vary depending on the characteristic under examination. For instance, Columns (6) to (8) show that the effect of short-termism on disclosure is 5% to 19% stronger if the "suitability" of a firm—measured by size, tangibility, or return volatility—is one standard deviation larger than its mean.[27]

## 4.2    Strategic Disclosure and Liquidity

*A. Baseline Regression: Liquidity Effect of Disclosure*

Our model implies that in the presence of *ex ante* optimal PBD, market liquidity of the affected asset improves relative to the baseline scenario when only PBT is used (Corollary 1). Thus, we test for the effect of strategic disclosure on the liquidity of the target stock. To that end, we consolidate our sample to firm-quarter level and estimate the following OLS model:

$$\Delta\log(\text{Amihud}_{i,t}) = \beta_0 + \beta_1\Delta\log(\#\text{Discl}_{i,t}) + \beta_2\Delta\log(\#\text{Discl}_{-i,t}) + \delta'\Delta\log(X) + \delta_y + \delta_q + \epsilon_{i,t} \quad (31)$$

where $\Delta\log(\text{Amihud})_{i,t}$ is the log change (from the previous to the current quarter) in Amihud's (2002) liquidity measure of firm $i$'s shares, $\Delta\log(\#\text{Discl})_{i,t}$ is the log change in the number of disclosures made (by all sample funds) about firm $i$, and $\Delta\log(X)$ is a vector

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[27]Since all variables are standardized in Table 6, $\hat{\beta}_1$ measures the effect of short-termism on disclosure at mean $Suit_{i,t}$, while $\hat{\beta}_1 + \hat{\beta}_3$ measures such effect when $Suit_{i,t}$ is one standard deviation above its mean.

of log changes in several control variables including firm size, intangibility, price level and return volatility. First-difference regressions alleviate potential non-stationarity biases due to persistence in firms' level illiquidity (e.g., an average AR(1) coefficient of 0.73 across the funds in our sample; Hamilton 1994). Data limitations preclude higher-frequency analysis of the liquidity externalities of PBD. We also include log changes in $\#\text{Discl}_{-i,t}$, the number of disclosures made about all firms except firm $i$, to control for the possibly contemporaneous release of market-level news. Lastly, we include year fixed effects ($\delta_y$) and quarter fixed effects ($\delta_q$) to control for long-term trends and seasonality.

The coefficient of interest is $\beta_1$. Since Eq. (31) is in (log) changes, its estimation is immune from any time-invariant (omitted) factor that may affect both levels of disclosure and liquidity. Our model predicts $\beta_1 < 0$: *ceteris paribus*, an increase in the number of strategic disclosures should be associated with an improvement in the liquidity of the disclosure target's shares. We report estimates of Eq. (31) in Column (1) of Table 7. Consistent with our model, estimated $\beta_1$ is negative and statistically significant. The economic magnitude of this effect, however, is quite small—e.g., a one standard deviation increase in disclosure changes only translates into a 0.008 standard deviation increase in liquidity improvement. The lack of economic significance may be due to several reasons. First, strategic disclosure is only one of the many factors influencing stock liquidity (e.g., shocks to ownership structure, equity issuance, changes in credit rating, earnings announcements, institutional trading, changes in trading platforms and specialist companies, etc.), all of which may cause variation in liquidity that mute the effect of PBD. Second, our sample is made of firms in the S&P 1500 universe, all of which are well-established, highly liquid companies, and thus may be the least suitable targets for PBD. The evidence in Ljungqvist and Qian (2016) suggests that more intense PBD may take place—with more pronounced effects—in smaller, more opaque and possibly private firms, for which liquidity and fund holding data are not available. Lastly, newspapers are only one of the venues through which a fund manager may disclose information. Thus, our measure of disclo-

sure may not fully capture the true intensity of PBD, subjecting Eq. (31) to attenuation bias.

## B. Liquidity Effect of Disclosure and Short-term Incentives

Information disclosures in general—not just strategic ones (PBD)—resolve uncertainty and thus may improve liquidity ($\lambda_1$ decreases in $\sigma_v^2$ as shown in Eq. (9)). To distinguish the effect of PBD from that of other disclosures, we test if the estimated liquidity improvement in correspondence with the disclosures in our sample is greater when a firm is more "pivotal" to the funds' short-term objectives. To that end, we amend Eq. (31) as follows:

$$\Delta\log(\text{Amihud}_{i,t}) = \beta_0 + \beta_1\hat{\gamma}_{i,t} + \beta_2\Delta\log(\#\text{Discl}_{i,t}) + \beta_3\hat{\gamma}_{i,t} \times \Delta\log(\#\text{Discl}_{i,t}) \quad (32)$$
$$+ \beta_4\Delta\log(\#\text{Discl}_{-i,t}) + \delta'\Delta\log(X) + \delta_y + \delta_q + \epsilon_{i,t},$$

where our "pivotal" measures are reused to reflect how well revelation of private information about a firm lines up with mutual funds' short-term incentives. Since our tests on liquidity are conducted at firm-quarter level, $\hat{\gamma}_{i,t}$ are constructed in two steps to capture the "pivotalness" of firm $i$ to the short-term objective of the mutual fund sector as a whole, not any individual fund. In what follows, we focus on our proxy based on fund-flow performance $\hat{\gamma}_{i,t}^1$.[28] First, we compute a weighted average flow-performance sensitivity across all mutual funds with non-zero holdings in firm $i$:

$$\overline{\hat{\gamma}^1}_{i,t} = \frac{1}{\sum_j |\text{Shr}_{i,j,t}|} \sum_j |\text{Shr}_{i,j,t}| \times \hat{\gamma}_{j,t}^1, \quad (33)$$

where $\text{Shr}_{i,j,t}$ is the number of firm $i$ shares held by fund $j$ at the end of quarter $t$, and $\hat{\gamma}_{j,t}^1$ is defined in Eq. (25). Since $\hat{\gamma}_{j,t}^1$ is weighted by the fund's shareholdings, $\overline{\hat{\gamma}^1}_{i,t}$ effectively measures the average flow-return sensitivity across firm $i$'s (mutual fund) shareholders.[29]

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[28]Estimates using $\hat{\gamma}_{i,t}^2$, which is based on deviation of the mutual fund sector's portfolio holdings from the market portfolio, yield quantitatively similar inference, as discussed later in this section.

[29]Absolute share holdings in Eq. (33) allow us to account for the few instances in which funds hold short stock positions; our inference is unaffected by either the removal of these positions from our sample or the use of signed share holdings. In unreported tests, we also consider an alternative weighting scheme in computing

Then, we define $\hat{\gamma}_{i,t}^1$ as

$$\hat{\gamma}_{i,t}^1 = \log(1 + \overline{\hat{\gamma}^1}_{i,t}) \tag{35}$$

Estimates of Eq. (32) are in Column (3) of Table 7: The coefficient $\hat{\beta}_3$ is negative and statistically significant. Consistent with our interpretation of the disclosures in our sample being due to PBD, the negative relationship between liquidity and firm-level strategic disclosures is stronger when such disclosures align more with the funds' short-term objectives; for instance, the liquidity improvement accompanying those disclosures is up to two times larger in correspondence with a one standard deviation increase in measured short-termism from its mean.

*C. Liquidity Effect of Disclosure, Short-term Incentives and Firm Characteristics*

To provide further evidence for PBD, we also explore whether the aforementioned liquidity effects are stronger when certain firm characteristics may make PBD more effective. As before, we focus on three firm characteristics ($Suit_{i,t}$)—size, intangibility, and stock return volatility. We amend Eq. (32) to include $Suit_{i,t}$ as an additional interaction term, each time reflecting (the log difference of) one of these firm characteristics:

$$\Delta\log(\text{Amihud}_{i,t}) = \beta_0 + \beta_1\hat{\gamma}_{i,t} + \beta_2\text{Suit}_{i,t} + \beta_3\hat{\gamma}_{i,t} \times \text{Suit}_{i,t} + \beta_4\Delta\log(\#\text{Discl}_{i,t}) \tag{36}$$

$$+ \beta_5\Delta\log(\#\text{Discl}_{i,t}) \times \hat{\gamma}_{i,t} + \beta_6\Delta\log(\#\text{Discl}_{i,t}) \times \text{Suit}_{i,t}$$

$$+ \beta_7\Delta\log(\#\text{Discl}_{i,t}) \times \hat{\gamma}_{i,t} \times \text{Suit}_{i,t} + \beta_8\Delta\log(\#\text{Discl}_{-i,t}) + \delta'\Delta\log(\text{X}) + \delta_y + \delta_q + \epsilon_{i,t}.$$

These estimates are in Columns (6) to (8) of Table 7. Estimated $\hat{\beta}_4$, $\hat{\beta}_5$, $\hat{\beta}_6$ and $\hat{\beta}_7$ are

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$\overline{\hat{\gamma}^1}_{i,t}$:

$$\overline{\hat{\gamma}^1}_{i,t} = \frac{1}{\sum_j |H_{i,j,t}^f - H_{i,t}^m|} \sum_j |H_{i,j,t}^f - H_{i,t}^m| \times \hat{\gamma}_{j,t}^1, \tag{34}$$

where $H_{i,j,t}^f$ and $H_{i,t}^m$ are defined as in Eqs. (26) and (27), respectively. This scheme puts larger weights on funds whose holdings in firm $i$ differ more from the market. As these funds are more likely to benefit from PBD in terms of their performance relative to the market, their short-term incentives (i.e., their flow-return sensitivity) are more likely to affect the gains from revealing private information about firm $i$. This alternative measure yields similar inference.

negative and both economically and statistically significant in most specifications, e.g., suggesting that the liquidity improvement associated with strategic disclosures about a firm is up to four times larger ($\hat{\beta}_4 + \hat{\beta}_5$ versus $\hat{\beta}_4$ in Eq. (36)) when mutual funds holding that firm's stocks have stronger short-term incentives, and, in those circumstances, up to more than two times as large ($\hat{\beta}_4 + \hat{\beta}_5 + \hat{\beta}_6 + \hat{\beta}_7$ versus $\hat{\beta}_4 + \hat{\beta}_5$) when PBD about that firm is likely more effective. This evidence is consistent with the model's notion that sophisticated speculators may use PBD to achieve their short-term objectives and, when they do so, the stock market liquidity of the target firm may improve.

*D. Liquidity Effects of PBT and PBD*

We note in Section 2.4.B that PBT may also improve the liquidity of the affected stock. As PBD and PBT are correlated, we need to control for PBT in testing for the effect of strategic disclosures on liquidity. As a first step, we examine the effect of PBT alone on liquidity through the following regression:

$$\Delta\log(\text{Amihud}_{i,t}) = \beta_0 + \beta_1 \hat{\gamma}_{i,t} + \beta_2 \Delta\log(\text{Trading}_{i,t}) + \beta_3 \Delta\log(\text{Trading}_{i,t}) \times \hat{\gamma}_{i,t} \qquad (37)$$
$$+ \delta' \Delta\log(\text{X}) + \delta_y + \delta_q + \epsilon_{i,t},$$

where $\Delta\log(\text{Trading})_{i,t}$ is the log change in aggregate percentage trading of firm $i$ by all sample mutual funds. Our baseline model (Proposition 1) implies that $\beta_2 < 0$ ($\lambda^* < \lambda^k$; see Section 2.1).[30] The sign of $\beta_3$, however, is ambiguous. Intuitively, in equilibrium, the speculator optimally employs both PBT and PBD to achieve her short-term objective. A stronger short-term objective (larger $\gamma$) has two opposing effects on the scale of PBT. First, it increases PBT, as it "pumps up" her short-term portfolio value. Second, stronger short-term incentives also induce the speculator to more aggressive PBD as a partial substitute

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[30]The premise for $\beta_2 < 0$ is that our measure of mutual fund trading indeed captures PBT. This may not be the case as $\Delta\log(\text{Trading})_{i,t}$ also contains speculative trading in the usual sense (Kyle 1985), which has the opposite effect on liquidity. Accordingly, Column (2) of Table 7 shows that the first order effect of trading on price impact is positive.

for costly PBT (in terms of loss of long-term profit from speculative trading).

Estimates of Eq. (37) are in Column (4) of Table 7. Consistent with our model, $\hat{\beta}_2$ is negative and statistically significant, while $\beta_3 > 0$ suggests that the substitution effect dominates the portfolio pumping effect, consistent both with our model and the increasingly stricter SEC enforcement of regulation prohibiting pumping by trading over our sample period.

Next, we examine the effect of PBT on the relationship between PBD and stock market liquidity. We do so by amending Eq. (36) to include mutual funds' trading as well as its interactions with short-term incentives and the relevant firm characteristics as follows:

$$
\begin{aligned}
\Delta\log(\text{Amihud}_{i,t}) = {} & \beta_0 + \beta_1\hat{\gamma}_{i,t} + \beta_2\Delta\log(\#\text{Discl}_{i,t}) + \beta_3\Delta\log(\#\text{Discl}_{i,t}) \times \hat{\gamma}_{i,t} \qquad (38) \\
& + \beta_4\Delta\log(\#\text{Discl}_{i,t}) \times \text{Suit}_{i,t} + \beta_5\Delta\log(\#\text{Discl}_{i,t}) \times \hat{\gamma}_{i,t} \times \text{Suit}_{i,t} + \beta_6\Delta\log(\#\text{Discl}_{-i,t}) \\
& + \beta_7\Delta\log(\text{Trading}_{i,t}) + \beta_8\Delta\log(\text{Trading}_{i,t}) \times \hat{\gamma}_{i,t} + \beta_9\Delta\log(\text{Trading}_{i,t}) \times \text{Suit}_{i,t} \\
& + \beta_{10}\Delta\log(\text{Trading}_{i,t}) \times \hat{\gamma}_{i,t} \times \text{Suit}_{i,t} + \beta_{11}\text{Suit}_{i,t} + \beta_{12}\hat{\gamma}_{i,t} \times \text{Suit}_{i,t} + \delta'\Delta\log(X) + \delta_y + \delta_q + \epsilon_{i,t}
\end{aligned}
$$

The signs, statistical significance and economic magnitude of the resulting estimates—in Columns (12) to (14) of Table 7—are very similar to those in Columns (6) to (8). Thus, the effect of funds' strategic disclosure on liquidity is robust to controlling for their strategic trading behavior. For example, relative to the case where both funds' short-term incentives ($\hat{\gamma}_{i,t}^1$) and firms' "suitability" as disclosure targets ($Suit_{i,t}$) are held at their means, the liquidity improvement associated with fund disclosures is between two and five times larger in correspondence with a one standard deviation increase in short-term incentives alone, and between eight and fourteen times larger in correspondence with a one standard deviation increase in both $\hat{\gamma}_{i,t}^1$ and $Suit_{i,t}$.

### E. Alternative Measure of Short-term Incentives

Lastly, we consider an alternative proxy for mutual funds' short-term incentives based on

$\hat{\gamma}_{i,j,t}^2$ of Section 4.1. Specifically, we construct $\hat{\gamma}_{i,t}^2$ as the percentage deviation in the mutual fund sector's holdings of firm $i$ from the market:

$$\hat{\gamma}_{i,t}^2 = \begin{cases} \log(\frac{H_{i,t}^f}{H_{i,t}^m}), & \text{if } H_{i,t}^f > H_{i,t}^m, \\ \log(\frac{H_{i,t}^m}{H_{i,t}^f}), & \text{otherwise,} \end{cases} \tag{39}$$

where $H_{i,t}^f = \frac{\text{Aggregate Holdings of Firm i by All Sample Funds at the End of Quarter t}}{\text{Aggregate Holdings of All S\&P 1500 Firms by All Sample Funds at the End of Quarter t}}$ and $H_{i,t}^m = \frac{\text{Market Cap. of Firm i at the End of Quarter t}}{\text{Total Market Cap. of All S\&P 1500 Firms at the End of Quarter t}}$.

We then run all of the tests in Table 7 using $\hat{\gamma}_{i,t}^2$ instead of $\hat{\gamma}_{i,t}^1$. These estimates, in Table 8, yield qualitatively and quantitatively similar inference. For instance, Column (1) of Table 8 indicates that more disclosures about a firm are accompanied by an improvement in the liquidity of its stock; according to Column (3), this effect is more pronounced when mutual funds are taking larger bets in a firm (i.e., have stronger short-term incentives to PBD)—e.g., about two times larger in correspondence with a one standard deviation increase in $\hat{\gamma}_{i,t}^2$ relative to its mean. Columns (6) to (8) further show that such effect is even stronger if a firm is a more "suitable" disclosure target—for example, increasing by up to two times $(\hat{\beta}_4 + \hat{\beta}_5 + \hat{\beta}_6 + \hat{\beta}_7$ versus $\hat{\beta}_4 + \hat{\beta}_5$ in Eq. (38)) when $Suit_{i,t}$ is one standard deviation larger than its mean.

# 5 Conclusions

In this paper, we model and provide evidence of sophisticated speculators' strategic disclosure of private information. First we develop a model of strategic speculation based on Kyle (1985) and show that when a speculator is (at least partially) short-term oriented, voluntary disclosure of private information is optimal. We model disclosure as a signal that depends positively on two pieces of a speculator's private information—asset fundamentals and her initial endowment in that asset. Intuitively, a positive (negative) endowment shock leads to a more positive (negative) signal realization, which, in turn, may be interpreted by uninformed

market participants—the market makers—as a positive (negative) fundamental shock, resulting in equilibrium price changes in the same direction as the endowment shock. Thus, strategic disclosure yields a positive correlation between a speculator's initial endowment in an asset and its short-term price, boosting her portfolio value and her overall value function. Additionally, we show that strategic disclosure has important implications for the affected market. Relative to the non-disclosure case, market depth increases and prices are more efficient. Overall, our analysis has the potential to bridge the gap between the conventional wisdom that information is valuable only if kept private and the not uncommon observation that sophisticated financial market participants voluntarily (and possibly strategically) disclose information to the public.

We provide supportive empirical evidence in the context of the U.S. mutual fund industry. We find that funds' stronger short-term incentives are associated with more frequent disclosures—a pattern that is most pronounced for target firm-level characteristics (namely small size, intangibility, and high return volatility) that likely make strategic disclosure more effective. We also find that (1) these disclosures in target firms are accompanied by liquidity improvements of their stocks and (2) this effect is stronger if the disclosure target is more "pivotal" to the funds' short-term objectives, and is even more so if once again the disclosure is likely more effective.

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# A Proofs

**Proof of Proposition 2.**

Conjecture MM's pricing strategy takes the following form:

$$P_1 = P_0 + \lambda_1(\omega - \bar{\omega}) + \lambda_2(s - \bar{s}). \tag{A.1}$$

After observing $v$ and $e$, the speculator's expected period $t = 1$ price is

$$\mathbb{E}(P_1|v, e) = P_0 + \lambda_1(x - \bar{x}) + \lambda_2(s - \bar{s}). \tag{A.2}$$

Plug this into her objective function:

$$\mathbb{E}(W(v, e, u)|v, e, D = 1, \delta) = \gamma e[\lambda_1(x - \bar{x}) + \lambda_2(s - \bar{s})] + (1 - \gamma)[x(v - P_0 - \lambda_1(x - \bar{x}) - \lambda_2(s - \bar{s}))]. \tag{A.3}$$

This leads to the first order condition:

$$\frac{\partial}{\partial x}\mathbb{E}(W(v, e, u)|v, e, D = 1, \delta) = \gamma e\lambda_1 + (1 - \gamma)[v - P_0 + \lambda_1\bar{x} - \lambda_2(s - \bar{s}) - 2\lambda_1 x] := 0. \tag{A.4}$$

Thus, defining $\beta = \frac{\gamma}{1-\gamma}$,

$$x^*(e, v) = \beta\bar{e} + \frac{\beta\lambda_1 - \delta\lambda_2}{2\lambda_1}(e - \bar{e}) + \frac{1 - (1 - \delta)\lambda_2}{2\lambda_1}(v - P_0). \tag{A.5}$$

To solve for $\lambda_1$ and $\lambda_2$, impose that, by competitive market making, the conjectured pricing rule (A.1) must be the MM's expected liquidation value:

$$P_1 = \mathbb{E}(v|s, y). \tag{A.6}$$

Under normality, the conditional expectation takes the following form:

$$\mathbb{E}(v|s, \omega) = P_0 + \sigma_v^2 \begin{bmatrix} 1 - \delta \\ 1 - (1 - \delta)\lambda_2 \end{bmatrix}' \times A^{-1} \times \begin{bmatrix} s - \bar{s} \\ 2\lambda_1(\omega - \bar{\omega}) \end{bmatrix}, \tag{A.7}$$

where $A =$

$$\begin{bmatrix} \delta^2\sigma_e^2 + (1 - \delta)^2\sigma_v^2 & \delta(\beta\lambda_1 - \delta\lambda_2)\sigma_e^2 + (1 - \delta)(1 - (1 - \delta)\lambda_2)\sigma_v^2 \\ \delta(\beta\lambda_1 - \delta\lambda_2)\sigma_e^2 + (1 - \delta)(1 - (1 - \delta)\lambda_2)\sigma_v^2 & (\beta\lambda_1 - \delta\lambda_2)^2\sigma_e^2 + (1 - (1 - \delta)\lambda_2)^2\sigma_v^2 + 4\lambda_1^2\sigma_z^2 \end{bmatrix}. \tag{A.8}$$

Relating Eq. (A.1) to Eq. (A.8) gives a system of equations, jointly solving which leads to

$$\lambda_1 = \frac{1}{\sqrt{\alpha^2\beta^2 + 4\frac{\sigma_z^2}{\sigma_v^2} + 4\alpha^2\frac{\sigma_z^2}{\sigma_e^2}}}, \tag{A.9}$$

and

$$\lambda_2 = -\frac{\lambda_1}{\delta}\left(\beta - \frac{4\lambda_1\sigma_z^2}{(\frac{1}{\alpha} - \beta\lambda_1)\sigma_e^2}\right). \tag{A.10}$$

∎

**Proof of Proposition 3.**

**Proof of Part 1** In an equilibrium with signal, the speculator's expected value function is

$$\mathbb{E}(W(v,e,z)|D=1,\delta) = \gamma\mathbb{E}[(P_1-P_0)e|D=1,\delta] + (1-\gamma)\mathbb{E}[x^*(v-P_1)|D=1,\delta]. \quad (A.11)$$

Substituting in Eq. (8) and (7) for $P_1$ and $x^*$ and simplifying gives:

$$\mathbb{E}[W(v,e,z)|D=1,\delta] = (1-\gamma)\lambda_1\sigma_z^2\frac{1+\alpha\beta\lambda_1}{1-\alpha\beta\lambda_1}, \quad (A.12)$$

where $\lambda_1$ is given by Eq. (9).

**Proof of Part 2** In a baseline equilibrium, the speculator's expected value function is:

$$\mathbb{E}(W(v,e,z)|D=0) = \gamma\mathbb{E}[(P_1-P_0)e|D=0] + (1-\gamma)\mathbb{E}[x^*(v-P_1)|D=0]. \quad (A.13)$$

Plugging in Eq. (3) and (2) for $P_1$ and $x^*$ and simplifying gives

$$\mathbb{E}(W(v,e,z)|D=0) = \frac{1-\gamma}{4\lambda}(\sigma_v^2 + \beta^2\lambda^2\sigma_e^2), \quad (A.14)$$

where $\lambda$ is given by Eq. (4).

**Proof of Part 3** To establish weak inequality, it suffices to show that there exist a $\hat{\delta}$ such that

$$\mathbb{E}(W(v,e,z)|D=1,\hat{\delta}) = \mathbb{E}(W(v,e,z)|D=0). \quad (A.15)$$

Consider the following candidate:

$$\hat{\delta} = \frac{1}{1+\hat{\alpha}}, \quad (A.16)$$

where

$$\hat{\alpha} = \lambda\beta\frac{\sigma_e^2}{\sigma_v^2} = \beta\sqrt{\frac{\sigma_v^2}{\beta^2\sigma_e^2 + 4\sigma_z^2}}\frac{\sigma_e^2}{\sigma_v^2}. \quad (A.17)$$

Substituting the expression for $\hat{\alpha}$ into Eq. (12) and (13) establishes the equality of speculator's value function between the baseline and signaling equilibrium.

To establish strict inequality, differentiating the speculator's value function in a signaling equilibrium w.r.t. the signal weight and evaluating the derivative at $\hat{\delta}$:

$$\frac{\partial\mathbb{E}(W(v,e,z)|D=1,\delta)}{\partial\delta}\bigg|_{\delta=\hat{\delta}} = -(1-\gamma)\sigma_z^2\frac{\hat{\alpha}}{\hat{\delta}^2}\lambda_1^3\frac{1+\alpha\beta\lambda_1}{1-\alpha\beta\lambda_1}(\beta^2+4\frac{\sigma_z^2}{\sigma_e^2})\frac{2\sigma_z^2}{2\sigma_z^2+\beta^2\sigma_e^2} < 0. \quad (A.18)$$

By choosing $\delta' = \hat{\delta} - \epsilon$, where $\epsilon$ is an infinitesimal positive number, there is $\mathbb{E}(W(v,e,z)|D=1,\delta') > \mathbb{E}(W(v,e,z)|D=0))$. This completes the proof. ∎

**Proof of Proposition 4.**

For some realization $(v, e, z)$, denote by $x^*(v, e, z)$ and $x^{**}(v, e, z)$ the equilibrium trading strategy of the speculator in the signaling equilibrium and the SPE, respectively, and by $P_1^*(v, e, z)$ and $P_1^{**}(v, e, z)$ the MM's pricing function in the signaling equilibrium and SPE, respectively. The SPE is equivalent to the signaling equilibrium if and only if (1) $x^*(v, e, z) = x^{**}(v, e, z)$ and $P_1^*(v, e, z) = P_1^{**}(v, e, z)$.

**Proof of (1)**  By construction, equilibrium trading strategy in the SPE is the baseline trading strategy with updated common prior. Thus from Eq. (2),

$$x^{**} = \frac{\beta}{2}(e + \tilde{e}) + \frac{v - \tilde{v}}{2\tilde{\lambda}}, \tag{A.19}$$

Note that $\tilde{\lambda} = \sqrt{\frac{\tilde{\sigma}_v^2}{\beta^2 \tilde{\sigma}_e^2 + 4\sigma_z^2}}$. Substitute in Eq. (19) and (20) for $\tilde{\sigma}_v^2$ and $\tilde{\sigma}_e^2$ and simplify:

$$\tilde{\lambda} = \lambda_1. \tag{A.20}$$

This is an intuitive result: if the signaling equilibrium is identical to the SPE, so should be their corresponding liquidity.

Substituting in Eq. (17) and (18) for $\tilde{v}$ and $\tilde{e}$ and apply $\tilde{\lambda} = \lambda_1$:

$$x^{**}(v, e, z) = \frac{v - P_0}{2\lambda_1} + \frac{\beta}{2}(e + \bar{e}) + \frac{1}{2\delta}[\beta - \frac{4\lambda_1}{\frac{1}{\alpha} - \lambda_1 \beta}\frac{\sigma_z^2}{\sigma_e^2}](s - \bar{s}) = x^*(v, e, z). \tag{A.21}$$

The last equality follows from Eq. (2) and recognizing that $\frac{1}{2\delta}[\beta - \frac{4\lambda_1}{\frac{1}{\alpha} - \lambda_1 \beta}\frac{\sigma_z^2}{\sigma_e^2}] = -\frac{\lambda_2}{2\lambda_1}$ by Eq. (10).

**Proof of (2)**  Similarly, equilibrium pricing function in the SPE is the baseline pricing function with updated prior. By Eq. (3),

$$P_1^{**}(v, e, z) = \tilde{v} + \tilde{\lambda}(\omega - \tilde{\omega}), \tag{A.22}$$

where $\tilde{\omega} = \tilde{x} = \beta\tilde{e}$.

Substituting in Eq. (17) and (18) for $\tilde{v}$ and $\tilde{e}$ and applying $\lambda_1 = \tilde{\lambda}$ gives:

$$P_1^{**}(v, e, z) = P_0 + \lambda_1(\omega - \bar{\omega}) - \frac{\lambda_1}{\delta}[\beta - \frac{4\lambda_1}{\frac{1}{\alpha} - \lambda_1 \beta}\frac{\sigma_z^2}{\sigma_e^2}](s - \bar{s}). \tag{A.23}$$

Substituting in Eq. (10) yields $P_1^{**}(v, e, z) = P_1^*(v, e, z)$.  ∎

**Proof of Corollary 1.**

**Proof of Part 1**  Note that $\lambda_1 = \tilde{\lambda} = \frac{\tilde{\sigma}_v}{2\sqrt{\beta^2\tilde{\sigma}_e^2+\sigma_z^2}}$. Thus by Eq. (19) and (20), the fact that $\tilde{\sigma}_v^2$ increases with $\delta$ and $\tilde{\sigma}_e^2$ decreases with $\delta$ implies that $\lambda_1$ is increasing in $\delta$.

**Proof of Part 2**  It can be easily shown that with $\delta = \hat{\delta}$, where $\hat{\delta}$ is given by Eq. (A.16), there is $\lambda_1 = \lambda$. This observation combined with Part 1 of Corollary 1 completes the proof.

**Proof of Part 3**  We first consider a necessary condition for $\delta$ such that disclosure is incentive compatible. Taking the derivative of $\mathbb{E}(W(v,e,z)|D=1,\delta)$, it can be shown that

$$\frac{\partial\mathbb{E}(W(v,e,z)|D=1,\delta)}{\partial\delta} = (1-\gamma)\sigma_z^2\frac{2\alpha}{\delta^2}\lambda_1^3\frac{1+\alpha\beta\lambda_1}{1-\alpha\beta\lambda_1}\left[-\frac{4\beta}{\alpha}\frac{\sigma_z^2}{\sigma_v^2}\frac{\lambda_1}{1-\alpha^2\beta^2\lambda_1^2}+\frac{1}{2}(\beta^2+4\frac{\sigma_z^2}{\sigma_e^2})\right], \quad\text{(A.24)}$$

with $\alpha = \frac{1-\delta}{\delta}$.

Note that $(1-\gamma)\sigma_z^2\frac{2\alpha}{\delta^2}\lambda_1^3\frac{1+\alpha\beta\lambda_1}{1-\alpha\beta\lambda_1} > 0$ always holds. Thus the sign of this derivative depends on the sign of the bracketed terms. The second term in the brackets is independent of $\alpha$ (thus of $\delta$), whereas the first term

$$-\frac{4\beta}{\alpha}\frac{\sigma_z^2}{\sigma_v^2}\frac{\lambda_1}{1-\alpha^2\beta^2\lambda_1^2} = -4\beta\frac{\sigma_z^2}{\sigma_v^2}\frac{1}{\alpha\lambda_1[4\frac{\sigma_z^2}{\sigma_v^2}+4\alpha^2\frac{\sigma_z^2}{\sigma_e^2}]} \quad\text{(A.25)}$$

is increasing in $\alpha$ as both $\alpha\lambda_1$ and $4\frac{\sigma_u^2}{\sigma_v^2}+4\alpha^2\frac{\sigma_u^2}{\sigma_z^2}$ increase in $\alpha$. Therefore, the bracketed terms in Eq. (A.24) increase with $\alpha$, and therefore decrease with $\delta$, monotonically.

It has been shown in the proof of Proposition 3 that $\left.\frac{\partial\mathbb{E}(W(v,e,z)|D=1,\delta)}{\partial\delta}\right|_{\delta=\hat{\delta}} < 0$. Therefore, either $\frac{\partial\mathbb{E}(W(v,e,z)|D=1,\delta)}{\partial\delta} < 0, \forall\delta\in[0,1]$, or $\exists\delta^*$, s.t. $\frac{\partial\mathbb{E}(W(v,e,z)|D=1,\delta)}{\partial\delta} > 0$ for $\delta < \delta^*$ and $\frac{\partial\mathbb{E}(W(v,e,z)|D=1,\delta)}{\partial\delta} > 0$ for $\delta > \delta^*$. It can be shown that, for $\check{\delta} = \frac{\sigma_v}{\sigma_v+\sigma_e} < \hat{\delta}$, $\left.\frac{\partial\mathbb{E}(W(v,e,z)|D=1,\delta)}{\partial\delta}\right|_{\delta=\check{\delta}} \geq 0$. Thus $\mathbb{E}(W(v,e,z)|D=1,\delta)$ is unimodal in $\delta$, as shown in Figure 8.

The fact that $\left.\frac{\partial\mathbb{E}(W(v,e,z)|D=1,\delta)}{\partial\delta}\right|_{\delta=\hat{\delta}} < 0$ also implies $\frac{\partial\mathbb{E}(W(v,e,z)|D=1,\delta)}{\partial\delta} < 0$ for all $\delta > \hat{\delta}$. Therefore $\mathbb{E}(W(v,e,z)|D=1,\delta) < \mathbb{E}(W(v,e,z)|D=1,\hat{\delta}) = \mathbb{E}(W(v,e,z)|D=0)$ for $\delta > \hat{\delta}$. This implies that a necessary condition for disclosure to be incentive compatible is $\delta < \hat{\delta}$, which, combined with the fact that $\lambda_1 < \lambda$ if and only if $\delta < \hat{\delta}$, completes the proof. ∎

**Proof of Corollary 2.** In a baseline equilibrium with $\rho = corr(v, e)$,

$$\mathbb{V}(v|P_1) = (1 - \phi^2)\sigma_v^2 = \frac{\left(\frac{1}{2\lambda}\sigma_v + \frac{\beta}{2}\rho\sigma_e\right)^2}{\frac{1}{4\lambda^2}\sigma_v^2 + \frac{\beta^2}{4}\sigma_e^2 + \frac{\beta}{2\lambda}\rho\sigma_v\sigma_e + \sigma_z^2}. \tag{A.26}$$

**Proof of Part 1** In a baseline game with $\rho = 0$,

$$\phi^2 = \frac{\frac{1}{4\lambda^2}\sigma_v^2}{\frac{1}{4\lambda^2}\sigma_v^2 + \frac{\beta^2}{4}\sigma_e^2 + \sigma_z^2} = \frac{1}{2}. \tag{A.27}$$

**Proof of Part 2** In a signaling equilibrium, there is

$$\mathbb{V}(v|P_1, s) = (1 - \tilde{\phi}^2)\tilde{\sigma}_v^2, \tag{A.28}$$

where $\tilde{\phi}^2$ is similarly defined as above but with $\sigma_v^2$ and $\sigma_e^2$ replaced by $\tilde{\sigma}_v^2$ and $\tilde{\sigma}_e^2$, respectively and with $\rho$ replaced by $\tilde{\rho} = -1$.

Since $\tilde{\sigma}_v^2$ represents remaining uncertainty about the fundamental after revelation of the signal and $\mathbb{V}(v|P_1, s)$ represents uncertainty remained after the MM observes aggregate order flow. Therefore, $1 - \tilde{\phi}^2$ measures the proportion of the speculator's private information (after revelation of the signal) that is not impounded into the price through trading. It can be shown that

$$1 - \tilde{\phi}^2 = \frac{1}{\left(\sqrt{\frac{\beta^2}{4}\frac{\tilde{\sigma}_e^2}{\sigma_z^2} + 1} - \frac{\beta}{2}\frac{\tilde{\sigma}_e}{\sigma_z}\right)^2 + 1}. \tag{A.29}$$

Since

$$\sqrt{\frac{\beta^2}{4}\frac{\tilde{\sigma}_e^2}{\sigma_z^2} + 1} - \frac{\beta}{2}\frac{\tilde{\sigma}_e}{\sigma_z} = \frac{1}{\sqrt{\frac{\beta^2}{4}\frac{\tilde{\sigma}_e^2}{\sigma_z^2} + 1} + \frac{\beta}{2}\frac{\tilde{\sigma}_e}{\sigma_z}} < 1,$$

thus $1 - \tilde{\phi}^2 > \frac{1}{2}$ - more than half of the private information remains unincorporated in the prices.

**Proof of Part 3** From Eq. (A.28) and (A.29), there is

$$\mathbb{V}(v|P_1, s) = \frac{\tilde{\sigma}_v^2}{\sqrt{\frac{\beta^2}{4}\frac{\tilde{\sigma}_e^2}{\sigma_z^2} + 1} + \frac{\beta}{2}\frac{\tilde{\sigma}_e}{\sigma_z}}. \tag{A.30}$$

Since increase in $\delta$ increases $\tilde{\sigma}_v^2$ and decreases $\tilde{\sigma}_e^2$, therefore $\mathbb{V}(v|P_1, s)$ increases in $\delta$.

**Proof of Part 4** Evaluating Eq. (A.30) at $\delta = \hat{\delta}$, with $\hat{\delta}$ given by Eq. (A.16) and $\tilde{\sigma}_v^2$ and $\tilde{\sigma}_e^2$ given by Eq. (19) and (20), respectively, gives

$$\mathbb{V}(v|P_1, s)\big|_{\delta=\hat{\delta}} = \frac{1}{2}. \tag{A.31}$$

From the proof of Proposition 1, if the fund manager voluntarily discloses, it must be that $\delta < \hat{\delta}$. Because $\mathbb{V}(v|P_1, s)$ increases in $\delta$, this implies $\mathbb{V}(v|P_1, s) < \frac{1}{2}$ when the signal is voluntarily disclosed. ∎

# B  Figures and Tables

## Figure 2:  Optimal Signal Weight and Short-termism
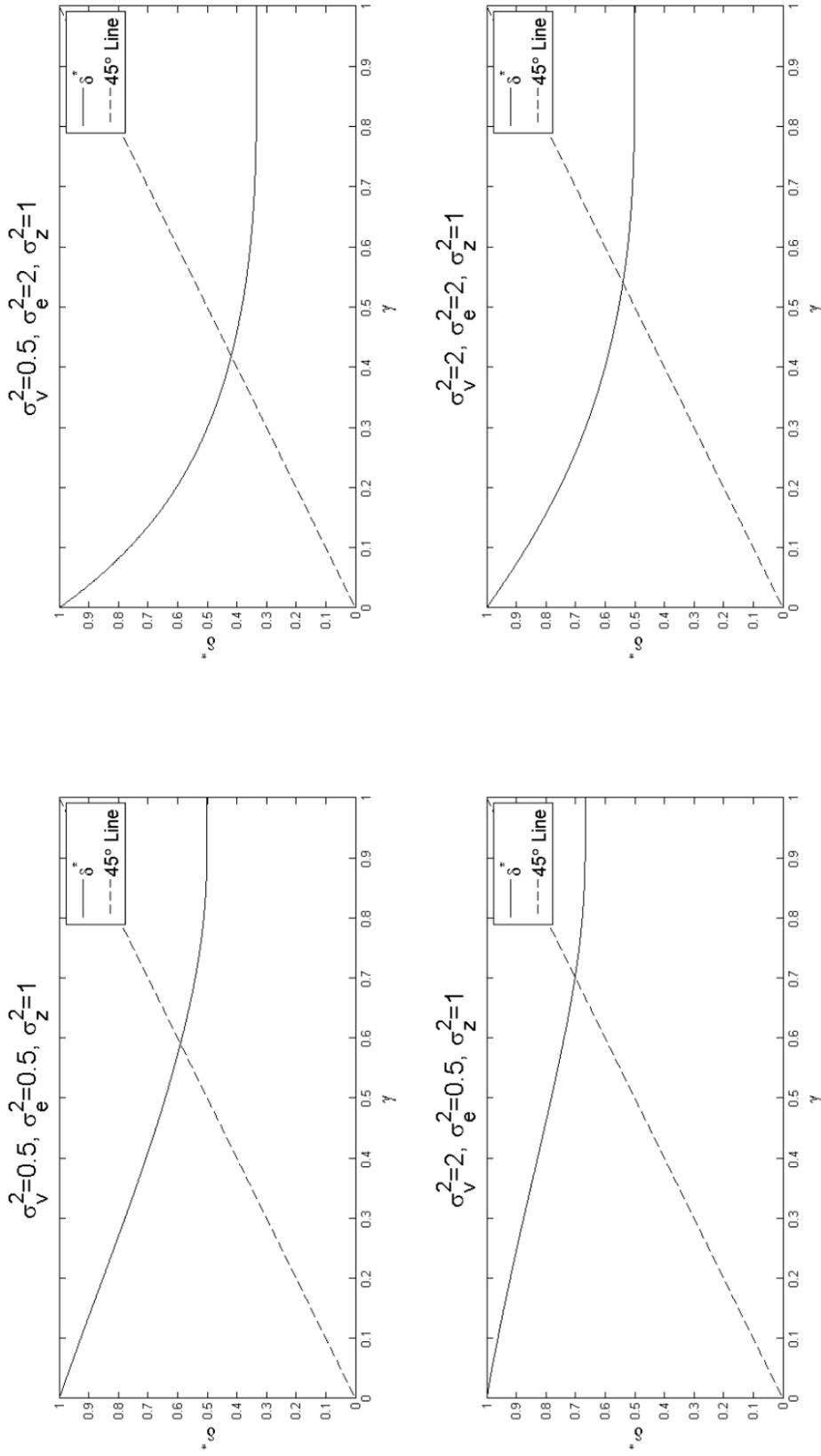


This figure plots, for four different combinations of $\sigma_e^2$ and $\sigma_v^2$, the optimal signal weight as a function of $\gamma$—the weight of short-term gain in the speculator's objective function. In each of the four graphs, the solid line represents $\delta^*(\gamma)$ and the dashed line is the $45°$ line. In all graphs, $\sigma_z^2$ is set to be 1.

**Figure 3: Optimal Signal Weight and Fundamental Uncertainty**
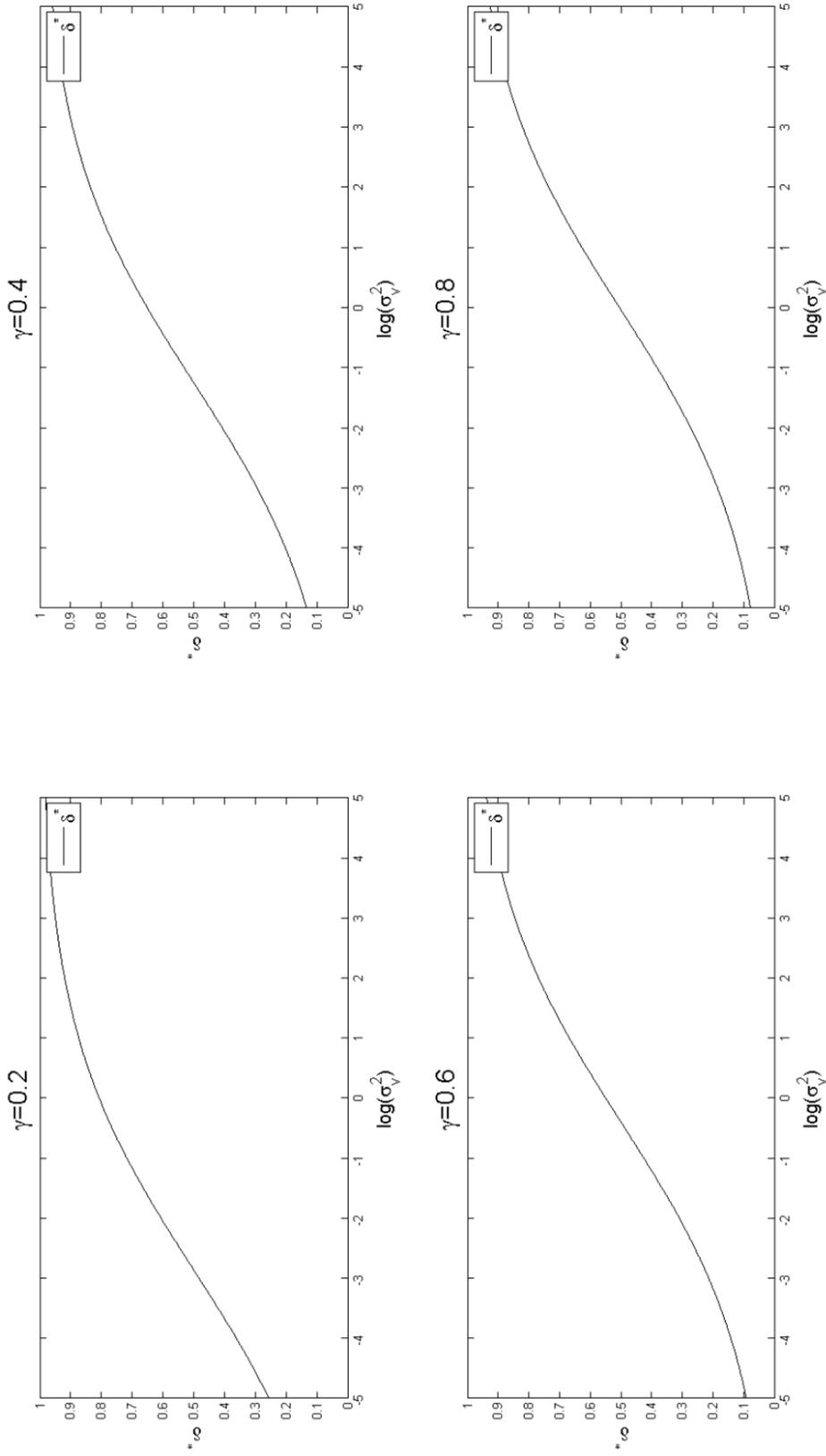


This figure plots, for four different $\gamma$'s, the optimal signal weight as a function of $\sigma_v^2$—information asymmetry surrounding the fundamental, when $\sigma_e^2 = \sigma_z^2 = 1$.

# Figure 4: Optimal Signal Weight and Endowment Uncertainty
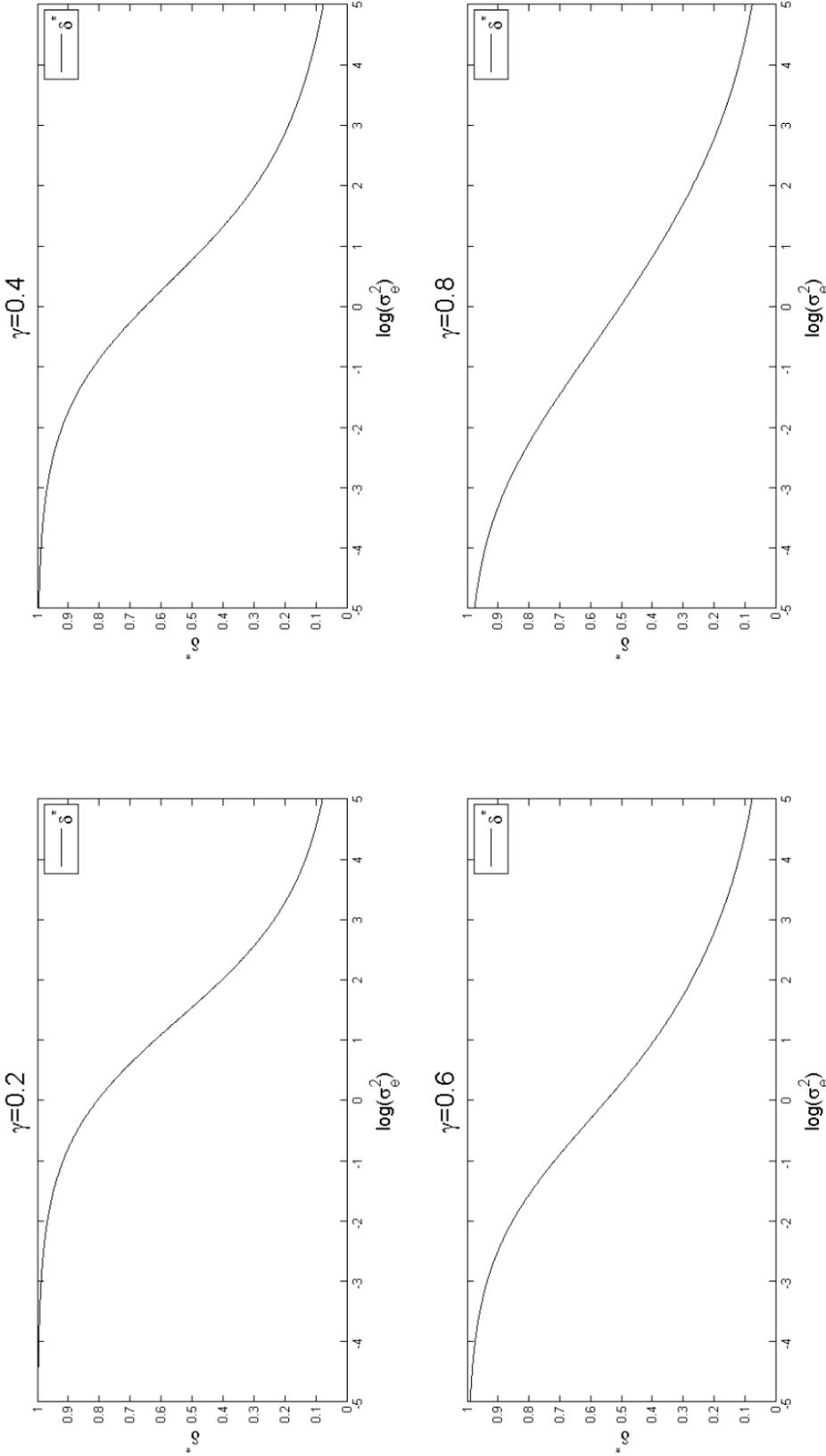


This figure plots, for four different $\gamma$'s, the optimal signal weight as a function of $\sigma_e^2$—information asymmetry surrounding the speculator's initial position, when $\sigma_v^2 = \sigma_z^2 = 1$.

Figure 5: Cost of Disclosure and Fundamental Uncertainty
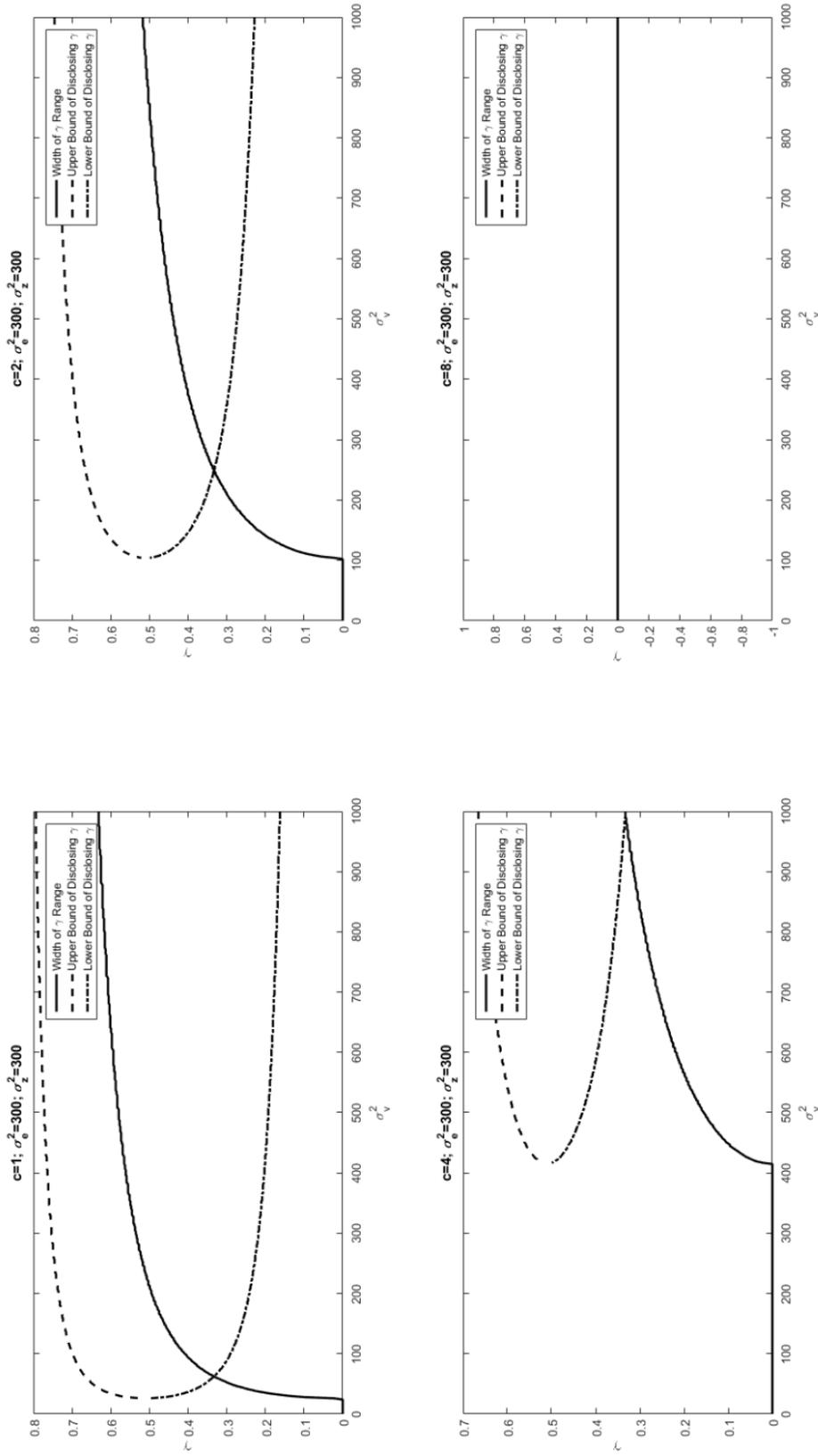
This figure plots, for four different values of a fixed disclosure cost $c$, the correspondence from $\sigma_v^2$ to $\Gamma^\gamma$, holding $\sigma_e^2$ and $\sigma_z^2$ fixed. $\Gamma^\gamma(c, \sigma_v^2, \sigma_e^2, \sigma_z^2)$ denotes the set of $\gamma$ such that the speculator prefers disclosure (with an optimally chosen signal weight) to no disclosure. The two dashed lines represent upper and lower bounds for $\Gamma^\gamma$ and the solid line represents the width of the interval $[\inf \Gamma^\gamma, \sup \Gamma^\gamma]$.

## Figure 6: Cost of Disclosure and Endowment Uncertainty



This figure plots, for four different values of a fixed disclosure cost $c$, the correspondence from $\sigma_e^2$ to $I^\gamma$, denotes the set of $\gamma$ such that the speculator prefers disclosure (with an optimally chosen signal weight) to no disclosure. The two dashed lines represent upper and lower bounds for $I^\gamma$ and the solid line represents the width of the interval $[\inf I^\gamma, \sup I^\gamma]$.

**Figure 7: Signal Weight and Market Depth**
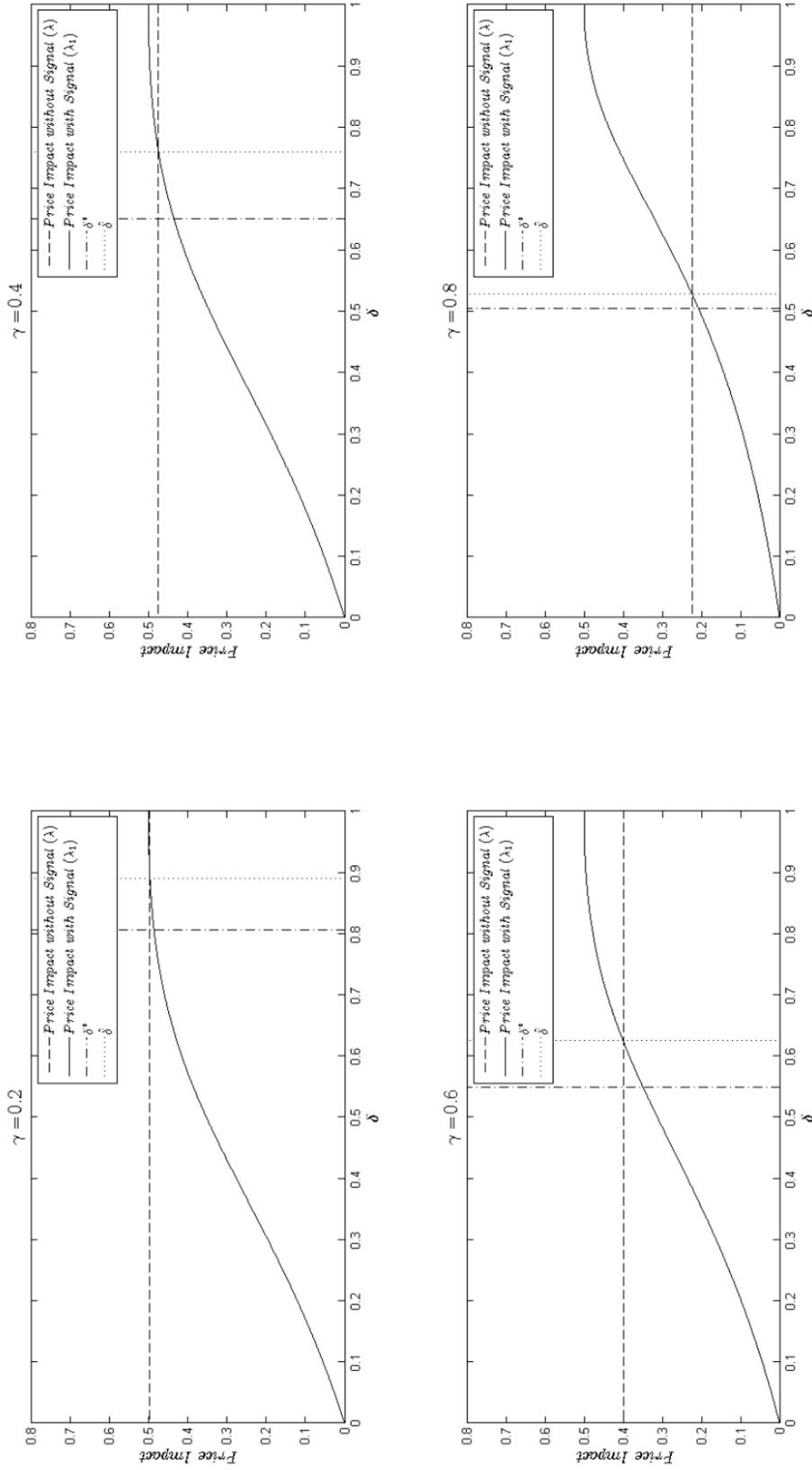


This figure plots, for different values of $\gamma$, equilibrium price impact as a function of signal weight $\delta$. Price impact is defined as how much the market clearing price changes in response to a unit increase in order flow. In each of the four graphs, the solid line represents price impact in the signaling equilibrium ($\lambda_1$), whereas the dashed line plots price impact in the non-signaling/baseline equilibrium ($\lambda^*$).

# Figure 8: Gains from PBT and PBD
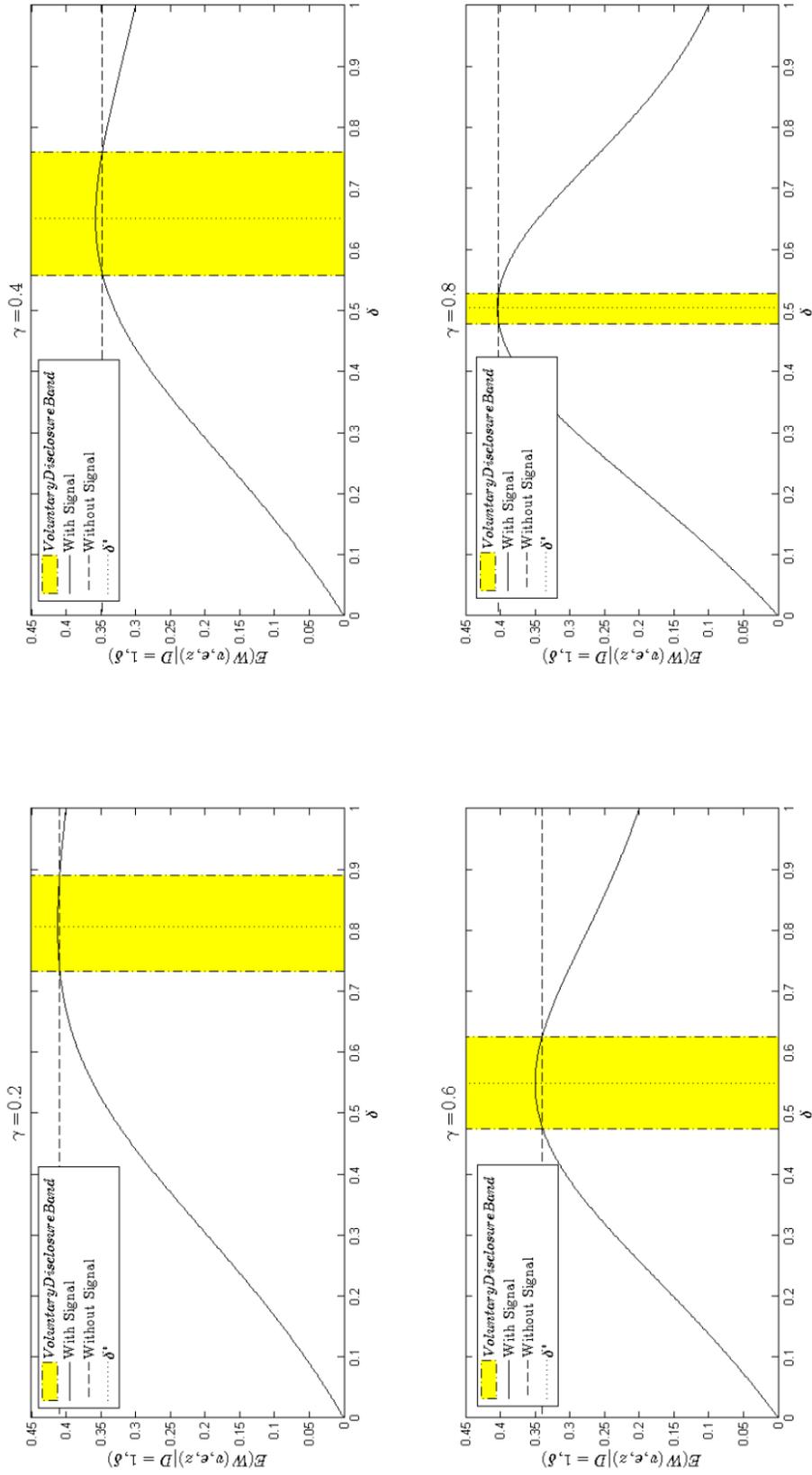


This figure plots, for four different values of $\gamma$, the speculator's value function as a function of the speculator's signal weight $\delta$. In each graph, the solid line and the horizontal dashed line represent the speculator's value function in the signaling equilibrium and baseline equilibrium, respectively. The vertical dotted line marks the optimal signal weight $\delta^*$, and the shaded area marks the range where disclosure is voluntary. In all four plots, $\sigma_v^2$, $\sigma_e^2$ and $\sigma_z^2$ are set to 1.

59

## Table 2: Summary Statistics of WSJ/NYT/FT Data

This table summarizes our disclosure data. Our sample spans from 2005 to 2014 and covers all articles published in the Wall Street Journal, the Financial Times and the New York Times. To identify a strategic disclosure, we apply the following criteria: An article is defined to be a disclosure made by fund holding company $j$ about target firm $i$, if there exists a paragraph in it such that either one of the following is satisfied.

1. Both names of the target company $i$ and the fund management company $j$ are found. Because investment banks are frequently covered in the media together with other firms for reasons unrelated to strategic information disclosure (equity/bond underwriting, grading assignments, etc.), to avoid confounding our analysis, we exclude investment banks (e.g. Goldman Sachs, Merrill Lynch, Wells Fargo, etc.) from fund management companies, unless (i) key words such as "analyst", "portfolio manager" or "strategist" appear in the same sentence as the mention of the fund holding company; (ii) key words such as "securities", "holdings" or "asset management", which indicates the disclosure comes from a non-investment banking branch of $j$, closely follow the mention of the fund management company (with no more than one word in between); or (iii) name (first name followed by last name) of a portfolio manager associated with fund holding company $j$ is also found in the same paragraph.

2. The name of the target company $i$ is found and either (i) all first, middle, and last names of any portfolio manager at fund holding company $j$ is found, or (ii) first and last names of any portfolio manager at fund holding company $j$ is found, and, in the same sentence, there is key word such as "analyst", "portfolio manager", etc.

For each of the three newspapers, we count separately the number of articles which we identify as disclosures, which we do not identify as disclosures but are published in a business-related section, and which are published in a non-business-related section such as leisure, art or food.

|  | # Articles | | | |
|---|---|---|---|---|
|  | FT | NYT | WSJ | All |
| **Disclosures** | 3,199 | 2,573 | 4,701 | 10,473 |
| **Business Related** | 203,551 | 155,477 | 451,311 | 810,339 |
| **Business Unrelated** | 466,748 | 1,043,981 | 5,795 | 1,516,524 |
| **All** | 673,535 | 1,202,035 | 461,819 | 2,337,389 |

## Table 3: Examples of Identified Disclosures

This table lists sample paragraphs—one for each newspaper—with which a journal article is identified as a strategic disclosure using our screening techniques.

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### Time Warner's Cable Plan Is Attracting Bargain Hunters
Julia Angwin

The Wall Street Journal, Mar. 3rd, 2005

*Time Warner plans to pay for Adelphia partly by issuing stock in the new Time Warner cable company. "I'm not the biggest cable bull in the world, but I'm positive on the speculated deal terms," said Henry Ellenbogen, an analyst with T. Rowe Price, which owned a 1.2% stake in Time Warner as of Dec. 31, according to FactSet Research. Mr. Ellenbogen believes the new cable stock likely would trade at a higher multiple than Time Warner shares do currently, indicating that it would be fast-growing. It would "showcase the growth and quality of cable operation and show that Time Warner's high-quality, albeit moderate-growth, media assets trade at a significant discount to their peers," he said.*


### How Often to Trade? It's Tricky for Funds, Too
Norm Alster

The New York Times, Jan. 8th, 2012

*But even low-turnover funds can be tempted by the bargains created in sharp downturns. "The volatility provides an opportunity to enter stocks that the market may have unduly punished," said Aram Green, one of four portfolio managers of the Legg Mason ClearBridge Mid Cap Growth fund. Though generally slow to turn over its portfolio, the fund managers did some selective nibbling during recent market sell-offs. One buy was F5 Networks, a computer networking company whose stock peaked above $140 early last year, but by August had dipped below $70. The fund stepped in, and the stock has since rebounded.*


### Reed Krakoff Seals $50M Buyout
Elizabeth Paton

The Financial Times, Sept. 3rd, 2013

*Henry Ellenbogen, portfolio manager at T Rowe Price, a mutual fund that has invested in US luxury retail companies such as Tory Burch and Michael Kors, said: "We have an extremely strong record in the sector and see this business as a future force to be reckoned with on a global scale."*


### Investors Question the Track Record of US Media
Aline van Duyn

The Financial Times, Aug. 8th, 2005

*Larry Haverty, portfolio manager at Gabell & Co, which owns Time Warner shares, said: "Increasing leverage is not sensible in an environment in which interest rates can go up and given the uncertainties in the media sector, such as growing competition from the internet."*

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# Table 4: Summary Statistics of Sample Firms and Fund Holding Companies

This table provides summary statistics for our sample firms and fund holding companies. Panel (A) summarizes the sample at holding company-quarter level. The first three rows (*Equity*, *Bond* and *Cash*) report the holding companies' asset allocation—measured as percentage holdings—in three (non-exhaustive) broad asset classes. *NAV* measures the combined net asset values of all funds managed by a holding company. *Expense Ratio* is the sum of 12b-1 fees and operating expenses, expressed as a percentage of a fund's net asset value and averaged (weighted by each individual fund's NAV) across all funds under the same holding company. $\hat{\gamma}_{j,t}^1$ is a measure of a holding company $j$'s overall flow-return sensitivity. To obtain $\hat{\gamma}_{j,t}^1$, we first estimate the following rolling regressions (Eq. (24)) for each fund $k$ under holding company $j$ at each quarter-end $t$ using monthly fund return and flow data in the past year (i.e., $m = t - 11, t - 10, ..., t$):

$$\text{Flow}_{k,m} = \alpha_{k,t} + \sum_{h=0}^{2} \zeta_{k,t}^h \text{Ret}_{k,m-h} + \epsilon_{m,t}. \tag{24}$$

where $Flow_{k,m}$ are fund inflows or outflows, and $Ret_{k,m-h}$ are fund portfolio returns. We sum the resulting coefficients $\zeta_{k,t}^0$, $\zeta_{k,t}^1$ and $\zeta_{k,t}^2$ to obtain the flow-return sensitivity for each fund $k$ at each quarter-end month $t$. $\hat{\gamma}_{j,t}^1$ is then defined as the NAV weighted average flow-return sensitivity of all funds managed by holding company $j$ at month $t$. #*Disclosures* is the number of disclosures made by the fund holding company about all sample firms during a quarter. *Age* is defined as the NAV weighted average of each of the holding company's individual fund's age (number of days since the first time a fund is offered). Panel (B) summarizes the sample at firm-quarter level. We report the sample firms' market capitalization, Amihud's (2002) measure of illiquidity, number of disclosures made about a firm by all sample funds during a quarter, stock volatility *Stdev(Ret)* (measured as the annualized standard deviation of daily stock return in the quarter), and asset intangibility (measured as intangible assets as a percentage of total assets). Panel (C) summarizes the sample at firm-fund-quarter level. #*Disclosures* is the number of strategic disclosures made by a fund holding company about a firm in the current quarter. $\hat{\gamma}_{i,j,t}^2$ is the deviation of a fund's percentage holdings of a firm from the benchmark. To get $\hat{\gamma}_{i,j,t}^2$, we first define $H_{i,j,t}^f = \frac{V_t(\text{Holding Company j's Holdings of Firm i})}{V_t(\text{Holding Company j's Holdings of All S\&P 1500 Firms})}$ and let $H_{i,t}^m = \frac{V_t(\text{Firm i})}{V_t(\text{All S\&P 1500 Firms})}$; we then compute (Eq. (28))

$$\hat{\gamma}_{i,j,t}^2 = \begin{cases} H_{i,j,t}^f / H_{i,t}^m, & \text{if } H_{i,j,t}^f > H_{i,t}^m, \\ H_{i,t}^m / H_{i,j,t}^f, & \text{Otherwise.} \end{cases} \tag{28}$$

For each of the characteristics, we report its mean and median in the full sample, and in each of the five subsamples characterized by the number of strategic disclosures. All variables are winsorized at the 2% and 98% levels, with the sole exception of the number of disclosures at the firm-fund-quarter level in Panel (C).

## Table 4 Continued

| | Mean | | | | | | Median | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Full | | | #Discl | | | Full | | | #Discl | | |
| | Sample | = 0 | ≥ 1 | ≥ 5 | ≥ 10 | ≥ 15 | Sample | = 0 | ≥ 1 | ≥ 5 | ≥ 10 | ≥ 15 |
| **Panel (A) Fund-Quarter Level** | | | | | | | | | | | | |
| **Equity (% )** | 72.2 | 73.1 | 69.5 | 65.4 | 64.8 | 65.0 | 76.5 | 78.3 | 72.9 | 70.2 | 69.4 | 69.4 |
| **Bond (% )** | 5.3 | 4.7 | 7.1 | 8.0 | 8.1 | 7.9 | 0.0 | 0.0 | 0.0 | 0.2 | 1.1 | 1.5 |
| **Cash (% )** | 4.3 | 4.5 | 3.6 | 3.3 | 3.2 | 3.3 | 3.0 | 3.1 | 2.8 | 2.8 | 2.9 | 2.9 |
| **NAV ($B)** | 0.928 | 0.624 | 1.852 | 3.076 | 3.360 | 3.474 | 0.146 | 0.109 | 0.653 | 2.233 | 2.662 | 2.820 |
| **Expense Ratio (% )** | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 |
| $\hat{\gamma}^1_{j,t}$ | 0.428 | 0.466 | 0.311 | 0.286 | 0.311 | 0.305 | 0.121 | 0.127 | 0.107 | 0.116 | 0.124 | 0.110 |
| **# Disclosures_jt** | 1.0 | 0.0 | 4.2 | 11.4 | 15.2 | 16.8 | 0 | 0 | 2 | 11 | 17 | 17 |
| **Age (Days)** | 3,111.3 | 3,174.5 | 2,919.3 | 2,950.7 | 2,929.4 | 2,960.8 | 2,992.5 | 3,032.6 | 2,900.7 | 3,017.2 | 3,059.7 | 3,056.8 |
| **Observations** | 10,932 | 8,226 | 2,706 | 709 | 401 | 270 | 10,932 | 8,226 | 2,706 | 709 | 401 | 270 |
| **Panel (B) Firm-Quarter Level** | | | | | | | | | | | | |
| **Market Cap ($B)** | 13.362 | 8.988 | 30.726 | 63.035 | 83.546 | 94.148 | 3.966 | 3.277 | 12.342 | 59.109 | 117.485 | 117.485 |
| **Amihud** | 1.678 | 1.837 | 1.047 | 1.200 | 2.527 | 4.517 | 0.329 | 0.418 | 0.105 | 0.028 | 0.017 | 0.015 |
| **# Disclosures** | 0.4 | 0.0 | 2.0 | 5.0 | 5.0 | 5.0 | 0 | 0 | 1 | 5 | 5 | 5 |
| **Stdev(Ret) (%)** | 35.4 | 35.7 | 34.3 | 32.7 | 37.4 | 43.0 | 30.0 | 30.5 | 27.8 | 24.4 | 25.3 | 31.3 |
| **Intangibility (%)** | 22.5 | 22.2 | 23.6 | 25.4 | 28.1 | 33.0 | 16.9 | 16.6 | 18.0 | 17.8 | 17.6 | 21.8 |
| **Observations** | 28,094 | 22,441 | 5,653 | 666 | 168 | 57 | 28,094 | 22,441 | 5,653 | 666 | 168 | 57 |
| **Panel (C) Firm-Fund-Quarter Level** | | | | | | | | | | | | |
| $\hat{\gamma}^2_{i,j,t}$ | 48.6 | 41.7 | 91.8 | 96.2 | 91.5 | 67.8 | 6.5 | 5.0 | 130.6 | 130.6 | 130.6 | 70.8 |
| **# Disclosures** | 0.2 | 0.0 | 1.3 | 7.1 | 13.8 | 20.0 | 0 | 0 | 1 | 6 | 12 | 18.5 |
| **Observations** | 85,240 | 73,472 | 11,768 | 198 | 29 | 8 | 85,240 | 73,472 | 11,768 | 198 | 29 | 8 |

63

## Table 5: Variable Definitions

| Variable | Interpretation/Construction |
|---|---|

### *Key Variables Used in Testing the Effect of Short-termism on Disclosures*

$\hat{\gamma}_{j,t}^1$ — For each fund $k$ managed by holding company $j$ and each quarter-end month $t$, we first estimate the following regressions over a rolling twelve-month window: $\text{Flow}_{k,m} = \alpha_{k,t} + \sum_{h=0}^2 \zeta_{k,t}^h \text{Ret}_{k,m-h} + \epsilon_{k,m}$, where $Flow_{k,m}$ and $Ret_{k,m}$ are monthly fund flows and returns, respectively. Each regression is estimated over twelve months of data, i.e., $m = t-11, t-10, ..., t$. We next define $\hat{\zeta}_{k,t} = \hat{\zeta}_{j,t}^0 + \hat{\zeta}_{j,t}^1 + \hat{\zeta}_{j,t}^2$. Lastly, we compute $\hat{\gamma}_{j,t}^1$ as the NAV-weighted average of those $\hat{\zeta}_{k,t}$ across all funds $k$ under holding company $j$ in quarter-end month $t$.

$\hat{\gamma}_{i,j,t}^2$ — $\hat{\gamma}_{i,j,t}^2 = \begin{cases} H_{i,j,t}^f / H_{i,t}^m, & \text{if } H_{i,j,t}^f > H_{i,t}^m \\ H_{i,t}^m / H_{i,j,t}^f, & \text{Otherwise} \end{cases}$, where $H_{i,j,t}^f$ and $H_{i,t}^m$ are defined in (26) and (27), respectively.

$\#\text{Discl}_{i,j,t}$ — Number of disclosures made by fund $j$ about firm $i$ during quarter $t$.

$\#\text{Discl}_{-i,j,t}$ — Number of disclosures made by fund $j$ about all firms except firm $i$ during quarter $t$.

$\#\text{Discl}_{i,-j,t}$ — Number of disclosures made by all funds except fund $j$ about firm $i$ during quarter $t$.

### *Key Variables Used in Testing the Effect of PBT/PBD on Liquidity*

$\text{Amihud}_{i,t}$ — Amihud's (2002) measure of liquidity. For each firm $i$ and quarter $t$, $\text{Amihud}_{i,t}$ is computed as

$$\frac{1}{N_t} \sum_d \frac{|r_{i,d}|}{\text{Dvol}_{i,d}}$$

where $r_{i,d}$ and $\text{Dvol}_{i,d}$ denote, respectively, daily return and dollar trading volume for firm $i$ shares on day $d$. The sum is taken over all trading days $d$ in quarter $t$, with a total of $N_t$ days.

$\hat{\gamma}_{i,t}^1$ — $\hat{\gamma}_{i,t}^1 = \log(1 + \frac{1}{\sum_j \text{Shr}_{i,j,t}} \sum_j \text{Shr}_{i,j,t} \times \hat{\gamma}_{j,t}^1)$, where $\text{Shr}_{i,j,t}$ is the number of firm $i$ shares held by fund $j$ at the end of quarter $t$.

$\hat{\gamma}_{i,t}^2$ — $\hat{\gamma}_{i,t}^2 = \begin{cases} \log(\frac{H_{i,t}^f}{H_{i,t}^m}), & \text{if } H_{i,t}^f > H_{i,t}^m \\ \log(\frac{H_{i,t}^m}{H_{i,t}^f}), & \text{Otherwise} \end{cases}$, where $H_{i,t}^f = \frac{\text{Value of Firm i Shares Held by All Sample Funds at the End of Quarter t}}{\text{Value of S\&P 1500 Firms Held by All Sample Funds at the End of Quarter t}}$ and $H_{i,t}^m = \frac{\text{Market Cap. of Firm i at the End of Quarter t}}{\text{Market Cap. of All S\&P 1500 Firms at the End of Quarter t}}$.

$\#\text{Discl}_{i,t}$ — Number of disclosures made by all sample funds about firm $i$ during quarter $t$.

$\#\text{Discl}_{-i,t}$ — Number of disclosures made by all sample funds about all firms except firm $i$ during quarter $t$.

$\text{Trading}_{i,t}$ — Percentage trading by all sample mutual funds, defined as: $\text{Trading}_{i,t} = \frac{|\text{Shr}_{i,t} - \text{Shr}_{i,t-1}|}{\text{ShrOut}_{i,t-1}}$, where $\text{Shr}_{i,t}$ is the total number of shares held by all sample mutual funds at the end of quarter $t$ and $\text{ShrOut}_{i,t}$ is firm $i$'s number of shares outstanding as of the end of quarter $t$.

### *Control and Conditioning Variables*

$Size_{i,t}$ — Market capitalization of firm $i$ as of the end of quarter $t$.

$Intan_{i,t}$ — $Intan_{i,t} = \frac{\text{Firm i's Intangible Asset at the End of Quarter t}}{\text{Firm i's Total Asset at the End of Quarter t}}$.

$Stdev(Ret)_{i,t}$ — Standard deviation of firm $i$'s stock return computed using daily return data in quarter $t$.

$\overline{Price}_{i,t}$ — Firm $i$'s average price computed using daily closing price in quarter $t$.

## Table 6: Strategic Disclosure and Short-termism

This table reports test results on the effect of short-termism on mutual fund disclosures. We estimate, in part or in full, the following regression model of Eq. (30):

$$\#\text{Discl}_{i,j,t} = \beta_0 + \beta_1 \hat{\gamma}^s_{(i,)j,t} + \beta_2 \text{Suit}_{i,t} + \beta_3 \hat{\gamma}_{i,j,t} \times \text{Suit}_{i,t} + \beta_4 \#\text{Discl}_{-i,j,t} \tag{30}$$
$$+ \beta_5 \#\text{Discl}_{i,-j,t} + \delta_q + \delta_y + \epsilon_{i,j,t}, \quad s = 1,2.$$

$\hat{\gamma}^1_{j,t}$ measures the flow return sensitivity of a fund holding company $j$. To obtain $\hat{\gamma}^1_{j,t}$, we first estimate the following rolling regressions (Eq. (24)) for each fund $k$ under holding company $j$ at each quarter-end $t$ using monthly fund return and flow data in the past year (i.e., $m = t-11, t-10, ..., t$):

$$\text{Flow}_{k,m} = \alpha_{k,t} + \sum_{h=0}^{2} \zeta^h_{k,t} \text{Ret}_{k,m-h} + \epsilon_{m,t}. \tag{24}$$

where $Flow_{k,t}$ are fund inflows or outflows, and $Ret_{k,t}$ are fund portfolio returns. We next sum the resulting coefficients $\zeta^0_{k,t}$, $\zeta^1_{k,t}$ and $\zeta^2_{k,t}$ to obtain flow-return sensitivity for each fund $k$ at each quarter-end month $t$. We then define $\hat{\gamma}^1_{j,t}$ as the NAV-weighted average flow-return sensitivity of all funds $k$ managed by holding company $j$ at month $t$. $\hat{\gamma}^2_{i,j,t}$ measures the "pivotalness" of a position (firm) $i$ to a fund holding company $j$ at the end of quarter $t$ as the deviation of $j$'s percentage holding of $i$ from the market's. That is, define $H^f_{i,j,t} = \frac{V_t(\text{Fund j's Holdings of Firm i})}{V_t(\text{Fund j's Holdings of All S\&P 1500 Firms})}$ and let $H^m_{i,t} = \frac{V_t(\text{Firm i})}{V_t(\text{All S\&P 1500 Firms})}$; then define (Eq. (28))

$$\hat{\gamma}^2_{i,j,t} = \begin{cases} H^f_{i,j,t}/H^m_{i,t}, & \text{if } H^f_{i,j,t} > H^m_{i,t}, \\ H^m_{i,t}/H^f_{i,j,t}, & \text{Otherwise.} \end{cases} \tag{28}$$

$Suit_{i,t}$, the conditioning variable, is defined in Table 5 as either the inverse of firm size (measured as market capitalization, $Size_{i,t}$), intangibility (proportion of intangible asset of total asset, $Intan_{i,t}$), or standard deviation of stock $i$'s past returns ($Stdev(Ret)_{i,t}$)—as indicated in the bottom row of this table. $\#\text{Discl}_{-i,j,t}$ is the number of disclosures made by fund $j$ about all S&P 1500 firms except firm $i$ during quarter $t$; $\#\text{Discl}_{i,-j,t}$ is the number of disclosures about firm $i$ made by all sample funds except fund $j$. For each quarter and each firm, we exclude the largest holder fund from the regressions. In all specifications, we include year fixed effects ($\delta_y$) and quarter fixed effects ($\delta_q$). All variables are winsorized at the 2% and 98% levels and standardized. Numbers in parentheses are robust (Huber-White) standard errors.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| LHS Var. | | | | | $\#\text{Discl}_{i,j,t}$ | | | |
| | $\hat{\gamma}^1$= Flow-Return Sensitivity | | | | $\hat{\gamma}^2$=Pivotal | | | |
| $\hat{\gamma}$ | 0.015*** | 0.010** | 0.015*** | 0.013*** | 0.222*** | 0.205*** | 0.222*** | 0.218*** |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| $\text{Suit}_{i,t}$ | | 0.118*** | 0.019*** | 0.069*** | | 0.041*** | 0.009*** | 0.035*** |
| | | (0.006) | (0.004) | (0.005) | | (0.004) | (0.003) | (0.004) |
| $\hat{\gamma} \times \text{Suit}_{i,t}$ | | 0.013* | 0.005 | 0.004 | | 0.082*** | 0.012*** | 0.042*** |
| | | (0.007) | (0.004) | (0.005) | | (0.005) | (0.004) | (0.005) |
| $\#\text{Discl}_{-i,j,t}$ | 0.225*** | 0.221*** | 0.225*** | 0.223*** | 0.217*** | 0.214*** | 0.217*** | 0.216*** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| $\#\text{Discl}_{i,-j,t}$ | 0.103*** | 0.117*** | 0.103*** | 0.107*** | 0.108*** | 0.111*** | 0.107*** | 0.108*** |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| Constant | -0.029*** | -0.044*** | -0.028** | -0.010 | -0.053*** | -0.075*** | -0.053*** | -0.047*** |
| | (0.011) | (0.011) | (0.011) | (0.012) | (0.011) | (0.011) | (0.011) | (0.011) |
| Observations | 85,240 | 85,240 | 85,240 | 85,240 | 85,240 | 85,240 | 85,240 | 85,240 |
| R-squared | 0.064 | 0.078 | 0.065 | 0.068 | 0.109 | 0.122 | 0.110 | 0.113 |
| $\text{Suit}_{i,t}$ | | $1/Size_{i,t}$ | $Intan_{i,t}$ | $Stdev(Ret)_{i,t}$ | | $1/Size_{i,t}$ | $Intan_{i,t}$ | $Stdev(Ret)_{i,t}$ |

# Table 7: PBT, PBD and Market Liquidity with $\hat{\gamma}^1_{i,t}$

This table reports test results on the effect of PBT and PBD on market liquidity. In each specification, we test—in part or in full—the following regression model of Eq. (38):

$$
\begin{aligned}
\Delta\log(\text{Amihud}_{i,t}) =& \beta_0 + \beta_1\hat{\gamma}^1_{i,t} + \beta_2\text{Suit}_{i,t} + \beta_3\hat{\gamma}^1_{i,t} \times \text{Suit}_{i,t} + \beta_4\Delta\log(\#\text{Discl}_{i,t}) + \beta_5\Delta\log(\#\text{Discl}_{i,t}) \times \hat{\gamma}^1_{i,t} \\
&+ \beta_6\Delta\log(\#\text{Discl}_{i,t}) \times \text{Suit}_{i,t} + \beta_7\Delta\log(\#\text{Discl}_{i,t}) \times \hat{\gamma}^1_{i,t} \times \text{Suit}_{i,t} + \beta_8\Delta\log(\text{Trading}_{i,t}) \\
&+ \beta_9\Delta\log(\text{Trading}_{i,t}) \times \hat{\gamma}^1_{i,t} + \beta_{10}\Delta\log(\text{Trading}_{i,t}) \times \text{Suit}_{i,t} \\
&+ \beta_{11}\Delta\log(\text{Trading}_{i,t}) \times \hat{\gamma}^1_{i,t} \times \text{Suit}_{i,t} + \delta'\Delta\log(\text{X}_{i,t}) + \delta_y + \delta_q + \epsilon_{i,t}.
\end{aligned}
\tag{38}
$$

The sample we use to test this model is constructed at firm-quarter level, as indexed by $i$ and $t$, respectively. $\Delta\log(\text{Amihud}_{i,t})$ measures the log change in Amihud's (2002) liquidity. $\hat{\gamma}^1_{i,t}$ is a proxy for funds' incentives to disclose about stock $i$ in quarter $t$ (short-termism) and is constructed as follows. In each quarter, we construct each holding company $j$'s flow-return sensitivity—labeled $\hat{\gamma}^1_{j,t}$—by first estimating, for each fund $k$ under the holding company, a rolling regression of its fund flows on its contemporaneous as well as past fund returns (Eq. (24)) and then computing $\hat{\zeta}_{k,t}$ as the sum of the resulting contemporaneous and lagged estimates of flow-performance sensitivity coefficients (Eq, (25)). We then define $\hat{\gamma}^1_{j,t}$ as the NAV-weighted average $\hat{\zeta}_{k,t}$ of all funds $k$ managed by holding company $j$ at month $t$. For each stock $i$ in each quarter $t$, we then compute a weighted average of $\hat{\gamma}^1_{j,t}$ across all holding companies with non-zero holdings in that stock using the absolute value of the corresponding number of its shares held as weights. We denote this weighted average by $\hat{\gamma}^1_{j,t}$ (Eq. (33)):

$$
\overline{\hat{\gamma}^1}_{i,t} = \frac{1}{\sum_j |\text{Shr}_{i,j,t}|} \sum_j |\text{Shr}_{i,j,t}| \times \hat{\gamma}^1_{j,t}.
\tag{33}
$$

We then define $\hat{\gamma}^1_{i,t}$ as $\log(1 + \overline{\hat{\gamma}^1}_{i,t})$. $\Delta\log(\#\text{Discl}_{i,t})$ is the log change in the number of disclosures about firm $i$ from quarter $t-1$ to quarter $t$. $\Delta\log(\text{Trading}_{i,t})$ is the log change in the percentage trading by all sample mutual funds; percentage trading is defined as $\text{Trading}_{i,t} = \frac{|\text{Shr}_{i,t} - \text{Shr}_{i,t-1}|}{\text{ShrOut}_{i,t-1}}$, where $\text{Shr}_{i,t}$ is the total number of shares held by all sample funds at the end of quarter $t$ and $\text{ShrOut}_{i,t}$ is firm $i$'s number of shares outstanding as of the end of quarter $t$. $Suit_{i,t}$, the conditioning variable, is defined in Table 5 as the log change in either the inverse of firm size (measured as market capitalization, $Size_{i,t}$), intangibility (proportion of intangible asset of total asset, $Intan_{i,t}$), or standard deviation of stock $i$'s past returns ($Stdev(Ret)_{i,t}$)—as indicated in the bottom row of this table.

In all specifications, we control for the log change of firm size, intangibility, stock return volatility and average price level. Whenever $\Delta\log(\#\text{Discl}_{i,t})$ is included as a RHS variable, we also control for $\Delta\log(\#\text{Discl}_{-i,t})$, the log change in the number of disclosures made about all firms except firm $i$ in quarter $t$. In all specifications, we include year fixed effects ($\delta_y$) and quarter fixed effects ($\delta_q$). All variables are winsorized at the 2% and 98% levels and standardized. Numbers in parentheses are robust (Huber-White) standard errors.

# Table 7 Continued

| LHS Var. | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | | | $\Delta$log(Amihud) | | |
| $\hat{\gamma}^1$ | | | 0.027*** | 0.024*** | 0.022*** |
| | | | (0.006) | (0.005) | (0.005) |
| $\Delta$log(#Discl) | -0.008** | | -0.010*** | | -0.009*** |
| | (0.003) | | (0.003) | | (0.003) |
| $\Delta$log(#Discl) $\times \hat{\gamma}^1$ | | | -0.020*** | | -0.018*** |
| | | | (0.005) | | (0.005) |
| $\Delta$log(Trading) | | 0.023*** | | 0.015*** | 0.013*** |
| | | (0.005) | | (0.005) | (0.005) |
| $\Delta$log(Trading) $\times \hat{\gamma}^1$ | | | | 0.023*** | 0.019*** |
| | | | | (0.004) | (0.005) |
| | | | | | |
| Observations | 28,094 | 28,094 | 28,094 | 28,094 | 28,094 |
| R-squared | 0.514 | 0.513 | 0.515 | 0.514 | 0.516 |

| LHS Var. | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | $\Delta$log(Amihud) | | | | |
| $\hat{\gamma}^1$ | -0.014*** | 0.026*** | 0.022*** | -0.011** | 0.021*** | 0.010* | -0.011** | 0.020*** | 0.009* |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| Suit$_{i,t}$ | 0.326*** | -0.001 | -0.025** | 0.347*** | -0.005 | -0.051*** | 0.345*** | -0.006 | -0.052*** |
| | (0.017) | (0.005) | (0.011) | (0.018) | (0.005) | (0.011) | (0.018) | (0.005) | (0.011) |
| $\hat{\gamma}^1 \times$ Suit$_{i,t}$ | -0.005 | 0.013** | 0.046*** | -0.000 | 0.008 | 0.010 | -0.002 | 0.006 | 0.002 |
| | (0.006) | (0.006) | (0.007) | (0.005) | (0.005) | (0.006) | (0.005) | (0.005) | (0.006) |
| $\Delta$log(#Discl) | -0.001 | -0.009** | -0.008** | | | | -0.002 | -0.007** | -0.005* |
| | (0.003) | (0.003) | (0.003) | | | | (0.003) | (0.003) | (0.003) |
| $\Delta$log(#Discl) $\times \hat{\gamma}^1$ | -0.008** | -0.018*** | -0.016*** | | | | -0.009** | -0.017*** | -0.012*** |
| | (0.004) | (0.004) | (0.004) | | | | (0.004) | (0.004) | (0.004) |
| $\Delta$log(#Discl) $\times$ Suit$_{i,t}$ | -0.002 | -0.011** | -0.017*** | | | | -0.002 | -0.009** | -0.012*** |
| | (0.004) | (0.005) | (0.004) | | | | (0.004) | (0.005) | (0.004) |
| $\Delta$log(#Discl) $\times \hat{\gamma}^1 \times$ Suit$_{i,t}$ | -0.016*** | -0.029*** | -0.036*** | | | | -0.016*** | -0.027*** | -0.028*** |
| | (0.004) | (0.006) | (0.005) | | | | (0.004) | (0.006) | (0.005) |
| $\Delta$log(Trading) | | | | -0.009* | 0.013*** | 0.014*** | -0.011** | 0.011** | 0.012** |
| | | | | (0.004) | (0.005) | (0.005) | (0.004) | (0.005) | (0.005) |
| $\Delta$log(Trading) $\times \hat{\gamma}^1$ | | | | -0.009** | 0.021*** | 0.022*** | -0.013*** | 0.017*** | 0.018*** |
| | | | | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| $\Delta$log(Trading) $\times$ Suit$_{i,t}$ | | | | 0.005 | -0.001 | 0.063*** | 0.007 | -0.002 | 0.061*** |
| | | | | (0.005) | (0.005) | (0.006) | (0.005) | (0.005) | (0.006) |
| $\Delta$log(Trading) $\times \hat{\gamma}^1 \times$ Suit$_{i,t}$ | | | | -0.010** | 0.023*** | 0.052*** | -0.011** | 0.020*** | 0.049*** |
| | | | | (0.005) | (0.005) | (0.006) | (0.005) | (0.005) | (0.006) |
| | | | | | | | | | |
| Observations | 28,094 | 28,094 | 28,094 | 28,094 | 28,094 | 28,094 | 28,094 | 28,094 | 28,094 |
| R-squared | 0.543 | 0.517 | 0.521 | 0.541 | 0.515 | 0.525 | 0.544 | 0.518 | 0.528 |
| | | | | | | | | | |
| Suit$_{i,t}$($\Delta$log) | $1/Size_{i,t}$ | $Intan_{i,t}$ | $Stdev(Ret)_{i,t}$ | $1/Size_{i,t}$ | $Intan_{i,t}$ | $Stdev(Ret)_{i,t}$ | $1/Size_{i,t}$ | $Intan_{i,t}$ | $Stdev(Ret)_{i,t}$ |

## Table 8: PBT, PBD and Market Liquidity with $\hat{\gamma}^2_{i,t}$

This table reports test results on the effect of PBT and PBD on market liquidity. In each specification, we test—in part or in full—the following regression model of Eq. (38):

$$
\begin{aligned}
\Delta\log(\text{Amihud}_{i,t}) =& \beta_0 + \beta_1\hat{\gamma}^2_{i,t} + \beta_2\text{Suit}_{i,t} + \beta_3\hat{\gamma}^2_{i,t} \times \text{Suit}_{i,t} + \beta_4\Delta\log(\#\text{Discl}_{i,t}) + \beta_5\Delta\log(\#\text{Discl}_{i,t}) \times \hat{\gamma}^2_{i,t} \\
&+ \beta_6\Delta\log(\#\text{Discl}_{i,t}) \times \text{Suit}_{i,t} + \beta_7\Delta\log(\#\text{Discl}_{i,t}) \times \hat{\gamma}^2_{i,t} \times \text{Suit}_{i,t} + \beta_8\Delta\log(\text{Trading}_{i,t}) \\
&+ \beta_9\Delta\log(\text{Trading}_{i,t}) \times \hat{\gamma}^2_{i,t} + \beta_{10}\Delta\log(\text{Trading}_{i,t}) \times \text{Suit}_{i,t} \\
&+ \beta_{11}\Delta\log(\text{Trading}_{i,t}) \times \hat{\gamma}^2_{i,t} \times \text{Suit}_{i,t} + \delta'\Delta\log(\text{X}_{i,t}) + \delta_y + \delta_q + \epsilon_{i,t}.
\end{aligned}
\tag{38}
$$

The sample we use to test this model is constructed at firm-quarter level, as indexed by $i$ and $t$, respectively. $\Delta\log(\text{Amihud}_{i,t})$ measures the log change in Amihud's (2002) liquidity. $\hat{\gamma}^2_{i,t}$ is a proxy for a fund's incentives to disclose (short-termism) and is constructed as follows. For each firm $i$ in each quarter $t$, we define $\hat{\gamma}^2_{i,t}$ as the deviation of the mutual fund sector's holdings of firm $i$ from firm $i$'s market share. Specifically, let $H^f_{i,t} = \frac{\text{Value of Firm i Shares Held by All Sample Funds at the End of Quarter t}}{\text{Value of All S\&P 1500 Firms Held by All Sample Funds at the End of Quarter t}}$ and let $H^m_{i,t} = \frac{\text{Market Cap. of Firm i at the End of Quarter t}}{\text{Market Cap. of All S\&P 1500 Firms at the End of Quarter t}}$, then define (Eq. (39))

$$
\hat{\gamma}^2_{i,t} = \begin{cases} \log(\frac{H^f_{i,t}}{H^m_{i,t}}), & \text{if } H^f_{i,t} > H^m_{i,t}, \\ \log(\frac{H^m_{i,t}}{H^f_{i,t}}), & \text{Otherwise.} \end{cases}
\tag{39}
$$

$\Delta\log(\#\text{Discl}_{i,t})$ is the log change in the number of disclosures about firm $i$ from quarter $t-1$ to quarter $t$. $\Delta\log(\text{Trading}_{i,t})$ is the log change in the percentage trading by all sample mutual funds; percentage trading is defined as $\text{Trading}_{i,t} = \frac{|\text{Shr}_{i,t} - \text{Shr}_{i,t-1}|}{\text{ShrOut}_{i,t-1}}$, where $\text{Shr}_{i,t}$ is the total number of shares held by all sample funds at the end of quarter $t$ and $\text{ShrOut}_{i,t}$ is firm $i$'s number of shares outstanding as of the end of quarter $t$. $Suit_{i,t}$, the conditioning variable, is defined in Table 5 as the log change in either the inverse of firm size (measured as market capitalization, $Size_{i,t}$), intangibility (proportion of intangible asset of total asset, $Intan_{i,t}$), or standard deviation of stock $i$'s past returns ($Stdev(Ret)_{i,t}$)—as indicated in the bottom row of this table.

In all specifications, we control for the log change in firm size, intangibility, stock return volatility and average price level. Whenever $\Delta\log(\#\text{Discl}_{i,t})$ is included as a RHS variable, we also control for $\Delta\log(\#\text{Discl}_{-i,t})$, the log change in the number of disclosures made about all firms except firm $i$ in quarter $t$. In all specifications, we include year fixed effects ($\delta_y$) and quarter fixed effects ($\delta_q$). All variables are winsorized at the 2% and 98% levels and standardized. Numbers in parentheses are robust (Huber-White) standard errors.

## Table 8 Continued

| LHS Var. | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | | | $\Delta$log(Amihud) | | |
| $\hat{\gamma}^2$ | | | 0.036*** | 0.028*** | 0.027*** |
| | | | (0.007) | (0.006) | (0.006) |
| $\Delta$log(#Discl) | -0.008** | | -0.011*** | | -0.010*** |
| | (0.003) | | (0.004) | | (0.004) |
| $\Delta$log(#Discl) $\times \hat{\gamma}^2$ | | | -0.021*** | | -0.019*** |
| | | | (0.005) | | (0.005) |
| $\Delta$log(Trading) | | 0.023*** | | 0.010** | 0.008* |
| | | (0.005) | | (0.005) | (0.005) |
| $\Delta$log(Trading) $\times \hat{\gamma}^2$ | | | | 0.035*** | 0.031*** |
| | | | | (0.004) | (0.004) |
| | | | | | |
| Observations | 28,094 | 28,094 | 28,094 | 28,094 | 28,094 |
| R-squared | 0.514 | 0.513 | 0.516 | 0.515 | 0.517 |

| LHS Var. | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | $\Delta$log(Amihud) | | | | |
| $\hat{\gamma}^2$ | -0.023*** | 0.035*** | 0.028*** | -0.021*** | 0.026*** | 0.007 | -0.021*** | 0.025*** | 0.007 |
| | (0.005) | (0.006) | (0.006) | (0.005) | (0.006) | (0.006) | (0.005) | (0.006) | (0.006) |
| Suit$_{i,t}$ | 0.304*** | -0.002 | -0.046*** | 0.303*** | -0.006 | -0.073*** | 0.300*** | -0.007 | -0.076*** |
| | (0.018) | (0.005) | (0.011) | (0.021) | (0.004) | (0.011) | (0.021) | (0.004) | (0.011) |
| $\hat{\gamma}^2 \times$ Suit$_{i,t}$ | 0.020*** | 0.009 | 0.085*** | 0.020*** | 0.002 | 0.031*** | 0.019*** | 0.000 | 0.028*** |
| | (0.006) | (0.006) | (0.007) | (0.005) | (0.005) | (0.006) | (0.006) | (0.005) | (0.006) |
| $\Delta$log(#Discl) | -0.003 | -0.008** | -0.008** | | | | -0.003 | -0.007* | -0.006* |
| | (0.003) | (0.003) | (0.003) | | | | (0.003) | (0.003) | (0.003) |
| $\Delta$log(#Discl) $\times \hat{\gamma}^2$ | -0.011*** | -0.019*** | -0.015*** | | | | -0.012*** | -0.017*** | -0.013*** |
| | (0.004) | (0.004) | (0.004) | | | | (0.004) | (0.004) | (0.004) |
| $\Delta$log(#Discl) $\times$ Suit$_{i,t}$ | -0.001 | -0.009* | -0.011*** | | | | -0.001 | -0.008* | -0.009** |
| | (0.004) | (0.004) | (0.004) | | | | (0.004) | (0.004) | (0.004) |
| $\Delta$log(#Discl) $\times \hat{\gamma}^2 \times$ Suit$_{i,t}$ | -0.013*** | -0.027*** | -0.028*** | | | | -0.012*** | -0.026*** | -0.022*** |
| | (0.004) | (0.006) | (0.005) | | | | (0.004) | (0.006) | (0.005) |
| $\Delta$log(Trading) | | | | -0.009* | 0.009* | 0.008* | -0.010** | 0.007 | 0.006 |
| | | | | (0.004) | (0.005) | (0.005) | (0.004) | (0.005) | (0.005) |
| $\Delta$log(Trading) $\times \hat{\gamma}^2$ | | | | -0.003 | 0.034*** | 0.030*** | -0.007* | 0.030*** | 0.026*** |
| | | | | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| $\Delta$log(Trading) $\times$ Suit$_{i,t}$ | | | | -0.001 | -0.001 | 0.032*** | 0.001 | -0.002 | 0.032*** |
| | | | | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| $\Delta$log(Trading) $\times \hat{\gamma}^2 \times$ Suit$_{i,t}$ | | | | 0.006 | 0.018*** | 0.072*** | 0.006 | 0.015*** | 0.069*** |
| | | | | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| | | | | | | | | | |
| Observations | 28,094 | 28,094 | 28,094 | 28,094 | 28,094 | 28,094 | 28,094 | 28,094 | 28,094 |
| R-squared | 0.544 | 0.517 | 0.526 | 0.541 | 0.516 | 0.532 | 0.544 | 0.519 | 0.535 |
| Suit$_{i,t}$($\Delta$log) | $1/Size_{i,t}$ | $Intan_{i,t}$ | $Stdev(Ret)_{i,t}$ | $1/Size_{i,t}$ | $Intan_{i,t}$ | $Stdev(Ret)_{i,t}$ | $1/Size_{i,t}$ | $Intan_{i,t}$ | $Stdev(Ret)_{i,t}$ |