Disclosing to informed investors

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Prices reflect information from multiple sources

Private information dispersed across investors

Strategic public disclosures by firms

Previous analysis focuses on one or the other, but misses the interaction

- How do strategic disclosures depend on investor information?
- How well do prices reflect fundamentals?

Especially important for empirical and policy analysis

What do we do?

Model of voluntary disclosure with risk averse, privately informed investors

- Manager may be uninformed / disclosure may be costly

Key questions:

- How do disclosure strategy and informed trading depend on each other?
- How well do prices aggregate and reflect information?
- What is the impact of exogenous public signals on disclosures / trading?

Challenge: Voluntary disclosure breaks “linearity” of equilibrium

What do we find?

Characterize conditions under which there exists a threshold equilibrium

- Firm discloses if and only if they have sufficiently good news

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Firm is "mis-valued" relative to expected cash flows

- Firm is **undervalued** when disclosure is costly
- Firm is **overvalued** when manager may not be informed

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Public information can **crowd in** more disclosure, contrary to common wisdom

- Important for regulatory policy

Related Literature

Voluntary disclosure: Jovanovic (1982), Verrecchia (1983), and Dye (1985)

- Investors are uninformed, risk neutral, or both
- Risk-averse and uninformed: Verrecchia (1983), Cheynel (2013), Jorgensen and Kirschenheiter (2015), and Dye and Hughes (2018)
- Risk neutral and informed: Bertomeu, Beyer, and Dye (2011), Petrov (2016); Einhorn (2018) - Kyle model

Dispersed information models: Disclosure is either exogenous or nondiscretionary i.e.,

firm commits to disclosure policy

- Rational expectations: Hellwig (1980), Admati (1985)
- Commitment to disclosure: Goldstein and Yang (2019), Yang (2020), Schneemeier (2019), Cianciaruso, Marinovic, and Smith (2020)

Non-linear noisy REE techniques: Breon-Drish (2015)

- Banerjee Green (2015), Albagli Hellwig Tsyvinski (2015), Chabakauri Yuan Zachariadis (2017), Glebkin (2015), Smith (2019)...

Model Setup

Payoffs, Preferences, Signals

"standard noisy RE setup"
(e.g., Hellwig)

Risk-free asset is numeraire

Risky asset pays off terminal cash flows $v \sim N(m, \sigma_v^2)$, where $m = 0$ WLOG

Aggregate supply is $\kappa \geq 0$

Noise traders demand $z \sim N(0,\sigma_z^2)$ shares

Continuum of CARA investors, with risk tolerance τ

Investor $i \in [0,1]$ observes "truth plus noise" signal:

$$s_i = v + \varepsilon_i, \text{ where } \varepsilon_i \sim N(0,\sigma_\varepsilon^2)$$

Disclosure frictions

Manager observes v with probability $p \in [0,1]$ and can disclose it at a cost $c \geq 0$

At least one of $p < 1$ or $c > 0$ must hold, else unravelling (all firms disclose)

"Costly Disclosure Benchmark" $(c > 0, p = 1)$ Verrecchia (1983)

- Information is useful to competitors
- e.g., Redactions in IPO filings, discussions of strategic plans in conf. calls

"Probabilistic Information Benchmark" $(c = 0\, p < 1)$ Dye (1985)

- Information arrival is stochastic
- e.g., Clinical trial / R&D outcomes, disputes with contracting parties

Timeline

t = 1

Manager observes v
with probability p
chooses $d \in \{D, ND\}$

t = 2

Investor i observes s_i
submits demand $D(s_i, s_p, P)$
market clears at $P \in \{P_D, P_{ND}\}$

t = 3

Firm pays v

Analysis

Threshold Equilibrium

Equilibrium characterized by:

- Disclosure strategy is optimal i.e,. disclose iff $P_D - c \geq \mathbb{E}[P_{ND} \mid v]$
- Investor demand maximizes expected utility, given information $\{s_i, P, d\}$
- The equilibrium price clears the market i.e.,

$$\int_i D(s_i, P, d)di + z = \kappa$$

Search for a **threshold equilibrium:** disclose iff $v \geq T$ for a threshold T

- if disclosed, $P = P_D = v$
- if not disclosed, either (i) manager is uninformed,

  (ii) manager is informed and $v < T$

Generalized linear equilibrium

Given non-disclosure, v is the mixture of a normal and truncated normal

- Standard equilibrium (price is a linear signal of payoff) is not possible!

We solve for the **generalized linear equilibrium** (Breon-Drish, 2015):

$$P_{ND}(v, z; T) = G(v + \beta z)$$

for an increasing function $G()$ and constant β

$\Rightarrow$ Price can be inverted to get a **linear signal** $s_p = v + \beta z$

$\Rightarrow$ Tractable for investor updating

Result 0: Non-disclosure price is a weighted average

In a threshold equilibrium with threshold T, the non-disclosure price is

$$P_{ND}(v, z; T) = \omega(s_p) \times P_U(v, z) + (1 - \omega(s_p)) \times P_I(v, z; T)$$

Weighted average of:

- Uninformed price $P_U(v, z) = \int_i \mathbb{E}[v \mid s_i, s_p] di + \frac{\mathbb{V}[v \mid s_i, s_p]}{\tau}(z - \kappa)$

  Price if manager is known to be uninformed (standard, Hellwig price)

- Informed price $P_I(v, z; T) = \mathbb{E}[v \mid v < T, s_i = s_p, s_p]$

  Price if manager is known to be informed, reflects truncation at threshold T

- Weights reflect aggregate information, $\omega(s_p)$ increases in s_p

$$\omega(s_p) \equiv \Pr(\text{not informed}) = \frac{1 - p}{1 - p + p \Pr(v < T \mid s_i = s_p, s_p)}$$

Result 1: Threshold disclosure equilibrium

Suppose either $p = 1$ or investors' information precision $1/\sigma_\varepsilon^2 + 1/\sigma_p^2$ is sufficiently low. Then, there exists a unique threshold equilibrium in which the manager discloses if and only if $v \geq T$. The threshold satisfies:

$$T - c = \mathbb{E}[P_{ND}(T, z; T)]$$

Existence / uniqueness of threshold equilibrium trickier than usual:

- Non-disclosure price partially reflects cash flows, unlike standard models
- Need to ensure that $\mathbb{E}[P_{ND} \mid v]$ doesn't increase too quickly otherwise, high cash flow managers may not want to disclose

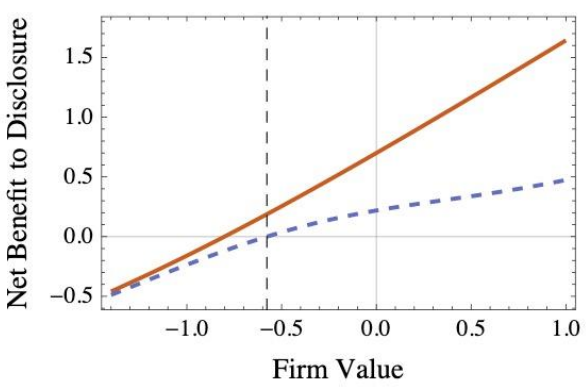
(Non) Existence of Threshold equilibria

Need net benefit of disclosure $v - c - \mathbb{E}[P_{ND}(v, z; T \mid v]$ to be increasing

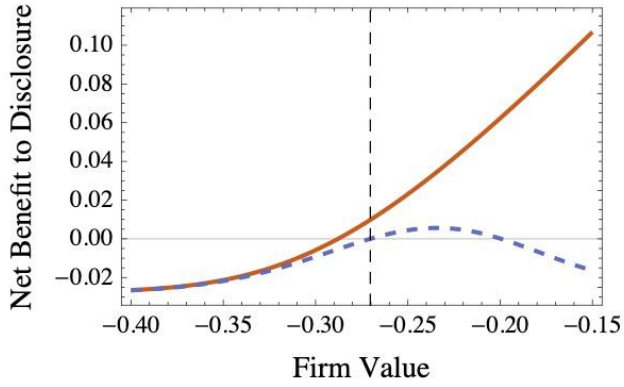
- Guaranteed for costly disclosure benchmark (i.e., $p = 1$)
- When $p < 1$ and info. precision is high, a lot of uncertainty is resolved when $v \approx T$

$\Rightarrow$ non-disclosure price can increase very quickly

Figure: Existence and non-existence of a threshold equilibrium. Solid line ($p = 1$); Dashed line ($p < 1$)



(a) Low Private Information ($\sigma_\varepsilon = 0.75$)



(b) High Private Information ($\sigma_\varepsilon = 0.2$)

Implications

Question: How well do prices reflect information?

Focus on the case where aggregate supply is zero, i.e., $\kappa = 0$

- Implies investors do not bear "systematic risk"
- Equivalent to focusing on disclosures of firm-specific information

Standard Intuition: Prices reflect (risk-adjusted) expected cash flows

- Standard noisy RE models without aggregate risk
- Standard voluntary disclosure models, since $P_{ND} = \mathbb{E}[v \mid ND]$

Mispricing is interpreted as evidence of behavioral biases / frictions

Result 2: Overvaluation and Undervaluation

Conditional on no disclosure, the average price differs from expected cash flows

*(i) In the **costly disclosure benchmark** $(c > 0, p = 1)$, the firm is **undervalued:***

$$\mathbb{E}[P_{ND}] \leq \mathbb{E}[v \,|\, ND]$$

*(ii) In the **probabilistic info. benchmark** $(c = 0, p < 1)$, when investor's private information is not too precise, the firm is **overvalued:***

$$\mathbb{E}[P_{ND}] \geq \mathbb{E}[v \,|\, ND]$$

This translates into unconditional mis-valuation, since the firm is correctly valued when there is a disclosure.

Intuition: Asymmetric response to liquidity trades

Non-disclosure changes the conditional distribution of cash flows

⇒ Investors require different compensation for liquidity sells vs. buys

Costly disclosure case: $ND \equiv \{v < T\}$

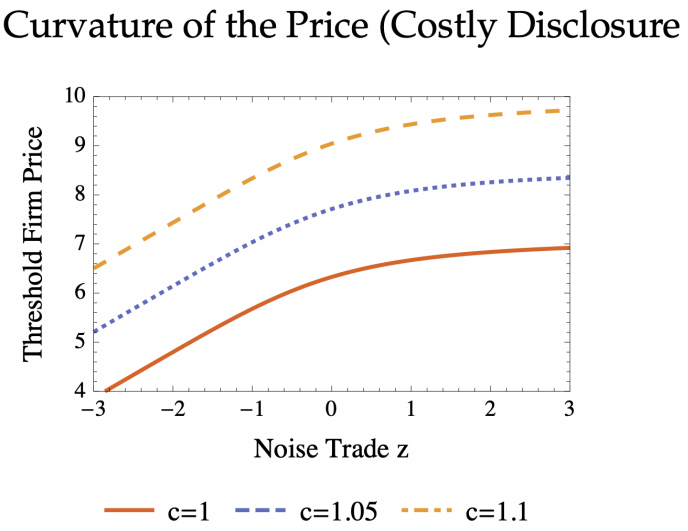
i.e., payoffs are bounded above

⇒ Upside limited relative to downside

⇒ Buying from noise traders is riskier

⇒ Price is **concave** in noise trades

⇒ Expected price is **lower** than expected cash flows



Intuition: Asymmetric response to liquidity trades

Probabilistic disclosure case:

$$ND \equiv \{v < T, \text{manager informed}\} \cup \{v, \text{manager uninformed}\}$$

i.e., non disclosure has some possibility of good news

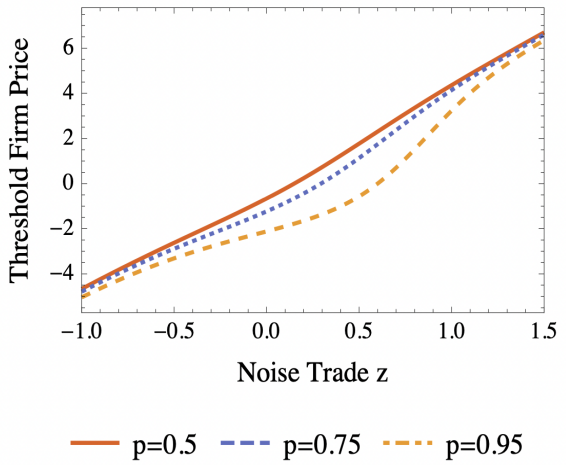
⇒ When signals are noisy, there is "upside risk": low price but high cash flows

⇒ Short-selling to liquidity traders is risky

⇒ Prices pushed up on average

⇒ Expected price is **higher** than expected cash flows

Curvature of the Price (Probabilistic Info



Implications of Misvaluation

Non-disclosure can generate over- / under- valuation without behavioral biases

Firm can have higher valuation when it **does not** disclose

e.g., pharma / biotech firms delay or don't disclose clinical trial failures

Negative relation between average returns and idiosyncratic skewness

- Usually attributed to investors having non-standard preferences
- Arises naturally due to non-disclosure
  - Costly disclosure benchmark: payoffs are negatively skewed + firm is undervalued
  - Probabilistic info benchmark: payoffs are positively skewed + firm is overvalued

Question: Does public information decrease disclosure?

Standard Intuition: Public information **crowds out** voluntary disclosure

More ex-ante public information

⇒ investors are less pessimistic about no-disclosure

⇒ firm has less incentive to disclose, especially if costly

Important for policy:

- Regulators propose mandatory disclosures to reduce investor uncertainty
- But firms / critics argue "crowding out" makes this counterproductive

Empirical evidence of the relation between public info and voluntary disclosure is mixed:

- **Negative:** Balakrishnan, Billings, Kelly, and Ljungqvist (2014), Guay, Samuels, and Taylor (2016), and Barth, Landsman, and Taylor (2017))
- **Positive:** Francis, Nanda, and Olsson (2008), Ball, Jayaraman, and Shivakumar

Ex-ante public signal

Introduce an ex-ante public signal before disclosure / trading

$$y = v + \eta \quad \text{where } \eta \sim N(0, \sigma_\eta^2)$$

Now the disclosure threshold depends on the public signal, so analogous equilibrium exists where the public signal shifts all participant's priors i.e.,

$$\mathbb{E}[v] \to \mathbb{E}[v \mid y] \quad \text{and } \mathbb{V}[v] \to \mathbb{V}[v \mid y]$$

Lemma: *The equilibrium threshold depends linearly on the public signal i.e.,*

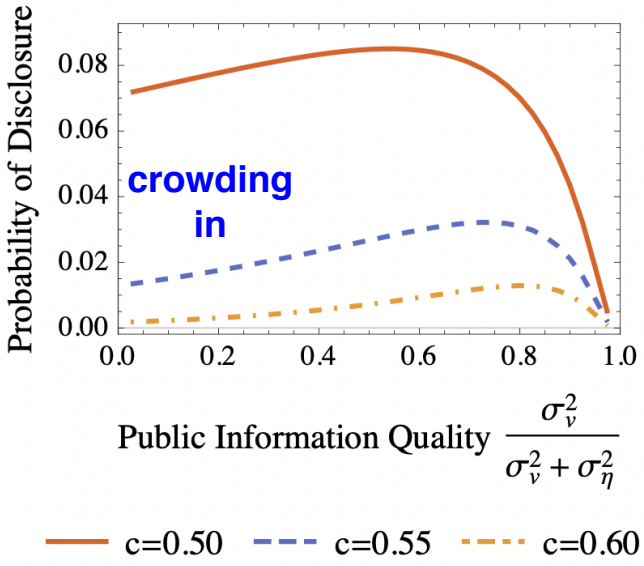
$$T(y) = T(0) + \mathbb{E}[v \mid y]$$

and so the probability of disclosure does not depend on the realization of the public signal, but does depend on the precision of the public signal i.e., $1/\sigma_\eta^2$

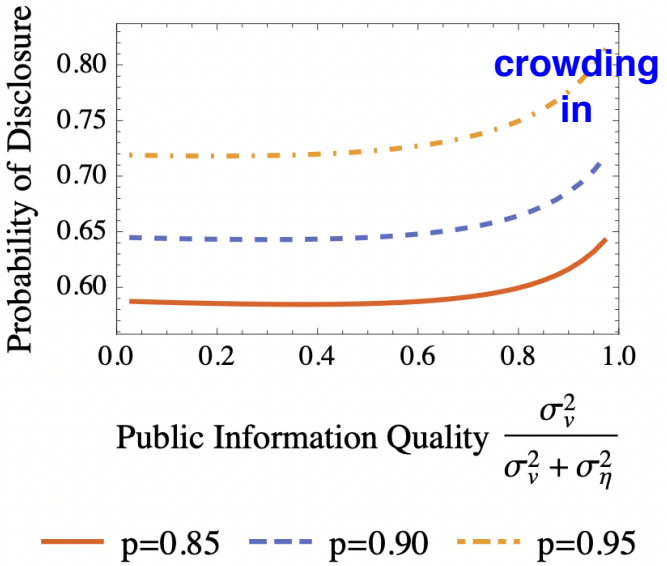
Result 3: Public info can **crowd in** disclosure

Crowding in more likely when

(i) disclosure costs are high or (ii) public signal is relatively more precise



(a) Costly Disclosure Benchmark
($p = 1$, $\sigma_\varepsilon = 0.75$, $\sigma_z = 1$)



(b) Probabilistic Endowment Benchmark
($c = 0$, $\sigma_\varepsilon = \sigma_z = 2$)

In addition to standard effect of public signal (which decreases incentives to disclose), two new channels:

Valuation channel: More precise public information reduces over-/under-valuation

- In the limit, if public signal were perfect, there would be no mis-valuation
- Reduces under-valuation in costly disclosure benchmark ⇒ less voluntary disclosure
- Reduces over-valuation in probabilistic info benchmark ⇒ more voluntary disclosure

Substitution channel: More precise public information

⇒ Less weight on private signals

⇒ Price is less informative if public signal is relatively noisy

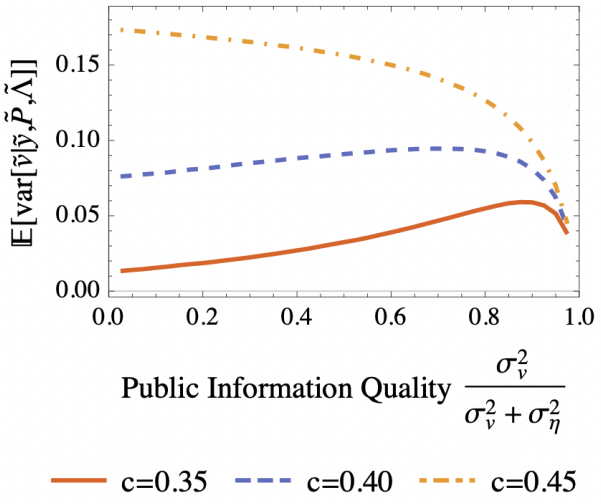
⇒ Disclosure is more attractive for firm

- **Costly disclosure benchmark:** Substitution channel dominates valuation channel when disclosure is sufficiently costly ⇒ public signal crowds in voluntary disclosure
- **Probabilistic info benchmark:** Valuation channel ⇒ public signal crowds in voluntary disclosure

Implications: Mandatory disclosure and overall informativeness

Crowding out: Mandatory disclosure can **reduce** overall informativeness when disclosure costs are low and manager is known to be informed

Crowding in: Mandatory disclosure **improves** overall informativeness when disclosure costs are high OR manager may not be informed - helps firms who need it!



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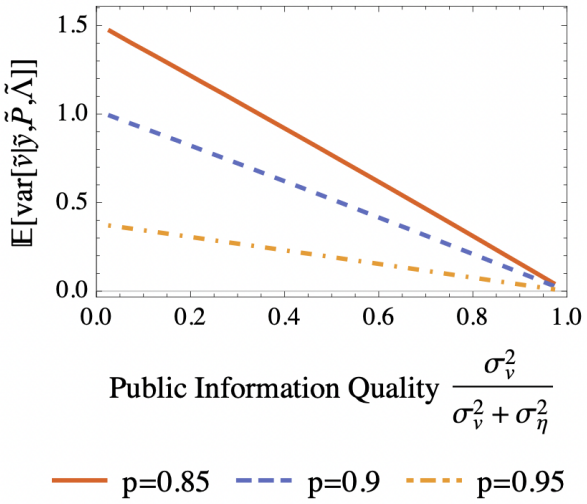

(b) Probabilistic Endowment Benchmark
($c = 0$, $\sigma_\varepsilon = \sigma_z = 2$)

Conclusions

Voluntary disclosure to informed investors

We develop a model to study how diverse, private information across investors affects voluntary disclosure by firms

- Prices can exhibit under- or over-valuation relative to expected cash flows
- Negative relation between expected returns and idiosyncratic skewness
- Public information can crowd in additional voluntary disclosure

Analysis emphasizes that identifying underlying reason for non-disclosure is key to understand empirical evidence / policy impact

Future work: Incentives for manager / investors to acquire information, endogenous investment decisions, other frictions that generate non-disclosure