Sequential Reporting Bias

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Overview

- Disclosure by different firms with **correlated** value/performance are issued **sequentially**
- Firms that disclose later observe earlier disclosure by other firms – **information spillovers** More
- Market pricing – uses information from all reports (Forster (1981), Thomas and Zhang (2008), Truong (2019), Gong et al. (2019))
- Previous studies have considered simultaneous reporting: Strobl (2013), Heinle and Verrecchia (2015), Einhorn, Langberg and Versano (2018), Gao and Zhang (2019)
- Sequential disclosure generates interesting new disclosure incentives, informational effects, price response effects, and insights on firm timing preferences

Main Research Questions

What is the effect of sequential disclosure on:

- **The reporting bias** – bias of early compared to late disclosures, and relative to simultaneous reporting setting
- **Price informativeness and volatility of prices**
- **Price response coefficients** – early compared to late disclosures, and relative to simultaneous reporting setting
- **Managers' timing preferences**
  - When do firms prefer simultaneous move over sequential move?

Setting

- Two firms, $i = 1, 2$, with values $\theta_i \sim N(0, 1/\tau_i^\theta)$
- Firm values, θ_1 and θ_2, are correlated with a correlation parameter $\rho \in (0, 1)$, such that the variance-covariance matrix of $(\theta_1 \; \theta_2)$ is given by:

$$\Sigma_\theta \equiv \begin{pmatrix} \frac{1}{\tau_1^\theta} & \frac{\rho}{\sqrt{\tau_1^\theta \tau_2^\theta}} \\ \frac{\rho}{\sqrt{\tau_1^\theta \tau_2^\theta}} & \frac{1}{\tau_2^\theta} \end{pmatrix}$$

- Alternatively, we can generate the correlation explicitly by having a common component between firms' values, whereby $\theta_i = v_i \pm \varphi$
- For simplicity, focus on positive correlation

Setting (Cont.)

- Each manager i privately observes
  - a noisy signal of her firm's value: $s_i = \theta_i + \varepsilon_i$, with $\varepsilon_i \sim N\left(0, 1/\tau_i^{\varepsilon}\right)$
  - an unknown parameter of her objective function – biasing cost parameter $\eta_i \sim N(0, 1/\tau_i^{\eta})$
- Managers are not confined to truthfully report their beliefs about the firm value ($\mathbb{E}\left[\theta_i|\Omega_i\right]$), however, biasing their report, r_i, is costly

$$\frac{c_i}{2}(r_i - \theta_i - \eta_i)^2$$

- An alternative specification that yields the same results is one with no uncertainty regarding the manager's misreporting costs η_i, but instead, the market observes the manager's report with noise, i.e., the manager reports r and the market sees $\hat{r}$,

$$\hat{r}_i = r_i + \eta_i$$

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Setting (Cont.)

- The first manager issues her report r_1 and, after observing r_1, the second manager reports r_2 – the order is exogenous

- **Pricing**: set by risk-neutral investors based on both reports

$$P_i = \mathbb{E}\left[\theta_i | r_1, r_2\right]$$

- Each manager, given her information set, chooses her report r_i

$$r_i = \arg\max_{r_i} \mathbb{E}\left[P_i - \frac{c_i}{2}(r_i - \theta_i - \eta_i)^2 | \Omega_i\right],$$

where the information sets are: $\Omega_1 = \{s_1, \eta_1\}$ and $\Omega_2 = \{s_2, \eta_2, r_1\}$

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Setting – Key Feature

The setting and the **objective function** are designed to capture the following features:

- Deviation of report from true value is costly to managers; manipulation of the report is costly
- Managers benefit from having more precise information; higher accuracy in the report
  - Reputational benefits of accuracy (Goodman et al. (2013), Graham et al. (2005))
- A manager's report does not fully reveal her private information

Timeline

Stage 1

Manager of firm 1 privately observes signal s_1 and manipulation cost η_1, and publicly issues a report r_1.

Stage 2

Manager of firm 2 observes r_1 and privately observes signal s_2 and manipulation cost η_2, and issues a report r_2.

Stage 3

Market sets prices P_1 and P_2.

Linear Equilibrium

- We conjecture (and later prove) the existence of a linear equilibrium, in which the prices are linear in the reports of both firms:

$$\begin{pmatrix} P_1 \\ P_2 \end{pmatrix} = \begin{pmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{pmatrix} \begin{pmatrix} r_1 \\ r_2 \end{pmatrix} + \begin{pmatrix} Z_1 \\ Z_2 \end{pmatrix}$$

i.e.,

$$P_1 = A_{11} r_1 + A_{12} r_2 + Z_1$$

Equilibrium reporting strategies

- Given the assumed linear pricing, the FOC of the expected utility of the second manager yields

$$r_2 = \mathbb{E}\left[\theta_2 | s_2, r_1\right] + \eta_2 + \underbrace{\frac{A_{22}}{c_2}}_{b_2}$$

- Denote $\frac{dr_2}{dr_1}$ by X (in equilibrium a constant). The FOC for the first manager (who considers X) yields

$$r_1 = \mathbb{E}\left[\theta_1 | s_1\right] + \eta_1 + \underbrace{\frac{A_{11} + A_{12}X}{c_1}}_{b_1}$$

Equilibrium reporting strategies (cont)

- Denoting by D_i the managers' Bayesian weight on the signal s_i when computing expected value of θ_i:

$$
\begin{aligned}
r_1 &= D_1 s_1 + \eta_1 + b_1 \\
r_2 &= D_2 s_2 + X(r_1 - b_1) + \eta_2 + b_2
\end{aligned}
$$

where

$$
D_1 = \frac{\tau_1^\varepsilon}{\tau_1^\varepsilon + \tau_1^\theta}\ , \qquad D_2 = \begin{pmatrix} 0 \\ 1 \end{pmatrix}^T \left(I + \Sigma\Sigma_\theta^{-1}\right)^{-1} \begin{pmatrix} 0 \\ 1 \end{pmatrix},
$$

$$
X = \frac{\tau_1^\varepsilon + \tau_1^\theta}{\tau_1^\varepsilon} \begin{pmatrix} 0 \\ 1 \end{pmatrix}^T \left(I + \Sigma\Sigma_\theta^{-1}\right)^{-1} \begin{pmatrix} 1 \\ 0 \end{pmatrix},
$$

$$
\Sigma = \begin{pmatrix} \frac{1}{\tau_1^\varepsilon} + \left(\frac{\tau_1^\varepsilon + \tau_1^\theta}{\tau_1^\varepsilon}\right)^2 \frac{1}{\tau_1^\eta} & 0 \\ 0 & 1/\tau_2^\varepsilon \end{pmatrix}
$$

Equilibrium reporting strategies (cont)

- As expected

$$\frac{\partial b_1}{\partial A_{11}} = \frac{\partial}{\partial A_{11}}\left(\frac{A_{11} + A_{12}X}{c_1}\right) > 0, \qquad \frac{\partial b_1}{\partial A_{12}} = \frac{X}{c_1} > 0$$

$$\frac{\partial b_2}{\partial A_{22}} = \frac{\partial}{\partial A_{22}}\left(\frac{A_{22}}{c_2}\right) > 0, \qquad \frac{\partial b_2}{\partial A_{21}} = \frac{\partial}{\partial A_{21}}\frac{A_{22}}{c_2} = 0$$

- Deriving the pricing that is consistent with the above reporting strategies yields pricing that is consistent with the assumption of linear pricing

- The equilibrium always **exists** and is **unique**

Benchmark – Simultaneous Reporting

- As a benchmark, we consider a setting with **simultaneous reporting**, in which both managers issue their reports simultaneously
  - Equivalent to a sequential regime in which the second manager does not observe r_1
- There exists a unique linear equilibrium of the benchmark setting in which:

$$r_i = D_i^B s_i + \eta_i + \frac{A_{ii}^B}{c_i}$$

where the coefficient D_i^B is given by

$$D_i^B = \frac{\tau_i^\varepsilon}{\tau_i^\varepsilon + \tau_i^\theta}$$

Manager's Use of Private Information – Sequential Reporting

- The weight that the first manager assigns to her private signal is the same under the simultaneous and the sequential setting

$$D_1 = D_1^B$$

- The weight that the second manager assigns to her private signal in the sequential setting is lower than in the simultaneous setting

$$D_2 < D_2^B$$

- If managers are identical, the weight that the second manager assigns to her private signal is lower than the first manager

Managers' weighing of private information

Proposition

The managers' reports have the following properties:

1. *The weight D_1 assigned to the first manager's signal in her report increases in τ_1^{ε}, and decreases in τ_1^{θ}*
2. *The weight D_2 assigned to second manager's signal in her report increases in τ_2^{ε} and τ_1^{θ}, and decreases in τ_2^{θ}, τ_1^{ε} and ρ*
3. *The weight X assigned in the second manager's report to the first manager's report increases in τ_1^{ε} and ρ, and decreases in τ_2^{ε}*

Informational Implications of Sequential Reporting

- The fact that in her report, the second manager assigns a lower weight to the private signal of her firm value, leads to loss of information
  - To demonstrate the information loss, suppose that a report is determined according to $r = D \cdot s_i + \eta_i + Const$, where the market does not observe s_i and η_i. A higher D makes the report r more informative about s_i (and hence about θ_i)

$\Longrightarrow$ Relative to the simultaneous regime, the sequential regime entails a greater conditional variance of firm values and lower price volatility

$$Var\left[\theta_i | P_1, P_2\right] > Var^B\left[\theta_i | P_1, P_2\right]$$
$$Var\left[P_i\right] < Var^B\left[P_i\right]$$

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Reporting Bias

Theorem

In the sequential regime, the bias by manager 1 always exceeds that of the corresponding bias in the simultaneous regime, i.e.,

$$b_1 > b_1^B.$$

The bias by manager 2 exceeds her bias in the simultaneous regime **if and only if** *the uncertainty about the second firm's objective* $(1/\tau_2^\eta)$ *is sufficiently low (so the market can make relatively precise inference of the second firm's value from* r_2*)*

$$b_2 > b_2^B \text{ **if and only if** } \tau_2^\eta > \bar{\tau}_2^\eta.$$

Reporting Bias – Intuition

- The equilibrium bias is determined such that the manager's marginal cost equals the marginal benefit from the bias. The marginal benefit is determined by the price response coefficients (A_{ii})

- **Bias of the first manager**
  - r_1 has a direct positive effect on P_1 (through A_{11}) – occurs in both regimes
  - The second manager relies less on her own report – results in information loss relative to simultaneous regime
  - Investors assign a higher weight to the first report (higher A_{11}) when forming beliefs
  - Higher weight on r_1 amplifies the first manager's manipulation incentive

  $\Rightarrow$ $b_1 > b_1^B$

- What about the second manager?

Reporting Bias of Second Manager

- The coefficient on r_2, A_{22}, is determined as

$$A_{22} = \frac{L_{22}}{D_2}$$

- Two countervailing effects
  - As r_2 becomes less informative, inference is less precise; L_{22} decreases.
  - Market must filter out D_2 when updating about s_2. A lower D_2 increases the weight A_{22}.
- As $\tau_2^\eta \to +\infty$, the market's inference of the report becomes near-perfect.
  - Information loss goes to zero, as s_2 can be recovered from r_2.
  - Second effect (scaling) unaffected with increases in τ_2^η.
- Sufficiently high τ_2^η implies that second effect dominates, resulting in $A_{22} > A_{22}^B$ and $b_2 > b_2^B$.

Reporting Bias – Additional Results

- Suppose that the two firms are ex-ante symmetric (i.e., $c_1 = c_2 \equiv c$, $\tau_1^\eta = \tau_2^\eta \equiv \tau^\eta$, $\tau_1^\theta = \tau_2^\theta \equiv \tau^\theta$, $\tau_1^\varepsilon = \tau_2^\varepsilon \equiv \tau^\varepsilon$).

  There exist thresholds τ_I^η and $\tau_{II}^\eta > \tau_I^\eta$ such that

$$\begin{cases} b_2 < b^B, & \text{if } \tau^\eta < \tau_I^\eta, \\ b_2 \in [b^B, b_1], & \text{if } \tau^\eta \in [\tau_I^\eta, \tau_{II}^\eta], \\ b_2 > b_1, & \text{if } \tau^\eta > \tau_{II}^\eta. \end{cases}$$

Comparative Statics – Reporting Bias and Correlation

- Under **simultaneity**, manipulation is decreasing in the extent of correlation for both firms $\left(\frac{db_i}{d\rho} < 0\right)$.
  - Peer firm's report becomes more informative for the firm as ρ increases, so each individual firm has less incentive to manipulate.
  - Established in previous studies that consider simultaneous reporting (e.g., Heinle and Verrecchia (2016)).
- Under **sequentiality**, manipulation of the follower decreasing in ρ, but leader's manipulation can be increasing in ρ.
  - Higher ρ implies greater information spillover and thus greater loss of information in the report of the second manager.
  - Market places higher weight on r_1 when forming beliefs, which intensifies manipulation incentive of the lead manager.
  - Requires information spillovers to be sufficiently valuable to second manager (high ρ, low τ_2^{ε}, high τ_1^{η}, high τ_1^{ε}, low τ_2^{η}).

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Managers' Timing Preferences

- Managers always prefer simultaneous reporting over being first under sequential reporting (since $b_1 > b_1^B$ and no information advantage)
- Depending on the parameter values, managers can prefer to be the first or the second mover
  - When $b_2 \leq b_1$ the manager prefers to be the second mover; more precise information as well as lower bias, both decrease expected costs
  - When $b_2 > b_1$ the manager may prefer to be first or second, depending on the parameter values
- when $\tau_1^\eta > \bar{\tau}_1^\eta$, $c_1 < \bar{c}_1$, $\tau_2^\eta > \bar{\tau}_2^\eta$ and $c_2 < \bar{c}_2$. both managers prefer simultaneous reporting over sequential reporting

Empirical predictions

Recall that the main role of uncertainty regarding manager's objective function, η, is imperfect revelation of the private signal through the report. Some other forms of noise to the managers' report yield similar results

- τ_i^η – also referred to as **market inference** – how well the market can infer the manager's private signal from the report.
  - Low τ_i^η can correspond to firms/industries that are, for example, more complex, high growth, emerging, or rapidly evolving.
  - High τ_i^η can correspond to firms/industries that are less complex, more stable, or established, where investors are able to more easily process information releases.

Empirical predictions - Reporting Bias

The model predicts variation in the manipulation behavior of firms depending on industry reporting pattern and informational environment

- Lead firms (report first) in industries with staggered reporting should exhibit higher levels of manipulation in their reports relative to firms in industries with clustered reporting
- Follower firms (report later) should exhibit greater manipulation than lead firms in industries with strong market's inference of information (high τ_i^η)
- In industries with relatively homogeneous firms and low market inference (low τ_i^η) – expect early reporters to have a greater bias relative to late reporters
- Total/overall manipulation by firms should be highest in industries with staggered reporting and high market inference (high τ_i^η)

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Empirical predictions

- We allow firms to be heterogeneous in *all* parameters; we can examine how bias levels change in the characteristics of the peer firm.

Proposition

The firms' manipulation levels have the following properties:

	τ_1^η, τ_1^ε, τ_2^θ	τ_2^η, τ_2^ε, τ_1^θ
b_1	*monotonically increasing*	*monotonically decreasing*
b_2	*monotonically decreasing*	*monotonically increasing*

Empirical predictions

- Connect to the recent stream of research on peer effects (e.g., Seo (2020)). Misreporting level by firms can be influenced by the characteristics of that firm's industry peers.

Prediction

In both reporting regimes, firms (both leaders and followers) exhibit greater manipulation when industry peers have
(i) A less opaque information environment or less information asymmetry between the firm and investors (high τ^{θ}_{-i});
(ii) Less precise information (low τ^{ε}_{-i});
(iii) Lower market inference of reports (low τ^{η}_{-i}).

Empirical predictions

Prediction

In more homogeneous industries with sequential reporting, early reporters are expected to have a greater bias relative to late reporters when the market's inference of reports is weak, such as in industries with greater complexity. When the market's inference is strong, later reporters should exhibit a greater bias relative to early reporters.

- Gong et al. (2019) and Kim et al. (2019) find that late announcers exhibit greater manipulation in their reports relative to early announcers.
- Our result suggests that the direction of this relation varies by industry/firm characteristics.

Extensions

- Alternative specification of market uncertainty
  - Exogenous noise to the manager's report – fully tractable and equivalent to the baseline model
- Short-term price considerations - managers care also about the price following the first report
  - The bias of the lead manager increases in extent of myopic incentives
- Project decisions – real effects of sequential reporting relative to simultaneous reporting
  - Not only information loss, but also efficiency loss by first mover

Summary

- Consider a setting where firms move sequentially and benefit from information spillovers.
- Manipulation incentive of firms depends on the ordering and pattern of reports.
- Many predictions concerning manipulation levels across industries and across firms within industries.
- Other predictions include price efficiency and price volatility (less efficient and less volatile prices under sequential reporting), short- and long-term association of prices with reports, and timing of reports (industries where we expect reporting to be more clustered).

Background – Gong, Li, and Yin (2019)

- "[...] This [two week] time window is sufficient for managers to deliberate last-minute accounting adjustments necessary to achieve (estimated) target performance. As noted in PricewaterhouseCoopers (2010) , 'companies are able to produce consolidated reports within five business days... [and in] many cases, this accelerated cycle is followed by a series of post-close adjusting entries that continue up to the release of earnings.' These anecdotal observations suggest that accounting adjustments are common and can be quickly approved by auditors prior to earnings releases" (p. 361).
- Other studies: Bratten et al. (2016), Kim et al. (2019).

Back