Imprecision in Accounting Measurement: Can It Be Value Enhancing?

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Is some imprecision in accounting information optimal for a firm?

- General intuition is that imprecision is bad
  - Increases risk in valuation, which leads to higher cost of capital
  - More precise measures of effort reduces monitoring costs in agency problems

- Considering how decisions depend on information system produces different implications
  - Paper shifts focus from users’ to managers’ decisions

Overview

1. Model setup
2. First-best world
3. Omniscience (but imprecision)
4. Perfect measurement (but ignorance)
5. Imprecision with ignorance
6. Optimal amount of imprecision?
7. Empirical implications

Model Setup

1. Accounting system is chosen exogenously
2. Manager makes an investment decision
   - Privately observes profitability, chooses investment amount
   - Discloses (truthfully) accounting measure of investment amount
3. Capital markets price firm using accounting measure and inferred investment profitability

Model Setup

- Why do we need an accounting system?
  - Agency costs – ruled out by the paper
  - Information asymmetry – focus of the paper
    - Why is there information asymmetry? – exogenous to the model (proprietary costs?)

- Information asymmetry is sufficient for incentive misalignment

First-Best World

- Firm's investment problem:

  $$\max_k \theta k - c(k) + v(k,\theta)$$

- FOC:

  $$c'(k) = \theta + v_k(k,\theta) \rightarrow \text{solved by } k_{FB}(\theta)$$

- Interpretation of $k_{FB}(\theta)$:
  - θ = marginal short-run profit induced by investment
  - $v_k(k,\theta)$ = marginal change in capital market value based on expected future profits from investment (always > 0)

Introducing Information Asymmetry

- Assumption:
  - Firm has private information about θ that can’t be communicated to capital market
    - (But not because of agency problems)
    - Omniscience vs. ignorance
  - Market has to rely on accounting system to determine amount of investment k
    - Perfect Measurement vs. imprecision

Omniscience (but Imprecision)

- Modeling imprecision:
  - Market receive accounting signal $\tilde{s}$, drawn from $F(s|k)$, where $f(s|k)$ has fixed support $[\underline{s}, \overline{s}]$

- Capital market price:
  - $\varphi(s, \theta)$ -- based on observed profitability and realized imprecise signal

Omniscience (but Imprecision)

- Equilibrium:
  1. For each θ, $k_M(\theta)$ solves
  $$\max_k \theta k - c(k) + \int_{\underline{s}}^{\bar{s}} \varphi(s,\theta) f(s|k) ds$$
  2. Rational expectations:
  $$\varphi(s,\theta) = E[v(k_M(\theta),\theta)|s]$$

Omniscience (but Imprecision)

- Proposition 1: Firm underinvests (myopically), market ignores accounting signal
  1. Equilibrium investment:
     $c'\left(k_M(\theta)\right) = \theta$
     $k_M(\theta) < k_{FB}(\theta)$ because $v_k(k, \theta) > 0$
  2. Equilibrium market price:
     $v(k_M(\theta), \theta), \forall s$

Omniscience (but Imprecision)

- Proof of Proposition 1:
  1. Omniscience leads market to infer $\hat{k}(\theta)$ and price entirely based on inference

$$\varphi(s,\theta) = E\left[v\left(\hat{k}(\theta),\theta\right)\middle|s\right] = v\left(\hat{k}(\theta),\theta\right) \equiv \hat{\varphi}(\theta)$$

  2. Firm now solves:

$$\max_k \theta k - c(k) + \hat{\varphi}(\theta)$$

FOC: $c'\left(k_M(\theta)\right) = \theta$

Omniscience (but Imprecision)

- Interpretation of Proposition 1:
  - Because capital market price is insensitive to actual investment, firm ignores marginal benefit of market price v_k when choosing investment
  - Firm maximizes short-term profitability

Perfect Measurement (but Ignorance)

- Equilibrium:
  1. Investment:
     $k(\theta) = argmax_k \, \theta k - c(k) + \varphi(k)$
  2. Market price:
     $\varphi(k) = v(k, I(k))$
  3. Rational expectations:
     $I\big(k(\theta)\big) = \theta, \forall \theta$

Perfect Measurement (but Ignorance)

- Proposition 2: Firm overinvests (for $\theta > \underline{\theta}$)

  Any fully-revealing equilibrium investment schedule must satisfy

  1. Monotonicity:
     $k'(\theta) > 0$

  2. First-order differential equation:
     $k'(\theta)\left[c'\left(k(\theta)\right) - \theta - v_k\right] = v_\theta$

Perfect Measurement (but Ignorance)

- Riley (1979) describes solutions to the differential equation
  - Worst-type chooses $k = k_{FB}$
  - Given $k'(\theta) > 0$ and $v_\theta > 0$, for differential equation to be satisfied then $c'\big(k(\theta)\big) > \theta + v_k$, which implies overinvestment

Perfect Measurement (but Ignorance)

- Interpretation of Proposition 2:
  - Firms have an incentive to make investments only high types would make, in order to deceive market
  - Market adjusts expectations in equilibrium, but firms are caught up in the possibility of deception, leading to overinvestment

Imprecision with Ignorance

- Market uses s to infer reasonable values of k and θ

- Given conjectured investment schedule $\hat{k}(\theta)$, posterior distribution is

$$g(\theta|s) = \frac{f\left(s\middle|\hat{k}(\theta)\right)h(\theta)}{\int_{\Theta} f\left(s\middle|\hat{k}(t)\right)h(t)dt}$$

Imprecision with Ignorance

- Equilibrium:
  1. For each θ, $k(\theta)$ solves

$$\max_k \theta k - c(k) + \int_s \varphi(s) f(s|k) ds$$

  2. Rational expectations:

$$g(\theta|s) = \frac{f(s|k(\theta))h(\theta)}{\int_\Theta f(s|k(t))h(t)dt}$$

  3. Sequentially rational market price:

$$\varphi(s) = \int_\Theta v(k(\theta), \theta) g(\theta|s) d\theta$$

Imprecision with Ignorance

- Interpretation of equilibrium:
  - Noisy signaling equilibrium -- investment affects the *distribution* of the signal, which is then priced by the market
  - Pooling of types depends on (1) equilibrium investment schedule, (2) accounting system, and (3) prior distribution of types ($h(\theta)$)

Imprecision with Ignorance

- Proposition 3:
  - Equilibrium investment schedule $k(\theta)$ must satisfy:

$$c'\big(k(\theta)\big) = \theta + \int_s \left\{ \int_\Theta v(k(t),t) \frac{f(s|k(t))h(t)}{\int_\Theta f(s|k(\tau))h(\tau)d\tau} dt \right\} f_k(s|k(\theta))ds$$

and $k'(\theta) > 0$

Imprecision with Ignorance

- Interpretation of Proposition 3:
  - The third term is the marginal change in pooling type induced by receiving a given signal s
  - Corollary 3 shows that as long as $f(s|k)$ satisfies monotone likelihood ratio property, $k(\theta) > k_M(\theta), \forall\theta > 0$
    - Higher k will induce a higher signal s, so firms consider sensitivity of market price to investment

Optimal Amount of Imprecision?

- With imprecision and ignorance, investment is more efficient than with imprecision and omniscience (myopic investment).

- But what about when we have perfect measurement and ignorance? Can some imprecision reduce overinvestment?

Optimal Amount of Imprecision?

- Two approaches:
  1. Signal is perturbed by normally distributed error

  2. Signal is perfect with probability $(1-\epsilon)$ and uninformative with probability (ϵ)

Optimal Amount of Imprecision?

1. Normally distributed error
   - Optimal amount of imprecision is positively related to the level of information asymmetry (Corollary to Proposition 4)
     - If low information asymmetry, market price is not very sensitive to noisy investment signal. Decreasing imprecision makes the market more sensitive and increases investment.
     - If high information asymmetry, market price is very sensitive and firms have incentives to deceive market. Reducing sensitivity through increased imprecision decreases overinvestment.

Optimal Amount of Imprecision?

2. Mixture of two distributions
   - Imprecise measurement always results in less investment than in the perfect measurement case (Proposition 6)
     - Because investment affects market price only with some probability, incentives to overinvest are reduced
   - For sufficiently small imprecision, efficiency is strictly improved (Proposition 7)
     - Seems possible ex-post to get the first-best investment (for some types)

Optimal Amount of Imprecision?

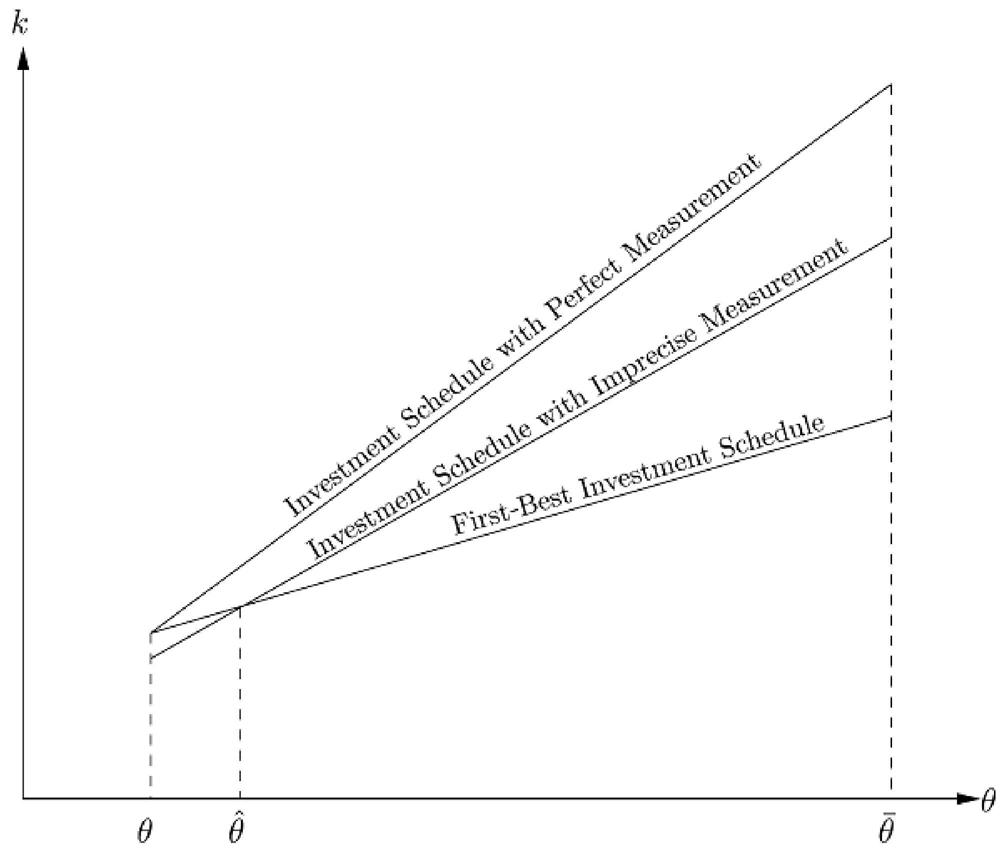

FIG. 2.—Effect of imprecision on the equilibrium investment schedule when the accounting signal is drawn from a mixture of two distributions.

Contribution

- Interesting thought experiment–when is imprecision optimal?
- Incentive misalignment solely through information asymmetry (maybe shown in prior research though)
- Intuitive results, framework for considering how price's *sensitivity* to signals affects firm's decisions

Limitations

- A setting without agency costs? (Does overlaying an agency problem add anything?)
- How does private information acquisition play into this? (Why is there information asymmetry?)

Empirical Implications

- Investors should tolerate (desire) some imprecision
  - Are better disclosures ever value destroying for investors? Do investors ever argue against better measurement (for reasons other than information advantage)?

- Negative relation between optimal precision and information asymmetry
  - Is there evidence internationally across different accounting jurisdictions?