Optimal Thresholds in Accounting Recognition Standards

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Duke Accounting Workshop

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- What is an accounting standard?
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- What instruments does a standard setter control in designing accounting standards?
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  - How does an accounting standard convert a firm’s transactions and events into summary financial numbers?
  - What instruments does a standard setter control in designing accounting standards?
  - What are the frictions in the process?
An example of accounting recognition: securitization

- Physical flow: asset transferred to transferee and cash to the transferor
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- Two problems with recognition
  - the binary classification suppresses information
  - the discreteness induces manipulation around the threshold
Research questions

1. Given the use of recognition, what is the optimal recognition threshold $P$?

2. Why are recognition thresholds used in the first place? Why is recognition superior to disclosure?
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A statistical/decision-making view

- Consider a medical diagnosis procedure
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- A higher threshold reduces undue optimism at the expense of increasing false alarm
- If two errors are equally costly for decision-making, the efficient threshold is 50% (more likely than not).
- Disclosure weakly dominates recognition.
- The choice of threshold does not affect the distribution of evidence.
Accounting aspect: evidence management (EM)

- The choice of threshold affects the distribution of evidence the threshold actually classifies.
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- How to set thresholds in the shadow of EM?
The strategic approach with EM

- The optimal threshold balances its statistical and strategic effects
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- In the previous example with EM, the optimal threshold can be either higher or lower than 50%.
The strategic approach with EM

- The optimal threshold balances its statistical and strategic effects
  - the statistical effect: trades off recognition errors for given evidence (ex post)
  - the strategic effect: affects evidence distribution (ex ante)

- In the previous example with EM, the optimal threshold can be either higher or lower than 50%.

- Disclosure may not dominate recognition.
Related literature


- A similar theme in agency literature: ex post inefficient use of information is necessary for ex ante optimal incentive
Timeline

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- At date 1, manager engages in evidence management (EM);
- At date 2, Nature draws the state. The state and EM jointly determine the evidence. A recognition report is generated.
- At date 3, a stakeholder receives the report and makes a decision. Payoffs are determined by both the decision and the state.
An example of accounting recognition

\[
\text{state } (\omega) \rightarrow \text{evidence } (t) \rightarrow \text{report } (r) \rightarrow \text{decision } (d)
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- state: whether revenue has been earned from a transaction
An example of accounting recognition

state \( (\omega) \) — evidence \( (t) \) — report \( (r) \) — decision \( (d) \)

- state: whether revenue has been earned from a transaction
- evidence: contract, product delivery, price determinability, ...
An example of accounting recognition

\[ \text{state} (\omega) \implies \text{evidence} (t) \implies \text{report} (r) \implies \text{decision} (d) \]

- state: whether revenue has been earned from a transaction
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- state: whether revenue has been earned from a transaction
- evidence: contract, product delivery, price determinability, ...
- report: revenue recognized or not
- decision: invest or not
Formalizing accounting recognition

state ($\omega$) — evidence ($t$) — report ($r$) — decision ($d$)

standard design

$\text{Info valuable to the stakeholder:}$ $F_L G v(G, 1) > 0$

$F_L B v(B, 0) > 0$

$\text{Conflict of interest:}$ $\delta \omega u(\omega, 1) u(\omega, 0)$
Formalizing accounting recognition

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\text{state } (\omega) \rightarrow \text{evidence } (t) \rightarrow \text{report } (r) \rightarrow \text{decision } (d)
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- state: \( \omega \in \{G, B\} \) with prior: \( \text{Pr}(\omega) = q_\omega \)
Formalizing accounting recognition

state ($\omega$) $\rightarrow$ evidence ($t$) $\rightarrow$ report ($r$) $\rightarrow$ decision ($d$)

- state: $\omega \in \{G, B\}$ with prior: $\Pr(\omega) = q_\omega$
- data (evidence) $t: f(t) = f^\omega(t)$, MLRP
Formalizing accounting recognition

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- data (evidence) \(t: f(t) = f^\omega(t)\), MLRP
- recognition report: \(r \in \{g, b\}\)
Formalizing accounting recognition

\[ \text{state } (\omega) \quad \text{— evidence } (t) \quad \text{— report } (r) \quad \text{— decision } (d) \]

- **state**: \( \omega \in \{ G, B \} \) with prior: \( \Pr(\omega) = q_\omega \)
- **data (evidence)**: \( t : f(t) = f^\omega(t) \), MLRP
- **recognition report**: \( r \in \{ g, b \} \)
- **decision**: \( d \in \{ 1, 0 \} \)
Formalizing accounting recognition

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- recognition report: $r \in \{g, b\}$
- decision: $d \in \{1, 0\}$
- stakeholder payoff $v(\omega, d)$ and manager payoff $u(\omega, d)$
Formalizing accounting recognition

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    - \( L_G \equiv v(G, 1) - v(G, 0) > 0 \)
Formalizing accounting recognition

\[ \text{state } (\omega) - \text{evidence } (t) - \text{report } (r) - \text{decision } (d) \]

\[ \text{standard design} \]

- **state**: \( \omega \in \{ G, B \} \) with prior: \( \Pr(\omega) = q_\omega \)
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    \[ L_B \equiv v(B, 0) - v(B, 1) > 0 \]
  - Conflict of interest: \( \delta_\omega \equiv u(\omega, 1) - u(\omega, 0) \)
The standard setter’s problem

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standard design
The standard setter’s problem

state \((\omega)\) — evidence \((t)\) — report \((r)\)— decision \((d)\)

- Design a recognition standard to maximize the stakeholder’s decision-making efficiency \(E_{\omega,r}[v(\omega, d(r))]\)
The standard setter’s problem

state ($\omega$) — evidence ($t$) — report ($r$) — decision ($d$)

- Design a recognition standard to maximize the stakeholder’s decision-making efficiency $E_{\omega,r}[v(\omega, d(r))]$
- Three instruments available
The standard setter’s problem

- Design a recognition standard to maximize the stakeholder’s decision-making efficiency $E_{\omega,r}[v(\omega, d(r))]$
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- Design a recognition standard to maximize the stakeholder’s decision-making efficiency $E_{\omega,r}[\nu(\omega, d(r))]$
- Three instruments available
  - admissible evidence
  - verification of evidence
The standard setter’s problem

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- Three instruments available
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  - threshold
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- A recognition standard is characterized by a threshold
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- A recognition standard is characterized by a threshold
  - the evidence threshold \( T : r(t) = g \text{ if and only if } t \geq T \)
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Design a recognition standard to maximize the stakeholder’s decision-making efficiency \( E_{\omega,r}[v(\omega, d(r))] \)

Three instruments available

- admissible evidence
- verification of evidence
- threshold

A recognition standard is characterized by a threshold

- the evidence threshold \( T : r(t) = g \) if and only if \( t \geq T \)
- the probability threshold \( P : r(t) = g \) if and only if \( \Pr(G|t) \geq P \)
The standard setter’s problem (cont’d)

state ($\omega$) — evidence ($t$) — report ($r$) — decision ($d$)

standard design

A threshold is associated with two types of recognition errors:
- a false alarm error: 
  $$\epsilon_G(T) = \Pr(t < T | G) = F_G(T)$$
- an undue optimism error: 
  $$\epsilon_B(T) = \Pr(t > T | B) = 1 - F_B(T)$$

The standard setter maximizes 

$$W(T) = W_{FB} q_G \epsilon_G L_G q_B \epsilon_B L_B$$
The standard setter’s problem (cont’d)

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  - a false alarm error: \(\varepsilon^G(T) \equiv \Pr(t < T | G) = F^G(T)\)
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The standard setter’s problem (cont’d)

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- The standard setter maximizes

\[
W(T) = W^{FB} - q_G \varepsilon^G L_G - q_B \varepsilon^B L_B
\]
Benchmark: the test of a simple hypothesis

- With MLRP an efficient recognition rule takes a threshold form $T$. 

\[ \begin{align*}
1 & \text{ the evidence threshold } \\
& \text{satisfies:} \\
\partial_{T} G(T) + q_{B} & = 0 \\
2 & \text{ the probability threshold } \\
& \Pr(\omega = G) = L_{B} + L_{G} \\
3 & \text{ Disclosure weakly dominates recognition.}
\end{align*} \]
Benchmark: the test of a simple hypothesis

- With MLRP an efficient recognition rule takes a threshold form $T$.
- The Bayesian efficient threshold satisfies:

$$\frac{\partial \epsilon}{\partial T} + \frac{\partial \epsilon}{\partial T} = 0$$

Disclosure weakly dominates recognition.

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Benchmark: the test of a simple hypothesis

- With MLRP an efficient recognition rule takes a threshold form $T$.
- The Bayesian efficient threshold satisfies:
  - the evidence threshold $T^{BM}$
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  q_G L_G \frac{\partial \varepsilon^G(T)}{\partial T} + q_B L_B \frac{\partial \varepsilon^B(T)}{\partial T} = 0
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Benchmark: the test of a simple hypothesis

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- The Bayesian efficient threshold satisfies:
  1. the evidence threshold $T^{BM}$
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  2. the probability threshold $P^{BM}$
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     P^{BM} \equiv \Pr(\omega = G|t = T) = \frac{L_B}{L_B + L_G}
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- Disclosure weakly dominates recognition.
The main friction: evidence management (EM)

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\begin{align*}
\text{state } (\omega) & \quad \text{evidence } (t) \quad \text{report } (r) \quad \text{decision } (d) \\
\text{manager influence} & \quad \text{standard design}
\end{align*}
\]
The main friction: evidence management (EM)

- state ($\omega$) — evidence ($t$) — report ($r$) — decision ($d$)

  manager influence  
  standard design

- stakeholder: $d^*(g) = 1$ and $d^*(b) = 0$, inducing managerial preference for $r = g$
The main friction: evidence management (EM)

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- Stakeholder: \(d^*(g) = 1\) and \(d^*(b) = 0\), inducing managerial preference for \(r = g\)

- EM \(\beta\): influence evidence distribution (without changing the state)
The main friction: evidence management (EM)

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- EM \(\beta\): influence evidence distribution (without changing the state)
  \[\tilde{f}(t|\omega; \beta) = (1 - \beta)f^\omega(t) + \beta f^G(t)\]
The main friction: evidence management (EM)

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  - at a private cost of \( cC(\beta) \)
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  \[ \tilde{f}(t|\omega; \beta) = (1 - \beta)f^\omega(t) + \beta f^G(t) \]
  at a private cost of \( c_C(\beta) \)
- EM increases the undue optimism error \( \varepsilon^B \):
  \[ \varepsilon^B(T; \beta) = 1 - F^B + \beta(F^B - F^G) \]
The main friction: evidence management (EM)

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- stakeholder: \( d^*(g) = 1 \) and \( d^*(b) = 0 \), inducing managerial preference for \( r = g \)

- EM \( \beta \): influence evidence distribution (without changing the state)
  - \( \tilde{f}(t|\omega; \beta) = (1 - \beta)f^\omega(t) + \beta f^G(t) \)
  - at a private cost of \( cC(\beta) \)

- EM increases the undue optimism error \( \varepsilon^B \):
  \[
  \varepsilon^B(T; \beta) = 1 - F^B + \beta(F^B - F^G)
  \]

- "Good" EM is considered as an extension.
The EM decision and the threshold’s strategic effect

- the manager’s net payoff with $\beta$:

$$E_{\omega,r}[u(\omega, d^*(r)|\beta; T) - cC(\beta)]$$
The EM decision and the threshold’s strategic effect

- the manager’s net payoff with $\beta$:

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$$q_B[F^B(T) - F^G(T)]\delta_B = cC'(\beta^*(T))$$
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**Lemma**

EM decreases in $T$ if and only if $T > \hat{T}$. $\hat{T}$ is uniquely determined by $f^B(T) = f^G(T)$.
Illustrating the threshold’s strategic effect

- EM is not monotonic in threshold $T$.

$$cC'(\beta^*(T)) = q_B \delta_B [F^B(T) - F^G(T)]$$

The effect of threshold $T$ on evidence management $\beta^*(T)$
Illustrating the threshold’s strategic effect

- EM is not monotonic in threshold $T$.
  - If the threshold is so low that anyone can clear it, costly EM does not arise;

$$cC'(\beta^*(T)) = q_B \delta_B [F^B(T) - F^G(T)]$$

The effect of threshold $T$ on evidence management $\beta^*(T)$
Illustrating the threshold’s strategic effect

- EM is not monotonic in threshold $T$.
  - If the threshold is so low that anyone can clear it, costly EM does not arise;
  - If the threshold is so high that no one can clear it even with EM, costly EM does not arise either.

\[
cC'(\beta^*(T)) = q_B \delta_B [F_B^B(T) - F_G^G(T)]
\]

The effect of threshold $T$ on evidence management $\beta^*(T)$
The standard setter’s threshold choice at date 0

\[
\begin{align*}
\max_T W(T; \beta^*(T)) & \equiv W^{FB} - \underbrace{q_G \varepsilon^G(T) L_G}_{\text{cost of false alarm}} - \underbrace{q_B \varepsilon^B(T; \beta^*(T)) L_B}_{\text{cost of undue optimism}} \\
\text{s.t. } cC'(\beta^*(T)) & = q_B [F^B(T) - F^G(T)] \delta_B
\end{align*}
\]
The first-order condition for the optimal threshold

\[ q_G L_G \frac{\partial \varepsilon^G(T)}{\partial T} + q_B L_B \frac{\partial \varepsilon^B(T; \beta^*)}{\partial T} + q_B L_B \frac{\partial \varepsilon^B(T; \beta^*)}{\partial \beta^*} \frac{\partial \beta^*(T)}{\partial T} = 0 \]

The optimal threshold balances its statistical and strategic effects on recognition errors.
Property 1: "More likely than not" is not optimal.

- The probability threshold without EM:

\[ P_{BM} = \frac{L_B}{L_B + L_G} \]
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- \( I(T) \) captures the transaction’s vulnerability to managerial influence.
  \[ I(T^*) \equiv \frac{q_B}{q_G} L_B \frac{\partial \varepsilon^B(T; \beta^*)}{\partial \beta^*} \frac{\partial \beta^*(T)}{\partial T} \bigg|_{T=T^*} \]
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**Proposition**

\[ P^* > P_{BM} \text{ if and only if } T^* > \hat{T}. \]
Inflatory EM does not necessarily lead to conservative thresholds

Consider two examples with following parameters:
\( \delta_B = 1.5, \ C(\beta) = \frac{\beta^2}{2}, \ c = 1, \ F^G(t) = t \text{ for } t \in [0, 1]. \)
\( L_G = L_B = 1, \) which implies \( P^{BM} = 50\%. \)
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Example

\[ F^B(t) = t^{\frac{1}{10}} \text{ for } t \in [0, 1]. \ q_G = 0.25. \text{ Then } \hat{T} = 0.08, \ T^* = 0.91. \]

\[ P^* = 60\% > P^{BM}. \]
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\[P^* = 60\% > P^{BM}.\]

Example

\[F^B(t) = t \frac{3}{10} \text{ for } t \in [0, 1]. \ q_G = 0.6. \text{ Then } \hat{T} = 0.18, \ T^* = 0.02.\]

\[P^* = 33\% < P^{BM}.\]
Empirical Implications

\[ P^* = \frac{L_B}{L_B + L_G + I(T^*)} \]  is determined by both decision-making costs \((L_B, L_G)\) and a transaction’s vulnerability to EM \((I)\).

1. explain variation of thresholds across transactions, time, and jurisdictions
Empirical Implications

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2. provide an additional explanation for conservative revenue recognition.
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1. explain variation of thresholds across transactions, time, and jurisdictions
2. provide an additional explanation for conservative revenue recognition.
3. reconcile conservative revenue recognition with "aggressive" contingency recognition rules.
The Bayesian approach with EM

- What is the efficient threshold upon observing evidence $t$?
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- What is the efficient threshold upon observing evidence $t$?
- Upon observing $t$, an accountant rationally understands EM $\tilde{\beta}$ and its effect on $t$: $\tilde{f}(t|B; \tilde{\beta})$
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  2. the likelihood threshold

  $$\tilde{P} \equiv \Pr(\omega = G|t = \tilde{T}; \tilde{\beta}) = \frac{L_B}{L_B + L_G} = P^{BM}$$
Property 2: the optimal threshold is not ex post efficient.

Proposition

1. \( P^* \neq \tilde{P} \).
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   - disclosure weakly dominates recognition.
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<td>1 ( P^* \neq \tilde{P} ).</td>
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Intuition

- At date 2, for given EM, the efficient decision threshold is \( \tilde{T} \);
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- At date 2, for given EM, the efficient decision threshold is $\tilde{T}$;
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- At date 0, the ex ante optimal threshold balances the dual effects.
- As a result, $T^*$ differs from either $\tilde{T}$ or $\pm \infty$. 
Empirical Implications

1. Is standard setting oriented for ex ante or ex post optimality?
2. How to evaluate accounting standards ex post?
3. The discrepancy between ex ante optimal and ex post efficient thresholds means that standard setters need to be insulated from ex post pressure.
Property 3: comparative statics

**Proposition**

1. *The ex ante firm value* \((W^*)\) *is decreasing in* \(\frac{\delta_B}{c}\).
2. *The optimal evidence threshold* \((T^*)\) *is increasing in* \(\frac{\delta_B}{c}\) *if and only if* \(T^* > \hat{T}\).
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Policy implications:

- Lease accounting: raise or lower the thresholds?
Property 4: recognition dominates disclosure.

Proposition

Compared with the recognition model, the ex ante firm value is lower and evidence management is higher if the accounting standard requires full disclosure of evidence to the stakeholder.
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   - recognition with an optimal threshold mitigates EM by suppressing info.
   - full disclosure is not optimal in general.
4. **The optimal recognition scheme is left for future research.**
   - with binary decisions, a binary recognition is optimal
   - with continuous decisions, info suppression under a binary recognition is costly. There is a trade-off.
Comparison with the prior literature

- a one-step representation in the prior literature
  effort \((e)\) — state \((\omega)\) — report \((r)\) — decision \((d)\)

standard design
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- A measurement rule: \(\Pr(r|\omega)\)
Comparison with the prior literature

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- Three instruments standard setters control
Extensions

1. endogenize $\delta_\omega$ and $L_\omega$ in a capital market setting
2. different timing of EM
3. "good" EM
4. different technologies of EM
Take-away

- a two-step representation of accounting measurement
  
  \[
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- the statistical approach to threshold design is incomplete and misleading.
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Take-away

- A two-step representation of accounting measurement:
  - state ($\omega$)
  - evidence ($t$)
  - report ($r$)
  - decision ($d$)

- Manager influence
- Standard design

- The statistical approach to threshold design is incomplete and misleading.

- The strategic approach is incentive-oriented and provides new explanations for cross-sectional variation of thresholds.