Marking to market versus taking to market

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I. Introduction

Accounting (snapshot of firm's performance) is not neutral

- affects stakeholder behavior
  [managerial turnover, refinancing/downsizing, compensation/option exercise, covenants in debt contracts...]

- accordingly, incentive compatibility of accounting matters.

Stakeholders = stockholders, debtholders, suppliers, workers,
prudential supervisors...

Important for regulation, financial supervision, competition, managerial incentives.

Introduction

Global debate on accounting standards: measurements based on fair value versus historical cost

- Historical-cost: Entry value regardless of accruing market data
- Fair-value: *"the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date."*(International Financial Reporting Standards 13).

Introduction

Observers take issues with each regime

- Historical cost: gains trading (selling of winners and keeping of losers), monitoring by firms' outsiders more difficult

  [S&Ls in 80's, Japan in 90's, US life insurance during crisis.]

- Fair value: imperfect comparability, irrelevant volatility (noise), inefficient pecuniary externalities ("fire sales")

  [Level 1 = quoted prices in active markets for identical assets; level 2 = quoted prices for similar assets in active markets or identical assets in inactive ones. Use of correlations; level 3 = based on unobservable inputs, maybe entity's own data.]

Introduction

- Burgeoning literature on the costs and benefits of either accounting standards:

  [e.g., Allen-Carletti 2008, Bleck-Gao 2012, Bleck-Liu 2007, Heaton et al. 2010, Otto-Volpin 2015, or Plantin et al. 2008]

- The goal of this paper is to micro-found and extend this literature in two directions:
  - firms optimize over their accounting rules
  - the quality of measurement is endogenous (equilibrium determined).

Introduction

We develop a model in which

1. Firms are free to use whichever measurements of future cash flows they see fit as part of the mechanism that they design to overcome their agency problems
2. These (privately) optimal mechanisms affect the liquidity of the market for the items to be measured:
   - Liquidity defined as the ease of selling one's assets;
   - Liquidity defined as the informational content of external transaction prices.

Introduction

- Starting point: Firm modelled as a principal-agent relationship
- Moral hazard: the agent secretly exerts effort to figure out the best of two projects (costly forecasting effort)
  $\Rightarrow$ If cash flows were observable, reward high CFs, punish low CFs
- We add a measurement friction to this standard corporate-finance framework: agent must be rewarded before the CF is observed
- Now the optimal mechanism optimizes over the measurement of the future CF.

Marking to market and/or taking to market

Corporate finance under perfect measurement

Forecasting effort

Asset pays off
Reward high CF/Punish low CF

Corporate finance with measurement frictions

Forecasting effort

Compensation based on two possible measures:

Marking to market: Compensation based on (noisy) market data for similar projects

Taking to market: Compensation based on the (costly) resale of the project to an informed buyer

Asset pays off

Roadmap

1. Optimal contract with exogenous resale costs and exogenous quality of market data
2. Equilibrium with privately optimal contracts, endogenous resale costs
3. Equilibrium with privately optimal contracts and endogenous liquidity (ease of trading and quality of price signals are equilibrium outcomes).

Main insights

(1) *Partial equilibrium*

- First model that obtains gains trading and MTM as components of an optimal mechanism.
- Interaction between accounting and the competitiveness of the resale market.

(2) *Externalities/market failure*

- The privately optimal mechanisms used by firms rely excessively on marking to market
- Imposing a lower degree of marking to market spurs liquidity
- It makes both marking to market and taking to market more effective and reduces firms' cost of capital.

II. Optimal contract in an exogenous environment

- t =0, 1, 2, 3
- A firm is comprised of a principal and an agent
- Firm initiates a project at date 0 that pays off at date 3
- Risk-neutral principal
- Agent
  - is cashless
  - derives utility $u \in [0, 1]$ at date 2 (money, private benefit from continuation in job)
- The principal can provide the agent with utility $u \in [0, 1]$ at the monetary cost u at date 2.

Optimal contract in an exogenous environment

Interpretations of u

(1) managerial compensation ($u \in [0, 1]$ simple way of capturing risk aversion; managerial accounting)

(2) rent from office at date 2

- keep in the job
- finance a new projet (balance sheet accounting)

[Private benefit $= 1$; NPV $= -1$ say.]

Optimal contract in an exogenous environment

Moral hazard

- Agent must select the project type among two available types
- One type pays off h, the other $l < h$. Common prior 50/50
- Before selecting a project type, the agent receives a private signal about the payoff of each type
- The private signal matches the true payoffs with probability p if the agent behaves and $p - \Delta p$ if he shirks

$$\frac{1}{2} \leq p - \Delta p < p < 1.$$

- Behaving costs a private benefit b to the agent

$\beta \equiv \dfrac{b}{\Delta p} \Rightarrow$ agency cost $p\beta$, were payoff perfectly measured at date 2 (second best).

- A public signal $s \in \mathbb{R}$ is available at date 1. The distribution of this signal conditional on a payoff $y \in \{h; l\}$ admits a continuous density $f_y(s)$ such that

$$L(s) = \frac{f_h(s) - f_l(s)}{f_l(s)}$$

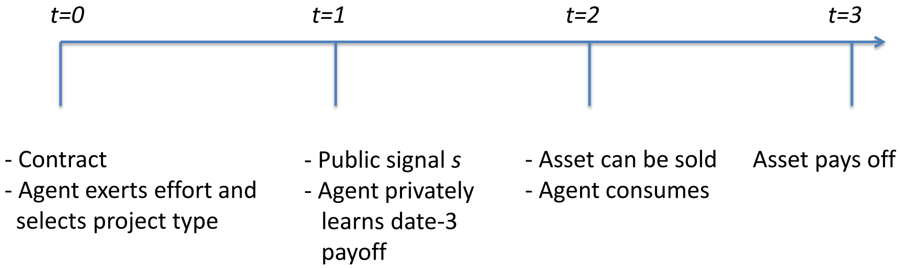
  is strictly increasing
- The principal can also allow the agent to sell the asset at date 2. Comes at a transaction cost (c_h, c_l) strictly positive and such that

$$h - c_h > l - c_l.$$

- The agent privately observes the project payoff at date 1 after the signal s is realized.

Optimal contract in an exogenous environment

Timeline



Optimal contract in an exogenous environment

We solve for the mechanism that

- induces the agent to behave
- at the smallest expected cost for the principal
- assuming that the principal can commit

A generic mechanism is such that the agent reports the project's payoff after the public signal s is realized and the principal may allow a resale and then compensation decision based on these.

Optimal contract in an exogenous environment

(Optimal contract.) The optimal contract is characterized by a threshold σ and a probability x such that:

- the agent receives utility 1 regardless of his report if the public signal is above σ;
- if the signal is smaller than σ and the agent reports a high payoff, then with probability x the principal allows him to sell the asset, and provides utility 1 if the sale confirms the report;
- the agent receives a zero utility otherwise.

The cost of capital for such a contract is

$$p\beta + 1 - F_l(\sigma) + pxF_h(\sigma)c_h.$$

Cost of capital

(Reduced-form) IC constraint

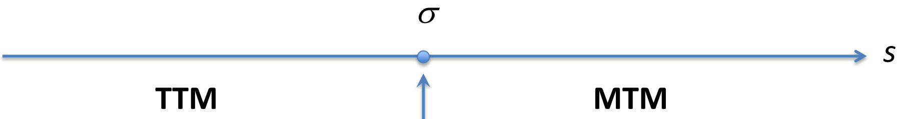
$$[1 - F_h(\sigma) + xF_h(\sigma)] - [1 - F_l(\sigma)] \geq \beta$$

$$\Leftrightarrow \quad \boxed{F_l(\sigma) - F_h(\sigma) + xF_h(\sigma) \geq \beta}$$

Cost of Capital

$$\underbrace{p\beta}_{\text{Second-best cost (observable payoff)}} + \underbrace{\underbrace{1 - F_l(\sigma)}_{\text{Cost of rewarding for luck}} + \underbrace{pxF_h(\sigma)c_h}_{\text{Resale cost}}}_{\text{Cost of imperfect measurement}}.$$

Properties of the optimal contract



- Gains trading: never optimal to sell losers regardless of the transaction costs
- "Fire sales": Sales upon bad market news

A higher cut off σ means that incentives rely relatively less on MTM and more on TTM

Properties of the optimal contract

Comparative statics

The degree of marking to market $\dfrac{F_l(\sigma) - F_h(\sigma)}{\beta}$ increases

- when resale costs are higher,
- the agency problem is less severe (β smaller), and
- the signal is more informative (likelihood ratio more variable on the right of the threshold).

So far unexplained features	**Endogenization**
Cost of resale c_h	Profit-maximizing bids } must be consistent with each other
How is x set?	Reserve price } must be consistent with each other
Market signal s	Similar assets' resale price

III. Optimal contract with imperfect competition in resale market

- Suppose now that at date 2, the agent can solicit bids for the project
- The agent privately observes the bids received by the firm
- The principal observes only whether the asset is sold and the price at which it is sold; optimum = set a reserve price r.
- Bids for a project with payoff $y \in \{h; l\}$ are smaller than y
- *A firm with a good project fails to receive any bid with probability q_0. With prob. $1 - q_0$, highest bid continuously distributed with support included in $(l, h]$, according to continuous cumulative distribution $H(t)$* (with $H(l) = q_0$).

Optimal contract with imperfect competition in resale market

For $x \leq 1 - q_0$: $\quad x = 1 - H(r)$ and so $c_h(x) = \int_{H^{-1}(1-x)}^{h} (h-t)dH(t)$

(Optimal contract with imperfect competition in resale market.)
The optimal incentive-compatible contract (if any) is characterized by a threshold σ and a reservation price r such that:

- if the signal is above σ, then the agent receives utility 1;
- if the signal is below σ, then the principal allows him to sell the asset above a reserve price $r > l$, and provides utility 1 if the sale is executed above this price;
- the agent receives zero utility otherwise.

Optimal contract with imperfect competition in resale market

The contract (σ, r) is determined by two conditions:

- A first-order condition: Indifference between MTM and TTM at the margin

$$\frac{f_h(\sigma)}{f_l(\sigma)} = \frac{p(h-r)+1}{p(h-r)+p\int_r^h (h-t)dH(t)}.$$

- An incentive-compatibility constraint:

$$\underbrace{F_l(\sigma) - F_h(\sigma)}_{\text{Incentives from MTM}} + \underbrace{[1-H(r)]F_h(\sigma)}_{\text{Incentives from TTM}} = \beta$$

or,

$$F_l(\sigma) - H(r)F_h(\sigma) = \beta$$

Endogenous sale price

- Unit-mass continuum of ex-ante identical firms facing the same problem as the previous one
- Do not observe each other's project choice
- Mass λ of informed buyers
- Each buyer randomly matched to firms (w.l.o.g. 1 firm) with a type h at date 2, then bids without observing the number of other buyers matched to that firm.

Endogenous sale price

- We construct equilibria with incentive-compatible contracts
- Informed buyers do not seek matches with low-payoff projects in equilibrium because the resale of such projects cannot be part of an optimal contract
- Matching technology is such that a firm with a high-payoff project is matched with k buyers with probability q_k.

Endogenous sale price

- Each firm designs a contract (σ, r) such that the agent is rewarded if the signal is above σ, or if it is below σ and he manages to sell the asset at some price larger than r. Anticipating such contracts (but without observing them), informed buyers place bids for the good project type according to a distribution with c.d.f. S
- An equilibrium is then a triplet (σ, r, S) such that:
  - Each firm finds the contract (σ, r) optimal given S
  - Each bidder is indifferent between each bid for a good project in the support of S.

Endogenous sale price

Key insight

- In equilibrium, informed buyers always bid above their (correct) anticipation of the reserve price r set by firms
- Thus the equilibrium probability that a sale fails to go through is only due to the matching failure:

$$H(r) = q_0$$

and the equilibrium cut off σ must satisfy the IC constraint:

$$F_l(\sigma) - H(r)F_h(\sigma) = F_l(\sigma) - q_0 F_h(\sigma) = \beta.$$

Endogenous sale price

What about the reserve price then?

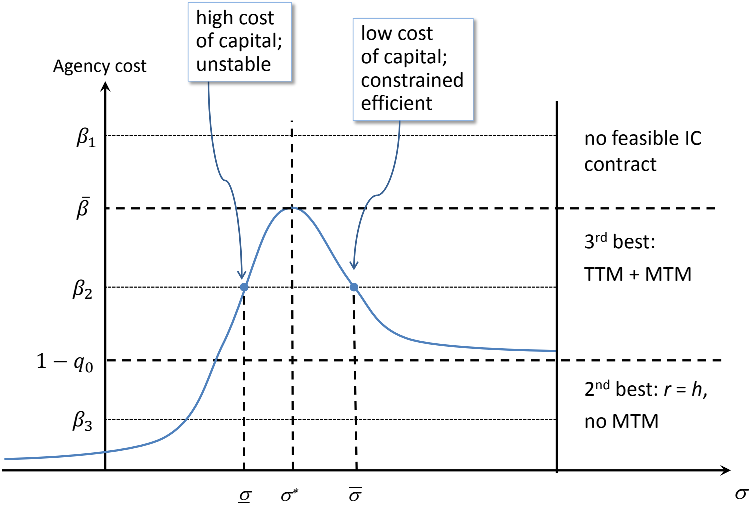
- The reserve price then must adjust so the first-order condition (indifference between MTM and TTM at the margin) holds:

$$\frac{f_h(\sigma)q_0}{f_l(\sigma)} = \frac{1 + \frac{1}{p(h-r)}}{1 + \frac{\lambda q_1}{p q_0}}$$

- There are several self-fulfilling degrees of liquidity in the market corresponding to several degrees of marking to market σ.

equilibrium and efficiency

Equilibria



Equilibria for three values of β.

IV. Endogenous liquidity

- Finally, we endogenize liquidity λ through a free-entry condition
- Continuum of initially uninformed potential buyers with arbitrarily large mass
- Each of them can privately observe the payoff of each project type by incurring a cost $\kappa > 0$ before being matched to a firm at date 1
- Uninformed bids are supposed to be too low to attract the attention of managers. (Other assets with very low payoffs)
- The mass of informed bidders is now an equilibrium outcome λ
- λ affects $(q_k(\lambda))_{\{k \in \mathbb{N}\}}$ and $F_h(., \lambda)$, $F_l(., \lambda)$ as follows.

Endogenous liquidity

(Regularity conditions for the matching process.) The functions $(q_k(\lambda))_{k\in\mathbb{N}}$ are continuously differentiable over $(0;+\infty)$, $q_0(\lambda)$ is strictly decreasing from 1 to 0, and $q_1(\lambda)/[q_0(\lambda)(1-q_0(\lambda)]$, $(q_k(\lambda)/q_1(\lambda))_{k>1}$ are strictly increasing

- Satisfied, for example, with an urn-ball process where $q_k(\lambda) = (\lambda/p)^k e^{-\lambda/p}/k!$

(Informed trading generates better market data.) For all (s,λ),

$$f_l(s,\lambda)\frac{\partial F_h(s,\lambda)}{\partial\lambda} \leq min\left\{0; f_h(s,\lambda)\frac{\partial F_l(s,\lambda)}{\partial\lambda}\right\}$$

- We offer microfoundations in the following.

Endogenous liquidity

- An equilibrium with entry is a triplet (σ, r, λ) such that
  - (σ, r) defines an equilibrium in the sense of the previous section given λ
  - Potential buyers are indifferent between becoming informed or not given (σ, r, λ)

$$\frac{f_h(\sigma,\lambda)q_0(\lambda)}{f_l(\sigma,\lambda)} = \frac{1+\frac{1}{p(h-r)}}{1+\frac{\lambda q_1(\lambda)}{pq_0(\lambda)}},$$

$$F_l(\sigma,\lambda) - F_h(\sigma,\lambda)q_0(\lambda) = \beta,$$

$$F_h(\sigma,\lambda)\frac{q_1(\lambda)(h-r)}{1-q_0(\lambda)} = \kappa$$

- We are interested in stable equilibria $(f_h q_0 / f_l > 1)$

(Existence of a stable equilibrium.) If, other things being equal, κ is sufficiently small, then there exists a stable equilibrium.

Endogenous liquidity

- In the previous section, with inelastic λ, stable equilibria were contrained-efficient. Imposing a higher cut-off σ' was at best useless, at worst counterproductive
- No longer so when λ responds elastically to firms' behavior:

(Excessive marking to market under laissez-faire.) If $\sigma' > \sigma$ is sufficiently close to σ, then

1. There exists an incentive-compatible equilibrium with σ'-contracts
2. Such equilibria feature a lower cost of capital than under laissez-faire. There are more informed buyers, firms set more aggressive reserve prices, bidders bid more aggressively, and market signals are more informative.

Intuition

- Firms fail to internalize the positive externalities that they create for each other when TTM $\rightarrow$ excessive MTM
- Forcing more TTM induces more liquidity (higher λ), which both lead informed buyers to bid more aggressively (TTM more efficient) and improves the quality of market data (MTM more efficient)
- So much so that firms can use higher reserve prices in equilibrium.

PUBLIC SIGNAL AS OBSERVED TRANSACTION PRICES: MICROFOUNDATIONS

I. Misclassification risk

- Merge dates 1 and 2
- REE: each firm observes a finite sample of other firms. Accuracy of classification (same project?) $= \rho$ drawn independently in $[0, 1]$ (realization unobserved).
- Only 1st channel: when λ increases, TTM becomes more efficient; no effect on MTM.

▸ misclassification risk

II. Liquidity shocks and idiosyncratic valuations

- Some firms distressed (must sell) at date 1. Highest bid reflects idiosyncratic value shock.
- Both TTM and MTM become more efficient as λ increases.

▸ liquidity shock

V. Conclusion

- Standard corporate finance model with measurement frictions where both contracts and market prices are the endogenous outcome of optimizing behaviors
- Gains trading and MTM outcome of optimal accounting, with intuitive comparative statics
- Laissez-faire leads to excessive MTM as firms free ride on the liquidity created by other firms' TTM.

  Reducing the degree of marking to market makes both taking to market and marking to market more efficient and reduces firms' cost of capital.

Equilibria

(Equilibria with endogenous sale price.) If $\beta > \overline{\beta}$, there is no equilibrium with incentive-compatible contracts. If $\beta \leq \overline{\beta}$,

- there exists a unique equilibrium in which the contract $(\overline{\sigma}, \overline{r})$ is such that $f_h q_0 / f_l \geq 1$. If $\beta > 1 - q_0$, then $\overline{\sigma}$ is finite and $\overline{r} < h$. If $\beta \leq 1 - q_0$, the equilibrium contract consists in selling the good asset at price h with probability $\beta/(1 - q_0)$(second-best).
- If β is sufficiently large, there also exists a unique equilibrium in which the contract $(\underline{\sigma}, \underline{r})$ is such that $f_h q_0 / f_l < 1$. It is such that $(\underline{\sigma}, \underline{r}) \leq (\overline{\sigma}, \overline{r})$.

Efficiency

- Equilibrium $(\underline{\sigma}, \underline{r})$ generates a higher cost of capital than $(\overline{\sigma}, \overline{r})$. More rewards for luck, more distressed prices
- Thus there is the possibility of excessive marking to market with rare but deep-discounted resales
- Equilibrium $(\overline{\sigma}, \overline{r})$ is constrained efficient.

Inefficient (MTM intensive) equilibrium is unstable

Inefficient equilibrium is unstable, however, in the following sense: Suppose that a regulation prevents firms from rewarding their agents based solely on the signal for signal realizations $s < \sigma'$: "σ'-contracts".

(Regulating marking to market.) Suppose there are two equilibria $(\underline{\sigma}, \underline{r}) \leq (\overline{\sigma}, \overline{r})$. For every $\sigma' \in (\underline{\sigma}, \overline{\sigma}]$, the only equilibrium with σ'-contracts is the one with the contract $(\overline{\sigma}, \overline{r})$. If $\sigma' > \overline{\sigma}$, there is no equilibrium with incentive-compatible σ'-contracts.

return

Microfoundation I for $F_h(., \lambda)$, $F_l(., \lambda)$ Misclassification risk

- We merge dates 1 and 2, and suppose that each firm observes asset resales by other firms before making its own trading and compensation decision at this date
- Each firm can collect data on the trading outcome for a sample of projects taken to market. It imperfectly identifies projects' types when collecting this data, however
- A fraction ρ of firms in the sample runs the same type of project as her whereas the residual $1 - \rho$ actually has a project of the other type. This accuracy parameter $\rho \in [0, 1]$ is i.i.d. across firms and admits a c.d.f. G that is strictly convex (to obtain MLRP).

Microfoundation I for $F_h(., \lambda)$, $F_l(., \lambda)$ Misclassification risk

- A firm does not observe its own accuracy parameter ρ
- Thus, it believes that the fraction of successfully trading firms in her sample should be distributed as $[1 - q_0(\lambda)]\rho$ if it has a high-payoff project and as $[1 - q_0(\lambda)](1 - \rho)$ if it has a low-payoff project
- This implies signal distributions:

$$F_h(s, \lambda) = G\left(\frac{s}{1 - q_0(\lambda)}\right),$$
$$F_l(s, \lambda) = 1 - G\left(1 - \frac{s}{1 - q_0(\lambda)}\right),$$

and $f_h(s, \lambda)/f_l(s, \lambda) = g\left(s/[1 - q_0(\lambda)]\right)/g\left(1 - s/[1 - q_0(\lambda)]\right)$ is increasing in s by convexity of G.

Microfoundation I for $F_h(., \lambda)$, $F_l(., \lambda)$
Misclassification risk

- We have

$$f_l(s,\lambda)\frac{\partial F_h(s,\lambda)}{\partial \lambda} = f_h(s,\lambda)\frac{\partial F_l(s,\lambda)}{\partial \lambda}$$

- Thus imposing a higher cutoff is beneficial because it makes TTM more efficient and has no first-order effect on the efficiency of MTM.

return

Microfoundation II for $F_h(., \lambda)$, $F_l(., \lambda)$ Liquidity shocks and idiosyncratic risk

- The payoff of each firm's project is the sum of h or l and of an idiosyncratic component
- Identically distributed across firms, log-concave density ψ
- Each agent privately observes the realization of its own idiosyncratic risk. So do buyers matched with this firm
- A negligible random subset of firms of each type experience a large private liquidity shock and need to sell their projects at date 1
- Each non-distressed firm can observe one price from such a distressed transaction for a project of its own type.

Microfoundation II for $F_h(., \lambda)$, $F_l(., \lambda)$ Liquidity shocks and idiosyncratic risk

- If a distressed firm has a low-payoff project or a high-payoff one but is not matched to any informed bidder, then its project is sold at a price equal to the uninformed bid u plus the value of the idiosyncratic term
- If the selling firm has a high-payoff project and is matched with at least one informed bidder at date 1, then it lets uninformed bidders bid competitively for the project
- The date-1 signal then has conditional c.d.f.:

$$F_l(s) = \Psi\left(s - u\right), F_h(s) = \Psi * H_0(s), \tag{1}$$

where H_0 the distribution of the highest informed bid. We also have that

$$\frac{f_h(s)}{f_l(s)} = q_0 + (1 - q_0) \int \frac{\psi(s-t)}{\psi(s-u)} dH_0(t) \tag{2}$$

is increasing in s since $t \geq u$ on the support of H_0 in equilibrium.

Microfoundation II for $F_h(., \lambda)$, $F_l(., \lambda)$
Liquidity shocks and idiosyncratic risk

- F_l is not affected by λ whereas F_h strictly increases in the sense of first-order stochastic dominance as λ increases since informed buyers compete more with each other and u is constant
- Thus imposing a higher cut off σ' makes both TTM and MTM more efficient
- Endogenous asset level. Forcing more TTM lowers the level (IFRS levels) for the asset.

return