Marking to market versus taking to market

Guillaume Plantin[1] Jean Tirole[2]

[1]Sciences Po

[2]TSE & IAST

Introduction

- Accounting statements are the primary source of verified information that firms provide to their stakeholders
- Important ingredient of corporate governance
- Historical cost: Balance-sheet items remain at 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

- The goal of this paper is to offer a framework for the study of accounting measures that builds on the primitive ingredients of information economics
- We introduce accounting measurements as important corporate governance tools
- We determine the extent to which they should reflect market data
- Focus on the mutual feedback between the design of privately optimal measurements by firms, and the efficiency of the secondary market for the items in their balance sheets

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 (forecasting effort or costly information acquisition)
  $\Rightarrow$ If cash flows were observable, reward high CFs, punish low CFs
- We add a measurement friction to this standard corporate-finance framework: agent's utility must be determined before the CF is observed
- The optimal mechanism then optimizes over the measurement of the future CF used as a contractual input

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

We study this setup in three steps

1. Partial equilibrium: Optimal contract with exogenous quality of market data and exogenous resale costs
2. Endogenous resale prices (Imperfect competition among informed buyers)
3. General equilibrium with endogenous liquidity (ease of reselling assets and informativeness of price signals are equilibrium outcomes)

1. Optimal contract in an exogenous environment

Optimal contract in an exogenous environment

- t =0, 1, 2
- A firm is comprised of a principal and an agent
- Firm initiates a project at date 0 that pays off at date 2
- Risk-neutral principal does not discount time
- Agent
  - is cashless
  - derives utility at date 1 only
- The principal can provide the agent with utility $u \in [0, 1]$ at the monetary cost u at date 1

Optimal contract in an exogenous environment

- Principal=outsiders (diffuse shareholders, arm's length creditors, prudential supervisor in the case of financial institutions)
- Agent=insiders (controlling blockholders, directors, top managers)

Interpretations of the date-1 utility transfer u

- Rents from office:
  - Private benefit from continuation/expansion versus downsizing/liquidation [Private benefit $= 1$; NPV $= 0$ say]
  - Private benefit from remaining in control
- Managerial compensation [$u \in [0, 1]$ simple way of capturing risk aversion]

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

$$\beta \equiv \frac{b}{\Delta p}$$

Optimal contract in an exogenous environment

Available measurements (1)

- 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

$$\frac{f_h(s)}{f_l(s)}$$

is strictly increasing

- Public signal - Publicly observable transaction data for assets that are comparable to that chosen by the agent

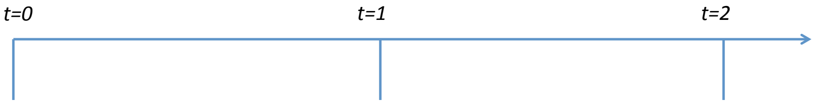
Optimal contract in an exogenous environment

Available measurements (2)

- The principal can also allow the agent to sell the asset at date 1
- At date 1, the firm receives 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
- Bids for a project with payoff $y \in \{h; l\}$ smaller than y
- A firm with a good project receives k bids with prob. q_k. Bids $> l$

Optimal contract in an exogenous environment

Timeline



t=0

- Principal and agent sign a contract
- Agent exerts forecasting effort and selects a project type

t=1

- Public signal *s*
- Agent privately observes, and reports bids
- Asset can be sold
- Agent consumes

t=2

Asset pays off

Optimal contract in an exogenous environment

Assuming that the principal can commit, we solve for the mechanism that

- induces the agent to behave
- at the smallest expected cost for the principal

Optimal contract in an exogenous environment

(Optimal contract.) 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 the agent to sell the asset above the reserve price r, and provides utility 1 if the sale is executed;
- the agent receives zero utility otherwise.

Either the reserve price satisfies $r > l$, or all bids strictly above l are accepted, in which case we adopt the notation $r = l^+$.

Properties of the optimal contract

H distribution of the highest bid for a good project

The "cost of capital" (=expected payment to insiders) at the optimal contract is

$$\underbrace{p\beta}_{\substack{\text{Second-best cost} \\ \text{(payoff observable at date 1)}}} + \underbrace{\underbrace{1 - F_l(\sigma)}_{\text{Cost of rewarding for luck}} + \underbrace{pF_h(\sigma)\int_r^h (h-t)dH(t)}_{\text{Resale cost}}}_{\text{Cost of imperfect measurement}}$$

Properties of the optimal contract

The IC contract (σ, r) that minimizes this cost is determined by two conditions:

- An incentive-compatibility constraint:

$$\Delta p \left[\underbrace{\int_{\sigma}^{+\infty} (f_h - f_l)}_{\text{Incentives from MTM}} + \underbrace{[1 - H(r)] F_h(\sigma)}_{\text{Incentives from TTM}} \right] = b$$

  or

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

- A first-order condition:

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

  Indifference between MTM and TTM at the margin

Implementation with an accounting measure

- A date-1 accounting measure is a valuation of the project equal to:
  - the resale proceeds if the project was resold at date 1
  - a value $m(s)$ otherwise, where $m(.)$ is increasing in the public signal s
- Suppose that an accounting measure satisfies $m(\sigma) = r$
- A mechanism that transfers utility to the agent from the principal if and only if the book value of the firm is larger than r at date 1 implements the optimal contract

Construction of such an accounting measure

- Distribution $D_s(x)$ of the resale price conditional on a signal s:

$$D_s(x) = \frac{pf_h(s)H(x) + (1-p)f_l(s)L(x)}{pf_h(s) + (1-p)f_l(s)}.$$

- Let $m_\alpha(s)$ the unique solution in m to $D_s(m) = 1 - \alpha$
  =resale price that can be exceeded with probability α

- α is the *degree of conservatism* of the accounting measure

- $m_\alpha(\sigma) = r$ with degree of conservatism α such that

$$\alpha = \frac{pf_h(\sigma)[1 - H(r)]}{pf_h(\sigma) + (1-p)f_l(\sigma)}$$

2. Endogenous resale price

Endogenous resale 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 potential buyers
- Each buyer randomly matched to a firm at date 1 and privately observes the payoff from its project, then bids without observing the number of other buyers matched to that firm
- Matching technology is such that a firm is matched with k buyers with probability q_k

Endogenous resale price

- We construct equilibria with incentive-compatible contracts
- 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 buyer is indifferent between each bid for a good project in the support of S

Endogenous resale price

Key insight

- In equilibrium, informed buyers always bid above their (correct) anticipation of the equilibrium 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 resale price

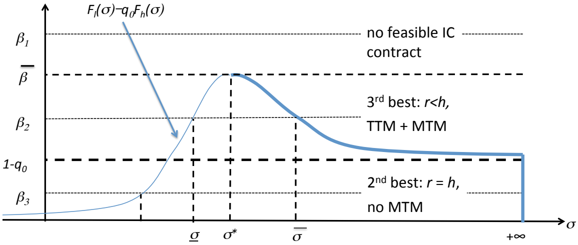
What about the reserve price then?

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

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

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

Equilibria



Equilibria for three values of β

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)
- 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

Inefficient (MTM intensive) equilibrium is unstable

- Illiquid equilibrium is unstable. If force firms to be an ϵ more conservative, equilibrium switches to more liquid one
- Under the implementation with an accounting measure, this amounts to imposing a sufficiently high degree of conservatism
- With exogenous λ, the liquid equilibrium is constrained efficient

3. Endogenous liquidity

Endogenous liquidity

- Finally, we endogenize liquidity λ through a free-entry condition
- Continuum of initially uninformed potential buyers with arbitrarily large mass
- By incurring $\kappa > 0$, each of them can become able to privately observe the payoff of its project once matched to a firm
- The mass of informed buyers is now an equilibrium outcome λ
- Competitive uninformed buyers
- 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.) $q_{k+1}(\lambda)/q_k(\lambda)$ increases in λ for all k, and $q_1(\lambda)/[q_0(\lambda)(1 - q_0(\lambda)]$ is increasing

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

(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)

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

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

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

- 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 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
- Again, implementation with a lower bound on the degree of conservatism

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

- REE: all asset resales take place at date 1 but each firm can condition its own resale decision on the observation of transactions by other firms
- When endowed with an asset of type $k \in \{1; 2\}$, a firm assigns a fraction ρ of any sample of assets in category k to category k, and mistakenly, a fraction $1 - \rho$ to the other category
- Accuracy of its classification ρ has increasing density $g(\rho)$ over $[0, 1]$
- A firm does not observe its ρ
- i.i.d. across firms

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

- A firm's signal s is then the fraction of resold assets to which it assigns the same type as its own asset and has conditional densities:

$$f_h(s) = f_l(1-s) = g(s),$$

and

$$\frac{f_h(s)}{f_l(s)} = \frac{g(s)}{g(1-s)}$$

- In this case λ affects cost of TTM not that of MTM (signal independent of λ)

Microfoundation II for $F_h(., \lambda)$, $F_l(., \lambda)$ Idiosyncratic risk

Here both TTM and MTM become more efficient as λ increases

- Idiosyncratic shock: Payoff of firm i $y + z_i$ where z_i has a log-concave density
- only firm and matched buyers observe z_i, outsiders do not (observe only resale price)
- We need l-payoff assets to be occasionally resold, otherwise signal is perfectly informative (no misclassification):
  - with probability γ, firm observes y
  - small gains from trade, so wants to sell l-asset when discovers that $y = l$
- competitive uninformed buyer bid l (to be checked)

Microfoundation II for $F_h(., \lambda)$, $F_l(., \lambda)$ Idiosyncratic risk

- Observe, say, one transaction (or a finite number)
- Outcome:
  - resell when $y = l$ and payoff is discovered (but $u = 0$)
  - resell when $y = h$ iff payoff is not discovered and $s < \sigma$, i.e. solely for measurement purposes (discount swamps gains from trade).

Conclusion

- Standard corporate finance model with measurement frictions where both contracts and quality of market data are the endogenous outcome of optimizing behaviors
- Gains trading and MTM outcome of optimal accounting
- Laissez-faire leads to insufficient conservatism—firms free ride on the liquidity created by other firms' TTM
- Imposing a higher degree of conservatism makes both taking to market and marking to market more efficient and reduces firms' cost of capital