Rational Opacity in Private Equity Markets

Cyril Monnet[1] and Erwan Quintin[2]

[1]University of Bern and Study Center Gerzensee

[2]Wisconsin School of Business

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Motivation

- Private equity investments are opaque and illiquid
- We build a connection between these two distinguishing features:
  1. Investors value liquidity in the sense of Diamond-Dybvig (1983)
  2. When – and only when – secondary markets are shallow, more information reduces expected liquidation value
  3. Withholding information is rational

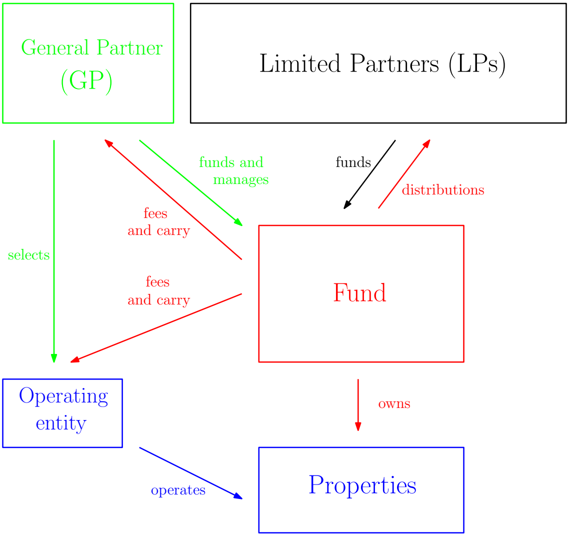
Key mechanism

- Investors face early consumption risk a la Diamond and Dybvig (1983)
- Storage is safe
- Long-term projects are risky but more productive in expected terms
- Information on project quality can be learned at an interim stage, and projects can be scrapped
- Investors choose ex-ante how much interim information gets revealed
- More information leads to better scrapping decisions but can hurt liquidation value when secondary markets are shallow
- Curtailing information is typically optimal

Private information

- Why don't project stakeholders keep all information private?
- As in Milgrom and Stokey (1982), all private information gets revealed when projects trade in secondary markets
- It is optimal to curtail private information too
- This is naturally implemented by delegating continuation decisions to a manager with the right incentives

The structure of private equity funds



Key predictions

- Imposing transparency can reduce long-term investment (cause “shot-termism” as in VonThadden, 1995)
- More liquidity-minded investors should opt for more opacity
- The optimal level of opacity depends on the state of secondary markets:
  1. Shallow secondary markets are necessary for opacity to play a role in the first place
  2. But the relationship between market depth is not monotonic, it is Kuznets-like

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The model

- $t = 0, 1, 2$, one good, no discounting
- Early and late investors
- Mass 1 of early investors at date 0 each endowed with one unit
- Mass 1 of late investors appear at date 1, endowed with quantity $A > 0$ of the good

Preferences

- Early investors value consumption at date 1 with probability $\pi > 0$, value consumption at date 2 otherwise
- From the vantage point of date 0, they maximize:

$$u(c_1, c_2; \pi) \equiv \pi c_1 + (1 - \pi) c_2$$

- Symmetrically, late investors value consumption at date 1 with probability $1 - \pi > 0$, value consumption at date 2 otherwise

Production technologies

- Storage across periods at zero net return
- Early investors can invest in a risky project that yields either $R > 0$ or nothing at date 2
- The project requires a total investment of one unit of capital
- Likelihood q of success is drawn from F at date 1
- Each investor receives a pro-rata share of output
- Each investor can scrap their share of the project at date 1 for $S \in (0, 1)$
- We will assume $A > S$ throughout

Information

- Information is a message function:

$$\{m : [0,1] \mapsto \mathcal{B}([0,1]) : q \in m(q) \text{ for almost all } q{\in}[0{,}1]\}$$

- Full information: $m(q) = \{q\}$ for all $q \in [0,1]$
- No information: $m(q) = [0,1]$ for all $q \in [0,1]$
- Early investors choose m to maximize their ex-ante expected utility

Market for projects

- At date 1 and once message is emitted, a Walrasian market for project share opens
- Supply side: early investors who need to consume at $t = 1$
- Demand side: late investors who need to consume at $t = 2$
- All agents take the price of shares as given

Timeline

1. At $t = 0$, early investors choose message function and how to invest
2. At $t = 1$, late investors appear, consumption types are revealed, and a message m is emitted
3. Agents compute:

$$E(q|m) = \frac{\int_m q dF}{\int_m dF}$$

4. Scrapping decisions are made
5. Remaining shares trade at $p(m)$
6. Early consumption
7. Late consumption

Equilibrium

An activation decision by early investors, a message function, a share price schedule, scrapping decisions, share trading decisions by early and late investors, and consumption plans, such that:

1. Given the message function, all agent decisions at date 1 are optimal and the Walrasian market for shares clears for every possible message;
2. No other message function and associated Walrasian price schedule gives early investors a higher expected payoff as of date 0.

Constrained optimality

- The information design that prevails in this equilibrium is the solution to a social planner problem where:
  1. the planner maximizes the welfare of early investors ...
  2. ...subject to mimimal participation constraints by late investors,
  3. the planner treats all early investors equally,
  4. the planner cannot preclude side-trades (debt contracts) between early and late investors.
- In that sense, the equilibrium we study is constrained efficient

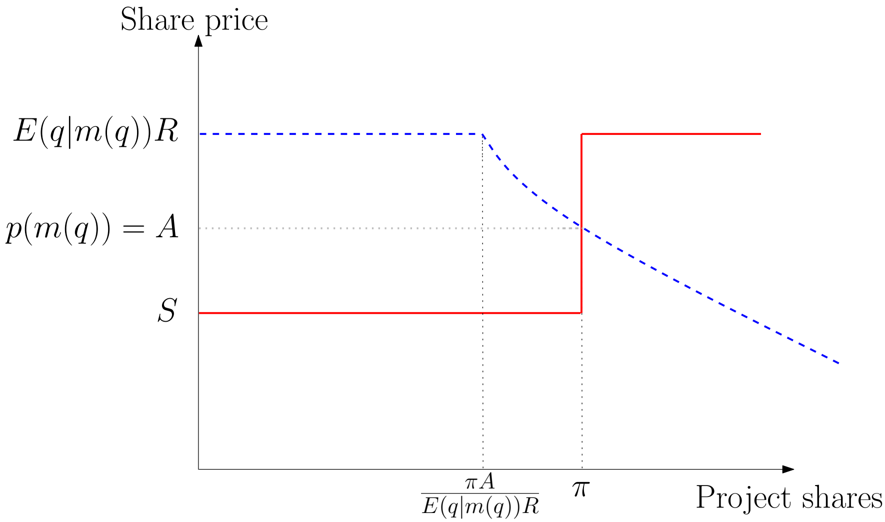
Share price

Proposition

Given a message function m , at the Walrasian stage and for almost all $q \in [0,1]$,

$$p(m(q)) = \max\left[S, \min\{E(q|m(q))R, A\}\right].$$

Walrasian stage with cash-in-the-market pricing



A bargaining interpretation

1. This environment is isomorphic to a world where each early investor is matched with one late investor and gets to make their counterpart a take-it-or-leave-it offer
2. Our results also hold for a situation where the surplus is shared between buyers and sellers

▸ Constrained optimality

A simple example

- Assume: $A < \int qRdF$
- Then:

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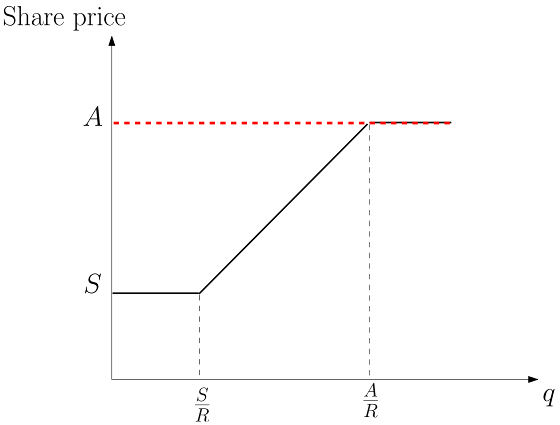

Full information vs **No information**

No info vs. full info

- No information payoff:

$$\pi A + (1 - \pi) \int qRdF$$

No info vs. full info

- No information payoff:

$$\pi A + (1-\pi)\int qRdF$$

- Full information payoff:

$$\pi\left\{\int_0^{\frac{S}{R}} SdF + \int_{\frac{S}{R}}^{\frac{A}{R}} qRdF + \int_{\frac{A}{R}}^{1} AdF\right\} + (1-\pi)\left\{\int_0^{\frac{S}{R}} SdF + \int_{\frac{S}{R}}^{1} qRdF\right\}$$

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- Key observation:

$$\left\{\int_0^{\frac{S}{R}} SdF + \int_{\frac{S}{R}}^{\frac{A}{R}} qRdF + \int_{\frac{A}{R}}^{1} AdF\right\} \quad < \quad A$$

but

$$\left\{\int_0^{\frac{S}{R}} SdF + \int_{\frac{S}{R}}^{1} qRdF\right\} \quad > \quad \int qRdF$$

No info vs. full info

Remark

Assume date-0 agents can only choose whether to reveal all information at date 1 or no information. Then there exists a threshold $\pi^F \in (0, 1)$ *such that agents of type* $\pi \in [0, 1]$ *choose to send a perfectly informative message only provided* $\pi \leq \pi^F$*.*

Straightforward message ($\approx$ Kamenica & Gentzkow)

- There is no need for the message function to partition $[0,1]$ in more than two subsets: scrap or hold.
- Furthermore:

Lemma

The scrapping message is of the form $[0,\bar{q}]$ where $\bar{q} \leq \frac{S}{R}$.

- In other words, given $\pi \in [0,1]$, for $q \in [0,1]$,

$$m(q) = \begin{cases} [0,\bar{q}] & \text{if } q < \bar{q} \\ (\bar{q},1] & \text{otherwise.} \end{cases}$$

Comparative statics

Define:

$$V(\bar{q};\pi) \equiv \pi \left\{ \int_0^{\bar{q}} S dF + \int_{\bar{q}}^1 A dF \right\}$$
$$+(1-\pi) \left\{ \int_0^{\bar{q}} S dF + \int_{\bar{q}}^1 qR dF \right\}$$

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Lemma

V is strictly submodular on $\left(0, \frac{S}{R}\right) \times (0,1)$.

- This implies that the scrapping threshold decreases as π increases
- Here in fact:

$$\bar{q} = \max \left\{ \frac{S - \pi A}{(1-\pi)R}, 0 \right\}$$

The general case

- The previous example assumed $A < \int qRdF \equiv E(qR)$
- As A rises, it enters the following interval:

$$E(qR) < A < E\left(qR|q \geq \frac{S}{R}\right)$$

- and, eventually,

$$A \geq E\left(qR|q \geq \frac{S}{R}\right)$$

The general case

Define:

$$\tilde{q}(A) = \max\left\{\tilde{q} \in [0, \frac{S}{R}] : E(qR|q \geq \tilde{q}) \leq A\right\}$$

with the understanding that $\tilde{q}(A) = 0$ if $E(qR) > A$.

Proposition

The optimal information design consists of a scrapping message and a holding message. The scrapping message is F- essentially an interval $[0, \bar{q}(\pi, A)]$ *where*

$$\bar{q}(\pi, A) = \max\left\{\frac{S - \pi A}{(1-\pi)R}, \tilde{q}(A)\right\}.$$

A Kuznets-like relationship between depth and opacity

- Shallow secondary markets is a necessary condition for some opacity to be optimal

A Kuznets-like relationship between depth and opacity

- Shallow secondary markets is a necessary condition for some opacity to be optimal
- But, as A rises opacity first worsens and then improves

Imposing transparency can destroy surplus

Corollary

Imposing full information can lead early investors to opt for storage rather than the risky project. In particular, it can cause expected output and expected consumption to fall.

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If early investors observe project quality privately then the only equilibrium allocation is the full information equilibrium allocation.

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Remark

If the design of the information technology is observable, the rational information design choice is the same regardless of whether the message is private or public.

Implementation via GP-LP structure

- Early investors hire a risk-neutral agent with no holdings in the project (GP or operating entity)
- The operator and only she observes q
- She receives a fixed payment $M > 0$ if the project is scrapped and receives a payment αR where $\alpha > 0$ if the project is continued and succeeds

Proposition

Let $\bar{q}(\pi)$ be the the optimal scrapping threshold given $\pi \in [0, 1]$. Let

$$M = \alpha \bar{q}(\pi) R.$$

Then the delegate implements the optimal scrapping policy and early investors get the constrained-efficient payoff.

Variation 1: continuous operating choice

- Suppose that a continuous operating choice x must be made after q is drawn at date 1
- For instance:
$$g(q,x) = q^{1-\alpha}x^{\alpha} - xw$$
- Note that $\arg\max_x g(q,x) = qR$ where $R \equiv \left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\alpha}}$
- So as long as operator can keep x to themselves nothing changes
- What if they can't?
- Some opacity remains optimal although the optimal solution may no longer be binary

Variation 2: stochastic secondary market depth

- In practice market depth is not known ex-ante and may in fact be correlated with project quality
- As long as the correlation is not perfect the bottom line is unchanged
- As long as cash-in-the-market pricing prevails with positive probability, some opacity is typically optimal.

Variation 3: endogenous market depth

- Consider a continuum of locations each with a project as we have modeled it
- A large mass of late investors can enter any location $i \in [0, 1]$ at a cost $c_i > 0$
- They can also store their unit of good
- In equilibrium, late investors must expect zero rents net of entry cost
- All locations must feature some cash-in-the-market pricing …
- …hence some opacity

Variation 4: endogenous market depth a la Allen-Gale

- In Allen-Gale 1994, secondary markets participants are also the primary investors
- Here, we separate primary and secondary investors fully
- If they were the same, transparency would be optimal
- What if primary investors are just part of secondary markets?
- This mitigates but does not eliminate the potential role of information curbs

Conclusion

- When the liquidation value of long-term projects is affected by the "cash-in-the-market", it is rational for liquidity-concerned investors to curtail the flow of information
- This can be accomplished by delegating decisions to a manager with the right incentives
- Imposing transparency, in such a world, can affect investment decisions (cause "short-termism") and reduce welfare