Venture Capital and Time to Sale: Outside Opportunities and Exit Decisions

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This paper presents a general equilibrium framework to analyze the Venture Capital market and the Initial Public Offerings market. It addresses main features of the market:

- Venture Capitalists take smaller and younger firms public;
- VC-backed firms have lower revenues and are less likely to be profitable at the IPO;
- VC-backed IPOs raise less cash than non-VC backed companies;
- IPO companies financed by young venture capitalists are nearly two years younger and more underpriced;
- Young VC companies spend on average 14 months less on the IPO company’s board and hold smaller equity stakes at the time of the IPO.

Even though:

- Projects associated with Venture Capitalists have a better initial quality.
We also can match results given by previous literature:

- As in Jovanovic and Rosseau (2001), a reduction in the cost of investment reduces the time to an IPO;
- The expected time to an IPO is reduced in hot issue markets;

Finally, once we model the bookbuilding procedure, we obtain:

- The higher the number of days in registration, the lower the underprice;
- If the value of the company is unknown by the seller, underprice in a crowded IPO is good news.
Grandstanding Hypothesis (Gompers (1996)):

- VC firms need to fund-raise periodically;
- IPOs are a signal of high quality by a VC firm.
- Young VCs lack reputation, having higher gains from signalling.
Features in this market omitted by the Grandstanding Hypothesis:

⇒ Relation between hot issue markets and equity stakes held by VCs.

⇒ Relation between Technological shocks, IPO markets and fund-raising by VCs:

- Jovanovic and Rosseau (2001): Technological shocks increase the speed at which firms come to an IPO;
- Gompers and Lerner (1998) and Bouis (2004): Technological shocks increase fund-raising by VCs.
Main Point

Interaction between Capacity Constraints and Timing:

⇒ Which projects accept and terminate given:
  - Cost of waiting: Capacity constraint + Impatience;
  - Benefits of waiting: Improved project and more potential buyers.

Example: Venture Capital Markets, Housing Markets and Labor Markets...

⇒ IPO can be seen as a process in which competition between institutional investors is built through time, while the regular investor sees the IPO outcome as an opportunity to extract a signal about the company’s quality.
Main Point

Explanations for Empirical Patterns observed in the VC market:

- Young VC companies are more capacity constrained;

- IPOs and Underpricing are good news (good projects were found);

- Technological shocks are structural shocks in the market (changes in the distribution/quality of projects, arrival of new deals, etc...).
Model

⇒ Time is continuous;

⇒ Three groups of agents:

1. Entrepreneurs (measure 1);

2. Venture Capitalists (measure \( m \));

3. Investors (\( \bar{N} \) finite but large).

All risk neutral, infinitely lived and ex ante identical.
1. Entrepreneurs

⇒ Project $S \sim H$ on $[0, \overline{T}]$, $S := \text{starting size}^{\text{"attractiveness"}}$;
$g(T) := \text{Project's expected return (realized when auctioned)}$;

Choices:

1. Autarky: $\gamma g(T)$
   Termination chosen by Entrepreneur;

2. VC Market: $(1 - \beta) g(T)$
   If unmatched, expected return is constant;
   No on the venture search;
   Termination chosen by VC;

⇒ Leave the market when finished.
1. Entrepreneurs

Entrepreneur runs by himself and looks for a venture capitalist (VC). Entrepreneur samples a project of initial quality $S$. If VC is found and accepts the project, entrepreneur decides to go public. If VC decides to go public, the final quality $T^A = S + \Delta S_A$. The entrepreneur’s return is $\gamma g(T^A)$. If the project is not accepted, the entrepreneur samples another project of initial quality $S$. If VC is found and accepts the project, the final quality is $T = S + \Delta S_{VC}$. The entrepreneur’s return is $(1 - \beta)g(T)$.
2. Venture Capitalists

⇒ Can handle only a limit number of projects (Capacity Constraint);

⇒ Find a partner with probability $\lambda > 0$;

⇒ No Free Entry.
3. Investors

⇒ Decide how to invest wealth. Two options:

(a) risk free asset (return $r$);

(b) auction (first price sealed bid).

Loser bids reinvested at risk free rate.

→ \( \omega \): Firm’s Value: known by underwriter and credibly transmitted to institutional investors.

→ \( \varepsilon_i \): Expected cost for investor \( i \) of future agreements with underwriter. Assume \( \varepsilon \sim Z \) on \([0, \omega]\).
Investor $i$’s payoff function when he bids $p$:

$$
\Pi_i = \begin{cases} 
\omega - \varepsilon_i - p_i & \text{if } p_i \geq \max_{j \neq i} p_j \\
0 & \text{if } p_i < \max
\end{cases}
$$

Then, the problem of investor $i$ is:

$$
\max_{p \geq 0} (\omega - \varepsilon_i - p) \left[ 1 - Z (\omega - P^{-1} (p)) \right]^{N-1}
$$
3. Investor’s Problem

⇒ Optimal bid in an auction with \( N \) buyer’s is given by:

\[
P (\omega - \varepsilon_i) = \omega - \varepsilon_i - \int_{\varepsilon_i}^{\omega} \left[ \frac{1 - Z(y)}{1 - Z(\varepsilon_i)} \right] \omega^{N-1} dy
\]

⇒ Auction’s Expected Return:

\[
\sum_{N=2}^{\infty} p_N(T) R(\omega, N).
\]

Solving, we obtain our \( g \) function:

\[
g(T) = \omega - \int_{0}^{\omega} \left[ 1 + \mu TZ(\varepsilon) \right] e^{-\muTZ(\varepsilon)} d\varepsilon.
\]
Investor’s Problem

Graphically:
Underprice can be seen as good news: Example

Assume $\varepsilon_i \sim U[0, \omega]$. Then, the expected value of the firm, $\hat{\omega} \equiv E[\omega | p \text{ is the winner}]$

$$\hat{\omega} = \frac{N + 1}{N - 1} p$$

then, since underprice is given by:

$$\hat{\omega} - p = \frac{2}{N - 1} p$$

substituting $p$ by its expected value, we have:

$$\text{expected underprice} = \frac{2}{N + 1} \omega$$

Therefore, a large underprice in a IPO with many potential buyers (large $N$) is good news, since represents a large $\omega$. 
On-the-Project Search:

\[ rV(T) = \lambda E_{\tilde{T}} \max \left\{ V(\tilde{T}) + \beta g(T) - V(T), 0 \right\} + \frac{\partial V(T)}{\partial T} \]

Threshold \( T^*(T) \) is given by:

\[ V(T^*(T)) = V(T) - \beta g(T) \]
On-the-Project Search

No sunk cost of changing projects $\Rightarrow$ VC terminates project when find a new one.
Introducing starting sunk costs
Theorem

\[ \frac{\partial T^*_c(T)}{\partial c} > 0, \text{i.e., an increase in the start up cost reduces VC companies incentive to change projects.} \]
Extension: Two Vacancies

As an extension, consider the case in which the VC has the possibility of running two projects at the same time. Then, we obtain the following results:

**Theorem**

Whenever a VC needs to choose a project to terminate, she will choose the older one (larger $T$)

and from this result we obtain the following corollary

**Corollary**

The survival rate of a project is longer if run by a two-projects VC.
Entrepreneur’s Problem

Autarky:

\[
\max_T e^{-(T-S)} [\gamma g(T)]
\]

Solution:

\[
\frac{g'(T^A)}{g(T^A)} = r
\]

Note that \( T^A = T^*_\emptyset \) (VC’s optimal time with no new project).

\[
A(T) = e^{-r(T^*_\emptyset - T)} \gamma g(T^*_\emptyset)
\]
⇒ Bellman function in partnership:

\[
rP(T) = \lambda \left[ 1 - F(T^* (T)) \right] \{(1 - \beta) g(T) - P(T)\} + \frac{dP(T)}{dT}
\]

⇒ Bellman function searching:

\[
S(T) = \frac{\eta \left[ 1 - F(T^{*-1} (T)) \right]}{r + \eta \left[ 1 - F(T^{*-1} (T)) \right]} P(T)
\]

Then, an entrepreneur enters the market iff:

\[
S(T) \geq A(T)
\]

**Theorem**

*There exists a threshold \( T_c^\bullet \) for entrance decisions.*
(a) No sunk cost: An increase in $\lambda$ increases $T_c^\star$. However, the expected time a VC keeps a project goes down.

(b) Sunk Cost: An increase in $\lambda$ increase $T_c^\star$ if $c$ is sufficiently small. A VC keeps low $T$ projects for a shorter period and high $T$ projects for longer. If $h$ is downward slopping, the expected time a VC keeps a project goes down.
Conclusion

This paper presents a general equilibrium framework to analyze the Venture Capital market and the Initial Public Offerings market. It addresses main features of the market and it is a tractable framework to discuss the impact of technological shocks, changes in information transmission and policies against collusion between institutional investors and investment banks on the market.