An Entrepreneur’s Choice of Venture Capitalist or Angel-financing: A Behavioral Game-theoretic Approach

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My Research

• Behavioural Corporate Finance
• => Emotional Corporate Finance !!! (Crazy!!!)
• Venture Capital/Entrepreneur financial contracting and performance.
• Audit tenure
• IEAs
Introduction.

- E’s choice of VC or Angel to finance innovative project
- Double-sided Moral Hazard: E and financier face DS Effort-shirking; and DS ex post expropriation (stealing) threat.
- Behavioural Game-theoretic approach:
- VCs have higher value-adding ability than Angels
- E/A: empathetic, close => trustworthy.
Literature

• VC/E contracting, performance, with DSMH (eg, Casamatta 2003; Repullo and Suarez 2004; Fairchild 2004; Houben 2003 DSMH + DSAS)

• Emerging area: E’s choice of start-up financier (Banks Versus VCs: DB and Brander JBV 2007, Ueda 2004 JOF)

• Angels versus VCs: Leschinskii 2002; Chemmanur and Chen 2006; Schure 2006: WPs
Literature (continued):


- Procedural Justice literature: fairness/trust, reciprocal behaviour (Management journals: eg Cable and Shane: conceptual repeated prisoner’s dilemma). Relational Rents (Sapienza et al)
Rational versus behavioural approach.

- Standard economic/game-theoretic approach: *Homo Economicus*: fully rational players, totally self-interested => DSMH in VC/E
- Behavioural Game-theory: *Homo Sapiens*: Not fully rational (overconfidence, depth-of-reasoning; mistakes, heuristics):
- Or: not fully self-interested: altruism, fairness, trust, reciprocal behaviour.
Es choice of VC or A: Puzzle?

- Evidence that VCs tend to add more value than As to a start-up (A’s tend to be unsophisticated investors, unable to add significant value to the firm: Erlich et al 1994, Prowse 1998, Wong 2002. VCs add value: complementary skills).
- But evidence that Es make much greater use of As than VCs.
- Wong (2002): evidence that A’s enjoy a more relational and informal partnership.
- Closer ties/Informal contracts/Ex entrepreneurs.
The Model.

- Players: An E, a VC and an A: all risk-neutral, risk-free rate = zero (no discounting)
- Timeline:
  - **Date 0**: E has an idea for an innovative project, requiring finance
  - **Date 1**: Simultaneous Effort levels => success probability
    \[ I > 0 \]
    \[ P = \gamma_{E,i} e_E e_i \Rightarrow R \]
    \[ 1 - P \Rightarrow 0 \]
  - => Expected Value
  - (if no ex post stealing)
    \[ V = PR = \gamma_{E,i} e_E e_i R. \]
The Model (continued)

- Date 2: Project either succeeds or fails.
- Date 3: if success => R, we enter the date 3 stealing game.
- E/VC Simultaneous stealing decision: $\{NS, S\}$
- If both NS, they both get R/2 (as agreed at date 0).
- If one steals: destroys some project value => $\mu R < R$
- Stealer gets it all, non-stealer gets zero.
- If both steal, destroys value $\phi R < \mu R < R$
- The players get half each: $\frac{\phi R}{2}$
Normal Form Stealing Game: Standard Game Theory

<table>
<thead>
<tr>
<th></th>
<th>NS</th>
<th>S</th>
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</thead>
<tbody>
<tr>
<td>NS</td>
<td>1, 2</td>
<td>3, 4</td>
</tr>
<tr>
<td>S</td>
<td>5, 6</td>
<td>7, 8</td>
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</tbody>
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Assumption: $\mu R > \frac{R}{2}$

Of course, $\frac{\phi R}{2} > 0$

Prisoner’s dilemma: dominant strategy to steal: Equilibrium \{S, S\}

1,2 $=>$ $\frac{R}{2}, \frac{R}{2}$

3,4 $=>$ 0, $\mu R$

5,6 $=>$ $\mu R, 0$

7,8 $=>$ $\frac{\phi R}{2}, \frac{\phi R}{2}$
Behavioural Game Theory

- Add in empathy.
- VC/E have no empathy (but higher synergistic ability at effort stage)
- E/A have empathy (but lower ability at the effort stage)

$$U_E = \Pi_E + \theta \Pi_A \quad \quad U_A = \Pi_A + \theta \Pi_E$$

- In E/VC relationship, zero empathy:

$$\theta = 0.$$
Really behavioural: we assume that if neither steals, they feel empathy for each other. If either, or both steals, empathy is destroyed.


But: psychology: framing.
Equilibrium of stealing game

• VC/E dyad: no empathy => stealing is a dominant strategy => eqm \{S, S\}
• E/A dyad: low empathy => eqm \{S, S\}
• E/A: high empathy => eqm \{NS, NS\}
• Critical empathy value:

\[ \theta > 2\mu - 1 \]
Date 1: Effort Stage:

1. If E chooses VC at date 0, they correctly anticipate mutual date 3 stealing at date 1 effort stage: therefore, choose date 1 effort to maximize

\[ \Pi_E = \frac{1}{2} \gamma(e_ee_{VC})^{\frac{1}{2}} \phi R - \beta e_E^2 \]
\[ \Pi_{VC} = \frac{1}{2} \gamma(e_ee_{VC})^{\frac{1}{2}} \phi R - \beta e_{VC}^2 \]

2. If E chooses A at date 0, with weak potential empathy \( \theta < 2\mu - 1 \)
Correctly anticipate mutual stealing: => they choose effort to maximize

\[ \Pi_E = \frac{1}{2} (e_ee_A)^{\frac{1}{2}} \phi R - \beta e_E^2 \]
\[ \Pi_A = \frac{1}{2} (e_ee_A)^{\frac{1}{2}} \phi R - \beta e_A^2 \]
Effort Stage (continued)

• If E chooses A at date 0, with high empathy;

\[ \theta > 2\mu - 1 \]

• E and A correctly anticipate no stealing at date 3 => they choose date 1 effort to maximize:

\[
U_E = \prod_E + \theta \prod_A = \frac{1}{2} (e_E e_A)^2 R(1 + \theta) - \beta e_E^2 - \theta \beta e_A^2
\]

\[
U_A = \prod_A + \theta \prod_E = \frac{1}{2} (e_E e_A)^2 R(1 + \theta) - \beta e_A^2 - \theta \beta e_E^2
\]
Optimal Effort level

• E/VC dyad: \( e_{E}^* = e_{VC}^* = \frac{\gamma \phi R}{8 \beta} \Rightarrow V = \frac{\gamma^2 \phi^2 R^2}{8 \beta} \)

• E/A dyad, with low empathy (S)
  \( e_{E}^* = e_{A}^* = \frac{\phi R}{8 \beta} \Rightarrow V = \frac{\phi^2 R^2}{8 \beta} \)

• E/A dyad with high empathy (NS)
  \( e_{E}^* = e_{A}^* = \frac{R(1 + \theta)}{8 \beta} \Rightarrow V = \frac{R^2(1 + \theta)}{8 \beta} \)

Interesting to note: higher effort in E/A dyad with high empathy compared to E/VC dyad (even though VC/E has higher value-creating abilities) iff

\[ 1 + \theta > \gamma^2 \phi^2 \]
Date 0 Bidding Game

\[ \Pi_E = \Pi_{VC} = \frac{3\gamma^2 \phi^2 R^2}{64\beta} \]

\[ \Pi_E = \Pi_A = \frac{3\phi^2 R^2}{64\beta} \]

\[ U_E = U_A = \frac{R^2}{64\beta} \left[ 4(1 + \theta)^2 - (1 + \theta)^3 \right] \]

VC and A bid at date 0 (by offering investment funds \( I \))
Bidding when E/A empathy is strong

- Critical VC/E synergy parameters

\[ \gamma_1 = \frac{1}{\phi} \sqrt{\frac{4(1 + \theta)^2 - (1 + \theta)^3}{3}} \]

\[ \gamma_2 = \frac{1}{\phi} \sqrt{1 + \theta} \]

Iff \( \gamma \leq \gamma_1 \), A wins bid (otherwise VC wins bid)

Iff \( \gamma \leq \gamma_2 \), expected venture value is higher under A than VC

\[ \gamma_2 < \gamma_1, \forall \theta \geq 2\mu - 1 \]

Interval widening as theta increases.
Effect of synergy and empathy on equilibrium when E/A empathy is strong

\[ \gamma \in [1, \gamma_2] \Rightarrow A \] \quad \text{Wins bid: value-maximizing}

\[ \gamma \in [\gamma_2, \gamma_1] \Rightarrow A \] \quad \text{Wins bid: value-minimizing}

\[ \gamma > \gamma_1 \Rightarrow VC \] \quad \text{Wins bid: value-maximizing}

In summary, E’s choice of financier, and effect on expected venture value depends on the VC/E synergy value compared with the E/A empathy value: possible that the E could choose the A although VC may add more value: warm-glow effect?

Evidence of much angel-financing.
Conclusion

• Descriptive/normative implications.
• E may need to consider both value-creating abilities and empathy effects when choosing financier.
• Competing Financiers may need to work on ability and empathy.
• Policy-makers (eg NVCA) may need to address relational aspects as well as contractual/ability factors.
Future Research

• Endogenize empathy (eg David Sally’s work)
• Fairness (inequity-aversion), social norms => bargaining over equity shares.
• Bounded Rationality
• Negative reciprocity: spite, anger, revenge (Utset)