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

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Background

- Traditional Finance and Economics: "Homo Economicus":
- => Fully rational, Self-interested, Utilitymaximiser.
- Behavioural Finance/economics: Bounded rationality, cognitive biases...
- Other-regarding preferences
- +ve reciprocity, Altruism, Fairness, empathy
- -ve reciprocity: Anger, revenge, spite.

My Research

- Behavioural Corporate Finance
- Venture Capital/Entrepreneur financial contracting and performance.
- Game-Theoretical Approaches
- More difficult aspect: empirical tests

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):

- My New Approach: Behavioural Game-theoretic: modelling method: empathy in E/A relationship
 trustworthy behaviour (less effort-shirking: less ex post stealing)
- ⇔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-ofreasoning; 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 I > 0.
- Date 1: Simultaneous Effort levels => success probability

$$P = \gamma_{E,i} e_E^{\overline{2}} e_i^{\overline{2}} \Longrightarrow R$$

$$1 - P => 0$$

- => Expected Value $V = PR = \gamma_{E,i} e_E^{\frac{1}{2}} e_i^{\frac{1}{2}} R.$
- (if no ex post stealing)

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:
- 2

φR



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)

 $U_E = \prod_E + \theta \prod_A \qquad \qquad U_A = \prod_A + \theta \prod_E$

• 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.

Camerer (1997): axiom of description invariance: rational game theory.

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

$$\Pi_{E} = \frac{1}{2} \gamma (e_{E} e_{VC})^{\frac{1}{2}} \phi R - \beta e_{E}^{2} \qquad \Pi_{VC} = \frac{1}{2} \gamma (e_{E} e_{VC})^{\frac{1}{2}} \phi R - \beta e_{VC}^{2}$$

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

$$\prod_{E} = \frac{1}{2} (e_{E} e_{A})^{\frac{1}{2}} \phi R - \beta e_{E}^{2} \qquad \prod_{A} = \frac{1}{2} (e_{E} e_{A})^{\frac{1}{2}} \phi R - \beta e_{A}^{2}$$

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:

$$U_{E} = \prod_{E} + \theta \prod_{A} = \frac{1}{2} (e_{E}e_{A})^{\frac{1}{2}} R(1+\theta) - \beta e_{E}^{2} - \theta \beta e_{A}^{2}$$
$$U_{A} = \prod_{A} + \theta \prod_{E} = \frac{1}{2} (e_{E}e_{A})^{\frac{1}{2}} R(1+\theta) - \beta e_{A}^{2} - \theta \beta e_{E}^{2}$$

Optimal Effort level

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

- E/A dyad, with low empathy (S) $e_E^* = e_A^* = \frac{\phi R}{8\beta} => V = \frac{\phi^2 R^2}{8\beta}$
- E/A dyad with high empathy (NS) $e_E^* = e_A^* = \frac{R(1+\theta)}{8\beta} => V = \frac{R^2(1+\theta)}{8\beta}$

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

$$+\theta > \gamma^2 \phi^2$$
¹⁷

Date 0 Bidding Game

$$\Pi_{E} = \Pi_{VC} = \frac{3\gamma^{2}\phi^{2}R^{2}}{64\beta} \qquad \Pi_{E} = \Pi_{A} = \frac{3\phi^{2}R^{2}}{64\beta}$$

$$U_{E} = U_{A} = \frac{R^{2}}{64\beta} [4(1+\theta)^{2} - (1+\theta)^{3}]$$

VC and A bid at date 0 (by offering investment funds $\geq I$

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
- $\gamma_2 < \gamma_1, \forall \theta \ge 2\mu 1$ Interval widening as theta increases.

Effect of synergy and empathy on equilibrium when E/A empathy is strong

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

$$\gamma \in [\gamma_2, \gamma_1] \Longrightarrow A$$
 Wins bid: value-minimizing

 $\gamma > \gamma_1 => VC$ 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 valuecreating 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), Costly Retaliation (Parisi and Fon)