

# **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):

- 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-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  $I > 0$  => success probability

$$P = \gamma_{E,i} e_E^{\frac{1}{2}} e_i^{\frac{1}{2}} \Rightarrow R$$

$$1 - P \Rightarrow 0$$

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



# The Model (continued)

- Date 2: Project either succeeds or fails.
- Date 3: if success  $\Rightarrow R$ , 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  $\Rightarrow \mu R < R$
- 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

• E

	i	NS	S
NS		1, 2	3, 4
S		5, 6	7, 8

$$1,2 \Rightarrow \frac{R}{2}, \frac{R}{2}$$

$$3,4 \Rightarrow 0, \mu R$$

$$5,6 \Rightarrow \mu R, 0$$

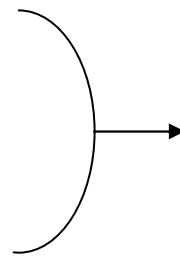
$$7,8 \Rightarrow \frac{\phi R}{2}, \frac{\phi R}{2}$$

Assumption:

$$\mu R > \frac{R}{2}$$

Of course,

$$\frac{\phi R}{2} > 0$$



Prisoner's dilemma:  
dominant strategy to steal:

Equilibrium {S, S}

# 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)

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

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

- In E/VC relationship, zero empathy:

$$\theta = 0.$$

# Behavioural Stealing Game: Angel/Entr.

•

		i	
		NS	S
E	NS	1, 2	3, 4
	S	5, 6	7, 8

$$1,2 \Rightarrow \frac{R}{2}(1+\theta), \frac{R}{2}(1+\theta)$$

$$3,4 \Rightarrow 0, \mu R$$

$$5,6 \Rightarrow \mu R, 0$$

$$7,8 \Rightarrow \frac{\phi R}{2}, \frac{\phi R}{2}$$

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

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

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

$$\Pi_E = \frac{1}{2} (e_E e_A)^{\frac{1}{2}} \phi R - \beta e_E^2 \quad \Pi_A = \frac{1}{2} (e_E e_A)^{\frac{1}{2}} \phi R - \beta e_A^2$$

# 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:

$$U_E = \Pi_E + \theta \Pi_A = \frac{1}{2} (e_E e_A)^{\frac{1}{2}} R(1 + \theta) - \beta e_E^2 - \theta \beta e_A^2$$

$$U_A = \Pi_A + \theta \Pi_E = \frac{1}{2} (e_E e_A)^{\frac{1}{2}} R(1 + \theta) - \beta e_A^2 - \theta \beta e_E^2$$

# Optimal Effort level

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

- 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

$$\Pi_E = \Pi_{VC} = \frac{3\gamma^2 \phi^2 R^2}{64\beta} \quad \Pi_E = \Pi_A = \frac{3\phi^2 R^2}{64\beta}$$

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

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

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

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

$\gamma \in [1, \gamma_2] \Rightarrow A$  Wins bid: value-maximizing

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

$\gamma > \gamma_1 \Rightarrow VC$  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 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)