Product Market Competition and the Financing of New Ventures

Jean-Etienne de Bettignies and Anne Duchêne

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Why Some Entrepreneurs Prefer Debt-Financing

"My error, sir. On the phone I thought you said 'venture' capitalist."
Financing Choices Over the Lifecycle of the Firm

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- Our suggestion: perhaps change in choice of financing is related to change in product market competition?
Is There Evidence of a Link Between Competition and Financing Choice?

- In the trade literature:
  - Baggs and Brander (2006): Import tariffs increase leverage
  - In the finance literature:
    - Titman and Wessels (1988): Product uniqueness reduces leverage
    - Kovenock and Phillips (1995): Leverage higher in concentrated industries
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Research Question

- How does product market competition affect entrepreneurs’ choice between VC financing and bank financing?
Related Literature

- **Debt and Competitive Behavior**
  - Debt as optimal contract, predation: Bolton and Scharfstein (1990)

- **Bank Financing Vs. VC Financing**
  - Entrepreneur/investor input complementarity: Bettignies (2008)
Two Primary Contributions

- Contribution #1: To place specific model of VC/bank financing choice in a duopoly model where competitive interaction is explicitly taken into account \( \rightarrow \) Link between the two literatures
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• Contribution #1: To place specific model of VC/bank financing choice in a duopoly model where competitive interaction is explicitly taken into account –> Link between the two literatures

• Contribution #2: To examine not only the impact of VC/bank financing choice on competitive behavior, but also the impact of competition on the financing choice itself.
Model Summary - Assumptions

- Two entrepreneur/financier pairs compete in two period game on Hotelling line, first in price, then in effort-then-price
- Contracts are incomplete
- Under bank financing: debt-type contract
  - Following date 1 success $\rightarrow$ debt is paid back $\rightarrow$ entrepr. keeps control and exerts effort $q^h$
  - Following failure $\rightarrow$ default $\rightarrow$ entrepr. loses control and zero effort exerted
- Under VC financing: equity-type contract
  - Joint control regardless of date 1 success/failure $\rightarrow$ entrepr. exerts effort $q^l$
Model Summary - Results

- Payoff from bank financing:

\[
\pi_i \left( 0, q^l, t \right) + X_{ibv} \left[ P_{ibv} + \pi_i \left( q^h, q^l, t \right) - c \right] - \pi_i \left( 0, q^l, t \right)
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Competition reduces cost of bank financing and increases benefit - more bank financing at individual firm level and industry level.
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- Payoff from VC financing:

\[ \pi_i \left( q^l, q^l, t \right) + X_{ivv} P_{ivv} \]

- Choose bank financing over VC financing iff:

\[ [B_{ibv} \left( s_{ibv} \left( t \right) - s_{jvb} \left( t \right), t \right) - B_{ivv} \left( t \right)] - [M_{ivv} \left( t \right) - M_{ibv} \left( t \right)] \geq 0 \]
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Basic Model Setup
Key Assumptions

- Two pairs of risk-neutral players: entrepreneur $e_i$ and financier $f_i$, $i = 1, 2$
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- Profits are observable but not verifiable
Timing of the Game

- At date 0:
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  - $e_i$ chooses type of financing and makes contractual offer to $f_i$
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  - Consumer buys from firm $i$ with probability $X_i$. Profit $P_i$ or 0
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  • $e_i$ chooses whether to participate, and if so whether to exert high effort $q^h$ at personal cost $c$, or low effort $q^l < q^h/2$ at zero cost.
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- At date 2:
Timing of the Game

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- At date 2:
  - Consumer buys from firm $i$ with probability $x_i$. Profit $p_i - a + q_i$ or 0
Incomplete Contracts and Property Rights in Period 2

- Note second period expected profits:

\[
\pi_i (q_i, q_j, t) = \left[ \frac{1}{2} + \frac{(q_i - q_j)}{6t} \right] \left[ t + \frac{(q_i - q_j)}{3} \right]
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- Three property rights allocations:
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  - Financier control (F): \( f_i \) extracts everything
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- We focus on parameter values such that \( e_i \) exerts \( q^h \) under E, \( q^l \) under J and no participation under F
Property Rights and Second Period Expected Profits

<table>
<thead>
<tr>
<th>$e_j \setminus e_i$</th>
<th>E Control</th>
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<th>F control</th>
</tr>
</thead>
<tbody>
<tr>
<td>E Control</td>
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Incomplete Contracts and Property Rights in Period 1

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- By default $e_i$ owns the venture in period 1
Bank Financing Versus Venture Capital

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  - Joint control is not available, only entrepreneur control and financier control

- Under VC financing
  - VC gains critical information about venture idea.
  - Even under entrepreneur control, cannot commit not to extract fraction of payoff. E.g. If VC can steal idea with probability \( \lambda \), same split as under joint control.

- Equity-type contract: joint control regardless of state of the world

In both cases, entrepreneur extracts all ex ante rents from financier.
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- In both cases, $e_i$ extracts all ex ante rents from $f_i$
Financing Choice When Rival Chooses VC Financing
Bank Financing - Second Period

- Following success for venture $i$ at date 1:
  - venture $i$: $\pi_i \left( q^h, q^l, t \right) - c$
  - venture $j$: $\pi_j \left( q^l, q^h, t \right)$

- Following failure for venture $i$ at date 1:
  - venture $i$: $\pi_i \left( 0, q^l, t \right)$
  - venture $j$: $\pi_j \left( q^l, 0, t \right)$

- Surplus from short-term success for ventures $i$ and $j$:

  \[ s_{ibv} = \left( \pi_i \left( q^h, q^l, t \right) - c \right) - \pi_i \left( 0, q^l, t \right) \]

  \[ s_{jvb} = \pi_j \left( q^l, 0, t \right) - \pi_j \left( q^l, q^h, t \right) \]
Bank Financing - First Period

- Maximization program for $e_i$:

$$\max_{P_{ibv}} X_{ibv} \left[ P_{ibv} + \left( \pi_i \left( q^h, q^l, t \right) - c \right) \right] + [1 - X_{ibv}] \pi_i \left( 0, q^l, t \right)$$

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$s_{ibv}$

$M_{ibv}$
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- Minimum expected return: $M_{ibv} = \pi_i \left( 0, q^l, t \right)$
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- Minimum expected return: $M_{ibv} = \pi_i \left( 0, q^l, t \right)$

- Expected bonus from short term success:

$$B_{ibv} = X_{ibv} \left[ P_{ibv} + s_{ibv} \right]$$
Bank Financing - First Period

- Maximization program for $e_i$:

$$\begin{align*}
\max_{P_{ibv}} & \quad X_{ibv} \left[ P_{ibv} + \left( \pi_i \left( q^h, q^l, t \right) - c \right) \right] + [1 - X_{ibv}] \pi_i \left( 0, q^l, t \right) \\
\max_{P_{ibv}} & \quad X_{ibv} \left[ P_{ibv} + \left( \pi_i \left( q^h, q^l, t \right) - c \right) - \pi_i \left( 0, q^l, t \right) \right] + \pi_i \left( 0, q^l, t \right) \\
& \quad \text{subject to} \\
& \quad s_{ibv} + M_{ibv} \\
& \quad \text{Minimum expected return: } M_{ibv} = \pi_i \left( 0, q^l, t \right) \\
& \quad \text{Expected bonus from short term success:} \\
& \quad B_{ibv} = X_{ibv} \left[ P_{ibv} + s_{ibv} \right] = \left[ \frac{1}{2} + \frac{s_{ibv} - s_{jvb}}{6t} \right] \left[ t + \frac{s_{ibv} - s_{jvb}}{3} \right] \\
& \quad \text{First period price: } P_{ibv} = t - \left( 2s_{ibv} + s_{jvb} \right) / 3
\end{align*}$$
Bank Financing - First Period (2)

- Maximization program for $e_j$:

$$
\begin{align*}
\max_{P_{jvb}} & \quad X_{jvb} \left[ P_{jvb} + \pi_j \left( q^l, 0, t \right) \right] + \left[ 1 - X_{jvb} \right] \pi_j \left( q^l, q^h, t \right) \\
\max_{P_{jvb}} & \quad X_{jvb} \left[ P_{jvb} + \pi_j \left( q^l, 0, t \right) - \pi_j \left( q^l, q^h, t \right) \right] + \pi_j \left( q^l, q^h, t \right) \\
\end{align*}
$$

- Minimum expected return: $M_{jvb} = \pi_j \left( q^l, q^h, t \right)$
- Expected bonus from short term success:

$$
B_{jvb} = X_{jvb} \left[ P_{jvb} + s_{jvb} \right] = \left[ \frac{1}{2} + \frac{s_{jvb} - s_{ibv}}{6t} \right] \left[ t + \frac{s_{jvb} - s_{ibv}}{3} \right]
$$

- First period price: $P_{jvb} = t - \left( 2s_{jvb} + s_{ibv} \right) / 3$
VC Financing

• Second period expected payoffs of ventures $i$ and $j$:
  \[ \pi_i(q^l, q^l, t) = \pi_j(q^l, q^l, t) \]
VC Financing

- Second period expected payoffs of ventures $i$ and $j$:
  $\pi_i (q^l, q^l, t) = \pi_j (q^l, q^l, t)$

- First period maximization for $e_i$: $\max_{P_{ivv}} \left( X_{ivv}P_{ivv} + \pi_i (q^l, q^l, t) \right)$

First period prices:

$P_{ivv} = P_{jvv} = t$
VC Financing

- Second period expected payoffs of ventures $i$ and $j$:
  $$\pi_i (q^l, q^l, t) = \pi_j (q^l, q^l, t)$$

- First period maximization for $e_i$: 
  $$\max_{P_{ivv}} \left( \chi_{ivv} P_{ivv} + \pi_i (q^l, q^l, t) \right)$$

  \[ B_{ivv} \]

  \[ M_{ivv} \]

- Minimum expected return:
  $$M_{ivv} = \pi_i (q^l, q^l, t) = \pi_j (q^l, q^l, t) = M_{jvv}$$
VC Financing

- Second period expected payoffs of ventures $i$ and $j$:
  \[ \pi_i(q', q', t) = \pi_j(q', q', t) \]

- First period maximization for $e_i$:
  \[
  \max_{P_{ivv}} \left( \underbrace{X_{ivv}P_{ivv} + \pi_i(q', q', t)}_{B_{ivv}} \right)
  \]

  \[
  M_{ivv} = \pi_i(q', q', t) = \pi_j(q', q', t) = M_{jvv}
  \]

  \[
  B_{ivv} = X_{ivv}P_{ivv} = t/2 = X_{jvv}P_{jvv} = B_{jvv}
  \]
VC Financing

- Second period expected payoffs of ventures $i$ and $j$:
  $$\pi_i \left( q^l, q^l, t \right) = \pi_j \left( q^l, q^l, t \right)$$

- First period maximization for $e_i$: 
  $$\max_{P_{ivv}} \left\{ X_{ivv} P_{ivv} + \pi_i \left( q^l, q^l, t \right) \right\}$$
  $$\min_{M_{ivv}} \left\{ \pi_i \left( q^l, q^l, t \right) \right\}$$

  - Minimum expected return:
    $$M_{ivv} = \pi_i \left( q^l, q^l, t \right) = \pi_j \left( q^l, q^l, t \right) = M_{jvv}$$
  - Expected bonus from short term success:
    $$B_{ivv} = X_{ivv} P_{ivv} = t/2 = X_{jvv} P_{jvv} = B_{jvv}$$

  - First period prices: 
    $$P_{ivv} = P_{jvv} = t$$
Financing Tradeoff

- Entrepreneur $e_i$ chooses bank financing over VC financing if and only if:

\[
\begin{align*}
\text{Bonus Differential} & \quad \left[ B_{ibv} (s_{ibv} (t), t) - B_{ivv} (t) \right] - \\
& > 0 \text{ iff } z(t) = s_{ibv}(t) - s_{jvb}(t) > 0 \\
\text{Minimum Return Differential} & \quad \left[ M_{ivv} (t) - M_{ibv} (t) \right] - \\
& = \pi_i (q^l, q^l, t) - \pi_i (0, q^l, t) > 0
\end{align*}
\]
Financing Tradeoff

- Entrepreneur $e_i$ chooses bank financing over VC financing if and only if:

  \[
  \frac{B_{ibv}(s_{ibv}(t) - s_{jvb}(t), t) - B_{ivv}(t)}{M_{ivv}(t) - M_{ibv}(t)} > 0 \quad \text{iff} \quad z(t) = s_{ibv}(t) - s_{jvb}(t) > 0
  \]

- Three possible cases:
Financing Tradeoff

- Entrepreneur $e_i$ chooses bank financing over VC financing if and only if:

\[
\begin{align*}
\text{Bonus Differential} & \quad [B_{ibv}(s_{ibv}(t) - s_{jvb}(t), t) - B_{ivv}(t)] - \\
\text{Minimum Return Differential} & \quad [M_{ivv}(t) - M_{ibv}(t)]
\end{align*}
\]

\[
> 0 \iff z(t) = s_{ibv}(t) - s_{jvb}(t) > 0
\]

- Three possible cases:
  - If $B_{ibv} - B_{ivv} \geq M_{ivv} - M_{ibv} > 0$: bank financing is optimal
Financing Tradeoff

- Entrepreneur $e_i$ chooses bank financing over VC financing if and only if:

$$\left[B_{ibv}(s_{ibv}(t) - s_{jvb}(t), t) - B_{ivv}(t)\right] - \left[M_{ivv}(t) - M_{ibv}(t)\right] > 0$$

iff $z(t) = s_{ibv}(t) - s_{jvb}(t) > 0$

- Three possible cases:
  - If $B_{ibv} - B_{ivv} \geq M_{ivv} - M_{ibv} > 0$: bank financing is optimal
  - If $M_{ivv} - M_{ibv} > B_{ibv} - B_{ivv} \geq 0$: VC financing is optimal
Financing Tradeoff

- Entrepreneur $e_i$ chooses bank financing over VC financing if and only if:

  $B_{ibv}(s_{ibv}(t) - s_{jvb}(t), t) - B_{ivv}(t) - [M_{ivv}(t) - M_{ibv}(t)] > 0$ if $z(t) = s_{ibv}(t) - s_{jvb}(t) > 0$

  $= \pi_i(q^l, q^l, t) - \pi_i(0, q^l, t) > 0$

- Three possible cases:

  - If $B_{ibv} - B_{ivv} \geq M_{ivv} - M_{ibv} > 0$: bank financing is optimal
  - If $M_{ivv} - M_{ibv} > B_{ibv} - B_{ivv} \geq 0$: VC financing is optimal
  - If $B_{ibv} - B_{ivv} < 0$: VC financing is optimal (no benefit from bank financing)
Financing choice and competitive behavior

- First period prices: lower under bank financing
Financing choice and competitive behavior

- First period prices: lower under bank financing
  - Venture $j$: predation $\Rightarrow P_{jvb} < P_{jvv}$
Financing choice and competitive behavior

- First period prices: lower under bank financing
  - Venture $j$: predation $\Rightarrow P_{jvb} < P_{jvv}$
  - Venture $i$: prevention $\Rightarrow P_{ibv} < P_{ivv}$
Financing choice and competitive behavior

- First period prices: lower under bank financing
  - Venture $j$: predation $\Rightarrow P_{jvb} < P_{jvv}$
  - Venture $i$: prevention $\Rightarrow P_{ibv} < P_{ivv}$
- Probability of short-term success: $X_{ibv}$ need not be lower than $X_{ivv}$ (could be higher)
Financing choice and competitive behavior

- First period prices: lower under bank financing
  - Venture $j$: predation $\Rightarrow P_{jvb} < P_{jvv}$
  - Venture $i$: prevention $\Rightarrow P_{ibv} < P_{ivv}$

- Probability of short-term success: $X_{ibv}$ need not be lower than $X_{ivv}$ (could be higher)

- Second period prices: conditional on short-term success for venture $i$, higher under bank financing than under VC financing
Recall the expression for venture $i$’s second period expected profits:

$$\pi_i(q_i, q_j, t) = \left[ \frac{1}{2} + \frac{(q_i - q_j)}{6t} \right] \left[ t + \frac{(q_i - q_j)}{3} \right]$$

$$\leftrightarrow \pi_i(\Delta_i, t) = x_i(\Delta_i, t) p_i(\Delta_i, t) \quad \text{with} \quad \Delta_i = q_i - q_j$$
Recall the expression for venture $i$’s second period expected profits:

$$\pi_i (q_i, q_j, t) = \left[ \frac{1}{2} + \frac{(q_i - q_j)}{6t} \right] \left[ t + \frac{(q_i - q_j)}{3} \right]$$

$$\Leftrightarrow \pi_i (\Delta_i, t) = x_i (\Delta_i, t) p_i (\Delta_i, t) \quad \text{with} \quad \Delta_i = q_i - q_j$$

Impact of competition:

$$\frac{d\pi_i}{dt} = \frac{dx_i}{dt} p_i + \frac{dp_i}{dt} x_i$$

business stealing  rent reduction
Recall the expression for venture $i$’s second period expected profits:

$$\pi_i (q_i, q_j, t) = \left[ \frac{1}{2} + \frac{(q_i - q_j)}{6t} \right] \left[ t + \frac{(q_i - q_j)}{3} \right]$$

$$\Leftrightarrow \pi_i (\Delta_i, t) = x_i (\Delta_i, t) p_i (\Delta_i, t) \quad \text{with} \quad \Delta_i = q_i - q_j$$

Impact of competition:

$$\frac{d \pi_i}{dt} = \frac{dx_i}{dt} p_i + \frac{dp_i}{dt} x_i$$

- business stealing: $(dx_i / dt) [p_i - mc_i] < 0$ if and only if $\Delta_i > 0$
Recall the expression for venture \( i \)'s second period expected profits:

\[
\pi_i (q_i, q_j, t) = \left[ \frac{1}{2} + \frac{(q_i - q_j)}{6t} \right] \left[ t + \frac{(q_i - q_j)}{3} \right]
\]

\( \Leftrightarrow \pi_i (\Delta_i, t) = x_i (\Delta_i, t) p_i (\Delta_i, t) \) with \( \Delta_i = q_i - q_j \)

Impact of competition:

\[
\frac{d\pi_i}{dt} = \frac{dx_i}{dt} p_i + \frac{dp_i}{dt} x_i
\]

- business stealing: \((dx_i / dt) [p_i - mc_i] < 0\) if and only if \( \Delta_i > 0 \)
- rent reduction: \((d [p_i - mc_i] / dt) x_i > 0\)
Competition and Financing Choice - Preliminary Note (2)

• Now consider difference b/w two expected profits, with $\Delta_i = q_i - q_j$, $\Delta'_i = q'_i - q'_j$, and $\Delta_i > \Delta'_i$:

$$\pi_i (\Delta_i, t) - \pi'_i (\Delta'_i, t) = x_i (\Delta_i, t) p_i (\Delta_i, t) - x'_i (\Delta'_i, t) p'_i (\Delta'_i, t).$$
• Now consider difference b/w two expected profits, with \( \Delta_i = q_i - q_j, \Delta'_i = q'_i - q'_j, \) and \( \Delta_i > \Delta'_i: \)

\[
\pi_i (\Delta_i, t) - \pi'_i (\Delta'_i, t) = x_i (\Delta_i, t) p_i (\Delta_i, t) - x'_i (\Delta'_i, t) p'_i (\Delta'_i, t).
\]

• Impact of competition

\[
\frac{d (\pi_i - \pi'_i)}{dt} = \left[ \frac{dx_i}{dt} p_i - \frac{dx'_i}{dt} p'_i \right] + \left[ \frac{dp_i}{dt} x_i - \frac{dp'_i}{dt} x'_i \right]
\]

\( \text{Differential BS}<0 \)
\( \text{Differential RR}>0 \)
Competition and Financing Choice - Preliminary Note (2)

- Now consider difference between two expected profits, with $\Delta_i = q_i - q_j$, $\Delta'_i = q'_i - q'_j$, and $\Delta_i > \Delta'_i$:

  $$\pi_i (\Delta_i, t) - \pi'_i (\Delta'_i, t) = x_i (\Delta_i, t) p_i (\Delta_i, t) - x'_i (\Delta'_i, t) p'_i (\Delta'_i, t).$$

- Impact of competition

  $$\frac{d (\pi_i - \pi'_i)}{dt} = \left[ \frac{dx_i}{dt} p_i - \frac{dx'_i}{dt} p'_i \right] + \left[ \frac{dp_i}{dt} x_i - \frac{dp'_i}{dt} x'_i \right]$$

  - Differential BS $< 0$
  - Differential RR $> 0$

- Key point: $(\Delta_i + \Delta'_i) / 2$ increases DBS but not DRR
Now consider difference b/w two expected profits, with \( \Delta_i = q_i - q_j, \Delta'_i = q'_i - q'_j \), and \( \Delta_i > \Delta'_i \):

\[
\pi_i (\Delta_i, t) - \pi'_i (\Delta'_i, t) = x_i (\Delta_i, t) p_i (\Delta_i, t) - x'_i (\Delta'_i, t) p'_i (\Delta'_i, t).
\]

Impact of competition

\[
\frac{d}{dt} (\pi_i - \pi'_i) = \left[ \frac{dx_i}{dt} p_i - \frac{dx'_i}{dt} p'_i \right] + \left[ \frac{dp_i}{dt} x_i - \frac{dp'_i}{dt} x'_i \right]
\]

\[
= \begin{cases} 
\text{Differential BS}<0 & \text{Differential RR}>0 
\end{cases}
\]

Key point: \( (\Delta_i + \Delta'_i) / 2 \) increases DBS but not DRR

\( (\Delta_i + \Delta'_i) / 2 = \left( mc_j + mc'_j \right) / 2 - \left( mc_i + mc'_i \right) / 2 = \text{venture i’ competitive advantage} \)
Now consider difference b/w two expected profits, with \( \Delta_i = q_i - q_j \), \( \Delta'_i = q'_i - q'_j \), and \( \Delta_i > \Delta'_i \):

\[
\pi_i(\Delta_i, t) - \pi'_i(\Delta'_i, t) = x_i(\Delta_i, t) p_i(\Delta_i, t) - x'_i(\Delta'_i, t) p'_i(\Delta'_i, t)
\]

Impact of competition

\[
\frac{d}{dt} \left( \pi_i - \pi'_i \right) = \left[ \frac{dx_i}{dt} p_i - \frac{dx'_i}{dt} p'_i \right] + \left[ \frac{dp_i}{dt} x_i - \frac{dp'_i}{dt} x'_i \right]
\]

Differential BS < 0

Differential RR > 0

Key point: \( (\Delta_i + \Delta'_i) / 2 \) increases DBS but not DRR

\( (\Delta_i + \Delta'_i) / 2 = \left( mc_j + mc'_j \right) / 2 - \left( mc_i + mc'_i \right) / 2 = \text{venture i' competitive advantage} \)

DBS dominates DRR iff \( (\Delta_i + \Delta'_i) / 2 > 0 \)
Impact of Competition on Financing - Minimum Return Differential

- Tradeoff: \[ B_{ibv}(z(t), t) - B_{ivv}(t) - [M_{ivv}(t) - M_{ibv}(t)] \]
Impact of Competition on Financing - Minimum Return Differential

- Tradeoff: \([B_{ibv}(z(t), t) - B_{ivv}(t)] - [M_{ivv}(t) - M_{ibv}(t)]\)

- Competition and minimum return differential: \(M_{ivv}(t) - M_{ibv}(t)\)
Impact of Competition on Financing - Minimum Return Differential

- Tradeoff: \([B_{ibv}(z(t), t) - B_{ivv}(t)] - [M_{ivv}(t) - M_{ibv}(t)]\)
- Competition and minimum return differential: \(M_{ivv}(t) - M_{ibv}(t)\)
  - \(\frac{\Delta_i + \Delta_i'}{2} < 0 \Rightarrow \frac{d(M_{ivv}(t) - M_{ibv}(t))}{t} > 0\)
Impact of Competition on Financing - Minimum Return Differential

- Tradeoff: \( [B_{ibv}(z(t), t) - B_{ivv}(t)] - [M_{ivv}(t) - M_{ibv}(t)] \)
- Competition and minimum return differential:
  \( M_{ivv}(t) - M_{ibv}(t) \)
  \[ \frac{\Delta_i + \Delta'_i}{2} < 0 \Rightarrow \frac{d(M_{ivv}(t) - M_{ibv}(t))}{t} > 0 \]
- \( \Rightarrow \) Competition reduces the cost of bank financing, \( M_{ivv}(t) - M_{ibv}(t) \)
Impact of Competition on Financing - Bonus Differential

- Bonus differential, $B_{ibv}(z(t), t) - B_{ivv}(t)$, is isomorphic to profit differential
Impact of Competition on Financing - Bonus Differential

- Bonus differential, $B_{ibv}(z(t), t) - B_{ivv}(t)$, is isomorphic to profit differential

$$
\frac{d(B_{ibv}(z(t), t) - B_{ivv}(t))}{dt} = \frac{\partial (B_{ibv}(z(t), t) - B_{ivv}(t))}{\partial t} + \frac{\partial B_{ibv}(z(t), t)}{\partial z} \frac{\partial z}{\partial t}
$$

Competition increases the (potential) benefit from bank financing, $B_{ibv}(z(t), t)$.
Impact of Competition on Financing - Bonus Differential

- Bonus differential, $B_{ibv}(z(t), t) - B_{ivv}(t)$, is isomorphic to profit differential

$$\frac{d(B_{ibv}(z(t), t) - B_{ivv}(t))}{dt} = \frac{\partial(B_{ibv}(z(t), t) - B_{ivv}(t))}{\partial t} + \frac{\partial B_{ibv}(z(t), t)}{\partial z} \frac{\partial z}{\partial t}$$

- $\partial (B_{ibv}(z(t), t) - B_{ivv}(t)) / \partial t < 0$
Impact of Competition on Financing - Bonus Differential

- Bonus differential, $B_{ibv}(z(t), t) - B_{ivv}(t)$, is isomorphic to profit differential

\[
\frac{d(B_{ibv}(z(t), t) - B_{ivv}(t))}{dt} = \frac{\partial (B_{ibv}(z(t), t) - B_{ivv}(t))}{\partial t} + \frac{\partial B_{ibv}(z(t), t)}{\partial z} \frac{\partial z}{\partial t}
\]

- $\frac{\partial (B_{ibv}(z(t), t) - B_{ivv}(t))}{\partial t} < 0$

- If $z(t) > 0$, venture $i$ has surplus adv. $\Rightarrow$ DBS > DRR
Impact of Competition on Financing - Bonus Differential

- Bonus differential, $B_{ibv}(z(t), t) - B_{ivv}(t)$, is isomorphic to profit differential
  \[
  \frac{d(B_{ibv}(z(t), t) - B_{ivv}(t))}{dt} = \frac{\partial(B_{ibv}(z(t), t) - B_{ivv}(t))}{\partial t} + \frac{\partial B_{ibv}(z(t), t)}{\partial z} \frac{\partial z}{\partial t}
  \]
- $\partial (B_{ibv}(z(t), t) - B_{ivv}(t)) / \partial t < 0$
  - If $z(t) > 0$, venture $i$ has surplus adv. $\Rightarrow$ DBS $>$ DRR
  - If $z(t) < 0$, venture $i$ has surplus disadv. $\Rightarrow$ DRR $>$ DBS.

But bonus diff. is $< 0$
Impact of Competition on Financing - Bonus Differential

- **Bonus differential**, $B_{ibv}(z(t), t) - B_{ivv}(t)$, is isomorphic to profit differential

\[
\frac{d(B_{ibv}(z(t), t) - B_{ivv}(t))}{dt} = \frac{\partial(B_{ibv}(z(t), t) - B_{ivv}(t))}{\partial t} + \frac{\partial B_{ibv}(z(t), t)}{\partial z} \frac{\partial z}{\partial t}
\]

- \( \partial (B_{ibv}(z(t), t) - B_{ivv}(t)) / \partial t < 0 \)
  - If \( z(t) > 0 \), venture \( i \) has surplus adv. \( \Rightarrow \) DBS > DRR
  - If \( z(t) < 0 \), venture \( i \) has surplus disadv. \( \Rightarrow \) DRR > DBS.
    But bonus diff. is \( < 0 \)

- \( \partial z(t) / \partial t = \partial (s_{ibv}(t) - s_{jvb}(t)) / \partial t < 0 \)
Impact of Competition on Financing - Bonus Differential

- Bonus differential, $B_{ibv}(z(t), t) - B_{ivv}(t)$, is isomorphic to profit differential
  \[
  \frac{d(B_{ibv}(z(t), t) - B_{ivv}(t))}{dt} = \frac{\partial (B_{ibv}(z(t), t) - B_{ivv}(t))}{\partial t} + \frac{\partial B_{ibv}(z(t), t)}{\partial z} \frac{\partial z}{\partial t}
  \]
  - $\partial (B_{ibv}(z(t), t) - B_{ivv}(t)) / \partial t < 0$
    - If $z(t) > 0$, venture $i$ has surplus adv. $\Rightarrow$ DBS > DRR
    - If $z(t) < 0$, venture $i$ has surplus disadv. $\Rightarrow$ DRR > DBS.
    But bonus diff. is $< 0$
  - $\partial z(t) / \partial t = \partial (s_{ibv}(t) - s_{jvb}(t)) / \partial t < 0$
    - Because
      $\partial s_{ibv}(t) / \partial t = \partial \left[ (\pi_i(q^h, q^l, t) - c) - \pi_i(0, q^l, t) \right] / \partial t < 0$
      and $\partial s_{jvb}(t) / \partial t = \partial \left[ \pi_j(q^l, 0, t) - \pi_j(q^l, q^h, t) \right] / \partial t > 0$
Impact of Competition on Financing - Bonus Differential

- Bonus differential, $B_{ibv}(z(t), t) - B_{ivv}(t)$, is isomorphic to profit differential
  
  $$\frac{d(B_{ibv}(z(t), t) - B_{ivv}(t))}{dt} = \frac{\partial(B_{ibv}(z(t), t) - B_{ivv}(t))}{\partial t} + \frac{\partial B_{ibv}(z(t), t)}{\partial z} \frac{\partial z}{\partial t}$$

- $\partial (B_{ibv}(z(t), t) - B_{ivv}(t)) / \partial t < 0$
  - If $z(t) > 0$, venture $i$ has surplus adv. $\Rightarrow$ DBS $>$ DRR
  - If $z(t) < 0$, venture $i$ has surplus disadv. $\Rightarrow$ DRR $>$ DBS.
    But bonus diff. is $< 0$

- $\partial z(t) / \partial t = \partial (s_{ibv}(t) - s_{jvb}(t)) / \partial t < 0$
  - Because
    $$\partial s_{ibv}(t) / \partial t = \partial \left[ (\pi_i(q^h, q^l, t) - c) - \pi_i(0, q^l, t) \right] / \partial t < 0$$
    and $\partial s_{jvb}(t) / \partial t = \partial \left[ \pi_j(q^l, 0, t) - \pi_j(q^l, q^h, t) \right] / \partial t > 0$

- $\frac{\partial B_{ibv}(z(t), t)}{\partial z} > 0$
Impact of Competition on Financing - Bonus Differential

- Bonus differential, $B_{ibv}(z(t), t) - B_{ivv}(t)$, is isomorphic to profit differential
  
  $$\frac{d(B_{ibv}(z(t), t) - B_{ivv}(t))}{dt} = \frac{\partial(B_{ibv}(z(t), t) - B_{ivv}(t))}{\partial t} + \frac{\partial B_{ibv}(z(t), t)}{\partial z} \frac{\partial z}{\partial t}$$

- $\frac{\partial (B_{ibv}(z(t), t) - B_{ivv}(t))}{\partial t} < 0$
  - If $z(t) > 0$, venture $i$ has surplus adv. $\Rightarrow$ DBS > DRR
  - If $z(t) < 0$, venture $i$ has surplus disadv. $\Rightarrow$ DRR > DBS.
    But bonus diff. is $< 0$

- $\frac{\partial z(t)}{\partial t} = \frac{\partial (s_{ibv}(t) - s_{jvb}(t))}{\partial t} < 0$
  - Because
    $$\frac{\partial s_{ibv}(t)}{\partial t} = \frac{\partial [\pi_i(q^h, q^l, t) - c] - \pi_i(0, q^l, t)]}{\partial t} < 0$$
    and $$\frac{\partial s_{jvb}(t)}{\partial t} = \frac{\partial [\pi_j(q^l, 0, t) - \pi_j(q^l, q^h, t)]}{\partial t} > 0$$

- $\frac{\partial B_{ibv}(z(t), t)}{\partial z} > 0$

- Competition increases the (potential) benefit from bank financing, $B_{ibv}(z(t), t) - B_{ivv}(t)$
Impact of Competition on Financing Choice

- There exists a threshold $t^{**}$ such that bank financing is optimal when $t \leq t^{**}$, and VC financing is optimal otherwise.
Industry Equilibrium
Financing Choice When Rival Chooses Bank Financing

- Entrepreneur $e_i$ chooses bank financing over VC financing iff:

  $$[B_{ibb}(t) - B_{ivb}(z(t), t)] - [M_{ivb}(t) - M_{ibb}(t)] \geq 0$$
Financing Choice When Rival Chooses Bank Financing

- Entrepreneur \( e_i \) chooses bank financing over VC financing iff:
  \[
  [B_{ibb}(t) - B_{ivb}(z(t), t)] - [M_{ivb}(t) - M_{ibb}(t)] \geq 0
  \]

- There exists a threshold \( t^{***} > t^{**} \) such that bank financing is optimal when \( t \leq t^{***} \), and VC financing is optimal otherwise.
Industry Equilibrium

- Equilibrium financing choices evolve with the degree of product market competition
Industry Equilibrium

- Equilibrium financing choices evolve with the degree of product market competition
- At low levels of competition \((t \geq t^{***})\), both entrepreneurs choose VC financing
Industry Equilibrium

- Equilibrium financing choices evolve with the degree of product market competition
- At low levels of competition \((t \geq t^{***})\), both entrepreneurs choose VC financing
- At moderate levels of competition \((t^{**} \leq t \leq t^{***})\), both entrepreneurs choose VC, or both choose bank
Equilibrium financing choices evolve with the degree of product market competition

- At low levels of competition \((t \geq t^{***})\), both entrepreneurs choose VC financing
- At moderate levels of competition \((t^{**} \leq t \leq t^{***})\), both entrepreneurs choose VC, or both choose bank
- At high levels of competition \((t \leq t^{**})\), both entrepreneurs choose bank financing.
Discussion/Conclusion
Three Empirical Implications

- **Prediction 1**: Product market competition should increase probability of bank financing over VC financing
Three Empirical Implications

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