Moral Hazard under Contagion

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Motivation

- This paper studies partnerships where
  - partners can exit at any time
  - partners who have exited still enjoy some free-riding benefits as long as remaining partners keep contributing to the partnership
  - free-riding makes it harder for remaining partners to operate the partnership; they may thus choose to exit as well
- Key trade-off
  - free-riding vs. contagion of defections it may trigger
- Real-world examples
  - European Super League
  - public protests
  - group lending programs
  - ...

Paper in a Nutshell

Dynamic moral hazard in teams + Irreversible defections

Main Findings

1. Curse of productivity: increasing the output of the partnership may strictly harm all the players
   - intuition: a larger output is a double-edged sword
     - it generates higher revenue to the players
     - but also exacerbates the free-riding problem, because remaining players have larger incentives to keep operating the partnership
   - a novel channel that high productivity can be detrimental
2. Partnership's ability to cooperate is non-monotonic in its group size
   - intuition:
     - $n-1$ players cannot cooperate $\xrightarrow{\text{maybe}}$ n players can cooperate
       * when there are n players, one's initial exit will trigger more to exit since $n-1$ players cannot cooperate
       * hence, gain from free-riding $<$ loss from contagious defections
     - n players can cooperate $\xrightarrow{\text{maybe}}$ $n+1$ players cannot cooperate
       * when there are $n+1$ players, one's initial exit will not trigger more to exit since n players can cooperate
       * hence, gain from free-riding $>$ loss from contagious defections
   - vs. static setting: large size exacerbates free-riding (Olson, 1965)

Model Setup (2 Players)

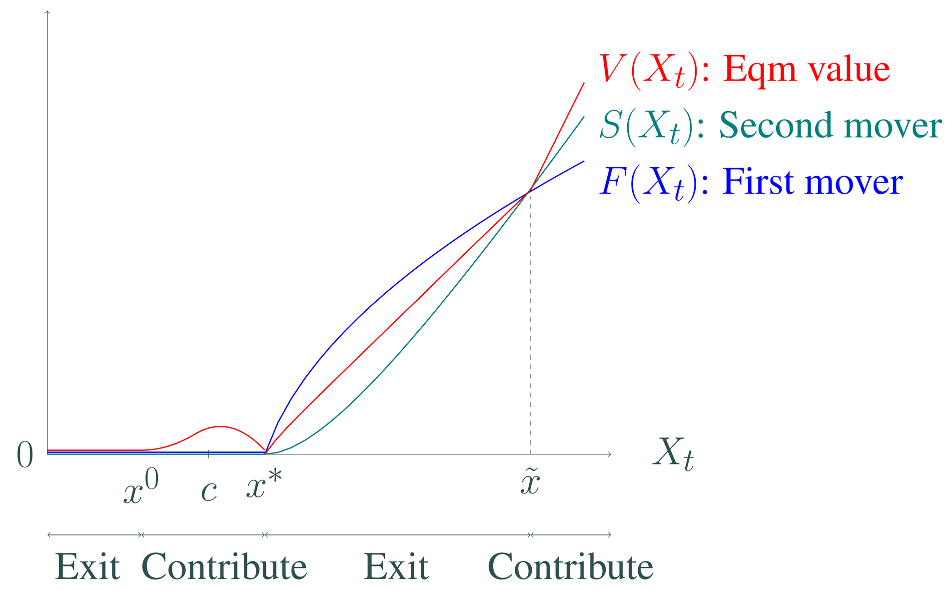
- Continuous time $t \in [0, \infty)$
- 2 players ($i = 1, 2$) run a joint project
  - $\Pi_i = \int_0^\infty e^{-rt}\pi_{it}dt$ where π_{it} is the flow payoff
- Flow payoff at time t

	Contribute	Defect
Contribute	$X_t - c,\, X_t - c$	$X_t - \beta c,\, \alpha X_t$
Defect	$\alpha X_t,\, X_t - \beta c$	$0, 0$

  - $X_t > 0$: project's flow output, follows $\frac{dX_t}{X_t} = \mu dt + \sigma dZ_t$
  - $\beta > 1$: the *reliance parameter*
  - $\alpha \in (0, 1)$: the *free-riding parameter*
- Timeline (*à la* Murto & Valimaki, 2013)
  - Stage 1: given that no one exited yet, i choose *exit region* $\mathcal{X}^i \subseteq \mathcal{X}$
    * if both intend to exit at the same time: flip a coin so that only one of them exits successfully (each w.p. $\frac{1}{2}$)
    * one player exits at Stage 1 and becomes the *first mover*
  - Stage 2: the *second mover* chooses *exit region* $\mathcal{X}^s \subseteq \mathcal{X}$

Model Result (2 Players)

- Stage 2: second mover's optimal exit threshold $x^* = \frac{r-\mu}{r}\frac{\gamma}{\gamma-1}\beta c$
- Stage 1: a canonical stopping game
  - before any player exits: flow payoff is $X_t - c$
  - the one who exits first gets $F(X_t)$, the remaining player gets $S(X_t)$
- Theorem 1: Pareto-undominated MPE (for Stage 1) is unique
  - Curse of productivity: ($\exists$ parameters) $V(X_t)$ is non-monotonic



Model Setup (N Players)

- Denote n_t as the number of players still contributing at time t
- Flow payoff if *Contribute* $= X_t - \beta_{n_t}c$
  - assumption: $\beta_1 \geq \beta_2 \geq ... \geq \beta_{N-1} \geq \beta_N$
- Flow payoff if *Defect* $= \alpha_{n_t}X_t$

Model Result (N Players)

- N-player cooperative outcome $\triangleq$ the outcome when N players jointly decide when to terminate the project (social optimal)
  - not necessarily an equilibrium: players may free-ride others
- Theorem 2: the group sizes that sustain a cooperative equilibrium are $\{n^{(1)}, n^{(2)}, ...\}$, where $n^{(0)} = 1$ and $n^{(k)} = \min\{n : \frac{\beta_{n^{(k-1)}}}{\beta_n} \geq \beta^*\}$
  - cooperation sustainability is non-monotonic in group size
  - example: when $\beta_n = \frac{N}{n}$ and $\beta^* = 2.2$, cooperation-sustaining group sizes are 3 ($=\lceil \beta^* \rceil$), 7 ($=\lceil 3 * \beta^* \rceil$), 16 ($=\lceil 7 * \beta^* \rceil$) ,...

Other Findings

1. Why some leaders (implicitly) commit not to exit before others?
   - Prop'n 1: Such a commitment may lead to Pareto improvement
     - intuition: gain from avoiding pre-emption $>$ loss from abandoning the option to exit first
2. How if partners' defections are reversible?
   - Prop'n 2: When returning to the partnership is costless, first-best outcome is achievable by a grim trigger strategy
     - consistent with repeated games wisdom: free-riding can be eliminated in teams that operate over time (McMillan, 1979)
     - irreversibility reintroduces the free-riding problem
3. How if players' inputs are homogeneous and substitutable?
   - Prop'n 3: Easier to sustain cooperation.

Related Literature

- Dynamic moral hazard in teams
  - Dynamic contribution games
- Stochastic stopping games
  - Real options games
- Voluntary partnerships
- Farsightedness in cooperative games