# Hybrid Contracting in Repeated Interactions

joint with B. Ganglmair & D. Shin

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# From Relational to Formal Contracting

*An alliance is a lot like a marriage. There are few rigidly binding provisions. It is a loose, evolving kind of relationship. [...] Both partners bring to an alliance a faith that they will be stronger together than either would be separately.*

Kenichi Ohmae, Harvard Business Review

- Strategic interactions frequently governed by formal contracts
  ⇒ Focus on firm-firm interactions: e.g. joint ventures
- Relational dynamics play crucial role in alliances and contract formation

⇒ Hybrid Contracts: Complementation of formal and relational contracting

- Specific form of hybrid contracting in practice: *Smooth Landing Contracts* (SLCs)
  - Start interaction with only loose contractual framework
  - Contract becomes (more) binding over time

# A (Finitely) Repeated Work-Effort Model

- Finitely repeated static stage game ($T + 1$ periods)
- Payoff from work-effort model (with moral/reputational cost of free riding)

| | | Player 2 | | |
|---|---|---|---|---|
| | | $s$ (shirk) | $l$ (loaf) | $w$ (work) |
| Player 1 | $s$ (shirk) | $\begin{pmatrix} 0 \\ 0 \end{pmatrix}$ | $\begin{pmatrix} \tilde{e}\pi - m \\ \tilde{e}\,(1/2 - \pi) \end{pmatrix}$ | $\begin{pmatrix} 2\pi - m \\ 1 - 2\pi \end{pmatrix}$ |
| | $l$ (loaf) | $\begin{pmatrix} \tilde{e}\,(1/2 - \pi) \\ \tilde{e}\pi - m \end{pmatrix}$ | $\begin{pmatrix} \tilde{e}/2 \\ \tilde{e}/2 \end{pmatrix}$ | $\begin{pmatrix} 1/2 + \tilde{e}\pi - m \\ 1 - (2 + \tilde{e})\,\pi \end{pmatrix}$ |
| | $w$ (work) | $\begin{pmatrix} 1 - 2\pi \\ 2\pi - m \end{pmatrix}$ | $\begin{pmatrix} 1 - (2 - \tilde{e})\,\pi \\ 1/2 + \tilde{e}\pi - m \end{pmatrix}$ | $\begin{pmatrix} 1 \\ 1 \end{pmatrix}$ |

$e \in \{0, \tilde{e}, 2\}$ effort level | $\pi$ payoff of effort | $c$ cost of effort | $m$ free-riding cost | $\delta$ discount factor

# A (Finitely) Repeated Work-Effort Model

- Finitely repeated static stage game ($T + 1$ periods)
- Payoff from work-effort model (with moral/reputational cost of free riding)

| | | **Player 2** | | |
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| | | $s$ (shirk) | $l$ (loaf) | $w$ (work) |
| **Player 1** | $s$ (shirk) | $\begin{pmatrix} 0 \\ 0 \end{pmatrix}$ | $\begin{pmatrix} \tilde{e}\pi - m \\ \tilde{e}\,(1/2 - \pi) \end{pmatrix}$ | $\begin{pmatrix} \pi^D \\ 1 - 2\pi \end{pmatrix}$ |
| | $l$ (loaf) | $\begin{pmatrix} \tilde{e}\,(1/2 - \pi) \\ \tilde{e}\pi - m \end{pmatrix}$ | $\begin{pmatrix} \pi^L \\ \pi^L \end{pmatrix}$ | $\begin{pmatrix} 1/2 + \tilde{e}\pi - m \\ 1 - (2 + \tilde{e})\,\pi \end{pmatrix}$ |
| | $w$ (work) | $\begin{pmatrix} 1 - 2\pi \\ \pi^D \end{pmatrix}$ | $\begin{pmatrix} 1 - (2 - \tilde{e})\,\pi \\ 1/2 + \tilde{e}\pi - m \end{pmatrix}$ | $\begin{pmatrix} 1 \\ 1 \end{pmatrix}$ |

$e \in \{0, \tilde{e}, 2\}$ effort level | $\pi$ payoff of effort | $c$ cost of effort | $m$ free-riding cost | $\delta$ discount factor

# ...and a Numerical Specification

- Example parametrization satisfying the paper's assumptions

| | | Player 2 | | |
|---|---|---|---|---|
| | | $s$ (shirk) | $l$ (loaf) | $w$ (work) |
| Player 1 | $s$ (shirk) | $\begin{pmatrix} 0 \\ 0 \end{pmatrix}$ | $\begin{pmatrix} -0.5 \\ -0.8 \end{pmatrix}$ | $\begin{pmatrix} 1.3 \\ -2 \end{pmatrix}$ |
| | $l$ (loaf) | $\begin{pmatrix} -0.8 \\ -0.5 \end{pmatrix}$ | $\begin{pmatrix} 0.4 \\ 0.4 \end{pmatrix}$ | $\begin{pmatrix} 0 \\ -0.8 \end{pmatrix}$ |
| | $w$ (work) | $\begin{pmatrix} -2 \\ 1.3 \end{pmatrix}$ | $\begin{pmatrix} -0.8 \\ 0 \end{pmatrix}$ | $\begin{pmatrix} 1 \\ 1 \end{pmatrix}$ |

- Standard discounted utility: $\Pi_i = \sum \delta^t \pi_{i,t} = \sum \delta^t \pi_i(a_{i,t}, a_{j,t})$

# Cooperative & Non-Cooperative Equilibria

- Non-cooperation: play NE each stage ($a_{i,t} = I$ payoff-dominant)
  $\Rightarrow$ equilibrium outcome: $(I, I), \ldots, (I, I)$
- (Partial) cooperation: play grim trigger with Nash-Reversion

$$a_{i,t}^{BL} = \begin{cases} s & \text{if } \exists \tau < t : a_{j,\tau} \neq w \\ I & \text{if } t = T \wedge \forall \tau < t : a_{j,\tau} = w \\ w & \text{otherwise} \end{cases}$$

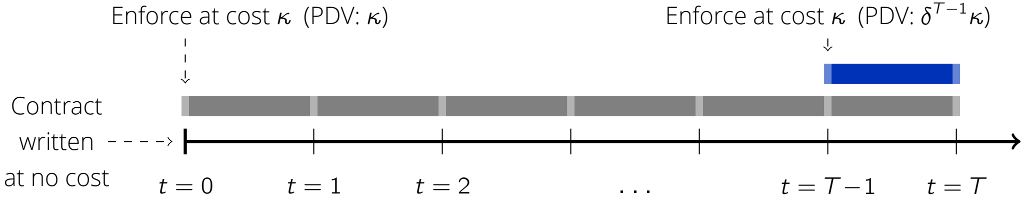
$\Rightarrow$ equilibrium outcome: $\overbrace{(w, w), \ldots, (w, w)}^{\text{Periods } 0 \ldots T-1}, (I, I)$

## Existence of the Baseline Equilibria

A non-cooperative equilibrium with $a_{i,t}^{*} = I$ exists for all $\delta \in [0, 1]$
A cooperative equilibrium with $a_{i,t}^{*} = a_{i,t}^{BL}$ exists for all $\delta > \frac{\pi^D - 1}{\pi^L} =: \bar{\delta}^{BL}$

# Introducing Formal Contracts

- Players can write contract $C$ in $t = 0$ : $C = (C_1, C_2)$ with $C_i(h) \subset A_i$
  - ⇒ Actions are verifiable: No hidden action problem
  - ⇒ Commitment device: $a_{i,t(h)} \in C_i(h)$ ⇒ has to be optimal *ex-ante*)
- No explicit modelling of contract negotiation
  - ⇒ Symmetrical bargaining power ⇒ symmetrical contracts
- Incur cost $\kappa$ **once** when contract comes into effect
  - ⇒ Independent of contract length, contingencies, amount of committed actions
  - ⇒ No intrinsic advantage of short or incomplete contracts



# Benchmark: Full Commitment Contract

- Commit to complete cooperation ex-ante

  ⇒ Contract prescribing $\tilde{A}_i = \{w\}$ every period

- Results in full cooperation: $(w, w), \dots, (w, w), (w, w)$

## Implementability & Profitability of Full Commitment

Implementability: Full commitment implementable for all $\delta \in [0, 1]$

Profitability: preferable to cooperative baseline if $\kappa < \delta^T(1 - \pi^L)$

preferable to non-cooperative baseline if $\kappa < \frac{1-\delta^{T+1}}{1-\delta}(1 - \pi^L)$

- Implementation cost $\kappa$ paid in period $t = 0$

  ⇒ Complete in the temporal dimension

# Shortening Full Commitment (Unsuccessfully)

- Commit to cooperation for limited time (**Abridged Commitment**)

  ⇒ Contract prescribing $\tilde{A}_i = \{w\}$ for last $\tau$ periods

- Partitioning the game: $\underbrace{(w,w),\ldots,(w,w),(l,l)}_{\text{Baseline Eq. for } 0\ldots T-\tau}, \underbrace{(w,w),\ldots,(w,w)}_{\text{Periods } T-\tau+1\ldots T}$

- Implementation cost $\kappa$ paid in period $t = T - \tau + 1$

  ⇒ Incomplete in the temporal dimension

**Suboptimality of Abridged Commitment**

An abridged commitment contract is strictly dominated by contracts prescribing full commitment or the baseline for any $\delta \in [0, 1]$.

- Unable to preserve incentives between contracting and pre-contracting stages

# A Simple Smooth Landing Contract

- Avoid crowding out: combine relational and formal contracting
  $\Rightarrow$ shifting rather than
- Reduce incentives for (late) deviation: prohibit $s$ in the last period
  $\Rightarrow$ creates new stage game in $t = T$

| | | **Player 2** | |
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| | $w$ (work) | $\begin{pmatrix} -0.8 \\ 0 \end{pmatrix}$ | $\begin{pmatrix} 1 \\ 1 \end{pmatrix}$ |

- Modify grim trigger (reward **always** with $w$, punish with $l$ in $t = T$)

# A Simple Smooth Landing Contract

- Modified grim trigger also generates full cooperation: $(w, w), \ldots, (w, w), (w, w)$

## Implementability & Profitability of SLC

Implementability: implementable for $\delta > \frac{\pi^D - 1}{1 - \pi^L} =: \bar{\delta}^{SLC}$

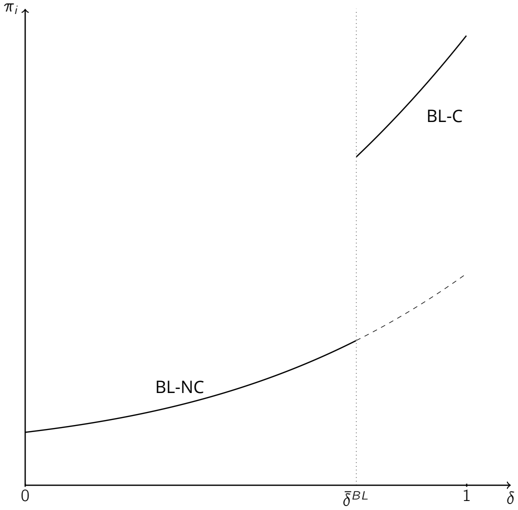
Profitability: preferable to cooperative baseline if $\kappa < 1 - \pi^L$

preferable to non-cooperative baseline if $\kappa < \frac{1 - \delta^{T+1}}{(1-\delta)\delta^T}(1 - \pi^L)$

- Same outcome as full commitment contract (when implementable)
- Lower cost-thresholds due to cost timing ($t = T$ instead of $t = 0$)

$\Rightarrow$ Incomplete in the temporal dimension

# When Are Smooth Landing Contracts Optimal?



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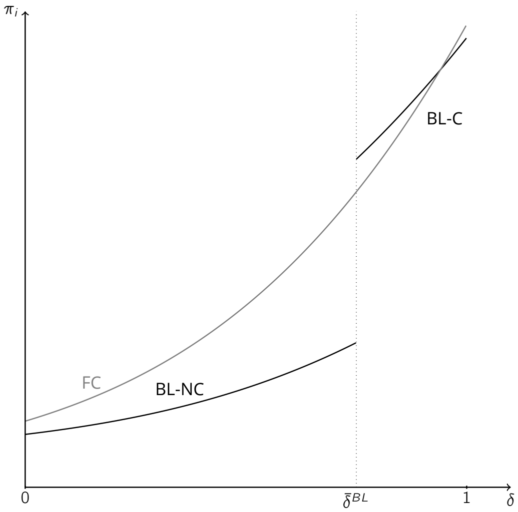


Full Commitment Contract

- Forces full cooperation

$\Rightarrow$ relatively high cost ($\kappa$ in $t = 0$)

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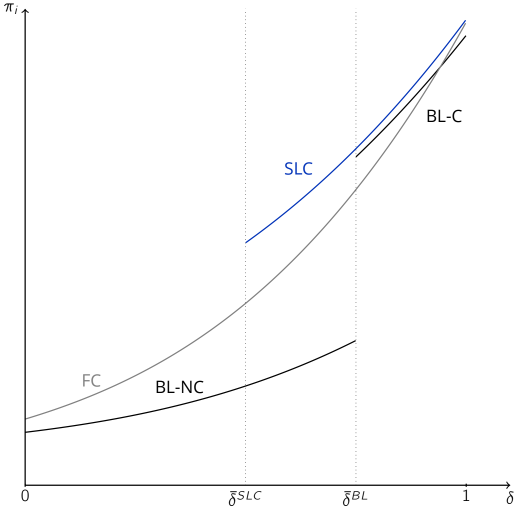



Full Commitment Contract

- Forces full cooperation

⇒ relatively high cost ($\kappa$ in $t = 0$)

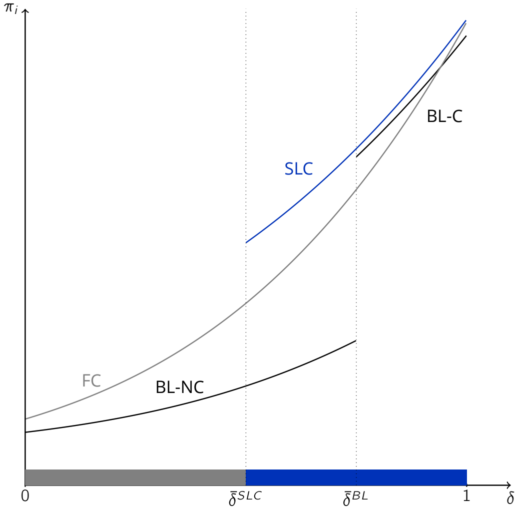
Smooth Landing Contract

- Complement relational contracting
- Preserve cooperation incentives

⇒ less costly (discounting $\kappa$ in $t = T$)

⇒ not always implementable

# When Are Smooth Landing Contracts Optimal?

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Smooth Landing Contract

- Complement relational contracting
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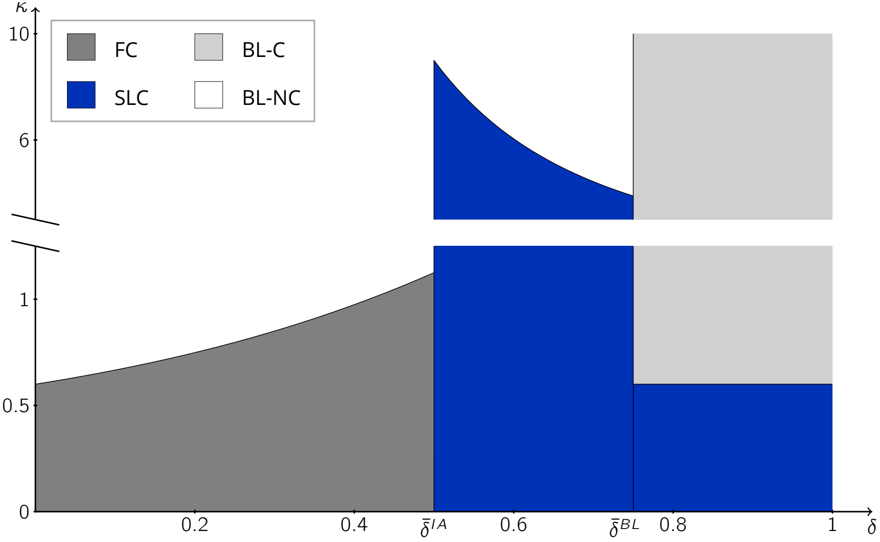
$\Rightarrow$ not always implementable

**Optimality of SLCs**

If the SLC is implementable and profitable, it is also optimal.

# When Are Smooth Landing Contracts Optimal?



# Generalizing the Model Framework

## Multi-Period Contracts

- SLCs effective from $\tau \leq T$

  $\Rightarrow$ trade-off cost $\leftrightarrow$ implementation

## Sophisticated SLCs

- SLCs contingent on prior actions

  $\Rightarrow$ improve implementability

## Generalized Contracting Costs

- Additional drafting costs

  $\Rightarrow$ no qualitative changes

## Endogenous Timing

- Contracting before any period

  $\Rightarrow$ all profitable SLCs in $t = 0$

# Multi-Period Contracts

- Extend SLC: prohibit $s$ in the last $\tau$ periods
  $\Rightarrow$ Same reduced stage game & same modified grim trigger strategy
- Induces full cooperation $\underbrace{(w,w),\dots,(w,w)}_{\text{Periods } 0\dots T-\tau},\underbrace{(w,w),\dots,(w,w)}_{\text{Periods } T-\tau+1\dots T}$

## Implementability & Profitability of Multi-Period SLCs

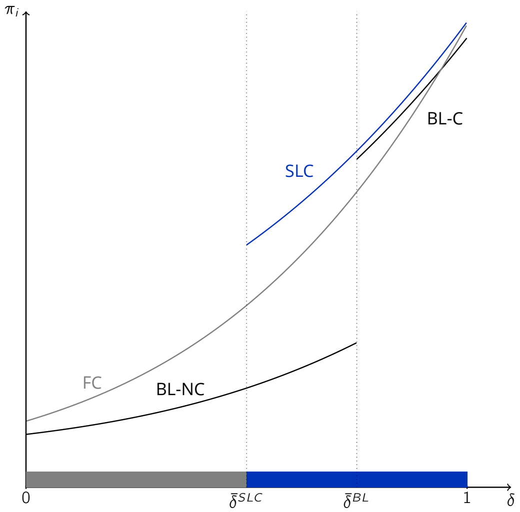
Implementability: implementable for $\delta > \bar{\delta}^{SLC}(\tau)$

Profitability: preferable to cooperative baseline if $\kappa < \delta^{\tau-1}(1-\pi^L)$

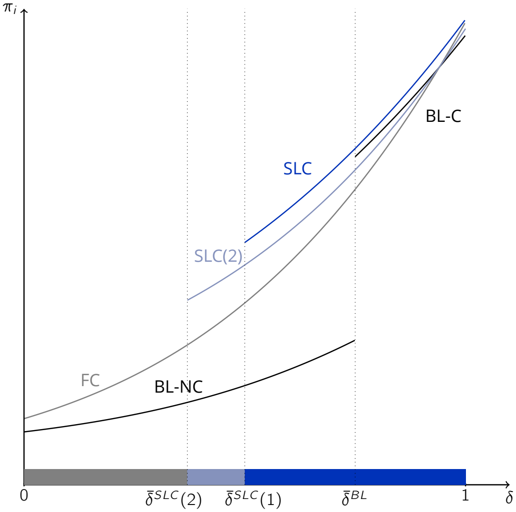
preferable to non-cooperative baseline if $\kappa < \frac{1-\delta^{T+1}}{(1-\delta)\delta^{T+\tau-1}}(1-\pi^L)$

- Payoff decreasing in $\tau$: Cost (paid in $t = T - \tau + 1$) increases with $\tau$
- Implementability threshold $\bar{\delta}^{SLC}(\tau)$ decreasing in $\tau$
  $\Rightarrow$ trade-off payoff $\leftrightarrow$ implementability

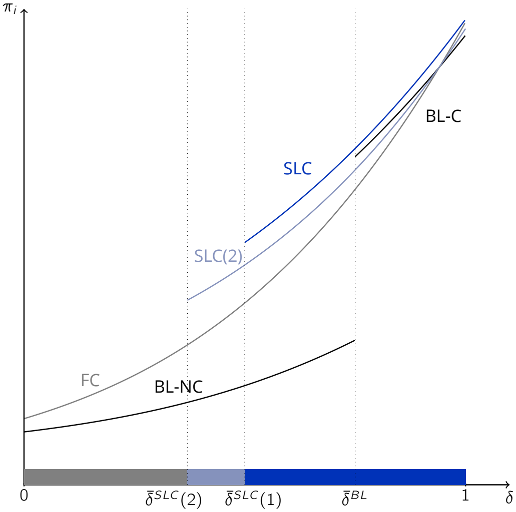
# Optimality with Multi-Period Contracts

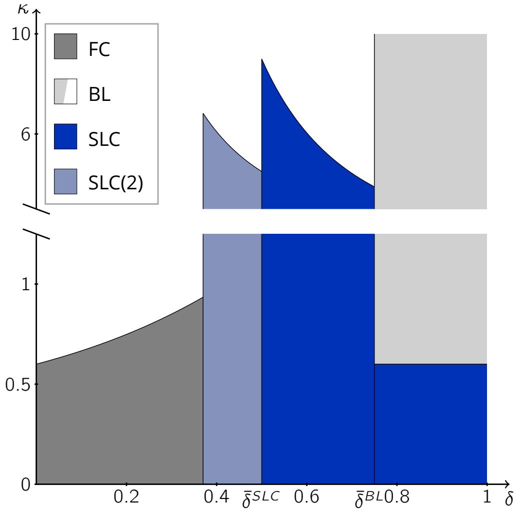


# Optimality with Multi-Period Contracts



# Optimality with Multi-Period Contracts



# Extensions

## Sophisticated SLC*

- SLCs contingent on prior actions

⇒ optimize punishment of SLCs

⇒ better implementable, same cost

## Generalized Contracting Costs

- Additional drafting costs $\kappa_d$

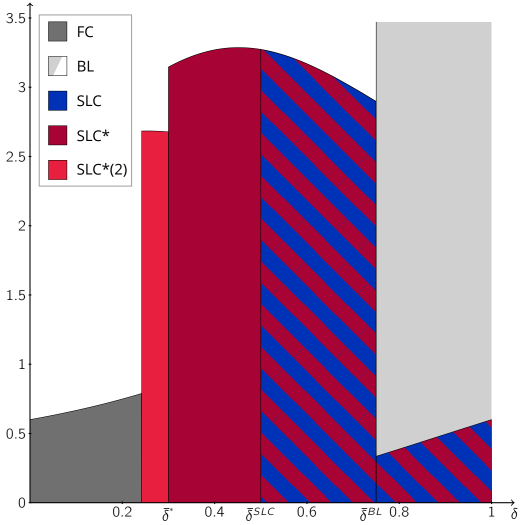
$$\kappa = \kappa_d + \delta^\tau \kappa_i$$

⇒ qualitatively unchanged

## Endogenous Contracting Timing

- Contracting before any period

⇒ all profitable SLCs in $t = 0$



# Conclusion

- SLCs can generate and extend cooperation
  - Intensive margin: Additional periods of cooperation
  - Extensive margin: Cooperation in new parameter regions
- Within considered contracts (e.g. symmetric) SLCs are optimal

## Takeaways for Hybrid Contracting in Strategic Alliances

- Contracting to counteract end-of-game dynamics (unravelling)
- Use formal contracts to complement (not replace) relational incentives
- Effective contracting requires long-term optimization

# Thank you for your attention!

Please contact me via mail if you have questions or suggestions or want to receive upcoming versions of this paper.

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