

Participation and Duration of Climate Contracts

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Climate Negotiations

- **The Kyoto Protocol (first commitment period):**
 - 35 countries
 - 5% average emission reduction (from 1990-levels)
 - 5y: 2008-2012
- **Durban Dec' 2011:**
 - EU promised to continue its commitments, if
 - Other countries specify targets by 2015 for 2020
 - Quantities and duration TBA
- **Investments in new technology:**
 - Importance of technology transfer/develop recognized..
 - "technology needs must be nationally determined, based on national circumstances and priorities" (§ 114 in the Cancun Agreement, confirmed in Durban)

Relationships

5%

Emissions

35 Participation

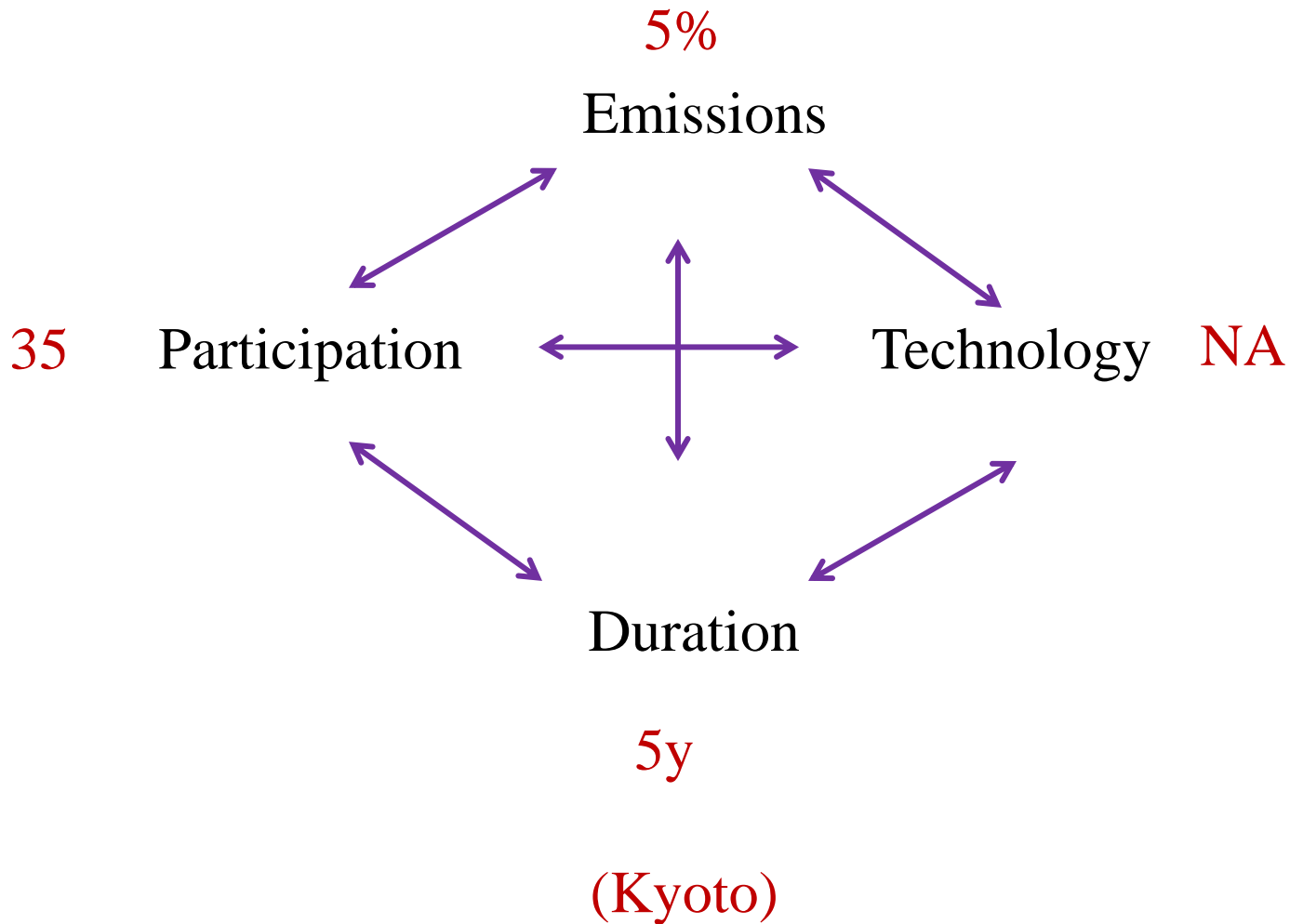
Technology NA

Duration

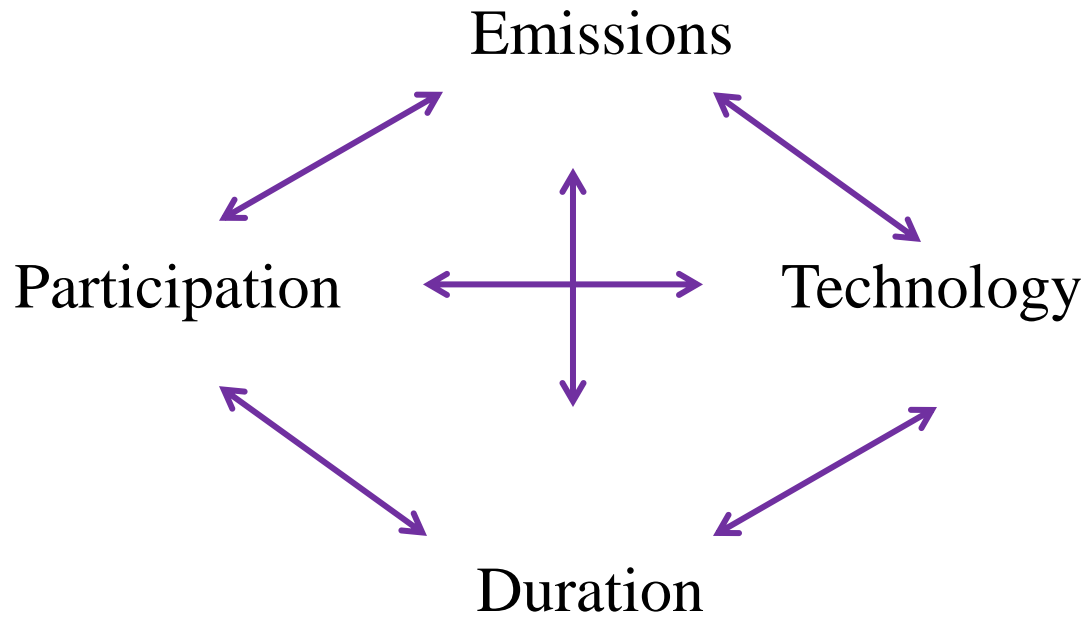
5y

(Kyoto)

Relationships



Relationships



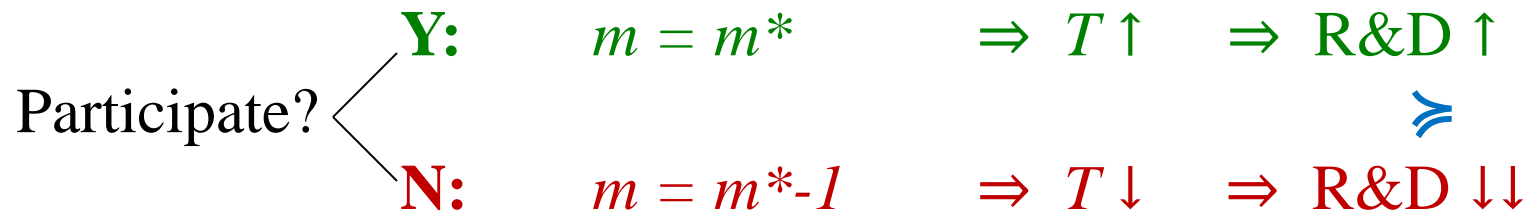
Questions – and Previous Answers

1. Is there a trade-off between width, depth, and length?
YES ☹ (Barrett, Finus and Maus, Carraro, trade-literature)
2. Is the equilibrium coalition necessarily small?
YES ☹ (Barrett, Carraro-Siniscalco, Hoel, Goeschl-Peroni)
3. Should one attempt to contract also on R&D?
YES! (Buchholtz-Konrad, Beccherle-Tirole, Harstad)
4. Is a long-term agreement better than a short-term one?
YES! (Harstad 2011-2012). **NO!** (Karp and Zhao 2010)

Questions – and **our** Previous Answers

1. Is there a trade-off between width, depth, and length?
YES 😞 (Barrett, Finus and Maus, Carraro, trade-literature)
NO 😊
2. Is the equilibrium coalition necessarily small?
YES 😞 (Barrett, Carraro-Siniscalco, Hoel, Dixit-Olson)
NO 😊
3. Should one attempt to contract also on R&D?
YES! (Buchholtz-Konrad, Beccherle-Tirole, Harstad)
NO!!
4. Is a long-term agreement better than a short-term one?
YES! (Harstad 2011-2012). **NO!** (Karp and Zhao 2010)
NEITHER!

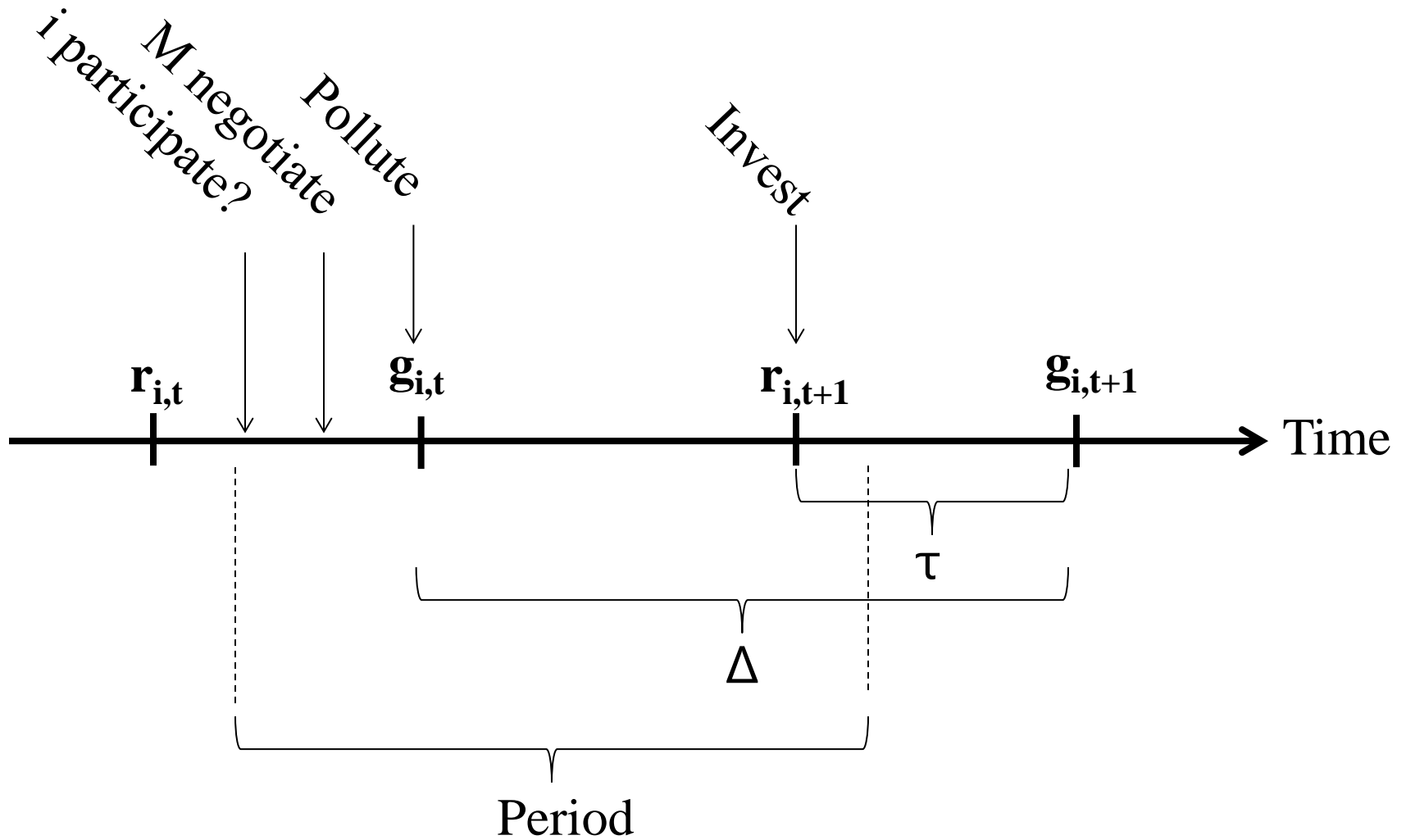
Intuition



Reasoning requires:

- T to be endogenous
- R&D to be non-contractible

Model: Timing



Model: Simplifying assumptions (relaxed in paper)

1. Pollution is flow (stock depreciates after a period)
2. Technology depreciates after a period
3. Parameters are time-invariant
4. Countries are symmetric
5. Permits are non-tradable

Model: Equations

A linear-quadratic model:

Benefit $B(y_{i,t}) = -\frac{b}{2}(\bar{y} - y_{i,t})^2, i \in N = \{1, \dots, n\}$

Emission $g_{i,t} = y_{i,t} - r_{i,t}$

Utility $u_{i,t} = B(y_{i,t}) - C \sum_{i \in N} g_{i,t} - \delta \frac{k}{2} r_{i,t+1}^2$

$$\delta \equiv e^{-\rho\Delta}$$

$$k \equiv e^{\rho\tau} \bar{k} \Rightarrow \delta k = e^{-\rho(\Delta-\tau)}$$

Preliminaries

Preferences rewritten. If:

$$d_{i,t} \equiv \bar{y} - y_{i,t} \Leftrightarrow g_{i,t} = \bar{y} - d_{i,t} - r_{i,t}$$

$$v_{i,1} \equiv \sum_{t=1}^{\infty} \delta^{t-1} \hat{u}_{i,t}, \text{ where}$$

$$\hat{u}_{i,t} = -\frac{b}{2} d_{i,t}^2 - C \sum_{j \in N} (\bar{y} - d_{j,t} - \delta r_{j,t+1}) - \delta \frac{k}{2} r_{i,t+1}^2$$

So, **no** past action is «payoff relevant»

... **except** whether commitments have been made...

=> Simple to use **Markov-perfect equilibria**

First Best

Concave & symmetric welfare f .

$$r_{i,t} = n \frac{C}{k}$$

$$d_{i,t} = n \frac{C}{b} \Leftrightarrow$$

$$g_{i,t} = \bar{y} - n \frac{C}{k} - n \frac{C}{b}$$

$$\frac{d_{i,t}}{r_{i,t}} = \frac{k}{b} \equiv x$$

Business as Usual

If nothing is contractible

$$r_{i,t} = \frac{C}{k}$$

$$d_{i,t} = \frac{C}{b} \Leftrightarrow$$

$$g_{i,t} = \bar{y} - \frac{C}{k} - \frac{C}{b}$$

$$\frac{d_{i,t}}{r_{i,t}} = \frac{k}{b} \equiv x$$

Nonparticipants always act this way

Complete Contracts

Depth: *for a given m and T ...*

$$r_{i,t} = m \frac{C}{k}$$

$$d_{i,t} = m \frac{C}{b} \Rightarrow$$

$$g_{i,t} = \bar{y} - m \frac{C}{k} - m \frac{C}{b}$$

$$\frac{d_{i,t}}{r_{i,t}} = \frac{k}{b} \equiv x$$

Length: $T(m) = \infty$ if $m > m^*$

$T(m) = 1$ if $m < m^*$

Width: $m^* = \{2,3\}$

Incomplete Contracts

$$r_{i,t} = \frac{b(\bar{y} - g_{i,t})}{b+k}, t \leq T, r_{i,T+1} = \frac{C}{k}$$

$$g_{i,t} = \bar{y} - m \frac{C}{k} - m \frac{C}{b} \Rightarrow$$

$$r_{i,t} = m \frac{C}{k} > r_{i,T+1} = \frac{C}{k} \Rightarrow$$

$$d_{i,t} = m \frac{C}{b}$$

$$\frac{d_{i,t}}{r_{i,t}} = \frac{k}{b} \equiv x$$

$T(m) = \infty$ if $m \geq \hat{m} < m^*$

$T(m) = 1$ if $m \leq \hat{m} < m^*$

Larger; $m^*=n$ possible

Intuition

Participate? $m = m^* \Rightarrow T = \infty \Rightarrow r = m(C/k)$

\Rightarrow **IFF** $m^* \leq \bar{m}_I \equiv \begin{cases} 3 + \frac{2\delta}{x-\delta} \text{ if } x > \delta \\ \infty \text{ if } x \leq \delta \end{cases}$

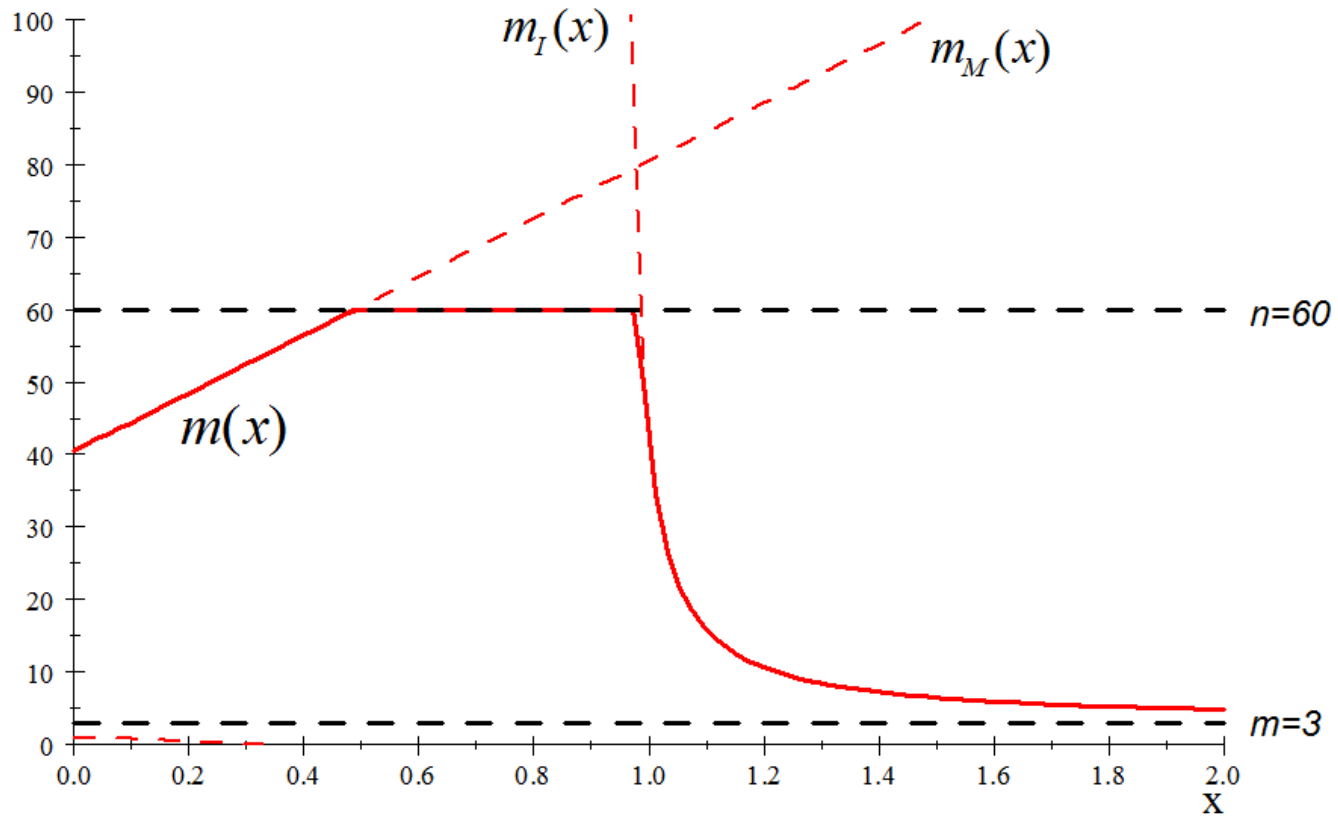
Deviate? $m = m^*-1 \Rightarrow T = 1 \Rightarrow r = C/k$

IFF $m^* - 1 \leq \hat{m} \Leftrightarrow m^* \leq \bar{m}_M$, where

$$\bar{m}_M \equiv 1 + \frac{1}{1 - \sqrt{\frac{x+\delta}{x+1}}}.$$

Proposition: m^* is an equilibrium iff:

$m^* \leq \min\{\bar{m}_I, \bar{m}_M, n\} = n \rightarrow$ **FB** iff $\delta \uparrow$ and x moderate



The key variable is: $x=k/b$

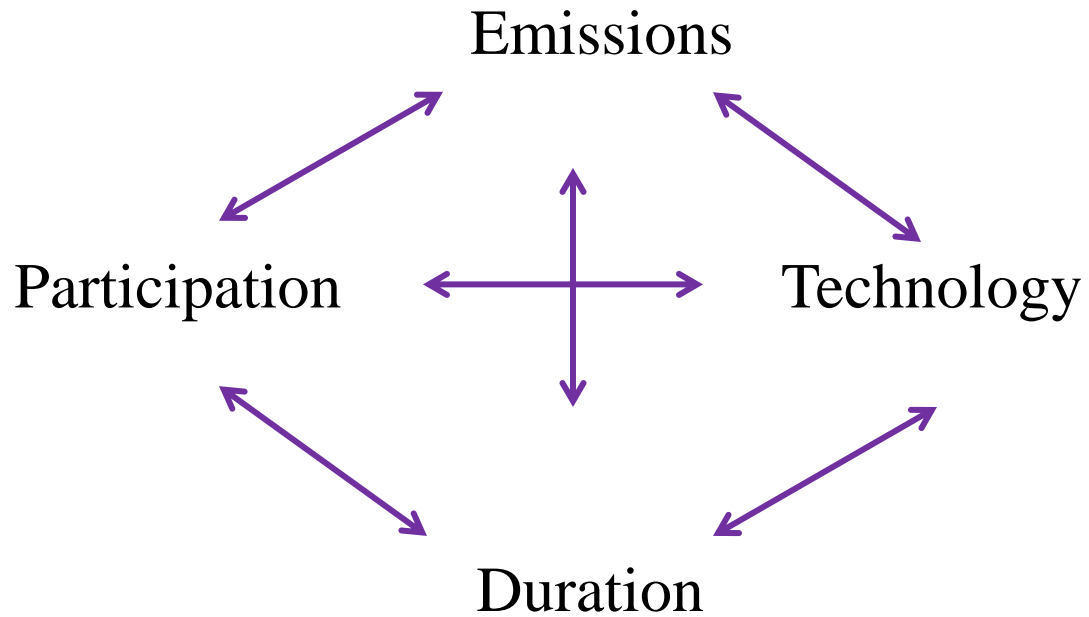
Bottom line

The hold-up problem is beneficial and a credible out-of-equilibrium threat, materialized if a participant deviates, investments are noncontractible, and T is endogenous

Assumptions we relax (in paper)

1. Pollution is flow (stock depreciates after a period)
2. Technology depreciates after a period
3. Parameters are time-invariant
4. Countries are symmetric
5. Permits are non-tradable

Relationships



Questions – and **our** answers

1. Is there a trade-off between width, depth, and length?
NO 😊 They are positively correlated in equilibrium
2. Is the equilibrium coalition necessarily small?
NO 😊 The coalition can be arbitrarily large
3. Should one attempt to contract also on R&D?
NO! Coalition large if R&D is noncontractible
4. Is a long-term agreement better than a short-term one?
NEITHER! Duration should be endogenously negotiated
Then: length \uparrow IFF width \uparrow