Bottom-Up Formation & Stabilisation of a Grand International Climate Coalition under Rationality

Jobst Heitzig, Potsdam Institute for Climate Impact Research (PIK), Transdisciplinary Concepts & Methods,   heitzig@pik-potsdam.de
Ulrike Kornek, Mercator Research Institute on Global Commons and Climate Change; **Kai Lessmann,** PIK

Summary

- Observed: shift from Kyoto top-down agreement to Durban bottom-up process of pledges, but slow progress and large uncertainties (Lima)
- Economic models had predicted global climate protection "coalition" likely "unstable" due to several obstacles for achieving high levels of cooperation (e.g. Barrett 2005)
- Formal analyses of strategic interactions often neglect the time-evolving ("dynamic") process inherent in negotiations
- Here: **Dynamic model** of bottom-up coalition formation *(Fig. 3)* under usual assumption of rationality **gives much more optimistic results!**

Findings   (similar for most parameter choices and payoff models)

- Typically **more than one consistent scenario** (= assignment of probabilities to transitions)
  - a "focal", more symmetric scenario *(Fig. 1c)*
  - several asymmetric scenarios (with one player being advantaged, *Fig. 1ab*)
- A stable grand (global) coalition always forms after several steps
- Closed-membership coalitions, once formed, will not be terminated later (although allowed unilaterally)
- Several **competing pathways** to global cooperation, differing in
  - no. of steps needed
  - allocation of mitigation costs (players joining later have a bargaining advantage)
- Path uncertainty largest in **early steps** with **medium farsighted** players, where
  - both *highly vulnerable and "reluctant" nations* (with low mitigation potential) *delay cooperation* (chicken-game-like, *Fig. 2b players AB*)
  - both *little vulnerable and "eager" nations* (with high mitigation potential, *Fig. 2b players CD*) *compete for forming a coalition* with many reluctant players and few other eager players
- Surprisingly, strategic interactions do *not* lead to a stalemate without progress (which would not form a consistent set of rational expectations)

(a) scenario best for player A   **(b) scenario best for player B**   **(c) scenario best for player C**
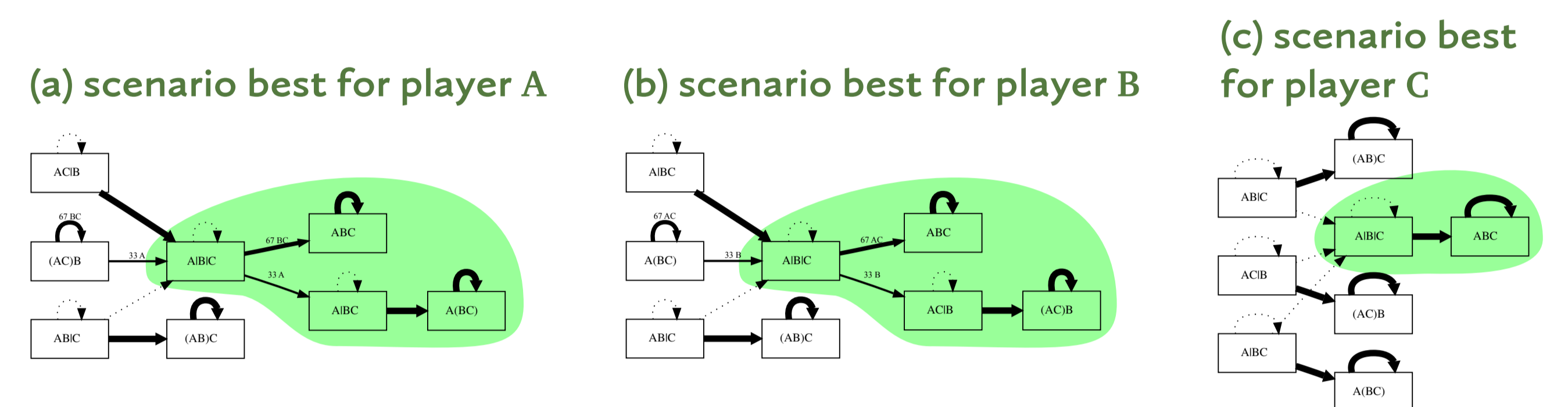
Fig. 1: Different consistent scenarios of coalition formation process between three medium farsighted players (A=USA, B=Europe, C=China, payoff estimates from MICA [5]), starting with no cooperation (box A|B|C) and producing grand coalitions (right end boxes) with different probabilities (arrow labels).
(a) If all believe that USA may try to delay cooperation to improve their bargaining position, this indeed gets a positive probability, leading to an intermediate coalition structure A|BC and then to the "nested" grand coalition A(BC). (b) Analogous for Europe. (c) If all players believe China will not agree to a non-grand coalition, it is rational for them to not try to delay cooperation.
Only these three potential scenarios form consistent sets of common expectations in this numeric example.

(a) myopic players   **(b) medium farsighted players**   **(c) very farsighted players**

final **stable grand coalition** (ACD)B = B signs an agreement with existing coalition ACD

with certainty

intermediate state ACD|B = all but B form a first coalition

with some probability

initial state A|B|C|D = no cooperation

one of several possible pathways (25% probability)

Fig. 2: Influence of farsightedness on coalition formation
between four players (A,B,C as in Fig.1, D=India, MICA payoffs [5]).
(a) Myopic players will form the grand coalition immediately.
(b) Medium farsighted players (discounting later payoffs at factor 0.7 per step) may need two steps, allowing USA or Europe to delay cooperation.
(c) Very farsighted players (discount factor 0.95) are patient enough to even terminate any "asymmetric" coalition to reach the "symmetric" grand coalition (box ABCD).

Model Details

- Dynamic, stochastic, game-theoretic, similar to [1–3]
- **Process** of international coalition formation under rationality
- Over time, nations can *form, grow, merge, shrink, split, or terminate* coalitions
  - existing coalitions assumed to ensure compliance internally (e.g. via [4])
- In proportion to *bargaining power*, players propose changes in coalition structure
  - Proposals will be accepted if *profitable* and *undominated* by another change (see figure)
- Players may *farsightedly* anticipate and discount later states to some degree
  - *Uncertainty* about proposals leads to unresolvable uncertainty about realised "pathway"
- Result: consistent scenario of different **branching pathways and their probabilities**
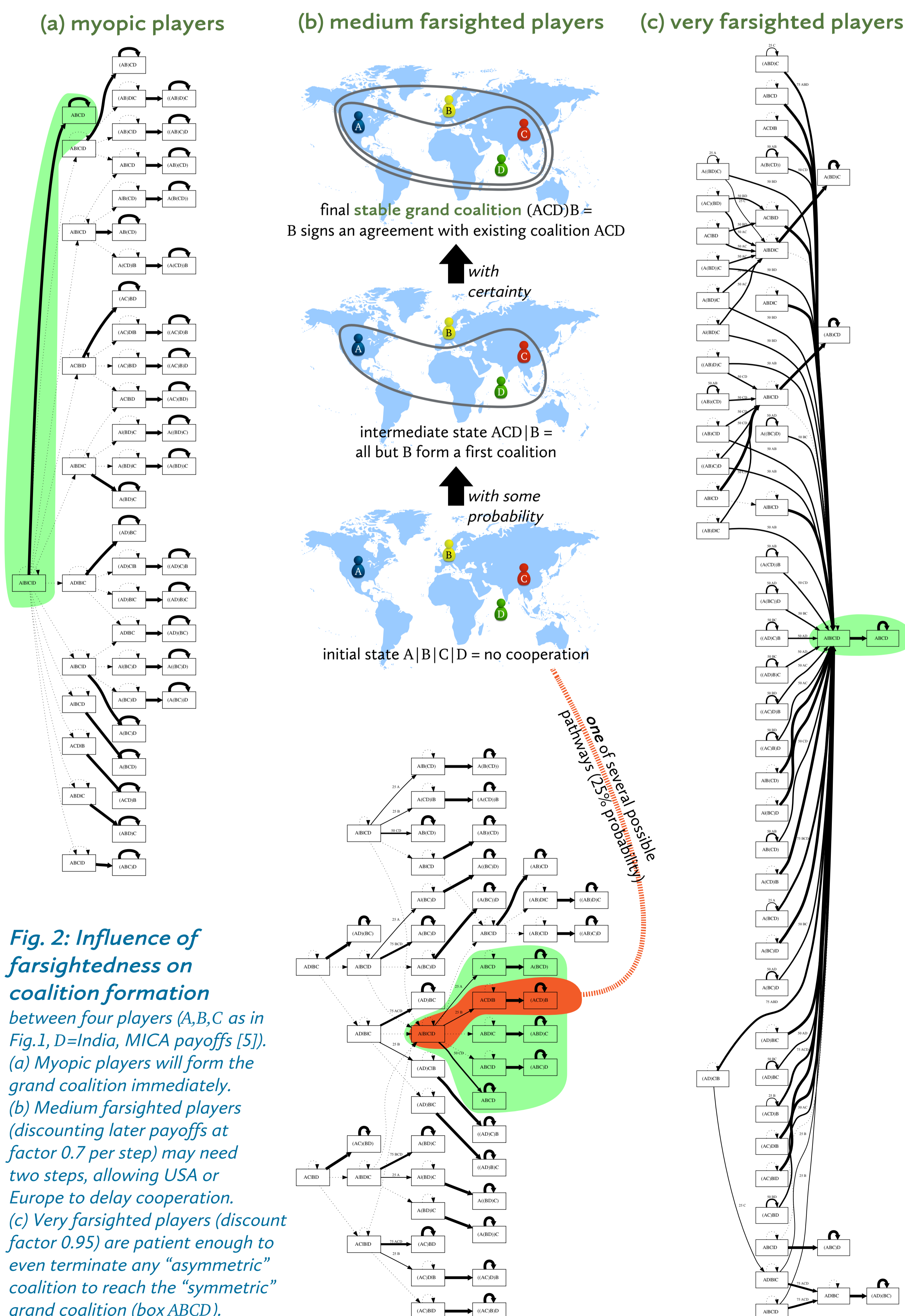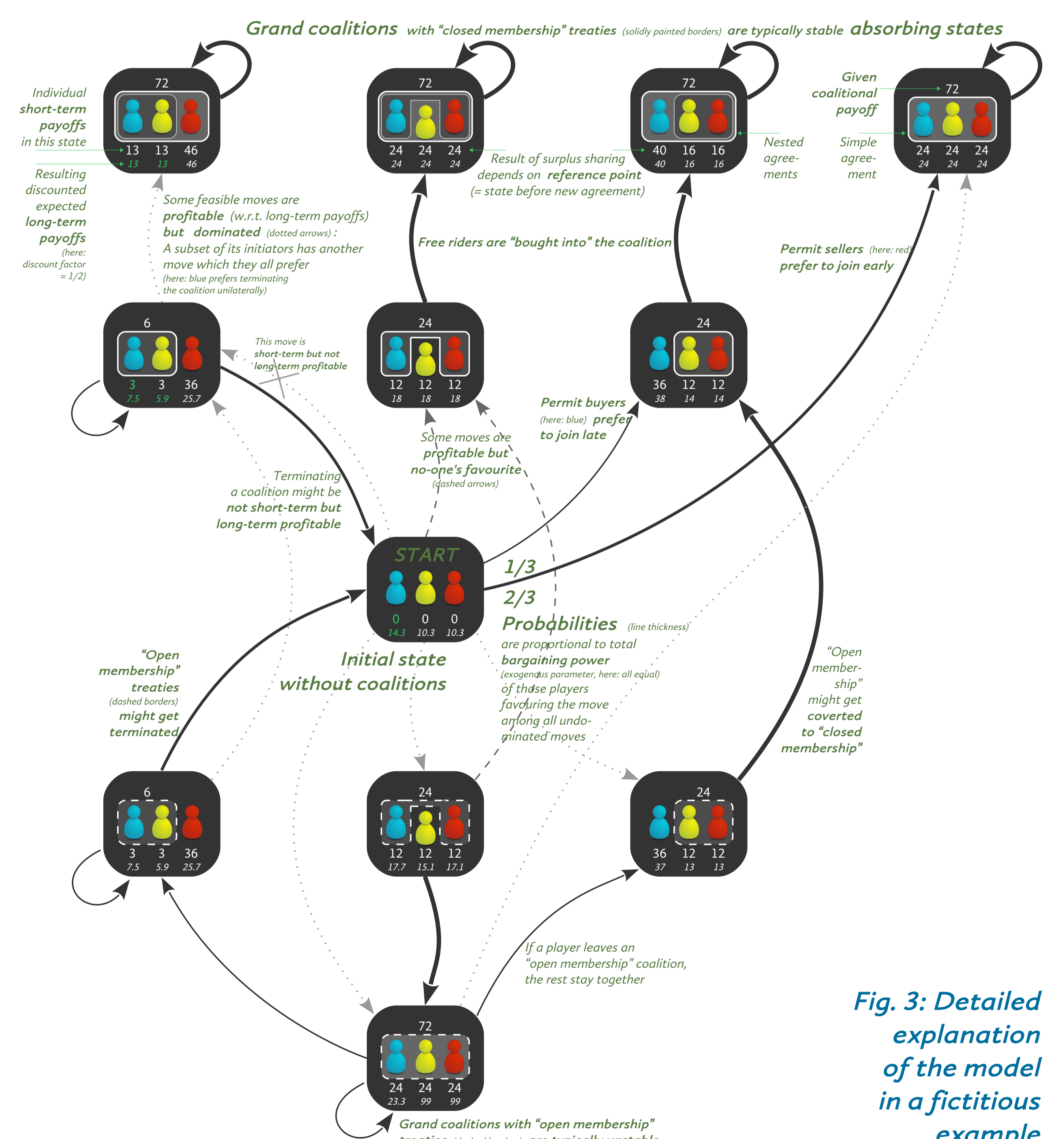- Different scenarios represent different consistent common expectations about process

Fig. 3: Detailed explanation of the model in a fictitious example

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[2] Hyndman K, Ray D (2007) Coalition formation with binding agreements. *Rev Econ Studies* 74 (4), 1125–47
[3] Heitzig J (2011) Efficiency in face of externalities when binding hierarchical agreements are possible. *Game Theory & Bargaining Theory eJournal* 3 (40), 1–16
[4] Heitzig J, Lessmann K, Zou Y (2011) Self-enforcing strategies to deter free-riding in the climate change mitigation game and other repeated public good games. *PNAS* 108 (38), 15739–15744
[5] Lessmann Kai, Kornek U et al. (2014) The Stability and Effectiveness of Climate Coalitions. *Environmental and Resource Economics*, 1-26

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