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Cooperative and Non-Cooperative Game Theory

Olivier Chatain

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Author: Olivier Chatain

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Definition: Cooperative game theory focuses on how much players can appropriate given the *value* each coalition of player can create, while non-cooperative game theory focuses on which moves players should rationally make.

 Abstract:

This article outlines the differences between cooperative and non-cooperative game theory. It introduces some of the main concepts of cooperative game theory as they apply to strategic management research.

Keywords:

cooperative game theory

coalitional game theory

value-based strategy

core (solution concept)

Shapley value; biform games

Cooperative and non-cooperative game theory

Game theory comprises two branches: cooperative game theory (CGT) and non-cooperative game theory (NCGT). CGT models how agents compete and cooperate as coalitions in unstructured interactions to create and capture value. NCGT models the actions of agents, maximizing their utility in a defined procedure, relying on a detailed description of the moves

and information available to each agent. CGT abstracts from these details and focuses on how the value creation abilities of each coalition of agents can bear on the agents' ability to capture value. CGT can be thus called *coalitional*, while NCGT is *procedural*. Note that 'cooperative' and 'non-cooperative' are technical terms and are not an assessment of the degree of cooperation among agents in the model: a cooperative game can as much model extreme competition as a non-cooperative game can model cooperation.

CGT analyses situations where agents can cooperate to create value by joining coalitions, but also where agents compete to capture value. Its formalism comprises a set of agents and a function that returns the value each subset of agent (i.e., each *coalition*) can create on its own (the *characteristic function*). The characteristic function is the input to a *solution concept*, which returns the value captured by each agent (their *imputation*).

Because no structure is put on the bargaining procedure, the solution concept models the outcome of the negotiations occurring among the agents, accounting for the value each coalition can create. We concentrate on the solution concepts of the core and the Shapley value, but a number of others have been developed. For textbook expositions, see for instance Osborne and Rubinstein (1994) and Owen (1995).

The core is the set of imputations such that each coalition receives at least as much as it can create on its own. This concept formalizes a notion of individual and coalitional self-interest. The core is thus appropriate to model the competitive nature of free-form competitive interactions. However, the core may not exist and is not necessarily unique. Non-existence of the core signals the intrinsic instability of a particular interaction. Non-uniqueness of the core implies that competitive forces alone are not enough to determine each agent's value capture and that negotiating abilities also come into play. The core is an attractive concept when building formal models for strategic management, as it focuses on the big picture, providing logically consistent bounds to value capture under competition, without delving into specific tactical moves.

An agent's added value (or marginal contribution) is the value lost to the grand coalition (the coalition of all agents) if the agent is not included. The added-value principle, implied by the core, states that under competitive free-form interaction an agent can capture no more than her added value. Otherwise, the other agents would be better off to exclude her and trade only among themselves.

The Shapley value is the average added value of an agent to all possible coalitions. It always exists and is unique. It emphasizes the fairness of the division of value among agents. It has been used to model the allocation of costs among users of a common facility and to measure political power. It can also be seen as the expected outcome of a non-cooperative negotiation procedure, for instance to model negotiation in a supply chain (de Fontenay and Gans, 2005).

Biform games are a blend of CGT and NCGT. They model the intuitive distinction between shaping the game and playing the game. These comprise two phases. In the first phase, modelled

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and solved non-cooperatively, agents independently take actions that determine the value they can create as coalitions (i.e., the characteristic function). In the second phase, modelled and solved as a cooperative game using the core, agents create and capture value. Biform games are well suited to model business strategy where decisions are about a firm's ability to create value (e.g., by building capabilities) and to influence the environment to improve value capture, while de-emphasizing tactical decisions (e.g., price-setting).

CGT was introduced to strategic management research by Brandenburger and Stuart (1996), who proposed added value as a key analytical concept. Lippman and Rumelt (2003) argued for using CGT in strategy research. MacDonald and Ryall (2004) characterized when an agent is assured to capture value in the core. Brandenburger and Stuart (2007) introduced biform games, used by Stuart (2004, 2005), Adner and Zemsky (2006) and Chatain and Zemsky (2007, forthcoming) in applied theory. Adegbesan (2009) uses CGT to analyse strategic factor markets. Chatain (2011) applies CGT ideas in a large sample empirical study by relating proxies of added value to firm performance.

See also complementors; co-opetition; game theory; negotiations; value; value net

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