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Analysis

Linking action situations: Coordination, conflicts, and evolution in electricity provision for irrigation in Andhra Pradesh, India

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ABSTRACT

Actor-centred institutional analysis can gain through an expanded focus from a focal action situation to the adjacent situations that make up its structure. Equilibrium outcomes in game models of a focal action situation may not be explainable without considering linked games. The concepts of an 'ecology of games', 'nested games' or economic network analysis indicate the relevance of this move, but a structured approach to heterogeneous networks of adjacent action situations encountered in resource and infrastructure governance has only recently been developed. This paper draws on the adjacency concept and proposes four types of links, a potential boundary for adjacency networks, and a condition for bidirectional causation between linked action situations. The relevance of the theoretical propositions laid out is empirically supported for the analysis of electricity governance of irrigation in Andhra Pradesh. The actual and empirically observed outcomes, as well as the potential capacity of an adjacent action situation to influence focal outcomes, are analysed through a set of stylised game theory models and their links.

1. Introduction

Actor-centred institutional analysis frequently focuses on selected key situations within a game theory framework, enabling identification of the critical variables that structure interdependent choice, actions and related outcomes, and facilitating the use of multiple methods (Poteete et al., 2010). One of the most prominent research areas is resource and infrastructure governance, where analytical frameworks of the elementary variables structuring action situations have been developed and refined (see e.g. Hagedorn, 2008; Ostrom, 2005).

Common-pool resource analysis is frequently associated with a game-model class known as the Prisoner's Dilemma, covering an extensive set of variations in the game structure. The origin of a situation's structure itself and structural changes are increasingly being considered (see e.g. Aoki, 2007; Bardhan and Ray, 2008). Particularly institutional structure is usually the outcome of other action situations, an example being the contact between resource users and a market for their products (Tarui, 2007). Institutions to govern common-pool resources are considered public goods with their own second-order provisioning challenges (Ostrom et al., 1994). Linked action situations are often decisive in shaping more complex settings (McGinnis, 2011). This paper contributes to the endeavour to analyse networks of action situations.

The empirical evidence presented here makes the relevance of adjacent situations become visible. In electricity utilisation for irrigation in Andhra Pradesh, India, farmers face a coordination problem regarding technological measures to improve power quality and prevent equipment damage. Coordination failures are common in rural infrastructure provision and agricultural technologies (Drèze and Sharma, 1998; Janssen, 2007). In the case analysed here, coordination is obstructed unless an underlying dilemma of grid-capacity overuse is tackled. Underprovision and unauthorised connections create overload and prevent farmers from using energy-efficient pumpsets and measures to effectively improve power quality. As Anderies et al. (2004) point out, the "link between resource users and public infrastructure providers is a key variable affecting the robustness of SESs that has frequently been ignored in the past". Collusion between some farmers and electricity staff enables illegal tapping and capacity overexploitation. Decreasing groundwater tables through excessive exploitation requires additional pumping capacity, further increasing load on the electricity grid. The political economy of electricity subsidisation nurtures this vicious circle (Tongia, 2007). Apparently, the inhibitor of coordination is rooted in multiple linked action situations of infrastructure utilisation and provision.

Recent conceptual developments and empirical studies of adjacent action situations (McGinnis, 2011) and the ecology of games (Lubell et al., 2010) enable a structured approach to capture the interdependencies of linked situations. The paper derives and tests theoretical propositions for the types of links, a potential boundary to delimit relevant situations, and to identify capacities of links that co-determine outcomes of adjacent situations. Six relevant situations and respective links for the case of electricity-driven irrigation in Andhra Pradesh are analysed and expected equilibria are derived from a basic game model. In a final stage, the

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network is synthesised to analyse interdependencies of co-determining situations and to identify situations that impede coordination to improve power quality and energy efficiency in the core action situation. The findings provide guidance to further structure the analysis of linked action situations. In practice, where electric infrastructure capacity and groundwater are overexploited, only an integrative approach to surmount these dilemmas will render effective any efforts to increase energy efficiency. Disregarding these linked situations will very likely even defeat measures to overcome the persisting political economy of electricity subsidisation.

The remainder is structured as follows: Section 2 reviews the literature on action situation links, networks, and the evolutionary perspective on institutions. Section 3 deduces a set of theoretical propositions concerning links, boundaries, and interdependencies. Section 4 briefly describes data and methods used. Section 5 presents the background to the case, and in Section 6 the most crucial action situations in electricity provision for irrigation and their links are analysed. The paper draws conclusions for the case and derives theoretical implications for further research.

2. Theories for Linked Action Situations

A game model requires the specification of a variety of parameters, before any equilibrium outcome can be derived. The number of actors involved, the choices available to them and the functional interdependence of choices together yield the dominant or most probable emerging equilibrium. Outcomes determine whether actors find themselves participating in situations of conflict or coordination. A wide variety of models can result, as even the taxonomy and topology of simple ordinal preference two-player, two-choice games indicate (Rapoport, 1966; Robinson and Goforth, 2005). Outcomes depend on the content of the actions, that is the properties of the transactions and their functional interdependence (Hagedorn, 2008), such as subtraction in common-pool resources, addition in public goods, or critical transactions in electricity provision (Künneke et al., 2010). The number of actors involved is crucial (Olson, 1965), as are the number and type of choices and outside options (Hirschman, 1970), communication, repetition, framing, and the rationales of actors (Bromley, 2006; Ostrom, 2010; Vatn, 2005). All parameters are shaped by both physical and institutional conditions.

The parameters that structure one situation, be they physical or institutional, may stem from other situations. As Ostrom et al. (1994, p. 45) emphasise, even though "a 'single' arena may include large numbers of participants and complex chains of action, most of social reality is composed of multiple arenas linked sequentially or simultaneously". Some individual parameters can be decisive for an outcome. It becomes necessary, then, to take into consideration a parameter's origin in a linked action, where the underlying structure can be quite different from that of the core action situation. The levels of operational, collective, and constitutional choice are a case in point (Kiser and Ostrom, 2000). Two-level games of domestic and international politics (Putnam, 1988), as well as the variety of games and time horizons within a game (Shubik, 1986) have been considered, but only recently have links become a more explicit matter of concern in the analysis of resource and polycentric governance, although the study of policy networks has long shown the importance of 'nested games' and the Ecology of Games (EG) approach (McGinnis, 2011). Important is the crucial analytical distinction between network connections and actual choices available in situations, where agency comes into play. Economic network analysis develops theories for a larger number of homogeneous games with varying network structures, relevant for example in studying physical and social infrastructures (Goyal, 2007). However, many empirical phenomena exhibit several co-existing types of links, and the linked situations may exhibit heterogeneous underlying structures, making such cases more complex for the researcher. Consequently, a more open concept is needed.

2.1. Networks of Adjacent Action Situations

According to the concept of Networks of Adjacent Action Situations (NAAS), "an action situation X_i is *adjacent* to Y if the outcome of X_i directly influences the value of one or more of the working components of Y" (McGinnis, 2011, p. 53). McGinnis proposes an extension of the Institutional Analysis and Development framework to identify related types of adjacent action situations. A systematic procedure to identify action-situation networks based on the generic tasks of polycentric governance (Ostrom et al., 1961) is proposed, including the tasks of production, provision, financing, consumption, coordination, dispute resolution, rule making, and monitoring, while the tasks of constructing collective entities and internalising norms are proposed as potentially relevant, though likely remote from the focal action situation. Each of these generic tasks can constitute multiple action situations, with a variety of actors involved in each of them. The theoretical relevance of EG and NAAS has been demonstrated with several empirical cases (Dutton et al., 2012; Lubell et al., 2010; McGinnis, 2011) that are instructive examples revealing the complexity of the adjacent situations that condition each other.

With the extension of analysis from the focal situation to the adjacency network, the researcher is confronted with different types of outcome. While the outcome of the focal situation in the resource context is usually the level of exploitation or a product or service delivered, the outcome of an adjacent situation is a working component of the focal situation (McGinnis, 2011). This outcome can be physical in nature, but is often an institution. The underlying situation can be the singular legislation of a law or a highly repetitive and long-lasting situation of reproducing habits and norms of behaviour. Especially in the latter case, the outcome is part of an underlying and persistent institutional structure that shapes the focal situation. Here, evolutionary concepts may be required.

2.2. Evolutionary Theories and Technology Adoption

Institutional economics and game theory have created some of the most fruitful insights into understanding the *performance* of institutions (see e.g. Ostrom et al., 1994). Evolutionary economics and evolutionary game theory focus on the *emergence* and *persistence* of institutions or stable strategies respectively. Both complement each other: institutions may, for example, contribute to coordination failure, inhibiting gains for the actors involved in an action situation, yet they may still survive. The institutions required for a change in performance may not easily emerge, let alone persist. If the research aims at explaining empirical phenomena emerging from linked action situations, both may be required. Accordingly, institutions have been defined as "rules and conventions of society that facilitate coordination among people regarding their behavior" (Bromley, 1989, p. 22), and as "durable systems of established and embedded social rules that structure social interactions" (Hodgson, 2004, p. 14). Law, conventions, custom, habits, routines and norms, and even strategies and heuristics may all be considered institutions, and both perspectives are helpful in explaining some of the linked action situations.

Probably the best known example of evolutionary game theory is the evolutionary stable strategy of tit-for-tat in the indefinitely repeated Prisoner's Dilemma with a sufficient likely continuing interaction (Axelrod, 1981). Analogously, several imitation and best-response strategies have been tested in repeated interactions in a class of coordination problems (Skyrms, 2004), known as the Stag Hunt or assurance problem (Sen, 1967), with two Nash equilibria in pure strategies, one being payoff-dominant, the other risk-dominant (Harsanyi and Selten, 1988). A coordination problem is at the core of the focal action situation analysed in Section 5. In both models, a Pareto-superior outcome has been shown to be feasible, given the evolution of strategies. While classical game theory bases its models on (boundedly) rational agents with common knowledge and frequently complete or perfect information,