

Rationality and complexity in the work of Elinor Ostrom

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Abstract: What role does the theory of rational choice play in the scientific evolution of the work of Elinor Ostrom? Ostrom accepts, rejects, and makes critical improvements to the prior achievements of the theory of rational choice, in the pursuit of a “creative synthesis.” She proposes that this theory can be used i) to study not only competitive situations involving the exchange of private goods, but also social dilemmas; ii) to construct a syntax and grammar of institutions; iii) to develop a broader concept of rationality; and iv) to integrate this theory into a complex and realistic concept of individuals and social structures.

Keywords: Bounded rationality, complexity, Elinor Ostrom, game theory, individuals, methodology, rational choice, structure

I. Introduction¹

One major concern for Elinor Ostrom (1933–2012), is the understanding of the nature and evolution of institutions. At a theoretical level, social scientists often overestimate their comprehension of problems and underestimate the complexity and uncertainty of social reality, offering simple solutions to complex problems. Ostrom warns over and over about the danger of this excessive certainty models and simple solutions. Against this reading that impoverishes the social reality, Ostrom in *Explaining Institutional Diversity* (2005), aims to understand the existence of “structures behind structures.” Complex problems require complex solutions and explanations.

¹ A Spanish version of this article will be published as an introductory study of *Understanding Institutional Diversity* (2005) (Spanish translation) of Elinor Ostrom. Fondo de Cultura Económica -UAM, Mexico.

Ostrom considers that no discipline or theory in isolation is able to respond to this challenge. In that spirit, Elinor Ostrom, Vincent Ostrom and colleagues built the Analysis and Development Institutional program (ADI) (Aligica and Boettke 2009; Aligica 2014). One of the main objectives of this program is to overcome the barriers created by languages associated with both several levels of analysis, as different scientific disciplines. The ADI is conceptualized as a framework and a theory of theories; it has different levels and different degrees of theoretical specificity that allow integration of a family of theories and models. All who live in this world need to solve complex and uncertain problems. This is the reason of the ontological nature, which justifies constructing a unified framework. Ostrom believes that it is possible to work together and ADI is an alternative framework, which has been experienced for more than 30 years with remarkable success in order to understand and help to solve collective action problems, in many situations, regions and countries.

The ADI is characterized primarily as an “analytical” scientific enterprise, which seeks to break down complexity into its simplest components, then, conversely – path from simple to complex – to explain how, from the patterns of interaction and aggregating agents, emerge a relatively decoupled multilevel hierarchical structure. For Ostrom, both strategies; descendant and ascendant causal explanations are key to the analysis of institutions as complex systems.

In this intellectual journey, Ostrom uses the theory of rational choice, on the one hand, to identify simple components or universal building blocks and on the other hand, to build a syntax and deep grammar of institutions.² Without falling into the temptation of reductionist theoretical explanations, Ostrom seeks to reconstruct the multilevel complexity of social reality. In this ascendant causal explanation path, Ostrom finds valuable images, concepts and analogies in biological sciences and in the theory of complex adaptive systems. It is therefore meaningful to ask: What is the role of rational election theory and complex adaptive systems in Ostrom framework?

The article is organized as follows. We begin by examining Ostrom’s thesis that the theory of rational choice, especially game theory, can be used as a method of analysis to study not only competitive situations involving the exchange of private goods, but also social dilemmas (1). Which assumptions are more useful for empirically validated science; unbounded or bounded rationality? (2). Complete or incomplete information? (3). Ostrom agrees with the theory of rational choice that individuals are selfish, but rejects the idea that the theory

² Both the content and structure of Ostrom theory program is largely concentrated particularly in two books. Firstly, *Governing the Commons* (1990) which Arrow et al. (2012) consider as a masterpiece. And secondly in *Understanding Institutional Diversity* (2005), this book is crucial since it synthesizes the complete framework of Ostrom. In the words of Ostrom (2009). “After many requests, I have finally devoted an entire book (*Explaining Institutional Diversity*) to explication of the full framework as it has developed over the years (Ostrom 2005)” (Ostrom 2009, 21) (emphasis added). This is the reason why our exegesis and analysis of Ostrom program follows closely the argument in both books.

can stand as the sole explanation for their behavior (4). Ostrom departs from the utilitarian concept in her belief that individuals have the capacity to construct a much more subtle, complex morality (5). To integrate the individual with the structure of the action, the key variables proposed by Ostrom for studying the decision process are described (6), and finally why it is useful to construct simple and complex models (7).

2. The theory of rational choice as syntax

The theory of rational choice is the product of the work of a large number of authors whose goal has been to construct a theory and models of human choice. For Ostrom, the most influential and important scholars in this tradition are Arrow (1951), Downs (1957), Olson (1965), William (1962), and Buchanan and Tullock (1962). The theory of rational choice is based largely on game theory and other mathematical models, with two fundamental assumptions: methodological individualism and intentional action.

In academic discussions of rational choice,³ its critics often represent the theory schematically and virtually empty of content. They construct a straw man whose defects are easy to find.⁴ It is not uncommon for academics to find any other theory than their own lacking in rigor or relevance. At the extremes of the debate are those who, following Kuhn, consider that scientific progress occurs when one theory or paradigm is substituted for another paradigm. For these academics, scientific progress is not so much an accumulation as a substitution of paradigms.

For Poteete et al. (2010, 11), however, different languages or paradigms are not incommensurable:⁵ “Despite references to “revolutions” and paradigm shifts, new social science theories and methods have not fully displaced their predecessors. Rather, each new theory and method has added another strand.” Even when vigorous competition rages between old and new theories and methods, the different traditions “coexist.” Academics engage in a “creative synthesis.” To translate from one theory to another is difficult but possible.⁶ It is from this perspective that Ostrom seeks to synthesize, insofar as her framework allows, microeconomic theory, game theory, transaction cost theory, theory of

³ They extend the same criticism to game theory.

⁴ They generally criticize it on the basis of the condensed version of the theory of rational choice presented in textbooks and manuals.

⁵ Kuhn's philosophy of science maintains that theories can not be compared if they are incommensurable. Following the theory of Gestalt psychology, Kuhn (1962) believes that when we perceive, we envisage images as wholes, not parts. Committing to this thesis runs the risk of severe relativism or anti-rationalism. It feeds a belief in the impossibility of progressive synthesis and unification of science and, in pragmatic terms, that dialogue between different traditions or linguistic communities is not possible.

⁶ A conception of scientific progress that coincides with Kitcher's vision (1993).

social choice and of public choice, constitutional theory, and theories of public goods and the commons (Ostrom 2005).

A particular set of problems and motives led Ostrom to link her research agenda to the theory of rational choice. During the 1980s, Ostrom needed a rich and varied set of case studies to construct an alternative inductive theory and narrative of Hardin's Tragedy of the Commons (1968, 1971). She found it a challenging task to synthesize and compare over 5000 studies of the commons from disciplines as diverse as rural sociology, anthropology, history, economy, sociology of irrigation, human ecology, and more (Ostrom 1990, xv). Evidence was drawn from a broad variety of situations and scientific communities that used different languages.⁷ Poteete, Janssen and Ostrom found that it is not possible to accumulate knowledge, construct theories, and refine concepts if cases can not be compared and patterns extracted. One of the greatest impediments to constructing a theory is "the difficulty of synthesizing findings from case studies." (Poteete et al. 2010, 37).

It is important to note that a minimum syntax can help provide structure to the infinite diversity of communicative possibilities and facilitate the conversion of separate fragments of scientific knowledge into common scientific knowledge. Ostrom's objective is to build a syntax and grammar for the study of institutions. Nevertheless, constructing a common language assumes that the academics involved in the task are able to overcome their own problem of collective action. Her work, like that of other academics and networks, would be directed in the ensuing years towards establishing a syntax and a grammar. During the 1980s in the United States, various efforts were made to construct a common language based on the analytical framework developed by Elinor and Vincent Ostrom and their fellow academics at the Workshop in Political Theory and Policy Analysis at Indiana University⁸ (Kiser and Ostrom 1982).

A first effort at such a synthesis is condensed in "Governing the Commons: The Evolution of Institutions for Collective Action" (1990). This exhaustive work makes use of many different resources to construct a complex multilevel alternative theory to Hardin's Tragedy of the Commons (1968). Through the use of game theory, Ostrom rejects Hardin's overly pessimistic idea that individuals are incapable of restructuring their own situation of interdependence. Hardin does not believe that individuals can learn to cope with social dilemmas, a conception which leads him to argue that the only way to escape the overexploitation of the commons is the Leviathan, or private property. For Ostrom, resource overexploitation is only one possible outcome. There are examples of self-governing individuals and communities that have been able to forge credible

⁷ The gaps between academics stem from a multiplicity of sources; different regions, disciplines, and resources.

⁸ The Workshop in Political Theory and Policy Analysis was founded in 1973 at Indiana University. The first issue studied by the Workshop was polycentric systems in metropolitan areas. (Ostrom 2005).

agreements; stable self-government experiences that have endured for hundreds of years. Having studied successful and unsuccessful cases, Ostrom is able to construct an inductive theory capable of explaining the broad diversity of empirical solutions (Ostrom 1990).

In 1995, Crawford and Ostrom published “A Grammar of Institutions.” In this article they propose a grammar of institutions based on a syntax provided by the theory of rational choice: a simple, powerful, useful syntax that can: i) specify the ways that institutional rules combine; and ii) construct an infinite set of analytical possibilities from a finite list of rules. The concept of grammar contains two meanings; a theory formulated by linguists – epistemology – and ontology, an internal component of the mind of the individual speaker and listener.⁹ Ostrom’s institutional grammar, understood as epistemology, seeks to reduce the existing hodgepodge of nomenclature corresponding to three concepts; norms, rules and strategies. From the ontological viewpoint of the grammar of institutions, structured around a theory of action, it provides a way to represent the “deep structure” of society (Crawford and Ostrom 1995).

Ostrom engages in dialogue, criticizes, transforms and assimilates the theory of rational choice and uses it to build a realist¹⁰ conception of science. She is interested in building an “empirically valid theory” (Ostrom 2009, 59). Poteete et al. (2010, 50) finds it useful to question the reality of the method of the theory of rational choice – that is, to the extent that theory – and the implicit influence of ontology – can be uncoupled from method.

Applying game theory as a method, Ostrom says of the elements of an “action situation;” “they are similar to the elements identified by game theorists to construct formal game models” (Ostrom 2005, 34). The essential elements used by game theory to describe the structure of the game are: i) a set of players, ii) a set of strategies, and iii) a set of rewards associated with particular strategies. In any analysis, Ostrom recommends using three basic assumptions of rational choice theory: i) Individuals have as much information on the structure of a situation as the situation itself contains. ii) Individuals assign a complete, consistent internal value to the results, which is a monotonic function of external payments. iii) After making a complete analysis of the situation, individuals choose an action, according to their available resources, that maximizes the expected net material benefit for themselves, given what others can be expected to do (Ostrom 2005, 103). Game theory is a good starting point for an analysis. But the complexity of social problems demands more.

It is challenging to study how individuals learn in social dilemma situations. There are two opposite explanations. At one end are the elegant, simplistic schemes of the rational choice model. At the other end, unnecessarily complex

⁹ Syntax describes only the shapes and structure of expressions, not their meanings. From this perspective, syntax requires semantics; that is, connecting signs with the things that they represent and with their users. Semantics connects language with reality (Carnap 1947).

¹⁰ The objective world exists and is outside us, and is independent of our consciousness.

explanations that do not admit the development of theory. How can these two extremes be avoided? The best way is a realist, ontologically based approach that tells us what scope or degree of complexity is required by the theory. "Ontological frameworks offer an analytical strategy for recognizing complexity without being overwhelmed by it" (Poteete et al. 2010, 216). Committed to a realist philosophy and methodology, Ostrom built an encompassing theory of human behavior consistent with the results of other scientific disciplines and with inputs from various disciplines (Ostrom 2002).¹¹ In what follows, the main differences Ostrom had with the theory of rational choice, in particular with game theory, are examined.

3. Unbounded rationality vs. bounded rationality

Unlike rational choice theory, which assumes that the individual has unlimited computing capability and perfect information, Ostrom believes that given our natural limitations, "the option of optimal design is not available to mere mortals" (Ostrom 2005, 31). Human beings are characterized by bounded rationality. Their constraints prevent them from calculating a solution based on a complete, comprehensive representation of the situation and choosing the global optimum solution. Individuals try to find a merely satisfactory solution given their resources and their objectives.

Paying attention, and obtaining and processing information incurs a cost and takes time. Therefore, "instead of presuming that some individuals are incompetent, evil, or irrational, and others are omniscient, I presume that individuals have very similar limited capabilities to reason and figure out the structure of complex environments" (Ostrom 1990, 25). To make reasonable decisions, individuals construct mental models of the situation.¹² These models arise from two sources; the individual's experience of interacting with the world, and shared culture or shared mental models (Ostrom 2005). But mental models are not a mirror or copy of reality; they are fallible human constructs; "cognitive scientists have also shown that our genetic inheritance does not give us the capabilities to do unbiased, complex, and full analyses without substantial acquired knowledge and practice as well as reliable feedback from the relevant environment" (Ostrom 1998, 2). With incomplete information and limited ability to represent the problem and identify all possible solutions and their consequences, individuals often construct incorrect or biased models of the situation (Ostrom 1986). Human beings are fallible learners (Ostrom 1998, 9).

Individuals, even if they have limited capability, are able to make decisions and choose actions from a set of possibilities. They have the cognitive capacity to

¹¹ Developmental psychology, social psychology, sociology, anthropology and political science can help us, Ostrom says (2002), to build the foundations of a realist theory of human behavior.

¹² In her description of mental models, Ostrom summarizes the perspective of Holland et al. (1986), and Denzau and North (2000).

evaluate their beliefs and discriminate between alternatives or courses of action on the basis of appropriate reasons. “Instead of relying entirely on blind variation, however, human agents frequently try to use reason and persuasion in their efforts to devise better rules” (Ostrom 2007, 15). Individuals have the capacity to engage in self-reflection (Poteete et al. 2010, 222). For this reason, Ostrom posits a theory of organizations based on human choice (Ostrom 1990, 24) that does not deny human rationality (Ostrom 2003, 384). On this point it largely coincides with the rational choice model. Both theories acknowledge that individuals’ rational intentions matter. But they differ in that in the rational choice model the course of action depends solely on the individual’s capacity for deliberation. The rational choice model overstates the role of conscious deliberation and the weight of individuals; a fundamental postulate in methodological individualism. Ostrom is far from supporting this reductionist methodology.

Ostrom states that individuals consciously construct rules (Ostrom 2005, 18) but that at the same time it is clear that “we are not even conscious of all of the rules, norms, and strategies we follow” (Ostrom 2005, 5). Many activities require little or no awareness. For example, human beings carry out, without being very aware of it, an internal mental accounting which facilitates their interactions with those who acted cooperatively in the past (Ostrom 2005, 295). This type of subconscious thought becomes a “social habit;” which participants can thematize and bring into consciousness (Ostrom 2005, 36).¹³

Following Smith (2000), Ostrom claims that we live in two worlds, one a world of “personal exchange” governed by conscious and intentional norms, and the other of “impersonal exchange” governed by rules that simply emerge, without having been designed by anyone in particular (Ostrom 2005, 294). Both V. Smith and Ostrom lean toward an explanation that integrates the individual with the structural conditions of society.

4. Complete information vs. incomplete information

In the rational choice model, agents have complete information; they have the ability to comprehensively represent all possible consequences and alternatives, enabling them to choose the best option. Does this idealization correspond to any observable situation? Ostrom believes that the hypothesis can be applied to only a very small set of situations. In highly competitive,¹⁴ structured markets, over the course of time, individuals – focused on material results – learn to construct an accurate picture of their options and the consequences of their actions. However, only if this kind of open, competitive market were the only kind that existed

¹³ Opening the black box of cognition and acknowledging the existence of conscious and subconscious processes poses a formidable challenge to the social sciences. “The capacity of humans to use complex cognitive systems to order their own behavior at a relatively subconscious level makes it difficult at times for empirical researchers to ascertain what the working rules for an ongoing action arena may actually be in practice” (Ostrom 2005, 19).

¹⁴ With strong pressure to improve performance.

in reality would predicting human behavior require nothing but rational choice theory, Ostrom says. But when market selection mechanisms are not so effective as to produce efficient outcomes; for example for the production of public goods and the commons – where the predictions of the theory of rational choice are not fulfilled – then the aid of a whole family of theories and models is required (Ostrom 1990, 1998, 2005).

The hypothesis of complete information does not exhaust the range of possibilities. Empirical research has shown that its predictions, even in simple situations, are not always fulfilled. There are systematic anomalies that prevent clear predictions from being made about how individuals choose when participants associate positive or negative values that are not monotonically related to rewards. This is especially true when their preferences take into account other individuals and/or the intrinsic values of the individual (Ostrom 1998, 2003).

Thus, when results and actions are not linked to a single immediate material motivation, but to complex intrinsic preferences, the situation is characterized as “incomplete information.” Other individuals cannot know precisely how a player values actions and to represent comprehensively results. Many different situations involve the generation of partial or incomplete, or asymmetric information. The social reality is made up of a broad, heterogeneous variety of social dilemmas characterized by uncertainty, incomplete information and individuals with bounded rationality. The theory of rational choice is imprecise in all these kinds of situations. This leads to the question of how individuals make decisions, given the ubiquity of asymmetric information and bounded rationality. Thus, the theory must incorporate: “1. the way that participants acquire, process, represent, retain, and use *information*; 2. the *valuation* that participants assign to actions and outcomes; and 3. the processes (maximizing, satisficing, or using diverse heuristics) that participants use for *selecting* particular actions or strategic chains of actions in light of their resources” (Ostrom 2005, 103).

5. Selfish motivation vs. multiple motivations

Both Ostrom and the model of rational choice recognize that the individual is selfish. What we are concerned with here is to specify the scope of the overlap between Ostrom and rational choice theory. Are humans always and totally selfish? Or does our propensity to selfishness emerge only to an extent that depends on the context? Posed in general terms, the question is: Are humans motivated by a single cause? Let us now examine the similarities and differences between Ostrom and rational choice theory.

According to the theory of rational choice, individuals value only results that are material, extrinsic, and related exclusively to themselves. Everyone values the world in the same way. For Ostrom, this thin model of rationality – selfishness – given by rational choice theory is useful for constructing clear, unambiguous predictions that serve as a reference point for measuring the

success or failure of any other explanation of human behavior (Ostrom 1998, 16).

It can be an appropriate model of rationality when the situation is extremely simple and the stakeholders lack information about who the other participants are and what rules should be followed (Ostrom 2005, 118). This would be the case, for instance, when individuals are scattered around the world with little chance to communicate or share common rules; for example, open-access ocean fisheries or access to Earth's atmosphere. Under these conditions, "the best predictions and explanations of behavior would be derived from assuming that most participants are rational egoists" (Ostrom 2005, 131). It also makes sense to accept the hypothesis of purely selfish behavior for describing certain subpopulations; for example, when agents with a variety of strategies – selfish, cooperative, altruistic, among others – coexist. The theory is useful for understanding the subpopulation of selfish, self-interested short-term maximizers. "In every culture there exist some individuals who are well modeled by *Homo economicus*" (Janssen and Ostrom 2006, 3). They are individuals who are focused solely on increasing their immediate material worth. For Ostrom, "rational choice theory helps us understand humans as self-interested, short-term maximizers" (Ostrom 1998, 2). The theory of rational choice provides methods to study how short-term hedonistic agents, amoral manipulators, and calculators can undermine institutions (Ostrom 1998, 16).

The problem arises when the selfish agent model, widely used in neoclassical theory, is taken as the general theory of rational behavior (Ostrom 2003).¹⁵ It is only one model within a much broader family of explanations (Ostrom and Hess 2006, 8; Poteete et al. 2010, 113). Following Selten (1975), for Ostrom full rationality is a limiting case of bounded rationality (Ostrom 2003, 39). It is reasonable to assume this hypothesis only in specific institutional contexts (Poteete et al. 2010).

In the rational choice model, the mental structure of a selfish agent has a single focus: to seek his own benefit. The agent always acts in the same way, consistently and predictably. No matter what context he finds himself in, he always resorts to the same strategy: maximize his expected utility. Such agents are unable to formulate a different response. One of the key assumptions of conventional game theory is that the strategy of any one agent is independent of that of the others. In this model, the agent does not adapt to the environment.

¹⁵ And the only way to construct social science: "Some of the factionalism does stem from the arrogance of those who consider the continued use of a narrow model of human rationality the essential qualification for doing good social science" (Ostrom and Hess 2006, 8). Excessive devotion to the use of simple rational choice models persists in spite of recommendations to the contrary by at least four Nobel laureates; Selten, North, Simon, and Vernon Smith (Ostrom and Hess 2006, 10). Unfortunately there are still many researchers who cling to simple explanations of social behavior and ignore the need to build complex models of social reality (Gibson et al. 2000).

The forum Ostrom chooses to defend her ideas is not primarily theory, but the results of natural and laboratory experiments. The debate moves from the logical consistency of the model to the explanation of reality. It does so by relying on field and laboratory work, and on the rich and abundant evidence produced by academics around the world who challenge the assumption that humans seek only material benefits. For Ostrom, only in simple and restricted situations may preferences be modeled as stable and complete. When problems are unstructured or weakly defined, “assuming complete preference functions of any shape is not meaningful.” (Ostrom 1990, 38).

Selfishness, following Ostrom, has played an essential role in the process of natural selection in both human history and the history of nature. “In prehistoric times, simple survival was dependent both on the aggressive pursuit of self-interest and on collective action to achieve cooperation in defense, food acquisition, and child rearing” (Ostrom 1998, 2). There is no doubt that selfishness is necessary. To survive, agents must utilize selfish characteristics that contribute to their survival, reproduction, and well-being.

But it is also critical that they have the ability to cooperate socially. “Human evolution occurred mostly during the long Pleistocene era that lasted for about 3 million years, up to about 10,000 years ago. During this era, humans roamed the earth in small bands of hunter-gatherers who were dependent on each other for mutual protection, sharing food, and providing for the young. Survival was dependent not only on aggressively seeking individual returns but also on solving many day-to-day collective action problems” (Ostrom 2000, 143). Cooperation is partly based on selfishness. “Our evolutionary heritage has hardwired us to be boundedly self-seeking at the same time that we are capable of learning heuristics and norms, such as reciprocity, that help achieve successful collective action” (Ostrom 1998, 2). And so, while for Ostrom this selfish motivation explains only part of history, for the rational choice model, in contrast, there is no other motivation but selfishness. For Ostrom, “maximizing a single goal is an extremely limited assumption about the nature of human decision making. But to capture the complexity of the decision-making process, we would like to propose a model of the individual pursuing multiple objectives rather than a single goal” (Kiser and Ostrom 1982, 8).

Like Sen (1977) and many other scientists, Ostrom rejects the idea that selfishness and opportunism are the only rationality expressed by the individual. There are other human motivations that must be taken into account (Cárdenas and Ostrom 2004; Ostrom 2005). Results in experimental economics clearly show that there are individuals with selfish behavior, but there are also altruistic individuals and conditional cooperators. It is not a question of replacing the assumption of universal selfishness by universal altruism, nor of claiming that a Mother Teresa or a Gandhi emerge frequently. “Human beings are neither all-knowing saints nor devilish knaves” (Ostrom 2005, 132). Individuals are different at various levels, because they have different mental models, and make different external and internal valuations. If we add further complexity, when it is acknowledged

that one person may have different preferences depending on the action situation they find themselves in, a broader theory of rational choice is needed.

6. Utilitarian morality vs. deontic morality

A typical rational choice theory commonly accepts some type of utilitarianism of results. According to this, what matters from an ethical point of view is “direct consequentialism” (Sidgwick 1962; Mackie 1977). The idea that rightness and goodness depend on direct consequences – which should produce more pleasure than pain – is a kind of evaluation that is both hedonistic and instrumental at the same time. It is not their inherent attributes, motives, or relationship to social norms that make actions right or obligatory. Any means can be justified by a sufficiently good end; for example incriminating an innocent person if this will save the life of others. This way of framing ethical decisions does not question the act or the intention, only the outcome.

The theory of rational choice assumes that all individuals maximize utility, without asking how they reach their judgment about the utility of an action. Hypotheses are not, however, the best basis for non-market interactions, where agents’ preferences are heterogeneous, and intrinsic motivations are not monotonically related to material goods. Even when individuals find themselves playing in an objective structure, they may evaluate it differently. They add positive values – pride and dignity, for example – and negative values – shame, guilt, and so on – to actions and rewards. The differing preferences of actors take into account the existence of different norms associated with emotions.

Ostrom assumes that when agents face social dilemmas, they are rational beings in the broadest sense; that they seek to optimize values that are important to them (including what happens to other individuals linked to them). They have the ability to deliberate, to use their conscience, to create forms of morality that give them personal identity insofar as they are connected to others. Ostrom distances herself from the hedonistic view that holds morality as a mere tool for obtaining more abundant material goods. “Norms of behavior reflect valuations that individuals place on actions or strategies in and of themselves, not as they are connected to immediate consequences.” (Ostrom 1990, 35). The deontic moral system is not governed by the notion of a goal to be achieved, but by what is allowed, required or forbidden (Crawford and Ostrom 1995, 584). Learned deontic rules vary from one culture to another, one family to another, one individual to another, and from one situation to another. Thus, instead of positing a one-dimensional world ruled by selfish instrumental values, Crawford and Ostrom (1995) considers it necessary to incorporate the diversity of agents, moral values, and situations into the theory.

Ostrom is guided by a non-reductionist explanation, opening the black box of cognition and morality on multiple levels. “Human decision making is the result of many layers of internal processing starting with the biophysical structure, but with layers upon layers of cognitive structure on top of the biophysical components (Hofstadter 1979)” (Ostrom 2005, 11). The individual has a variety of conscious

and subconscious abilities that allow him to construct moral judgments on different layers and by different processes. Following Hauser (2006), a deep moral grammar, imbedded in our brains, can be identified in Ostrom. This deep morality, partially subconscious, is distributed among various cognitive and emotional modules, which, while not specific to moral evaluation, do enable us to construct a moral sense of the world (Walker and Ostrom 2003). Ostrom's comparison of subconscious learning of morality to subconscious learning of grammar can be understood from this perspective. "Developments in evolutionary theory and supporting empirical research provide strong support for the assumption that modern humans have inherited a propensity to learn rules and norms similar to our inherited propensity to learn grammatical rules (Pinker 1994)" (Ostrom 2005, 126).

This is why Ostrom constructs a broad concept of rationality rather than a restricted one. It is broad in that it includes not only emotions but also cognition in the explanation of human behavior. Individuals are bearers of extrinsic and intrinsic values, and of interests, but also of moral commitments that bind them to others (Ostrom 2003, 40). For this reason "we need to formulate a behavioral theory of boundedly rational and moral behavior" (Ostrom 1998, 2). The agent described by Ostrom is a subject with the autonomy to have ideas about the world, represent it, and be guided by these values. And since the subject has an internal world with complex ethical norms, he can use contingent strategies (Ostrom 1990, 36). Normative behavior is sensitive to context. This will be examined in the next section.

7. Agent vs. structure of the action situation

The theory of rational choice has proven useful for predicting, at an aggregated level, human behavior in stable environments, such as in competitive markets and competitive elections, where the structure of the problems is well defined. "In these stable and repetitive settings, individuals are able to learn about the full, relevant structure of the situation and attach positive or negative preferences to actions and outcomes. [...] One can assume that learning has taken place and proceed with an explanation of behavior by informed participants using a mental model of the situation that is at least roughly approximate to the external situation itself" (Ostrom 2005, 100). In these kinds of structural conditions, it is reasonable to assume that individuals have complete information. Structural market institutions contain enough statistics to enable individuals to maximize their benefit. Individuals who do not adapt are eliminated by market selection mechanisms, as noted by Alchian (1950).

However, Ostrom says, it is not the individual's extraordinary abilities that explain this process. More than the assumptions of economic theory about the internal structure of choice and individual assessment, it is the structure of the market that leads participants to make efficient decisions. The specific attributes of the situation are much more relevant for predicting outcome than is the model of

rational behavior (Poteete et al. 2010, 113). Because of this, the predictive ability of the neoclassical model is highly dependent on the structure of the situation, according to Ostrom. Market efficiency stems more from the set of market rules than from sophisticated calculations by individuals. “The differences in their behavior are attributed to fundamental differences in the institutional incentives they face, rather than basic differences in the nature of the individuals involved” (Kiser and Ostrom 1982, 8).

This is why Ostrom seeks to integrate human rationality with the structural conditions that make it possible, avoiding a debate of “this will allow scholars who stress structural explanations of human behavior and those who stress individual choice to find common ground, rather than continue the futile debate over whether structural variables or individual attributes are the most important” (Ostrom 1998, 2). A theory is needed that can explain how contingent strategies arise; that is, the “whole class of planned actions that are contingent on conditions in the world” (Ostrom 1990, 36).

Explaining the emergence of contingent strategies requires agent theory to be integrated with the structure of the situation. How does Ostrom assimilate game theory to make progress in this direction? In other work (Schlager and Ostrom 1992, 1993; Gibson et al. 2000; Poteete and Ostrom 2004; Moran and Ostrom 2005) and using extensive databases, Ostrom and her team strive to represent the structure and the results of different social dilemmas as fully and completely as possible. Ostrom draws various lessons from this experience; not to limit the analysis to simple situations where formal models have demonstrated their predictive power – “the mathematical tools of game theory are powerful and enlightening” (Ostrom 2005, 34). The game theory model contains components and simplified universal patterns of the individual and the action (Poteete et al. 2010, 9), which can help to identify patterns, understand and coherently explain social complexity (Ostrom 2005, 10–11).

How does Ostrom assimilate game theory in more complex cases of agent/structure interaction? First, she does not aim to represent the strategy of the complete game, only of “key links” (Ostrom 2005, 34). Identifying these key links requires a broad array of methods; analytical narratives, comparative studies, formal mathematical models and agent-based simulations that illuminate the complexity of the multiple forms of causality (Poteete et al. 2010). It requires the use of multiple methods to progressively explain the enormous diversity of action situations.¹⁶ Ostrom thus uses game theory as a starting point to construct a concept of the “action situation”¹⁷ consisting of the following variables:

¹⁶ Ostrom advises us to follow the example of ecologists, who have been able to successfully fit together the results of case studies, analytical modeling and simulations (Ostrom 2005, 33).

¹⁷ Many different units of analysis have been proposed for the social sciences; collective structures, events, frameworks, venues of social action or interaction, logic of situations, scripts, transactions, or units of meaning, among others. The concept of an “action situation” synthesizes these different concepts.

(1). The group of participants. Individuals are capable of being aware and self-aware, which enables them to design rules to structure the action situation (Ostrom 2005, 85). Of these rules, a key part is concerned with defining the positions of the subjects. When they interact, they are located in a particular position. Their attributed or acquired personal attributes and characteristics are of interest. The rules distinguish the degrees of inequality of power, knowledge, resources and other attributes of the members of the group.

(2). The positions occupied by the participants. The positions of the players are not usually included in the analysis. In Ostrom's analytical scheme, participants can simultaneously occupy more than one position, as a function of the structure of the situation. The position is included in the analysis, and it contributes to the connection between the participants and the actions.

Game theory recognizes the importance of the "rules of the game" but does not concern itself with explaining where the rules come from and how they might change (Ostrom 2005, 17). Ostrom quotes one of the most prominent proponents of game theory, Rapoport (1966) on the irrelevance of how the rules arise; "Rules are important only to the extent that they allow the outcomes resulting from the choices of participants to be unambiguously specified. [...] Any other game with possibly quite different rules but leading to the same relations among the choices and the outcomes is considered equivalent to the game in question. In short, game theory is concerned with rules only to the extent that the rules help define the choice situation and the outcomes associated with the choices. Otherwise the rules of games play no part in game theory" [(Rapoport (1966) cited in Ostrom 2005, 17–18)]. For Ostrom, on the other hand, it is important to go deeper into the issue and provide a historical explanation of how and where the rules were created.

(3). The potential results. As in game theory, assuming that joint decisions are ordered by their external or extrinsic utility allows the analysis to be reduced. This type of analysis does not, however, help us identify how certain rules may change the structure of the situation. For this, it is necessary to link the biophysical results, external rewards, and internal valuations made by the participants, as well as to include "unwanted results" in the analysis.

(4). The set of possible actions. In an action situation, participants who have a position choose from among a set of actions; actions that influence the results. The concept of action includes both actions as such and the decision not to act or to leave the game.

(5). The degree of control. Unlike conventional game theory, which does not include the option for individuals to enter or depart from the game, Ostrom considers it necessary to include the possibility of quitting the game, since this possibility reconfigures the nature of the social dilemma. Game theory assumes that the link between actions and results is predictable and can therefore be represented. There is certainty or at least objective risk.

Ostrom considers that the situations characterized by social dilemmas are, instead, uncertain situations, in which we can not know the objective or subjective probability relationships. Probabilities cannot be assigned to a set of future events.

What are the main sources of uncertainty for Ostrom? First, the set of institutional rules contributes to the generation of expectations since it covers only the space of possibilities, leaving decision-making processes open. The second source of uncertainty is that the result of an individual decision depends on the decisions made by the other players. Considering different configurations of certainty, risk and uncertainty, a participant can exercise from maximum control to zero control.

(6). The information available. Formal game theory often assumes that the participants have complete information on the action situation. In other words, everyone involved knows: the number of participants; the positions, results, and actions available; how actions and results are linked; information available to other players; and rewards. If we consider human cognitive abilities, there is no possibility that these assumptions can all be true.

The usual scheme for game theory has all participants holding “common knowledge” of the structure of the situation and of the payment matrix. Knowledge in the game is recursive; that is, all participants know X , all participants know that all the others know X , and so on. In other words, everyone knows that everyone knows *ad infinitum*. Common knowledge implies mutual knowledge.

Ostrom is interested in explaining how fragmented personal knowledge distributed across a community becomes common knowledge. In social reality, each agent has a unique personal view in time and space of a problem (Ostrom 1990, 20). When it comes to complex social dilemmas and multiple representations of the problem, those involved must communicate and tell each other about it, in such a way that personal knowledge becomes common knowledge. The more this fragmented information becomes available to others, the closer it is to becoming “common knowledge” (Ostrom 1990, 125). It is therefore necessary to consider action situations in which information is not complete, and hence the problem of evaluating different nodes of the game arises.

(7). The costs and benefits assigned to actions and results (Ostrom 2005). In addition to actions and material results, the analysis must include the values of the costs and rewards for the participants. Institutions configure the incentives that direct individuals which way to go.

Neoclassical theory has the enormous undeniable appeal of elegant and simple explanations, which serve to abstract details from reality. For Ostrom, this crude reduction is only part of the scientific process. The challenge of science does not end here. Complexity can not be reduced to its most elemental parts. It is necessary, says Ostrom, to lean first toward simplicity in constructing a theory – the principle of parsimony – but only temporarily. The difficulty is that complex realistic explanatory architectures emerge from our constructions (Ostrom 1990, 1998, 2005).¹⁸ Can we rise to the challenge of using multiple models to reconstruct the complexity of complex adaptive systems? (Ostrom 2005, 12).

¹⁸ Unfortunately, as Gibson et al. (2000) point out, there are some who prefer simple explanations of social behavior.

8. Simple explanation vs. complex explanations

It is challenging to study how individuals learn in situations of social dilemmas. There are two extreme explanations. On one side, elegant, simplistic schemes of the rational choice model. On the other, unnecessarily complex explanations that do not allow the development of the theory. How to avoid these extremes situations?

Ostrom (2005, 225) says that it is “highly recommended”, to learn the use of rational choice models. For Ostrom this theory, especially game theory, provides valuable simple models of reality. It is necessary to build simple models, not because the world may be considered as simple, but because it is a useful heuristic tool to deal with complexity. Simple models in the theory of rational choice according to Ostrom, are powerful methodological tools which identify the essential components of an action situation. They pull out from the mass of varied circumstances a small number of crucial components in order to represent reality.¹⁹

In scientific practice, when simple models are useful? For Ostrom, rational choice models are effective to predict outcomes when the structure of the world is simple and well-structured also when selection mechanisms are powerful and its results are close to optimal. If certain properties of nature are simple, then simple models must be built. However, the history of science teaches us that the apparent simplicity hides often deep complexities. Also, the apparent complexity may hide or disguise extremely simple realities. Then, the type of model used depends on the structure (single or complex) of the world. From our explanatory constructions should emerge realistic complex architectures, that is the challenge. (Ostrom 1990, 1998, 2005).

From an ontological point of view, one of the essential epistemic values of science is to build descriptively adequate models, that is to say representing the causal or probabilistic structure of the world. The models are true or false inasmuch as their fundamental assumptions or hypotheses represent properties of the objective structure of reality.²⁰ Choosing simple theories, just because they are easier to use than complex theories, may move us away from a more precise understanding of the world. Unlike the theory of rational choice, for Ostrom, if the theoretical entities postulated are insufficient to explain reality then, it is necessary to posit for more complex models. For that reason, when the objects of study are complex, simple models are recommended only as a starting point, before moving into a more complex modeling.

To postulate a universal model of rational behavior is one of the methodological problems of the theory of rational choice (Ostrom 2005). The

¹⁹ Certainly, economic theory and rational choice theory have succeeded in part because of strategies such as isolation, abstraction and idealization.

²⁰ It is important to note that a model has auxiliary hypotheses that are often unrealistic. Therefore, all the assumptions of a model are not necessarily realistic (Nagel 1963).

tragedy of the commons (Hardin 1968), the conventional theory of collective action (Gordon 1954; Olson 1965) and the theory of non-cooperative games, assume the hypothesis of universality of social patterns. From simple models, rationality abstracts, clear and unambiguous predictions are obtained. A useful model is intended in order to analyze and provide solutions for a wide diversity of collective action experiences.

For Ostrom, this logic has led to build analytical panaceas: simple solutions to complex problems (Ostrom 2005, 2009). This is particularly so in two circumstances: when the theory is too precise to be adapted to a wider spectrum of cases; and when theories are too vague, and suggest simple solutions – market or government²¹- ignoring the vast complexity of interactions that occur in institutional rules, the nature of resources and the community attributes (Ostrom 2005, 2007; Ostrom and Cox 2010). Ostrom asks, in this context, if panaceas are seeking for the replacement or suppression of social complexity and diversity.

What are the ways to analyze complexity? How to identify relevant connections that occur between the rules, community attributes and biophysical nature of resources? How to find behind the apparent diversity of rules, the existence of universal building blocks? How to detect within the apparent simplicity of institutional rules its complex multilevel nature?

To find answers, Ostrom notes that it is required to construct not very complex theories that allow us to simplify the most relevant properties of the world. It is necessary, to identify the “universal building blocks” existing in all situations of action and on the other hand, go for complex explanations as austere as possible. Conceptual entities should not be multiplied beyond indispensable. Ostrom declares emphatically, “I do not introduce complexity lightly. I view scientific explanation as requiring just enough variables to enable one to explain, understand, and predict outcomes in relevant settings” (Ostrom 2005, 7).

For Poteete et al. (2010, 7–9), the rational choice approach is modeled on the natural sciences, especially physics. Emulating its logical method of building theory, its deductive-nomological reasoning, and its search for universal deterministic laws. Does it make any sense the universality of social patterns assumed by the rational choice theory? The physics model suggests a mechanical and linear view of the social world; and leaves no room for contingency, emergency, history, context, agency and capacity of human reflection.

How to study nested hierarchical social systems, systems within systems? How to integrate in the explanation the human ability to use a complex moral cognitive system to organize his behavior? What theory is required to understand the structure and evolution of uncertain and complex social dilemmas? How to create diagnostic

²¹ “Adalids of community governance” (Ostrom 2005, 617) sometimes have fallen in this same trap. Ostrom does not try to replace the tragic conception of collective action for a victorious naive view. Success or failure depends on a complex constellation of factors. The dichotomies that simplify reality may be very dangerous as shown in history.

theories in order to identify combination of rules, community attributes and the biophysical world? Ideally, Poteete, Janssen and Ostrom stresses, a realistic approach, ontologically founded, indicating the extent or degree of complexity required by the theory. “Ontological frameworks provide an analytic strategy to recognize the complexity without being overwhelmed by it.” (Poteete et al. 2010, 216).

Low et al. (2003) agrees with John Holland, scientist at the University of Michigan and Santa Fe Institute, father of genetic algorithms, in that the causal model of physics is inappropriate for social sciences. “Holland pointed out that complex adaptive systems differ from physical systems that are not adaptive and that have been the foci of most scientific effort yet, inappropriately, the physical sciences have been the model for many aspects of contemporary social science. We find it odd that social scientists have traditionally drawn more on physical analogies in developing an approach to scientific explanation than on biology and ecology. The concepts needed to understand the behavior of complex systems are not yet well developed by social scientists.” (Low et al. 2003, 103).

Unlike physics, most of the explanation of complex adaptive systems, says Ostrom, is not based on laws but on specific concepts or principles, being adaptation, one of the most important. The crucial feature of complex adaptive systems is not in the lowest level of organization. It is located in the configuration of the system as a whole. Isolated components are important, but especially how their interactions lead to raise multiple unexpected properties, particularly agent’s aggregation and hierarchy.

All of these ontological characteristics justify and explain why scientists in social science, biology, ecology and theory of complex adaptive systems²² are cooperating to delineate a richer, more varied and comprehensive picture of mechanisms and properties that characterize complex adaptive systems (Ostrom 2007; Ostrom and Cox 2010).²³ It is only the cooperative work of various scientific communities provided with disciplines, theories, models and techniques, which allow us to understand “the structure behind the structure” (Ostrom 2005).”

9. Conclusion

Ostrom believes that rational choice theory can be a good starting point for improving the conceptual clarity and analytical rigor of the social sciences. The rational choice theory’s model of rationality and the individual are extremely simple and well structured for analyzing both structured and competitive situations, such as social dilemmas.

²² Arrow et al. (2012, 1) pointed out that: “Ostrom... became fascinated with the perspectives that could be gleaned from the study of complex adaptive systems more generally, which helped inform her emphasis on the need to take polycentric approaches.”

²³ This is another fundamental difference in Ostrom’s program regarding the theory of rational choice. In order to represent the complex social ontology, she considers as necessary to cultivate the theoretical and methodological pluralism. In contrast, the theory of rational choice is self-sufficient, with the power to reduce and integrate the various theories of social sciences.

However, supported by a rich, extensive body of empirical evidence, she rejects the universal and deterministic explanations of the theory in which selfish agents –utility maximizers – always respond the same way. Ostrom agrees with the theory of rational choice that individuals are selfish, but rejects this as the only explanation for their behavior. In Ostrom’s model, humans are selfish but also hold deontic moral standards. They are vulnerable beings who must adapt to a complex and uncertain social and biophysical world. They require others for survival. During the long history of the evolution of our species, says Ostrom, the mechanisms of natural selection have favored individuals who had the ability to compete but also to cooperate.

Finally, some characteristics of human nature and rationality can be identified in Ostrom’s framework. There is no doubt that the agent is not the solitary, one-dimensional, short-term selfish agent. He is an intentional subject with the cognitive and emotional capacity to construct short and long-term contingent strategies. Supported by conscious and subconscious resources, he has the ability to make decisions. Sometimes they are wrong, while other times they are useful and appropriate. The inner world of these mortal individuals of flesh and blood is sophisticated, diverse, rich, contradictory and complex. They are imperfect and incomplete but therein lies the significance and appeal of the human condition.

In her quest to achieve a creative synthesis, Ostrom cultivates a critical but constructive relationship with the theory of rational choice. At different levels of analysis she accepts, rejects, improves and revises the achievements of the theory. Ostrom constructs a syntax and grammar of institutions using the methods of the theory of rational choice. Moreover, she incorporates the method into a realistic theoretical program that helps represent individuals and society consistently across scientific disciplines. To address diverse, complex problems, says Ostrom, the social sciences need to use multiple methods and theories. Indeed, the rational choice theory is just one theory within a much broader family of theories.

Literature cited

- Alchian, A. 1950. Uncertainty, Evolution and Economic Theory. *The Journal of Political Economy* 58(3):211–221.
- Aligica, D. 2014. *Institutional Diversity and Political Theory*. The Ostroms and Beyond. New York: Oxford University Press.
- Aligica, D. and P. Boettke. 2009. *Challenging the Institutional Analysis of Development*. U.K: Routledge.
- Arrow, K. 1951. *Social Choice and Individual Values*. New York: Wiley.
- Arrow, K., R. Kehohane, and S. Levin. 2012. “Elinor Ostrom: An Uncommon Woman For The Commons”, PNAS, vol. 109, núm. 33, pp. 13135–13136. Disponible en: <http://www.pnas.org/content/109/33/13135.full.pdf+html>.
- Buchanan, J. M. and G. Tullock. 1962. *The Calculus of Consent, Logical Foundations of Constitutional Democracy*. Ann Arbor: University of Michigan Press.

- Cárdenas, J. C. and E. Ostrom. 2004. What Do People Bring into the Game? Experiments in the Field about Cooperation in the Commons. *Agricultural Systems* 82(3):307–326.
- Carnap, R. 1947. *Meaning and Necessity: A Study in Semantics and Modal Logic*. Chicago: University of Chicago Press.
- Crawford, S. and E. Ostrom. 1995. A Grammar of Institutions. *The American Political Science Review* 89(3):582–600.
- Denzau, A. T. and D. C. North. 2000. Shared Mental Models: Ideologies and Institutions. In *Elements of Reason: Cognition, Choice, and the Bounds of Rationality*, eds. A. Lupia, M. D. McCubbins, and S. L. Popkin, 23–46. San Diego: Cambridge University Press.
- Downs, A. 1957. An Economic Theory of Political Action in a Democracy. *The Journal of Political Economy* 65(2):135–150.
- Gibson, C., M. McKean, and E. Ostrom, eds. 2000. *People and Forests: Communities, Institutions, and the Governance of Forests*. Cambridge: MIT Press.
- Gordon, H. S. 1954. The Economic Theory of a Common-Property Resource: The Fishery. *Journal of Political Economy* 62:124–142.
- Hardin, G. 1968. The Tragedy of the Commons. *Science, New Series* 161(3859):1243–1248.
- Hardin, R. 1971. Collective Action as an Agreeable n-Prisoners' Dilemma. *Behavioral Science* 16(5):472–481.
- Hauser, M. D. 2006. *Moral Minds: How Nature Designed Our Universal Sense of Right and Wrong*. New York: Ecco/Harper Collins.
- Hofstadter, D. R. 1979. "...Ant Fugue", en Gödel, Escher, Bach: An Eternal Golden Braid, ed. D. R. Hofstadter, 310–336. Nueva York: Basic Books.
- Holland, J. H., K. J. Holyoak, R. E. Nisbett, and P. R. Thagard. 1986. *Induction: Processes of Inference, Learning and Discovery*. Cambridge: Bradford Books/ MIT Press.
- Janssen, M. A. and E. Ostrom. 2006. Empirically-Based, Agent-Based Modeling of Social-Ecological Systems. *Ecology and Society* 11(2):1–13.
- Kiser, L. and E. Ostrom. 1982. The Three Worlds of Action: A Metatheoretical Synthesis of Institutional Approaches. In *Strategies of Political Inquiry*, ed. E. Ostrom, 179–222. Beverly Hills: Sage Publications.
- Kitch, P. 1993. *The Advancement of Science*. New York: Oxford University Press.
- Kuhn, T. S. 1962. *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.
- Low, B., E. Ostrom, C. Simon, and J. Wilson (2003), "Redundancy and Diversity: Do They Influence Optimal Management?", in *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*, ed. F. Berkes, J. Colding, and C. Folke, 83–114. New York: Cambridge University Press.
- Mackie, J. L. 1977. *Ethics: Inventing Right and Wrong*. New York: Viking Press.
- Moran, E. and E. Ostrom. 2005. *Seeing the Forest and the Trees: Human-Environment Interactions in Forest Ecosystems*. Cambridge: MIT Press.

- Nagel, E. 1963. Assumptions in Economic Theory. *The American Economic Review* 53(2):211–219.
- Olson, M. 1965. *The Logic of Collective Action: Public Goods and the Theory of Groups*. Cambridge: Harvard University Press.
- Ostrom, V. 1986. A Fallibilist's Approach to Norms and Criteria of Choice. In *Guidance, Control, and Evaluation in the Public Sector*, eds. F. X. Kaufmann, G. Majone, and V. Ostrom, 229–244. Berlin: Walter de Gruyter.
- Ostrom, E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge: Cambridge University Press.
- Ostrom, E. 1998. A Behavioral Approach to the Rational Choice Theory of Collective Action. *American Political Science Review* 92(1):1–22.
- Ostrom, E. 2000. Collective Action and the Evolution of Social Norms. *Journal of Economic Perspectives* 14(3):137–158.
- Ostrom, E. 2002. Policy Analysis in the Future of Good Societies. *The Good Society* 11(1):42–48.
- Ostrom, E. 2003. Toward a Behavioral Theory Linking Trust, Reciprocity, and Reputation. In *Trust and Reciprocity: Interdisciplinary Lessons from Experimental Research*, eds. E. Ostrom and J. Walker, 19–79. New York: Russell Sage Foundation. (The Russell Sage Foundation Series on Trust, vol. VI).
- Ostrom, E. 2005. *Understanding Institutional Diversity*. Princeton: Princeton University Press.
- Ostrom, E. 2007. Institutional Rational Choice: An Assessment of the Institutional Analysis and Development Framework. In *Theories of the Policy Process (2nd edition)*, ed. P. A. Sabatier, 21–64. Boulder: Westview Press.
- Ostrom, E. 2009. Design Principles of Robust Property Rights Institutions: What Have We Learned? In *Property Rights and Land Policies*, eds. G. K. Ingram and Y.-H. Hong, 25–51. Cambridge: Lincoln Institute of Land Policy.
- Ostrom, E. and M. Cox. 2010. Moving Beyond Panaceas: A Multi-tiered Diagnostic Approach for Social-Ecological Analysis. *Workshop in Political Theory and Policy Analysis, Indiana University*.
- Ostrom, E. and C. Hess, eds. 2006. *Understanding Knowledge as a Commons: From Theory to Practice*. Cambridge: The MIT Press.
- Pinker, S. 1994. *The Language Instinct*. New York: Harper Perennial Modern Classics.
- Poteete, A. R. and E. Ostrom. 2004. Heterogeneity, Group Size and Collective Action: The Role of Institutions in Forest Management. *Development and Change* 35(3):437–461.
- Poteete, A. R., M. A. Janssen, and E. Ostrom. 2010. *Working Together: Collective Action the Commons, and Multiple Methods in Practice*. New Jersey: Princeton University Press.
- Rapoport, A. 1966. *Two-Person Game Theory: The Essential Ideas*. Ann Arbor: The University of Michigan Press.
- Riker W. H. 1962. *The Theory of Political Coalitions*. New Haven: Yale University Press.

- Schlager, E. and E. Ostrom. 1992. Property-Rights Regimes and Natural Resources: A Conceptual Analysis. *Land Economics* 68(3):249–262.
- Schlager, E. and E. Ostrom. 1993. Property-Rights Regimes and Coastal Fisheries: An Empirical Analysis. In *The Political Economy of Customs and Culture: Informal Solutions to the Commons Problem*, eds. R. Simmons and T. Anderson, 13–41. Lanham: Rowman & Littlefield.
- Selten, R. 1975. A Reexamination of the Perfectness Concept for Equilibrium Points in Extensive Games. *International Journal of Game Theory* 4(1):25–55.
- Sen, A. 1977. Rational Fools: A Critique of the Behavioral Foundations of Economic Theory. *Philosophy and Public Affairs* 6(4):317–344.
- Sidgwick, H. 1962. *The Methods of Ethics*. Chicago: University of Chicago Press.
- Smith, V. 2000. *Bargaining and Market Behavior: Essays in Experimental Economics*. New York: Cambridge University Press.
- Walker, J. M. and E. Ostrom. 2003. Conclusion. In *Trust and Reciprocity: Interdisciplinary Lessons from Experimental Research*, eds. E. Ostrom and J. Walker, 381–388. New York: Russell Sage Foundation. (The Russell Sage Foundation Series on Trust, vol. VI).
- William, H. R. 1962. *The Theory of Political Coalitions*. New Haven: Yale University Press.