Optimization-Based Explanations

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Abstract

This article argues that evolutionary models based on selection validate, under appropriate conditions, the relevance of optimality as an explanatory mechanism in rational choice theory. The reason is that these frameworks share the mechanism that drives the results, namely, optimization, even if they situate it at different levels. The consequences of our argument are twofold. First, it resolves the tension between those predictions of rational choice theory that are accurate and the evidence showing that individuals seldom optimize. Second, it relativizes the explanatory import of rationality without diminishing the role of optimization as a mechanism.

Keywords

rationality, rational choice, optimization, evolutionary theory

1. Introduction

In the last decades, rational choice theory made significant inroads in disciplines such as economics, political science, sociology, anthropology, and law, becoming a prominent framework in the social sciences (Green & Shapiro 1996; Mäki 2009a, 2009b). The work that best epitomizes the breadth of these applications is that of Gary Becker who contended that rational choice

theory could be applied to address problems as diverse as investment in human capital, criminal behavior, drug addiction, altruistic behavior, and child rearing among others (Becker 1978).

The primary goal of rational choice models is to explain and predict human behavior from the assumption that individuals maximize their expected utility subject to their beliefs concerning the environment and the actions of other individuals. Even when rational choice theory is committed to a broad set of alternative assumptions about the nature of individual preferences and the environment in which decisions are made, the most important tenet is that individuals make decisions by means of an optimization mechanism.[1] Yet, extant experimental evidence shows that in certain kinds of circumstances, decision makers fail to optimize (Kahneman and Tversky 1979; Schoemaker 1982). In spite of this, the rational choice model is still capable of yielding reasonably sound predictions in a wide variety of contexts (Levine 2009).

An important strand of criticism purports to show that rational choice theory lacks secure empirical foundations. For instance, Green and Shapiro (1996, 6) argue that despite its increasingly sophisticated theoretical machinery, rational choice theory has provided few testable hypotheses:

> We do not dispute that theoretical models of immense and increasing sophistication have been produced by practitioners of rational choice theory, but in our view the case has yet to be made that these models have advanced our understanding of how politics works in the real world.

We think this point is overstated. Despite ongoing skepticism, rational choice theory considerably modified the way we understand the social world. It would be difficult to approach actual political behavior without resorting to concepts such as free-riding, pork barreling, vote trading, opportunistic shirking, minimal winning coalitions, just to mention a few of them. These notions were coined within the context of rational choice theory and would be useless if the theory of rational choice was not empirically relevant.

In this article, we take a different tack. We do not dispute the predictive power of rational choice theory, and we agree that agents sometimes fail to optimize. Rather we try to conciliate the predictive power of the theory with the existence of deficient optimizers. We contend that the mechanism of

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[1]The term "optimization" may indicate either a mechanism or an outcome. In this article, we are concerned with optimization as a mechanism or process. Therefore, unless otherwise stated, the term "optimization" refers to the process that selects the best choice.

optimization, although essential for supporting rational choice predictions, need not be implemented at the individual level. Consider selection mechanisms operating at the population level as modeled by evolutionary theory. They are also capable of yielding optimal behavior at the aggregate level, as predicted by rational choice theory. Both theories agree in postulating an optimizing mechanism, but they disagree on its *location*. Whereas rational choice theory assumes that the process of optimization takes place at the individual level, natural selection locates the optimization mechanism at the population level.

To develop our argument, we proceed as follows. In Section 2, we present an overview of the rational choice model. In Section 3, we discuss two ways in which evolutionary models can be used to validate the implications of rational choice theory, taking as illustrations the neoclassical theory of the firm and mainstream evolutionary game theory. In Section 4, we qualify the conditions for the application of evolutionary theorizing in the social sciences. Finally, we conclude the article by summarizing the results.

2. Rational Choice Theory

Rational choice theory deals with decision making performed by individuals in more or less ideal conditions. These ideal conditions concern the psychology of the decision makers as well as the structure of the environment and their knowledge of it. The core model consists of a set of available actions leading to different outcomes, which the individual prefers to different extents. In the simplest model, each action leads to only one possible outcome. In more complex models of the environment, actions lead to a set of outcomes whose occurrence is governed by a probability measure that satisfies standard conditions. Outcomes are sometimes subject to the decisions of other individuals, in which case risk is strategic. Whereas the first scenarios are instances of individual decision making, the last belong to the realm of game theory.

The theory of rational choice addresses individual decision making in different contexts. Decision makers are typically assumed to have the capacity to choose the most effective action given well-ordered preferences for possible outcomes. This capacity usually involves the aptitude to weigh the pros and cons of every course of action and in the case of expected utility theory, the ability to assess risky prospects and actions. Furthermore, decision makers are supposed to be able to order their preferences for lotteries and outcomes in a stable and coherent manner (Hausman 2011; Sánchez-Cuenca 2008). In some setups, individuals are endowed with an exogenously given utility function, which presupposes the capacity to assess the intensity of

preferences for outcomes in absolute terms, whereas in other setups, individuals are only assumed to ordinally rank their preferences.[2] In any case, rational choice theory is capable of deriving important empirical predictions from a relatively parsimonious description of individual's objectives, preferences, and constraints.

Rational choice theory critically hinges on individuals' capacity for making optimal decisions. Herbert Simon (1956) challenged this assumption with the notion of bounded rationality. According to Simon, individual decision making is informationally and computationally constrained. As information processing is a costly endeavor, decision makers use simple heuristics to cope with the environment. For instance, in the presence of incomplete knowledge about alternatives ahead of time and limited forecasting capacity, individuals stop searching for options as soon as they find an alternative that satisfices their aspirations (Simon 1956). Empirical evidence shows that these heuristics are often adapted to their environment and use available information efficiently (Gigerenzer and Selten 2002).

Beyond the empirical and theoretical setbacks concerning proven failures in optimization, the rational choice model was nevertheless quite powerful in providing robust explanations of significant social phenomena (Clarke and Primo 2007). Examples abound. Free-riding phenomenon is widespread in social life, and it is rightly illuminated by rational and strategic considerations (Olson 1965). End-game defections are extremely common in a wide variety of social interactions. Legal contracts are a good illustration of this effect, and it clearly responds to the predictions of rational choice theory. As it is well known in the law and economic literature, legal contracts are especially devised to avoid this kind of opportunistic behavior and enable players to commit themselves to a mutually advantageous agreement (Cooter and Ulen 2003).

The ability to explain a wide range of phenomena in a parsimonious way raises the question as to the source of this success. Instead of engaging with this paradox, a common reaction favored by many friends of the rational choice model was to endorse instrumentalism to rescue the theory from the critique launched against its assumptions. Instrumentalism downplayed the pressures to provide a plausible account of the decision-making process, by focusing instead exclusively on the predictive success of the theory (Schoemaker 1982). In this article, we present an alternative strategy to deal with this problem.

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[2]We do not distinguish between different expected utility variants because they are not relevant for our argument. For a discussion on this matter, see Schoemaker (1982).

3. Population and Individual Optimization

As stated in the previous section, a major methodological challenge is to substantiate the predictive and explanatory potential of rational choice theory, despite the fact that agents fail to optimize. This objection might be accepted as a matter of psychological accuracy, but it is nevertheless insufficient to dismantle the explanatory power of rational choice theory at the population level. Our main contention is that the mechanism of natural selection provides a way to circumvent the problem of individual optimization by shifting the focus of analysis to a population level.

In this section, we illustrate our argument with two examples. The first one is Milton Friedman's defense of the predictive power of the neoclassical theory of the firm. The second one is the adoption of evolutionary game theory as a new foundation for the concept of Nash equilibrium. Whereas the first example concerns exchanges involving a considerably large numbers of decision units, the second covers the case of strategic interactions among a limited number of players. Both cases are crucial to show how the optimization mechanism posited by rational choice theory may lead to the same results as the evolutionary model at a population level.

3.1. Friedman's Neoclassical Theory of the Firm

The neoclassical theory of the firm derives the output supply, the input demands, and the size of the firm from the assumption of profit maximization subject to a given technology and a budget constraint. It has been claimed that this theory lacks empirical validity for two main reasons. First, firm managers rarely know the precise form of the production function and second, even if they knew it, they do not pursue such optimization strategies. Milton Friedman was one of the first economists to propose an alternative foundation for the theory of the firm based on selective mechanisms. He argued that regardless of whether this theory provides an accurate description of output decision processes by managers, those firms that consistently failed to choose the profit maximizing output quantity would have to quit the market sooner or later.[3]

> Let the apparent immediate determinant of business behaviour be anything at all—habitual reaction, random chance or what not. Whenever this determinant

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[3]It should be acknowledged that Armen Alchian, already in 1950, resorted to evolutionary arguments based on mutation and selection to avert criticisms to neoclassical microeconomic theory's postulate of profit maximization in the face of uncertainty. However, his suggestion lacked the impact of Friedman's argument 20 years later.

happens to lead to behaviour consistent with rational and informed maximization of returns, the business will prosper and acquire resources with which to expand; whenever it does not the business will tend to lose resources . . . [G]iven natural selection, acceptance of the hypothesis [of maximization of returns] can be based largely on the assumption that it summarizes appropriately the conditions for survival. (Friedman 1953, 22)

There are different ways to interpret Friedman's suggestion. One option is to analyze it as giving support to the defense of mainstream neoclassical theory based on its predictive power. Much of the debate on Friedman's position has followed this line of interpretation, by focusing on the acceptability of instrumentalism (see Lehtinen and Kuorikoski 2007; Mäki 2009b; Schoemaker 1982 for a general discussion on this issue). In this article, however, we suggest a new synthesis. We take Friedman's insight as opening the path for an evolutionary analysis of economic behavior through natural selection by displacing the optimization process from the individual to the population. Note that this analysis does not necessarily entail instrumentalism. We do not claim that rational choice theory is valid regardless of the soundness of its assumptions. We rather contend that its explanatory power is a consequence of the fact that optimization works at the population instead of at the individual level.

To illustrate this point, consider a mainstream model of evolution based on selection, replication, and variation. The selection mechanism excludes some phenotypes or behaviors and retains others according to their ability to deal with the environment. Variation in phenotypic traits provides relevant material for selection to operate, and replication makes the evolutionary change cumulative.[4] The concomitant presence of these factors is neither necessary nor sufficient to produce cumulative change, let alone to capture all cases of evolution by natural selection (Godfrey-Smith 2009). Yet it is useful to illustrate our argument.

When applied to Friedman's theory of the firm, variation results from differences in performance deriving from the availability of idiosyncratic resources such as human and nonhuman capital, governance structure, organizational culture, and so on. As for replication, routines and other kinds of recurrent procedures in organizations provide vehicles for the persistence of behaviors (Nelson and Winter 1982). Extant behaviors and novel ones determine the relative fitness of firms, and competition within the market place provides the setup in which selection operates.

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[4]The notion of replication was introduced by the biologist George C. Williams (1966) and later adopted by Richard Dawkins, to refer to nearly perfect copying.

To illustrate the mechanics of selection, consider a population of firms competing in a market environment. Assume that these firms differ in terms of their abilities to generate profit, which in turn, depend on their routines and skills (Nelson and Winter 1982). Under these circumstances and to the extent that routines and skills persist over time, some firms will tend to outperform others. If we further assume a limited market capacity, we will observe that some behaviors or routines will increase their share in the population while others will be eliminated. As long as underperforming firms exit the market and new routines are adopted (either by mistake or because firms adopt new behavior), there will be a tendency toward optimal outcomes. Although individual firms do not implement optimizing procedures, competition among them will lead to the selection of optimal behavior at the aggregate level.

The assumptions of this model are not always satisfied in real-world markets. For instance, the existence of financial buffers or other similar mechanisms may mitigate the effects of selection upon underperforming units. This notwithstanding, the forces of selection are likely to prevail in the long run. The existence of a competitive environment, in which new entrant firms challenge incumbent ones, increases selective pressures and leads eventually to the exit of nonprofitable firms (Nelson and Winter 2002).

The assumption concerning the replication of behaviors means that perfect copying occurs most of the time. In real settings, however, perfect copying need not be the norm. Organizational procedures may be miscopied because of implementation errors and changes in the context of application, or because of their inherent complexity and ambiguity. In the first case, the source of imperfect copying is random, whereas in the second it is systematic. Furthermore, the deliberate *exploration* of the phenotypic landscape undertaken by organizations in search for more adaptive routines is another source of imperfect copying and consequent variation. Yet the existence of bounded resources imposes a limit to the adoption of novel routines and reinforces the retention or *exploitation* of already adopted behaviors (March 1991). As we explain in Section 4, this standard assumption is not required for natural selection to occur.

The mechanism illustrated in this section depends on the combined effects of selection, variation, and replication. The strength with which these factors operate in the real world varies from case to case. However, there is a wide range of parametric conditions concerning these forces capable of producing cumulative change via selection (Godfrey-Smith 2006, 2009). In this section, we have specified conditions under which market interactions converge to optimal behavior, even when individual units fail to use optimizing procedures. We do not contend that all market exchanges will lead to optimal behavior through the mechanism just described. We rather provide an

existential claim, by describing an environment in which the combined strengths of selection, variation, and replication lead to optimal behavior.

3.2. Evolutionary Game Theory

The theory of games deals with individual behavior in strategic scenarios. It revolves around the concept of Nash equilibrium, defined as a set of strategies, one for each player, such that each strategy is a best response to the strategies used by the opponents. John Nash (1950) provided two interpretations of his equilibrium concept. According to the first interpretation, rational individuals who have common knowledge of the full structure of the game and of their rationality would discover such a profile before playing the game for the first time by introspection. According to the second interpretation, the so-called mass-action interpretation, the game in question is played over and over again by individuals who are not necessarily rational, in the sense of optimizing behavior subject to beliefs, and who need not know the structure of the game. As Nash (1996, 32) puts it,

> It is unnecessary to assume that the participants have full knowledge of the total structure of the game, or the ability and inclination to go through any complex reasoning processes. But the participants are supposed to accumulate empirical information on the relative advantages of the various pure strategies at their disposal.

The introspective interpretation of Nash equilibrium is the one that became dominant, and this prompted a new set of challenges. The reasons are two-fold. On one hand, the concept of Nash equilibrium does not specify any mechanism for the formation of beliefs regarding the play of the opponents (Nash 1950). On the other hand, it is not susceptible of being modeled as a dynamic process. As a matter of fact, Nash equilibrium came to be justified in terms of deviations. According to this rationale, Nash equilibrium is a good guess at how rational players are expected to play on the grounds that if they were told that their opponents intended to play their parts, they would have no incentives to play otherwise. If the notion of Nash equilibrium involves a process at all, it does so in the minds of the players who are assumed to engage in individual introspection and optimization. As the players do not interact, they lack any information to form and update beliefs.

This logic was further challenged by the existence of multiple Nash equilibria, because the concept offered no grounds to justify the choice between them. Game theorists approached this problem by strengthening the conditions for rationality and imposing additional structure, an approach that gave

birth to the so-called equilibrium refinement literature. Most refinements tightened rationality requirements by assuming that players, in addition to optimization, engaged in sophisticated chains of introspective reasoning and counterfactual reasoning (Binmore 1987, 1988).[5] The existence of diverse game structures—in terms of the sequences of their interactions, publicly known information, and payoffs—naturally led to a profusion of refinements and criteria to justify them. In the end, the body of refinements became markedly ad hoc and, to some extent, internally inconsistent (Fudenberg and Levine 1998; Kuechle 2009; van Damme 1987).

Not only for theoretical but also for empirical reasons, it became clear that the refinement literature had produced unsatisfactory solutions to the problem of equilibrium selection and that the field needed new foundations (Binmore 1987; Fudenberg and Levine 1998). Experimental studies demonstrated that in certain types of games, individuals fail to play both Nash equilibria and its refinements even when they conform to them in other games (Camerer 2003; Levine 2009). For instance, individuals fail to play Nash equilibria in games that involve social preferences, altruism, and fairness (Fehr and Schmidt 1999; Güth, Schmittberger, and Schwarze 1982). Yet they perform remarkably close to it in competitive environments such as market entry games (Rappoport et al. 1998). Furthermore, when given the opportunity to learn through repeated play, experimental evidence shows remarkable learning rates across trials (Fudenberg and Levine 1998).

Experimental studies and evidence from the field attest to the fact that equilibrium is an important phenomenon in the biological world, which often lacks any form of individual-level rationality (Maynard Smith 1982; Sigmund 1993). Consider, for instance, Milinski's experiments with stickleback fish (Sigmund 1993). Facing the problem of choosing between different sources of supply in the presence of other stickleback, the fish distributed themselves in proportion to the relative strength of the food sources. Furthermore, within a few minutes, they relocated in response to changes in the feeding rates of the different sources (Sigmund 1993). Such regularities came to be explained with the analytical tools of evolutionary game theory.

Evolutionary game theory focuses on the long-run dynamics of behaviors when their fitness depends on their frequency in the population (Maynard Smith 1982). In the case of the stickleback fish for instance, the fitness of visiting a given food source decreases with the frequency of visitors (or fish adopting that behavior). The proportion of fish exploiting each feeding source

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[5]An exception is the concept of "focal points" proposed by Thomas Schelling (1960) that relies on individuals' capacity to identify salient and prominent solutions.

evolves through a process of trial and error and stabilizes after the gains from switching are exhausted. To predict the circumstances under which such frequency-dependent behaviors are prone to persist, disappear, or coexist, evolutionary game theory assumes a certain amount of phenotypic variation, a mechanism of selection over phenotypes and a rule of replication (Samuelson 2002).

The typical replication rule, namely, the replicator dynamics, establishes that the frequency of a strategy in a population changes according to how the expected fitness of an individual who adopts it compares with the average fitness of the population (Bergstrom 2002; Maynard Smith 1982; Samuelson 2002). In other words, the strategies or behaviors whose expected fitness outperforms the average fitness of the population increase their frequency. In evolutionary biology, the replicator dynamics assume that organisms with above average fitness reproduce at a higher rate, that is, leave more offspring. In cultural-evolutionary models, the replicator dynamics assume that more people will adopt behaviors whose expected fitness exceeds the average fitness of the population. In these models, individuals revise their strategies periodically and at the end of each review process, they switch to a strategy with a higher expected fitness if their current behavior yields below average fitness (Alexander 2007).

There is an ample array of individual behaviors leading to dynamics in which the frequency of a strategy grows in proportion to how well the strategy is doing relative to the mean population payoff. Among such individual behaviors, we find those based on social learning and imitation as well as learning rules that best respond to opponents' past play by reinforcing successful behaviors (Fudenberg and Levine 1998). Another group of rules or heuristics compatible with the replicator dynamics are those in which individuals satisfice. In some contexts, individuals' degree of satisfaction is related to the current average payoff in the population and in others to the current lowest payoff (Alexander 2007; Bjornerstedt 1995). Empirical evidence shows that these heuristics are particularly adequate in settings in which individuals are boundedly rational (Gigerenzer 2000).

In evolutionary game theoretic models, equilibrium emerges as the long-run outcome of a series of repeated interactions among less than fully rational players. Although players adopt extremely simple heuristics, the dynamics may match the long-run behavior of models in which players strive for optimality over time. Even when evolutionary considerations do not fit well with the environment of certain games—notably those that lack a large time frame and are played by small populations—they may provide solid foundations for the emergence of nearly optimal behavior. We analyze this issue further in the next section.

	A	B
S1	(2, 2)	(5, 1)
S2	(0, 0)	(5, 1)

Figure 1. Weakly dominated strategies.

4. Disclaimer

We have argued that evolutionary dynamics may converge to the same equilibria as a population of optimizing players. As stated before, the success in attaining optimal behavior at the aggregate level depends on different factors—the pace of adjustment, the peculiarities of the replication process, the existence of enough variability in the phenotypic population, as well as on the strength of selective forces. In real settings, the resulting dynamics of behaviors will depend on the combined effect of a myriad of factors. In this section, we discuss this issue in detail.

Consider, for instance, the case of weak selective pressures due to the existence of financial buffers. In their presence, firms and organizations will have enough capital to remain in the population despite their suboptimal performance. If we further assume that routines are perfectly copied, then suboptimal behaviors will persist. Notice that commonplace evolutionary models are not committed to the exclusion of any single underperforming firm or behavior, but rather to the claim that the average fitness of the population will increase over time. Organizations may be able to avoid immediate exit, yet as their financial situation worsens, it will become more difficult to gain access to additional resources. In the long run, unfit organizations will exit the market, yet this effect may take time to occur.

In the domain of strategic interaction, weakly dominated strategies might be resilient, despite the existence of severe selective pressures favoring their exclusion. If this is the case, then eventually underperforming behavior need not be eliminated. Consider, for instance, the game in Figure 1. The row player has two possible strategies, namely, S_1 and S_2. The column player has strategies A and B. S_1 weakly dominates S_2 and the Nash equilibria are given by (S_1, A) and (S_2, B). The problem with (S_2, B) is that as long as player 2 does not play A, the inferiority of S_2 is not uncovered. In a model of individual decision making, we could think of A and B as states of nature, so that player 2 can be thought of as an exogenously given environment randomizing between A and B. S_1 is a superior strategy and S_2 cannot be observed in a population of optimizing individuals as long as A occurs with a positive probability (of course, if A occurs with a probability of zero we can expect S_2 to

be played as well). This simple example illustrates the constraints that may hinder selective pressures from yielding optimal behavior. Nevertheless, if mistakes or mutations occur from time to time, so that A is played with a positive probability, then S_2 can be expected to disappear as well.

Consider now the role of replication models of cultural evolution. It has been claimed that imperfect transmission of cultural practices represents a problem for evolutionary dynamics of social interactions (in fact, fidelity in replication is the exception rather than the norm). This notwithstanding, Henrich, Boyd, and Richerson (2008) argue that many conditions that guarantee replication and variation are not necessary for cumulative adaptive evolution to occur and that biased transmission can lead to accurate copying at the population level, even if the transmission process is inaccurate and error prone at the individual level (Henrich and Boyd 2002; Henrich et al. 2008). The reason is that individuals' psychological propensity for conformist adoption of behaviors—to wit, the imitation of the most frequent behavior in the population—may counterbalance the effects of noisy transmission at the individual level allowing for cumulative adaptation to occur (Henrich et al. 2008). Furthermore, even in cases of inaccurate copying, prestige-biased transmission may buttress the evolutionary process. The distinctive feature of this mechanism is that it takes as input neither the average nor the modal behavior currently available in the population but rather the behavior performed by prestigious individuals. In a nutshell, although inaccurate transmission might hinder the process of evolutionary change, it does not necessarily follow that without replication there is no possibility of cumulative evolution. Conformist and prestige-biased transmission reinforce selective pressures at the population level because they increase the probability that successful behaviors pass to the next generation.[6]

There is another caveat that constrains the scenarios in which evolutionary models and rational choice theory are functionally equivalent. Selection is essentially myopic and operates by "chance and necessity" (Monod 1973): While mutations are random, the retention of these mutations is not (Elster 1979). Furthermore, selection mechanisms have no foresight; they take actual fitness as inputs and disregard future payoffs in stark contrast with optimization mechanisms characteristic of rational choice, such as backward induction. For this reason, rational choice models can account for time-consistent behavior in a way that is foreclosed to natural selection models.

This has important implications for the attainment of global as opposed to local maxima in evolutionary dynamics. Jon Elster (1979, 6) made this point very clearly: Within the evolutionary context,

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[6]Godfrey-Smith (2009, 33) illustrates this point with a model of biological evolution.

the population climbs along a fitness-gradient until it reaches a point from which all further movement can be downward only; and there it comes to a halt. For a given initial state, several local maxima may be accessible, the choice between which depends upon the random order in which the mutations happens to occur.[7]

Individual forward-looking optimization, however, can attain global maxima, but this need not be so. As it is well known in mainstream game theory, optimal behavior at the individual level might nevertheless lead to a local maximum as it happens with suboptimal social outcomes.

Finally, it is necessary to mention that in situations characterized by low complexity and well-understood cause–effect relationships, economic agents can be expected to engage in complicated reasoning and adopt a forward looking—instead of a myopic—frame, especially if there is a lot at stake. In many cases, the existence of social norms and the availability of background information may allow players to make informed decisions. In these cases, models of rational choice are likely to provide a more accurate representation of the phenomenon at hand than evolutionary models based on simple heuristics.

5. Conclusion

In this article, we argue that evolutionary models based on selection mechanisms provide an alternative foundation to the assumption of individual optimization as postulated by the theory of rational choice. We do not argue that evolutionary models should be taken as a substitute for the theory of rational choice. As we explain in the previous section, there are situations in which both frameworks yield different predictions. Our claim instead is that selection models validate, under appropriate conditions, the explanatory role and the relevance of optimization.

We claim that the reason for this effect is that the two frameworks share the mechanism that drives the results, namely, optimization, even when they place it at different levels. The consequences of our argument are twofold. First, it resolves the tension between the accurate predictions of rational choice and the empirical findings showing that individuals seldom optimize. Second, it relativizes the role of rationality without diminishing the role of optimization in the explanation of behavior.

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[7]Random drift, for instance, may cause evolutionary dynamics to get stuck at local optima. Likewise it may also help the dynamics to get unstuck from them.

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