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by

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A Non-Bayesian Approach to (Un)Bounded Rationality

Werner Güth*

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Abstract

Can one define and test the hypothesis of (un)bounded rationality in stochastic choice tasks without endorsing Bayesianism? Similar to the state specificity of assets, we rely on state-specific goal formation. In a given choice task, the list of state-specific goal levels is optimal if one cannot increase the goal level for one state without having to decrease that for other states. We show that this allows to relate optimality more easily to bounded rationality where we interpret goal levels as aspirations. If for the latter there exist choices satisfying all state-specific aspirations and if one such choice is used, we speak of satisficing which may or may not be optimal.

JEL classification: B4, D81, D10

Keywords: Satisficing, bounded rationality, optimality

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1. Introduction

Ever since von Neumann and Morgenstern (1944), economists seem to identify the rational choice approach in risky decision tasks with maximizing expected utility. What we suggest here is a more basic testable definition of rationality which does not endorse probability weights of payoffs where payoffs are understood as utilities in case of rational choice and aspirations when trying to define bounded rationality.

The simple idea is that the decision maker is not assumed to generate an overall evaluation of choices but rather a list of payoffs, one for each possible event (state of the world). Similar to the idea of state-specific assets, we assume that the decision maker aims at state-specific goal levels without necessarily aggregating them as in expected utility theory.

It will be argued that this non-Bayesian approach allows for a more obvious transition from bounded to unbounded decision rationality (see Simon, 1955) and to test both without having to consider risk attitudes as, for instance, captured by the curvature of the utility of money curve.

2. Defining (un)bounded rationality in stochastic choice tasks

Let $S = \{S_1, \dots, S_n\}$ with $n \geq 1$ denote the finite set of states S_i . When selecting a choice alternative, possibly a multi-dimensional choice vector, the decision maker does know the set S but not which state $S_i \in S$ will occur. We do not endorse any prior governing the selection of a state $S_i \in S$, but assume that all n states are (expected to be) possible.

A payoff profile $U = (U_i)_{1 \leq i \leq n}$ is a vector of payoffs U_i , one for each state $S_i \in S$. We refer to $U(c) = (U_i(c))_{1 \leq i \leq n}$ as the payoff profile, implied by the choice c . Payoff is interpreted as (material) success like profit when the decision maker is

a firm. When speaking of optimality it is assumed that utility is monotonically increasing in success. For a given choice set $C \neq \emptyset$, we say that $c^* \in C$ is optimal if there exists no alternative choice $c \in C$ such that $U(c) \geq U(c^*)$ and $U(c) \neq U(c^*)$, i.e., no component $U_i(c)$ of $U(c)$ is smaller and at least one is larger than the corresponding component $U_i(c^*)$ of $U(c^*)$.

Clearly, in deterministic choice tasks with $n = 1$, this definition coincides with utility maximization. If for $n \geq 2$ and any generic prior on S the choice $c^* \in C$ maximizes the expected utility over the given choice set C , it is also optimal. The reverse, however, does not hold, simply because the definition of optimality does not require a prior which is so crucial when maximizing expected utility. We therefore speak of a non-Bayesian - in the sense of a prior-free - definition of optimality in case of $n \geq 2$. As efficiency in case of non-transferable utilities¹, optimality, in this basic sense, will usually imply a large set of optimal payoff constellations U . Only when selecting one of them, the decision maker encounters the tradeoff whether to demand more in one state at the cost of getting less in other states.

When referring to bounded rationality, we rely on payoff profiles $A = (A_i)_{1 \leq i \leq n}$ whose components are aspirations rather than utilities, meaning that A_i is what the decision maker wants to achieve in state $i = 1, \dots, n$ and that we rely on satisficing rather than optimizing. For an aspiration profile A we say that it is satisfiable if there exists some choice $c \in C$ with $U_i(c) \geq A_i$ for all states $i = 1, \dots, n$, i.e., the actual payoffs $U_i(c)$ of some choice c guarantee the aspiration levels A_i in all states i . Satisfiability in this sense does not require that the decision maker is aware of all possible choices $c \in C$ nor, when knowing C , would compare all alternatives c in C . All what is needed is that he can find one choice $c \in C$ which meets the satisficing condition $U_i(c) \geq A_i$ for $i = 1, \dots, n$.

A decision maker with a satisfiable aspiration profile A is said to be satisficing when using a choice $c \in C$ for which $U_i(c) \geq A_i$ holds for all states $i = 1, \dots, n$.

¹To illustrate the analogy assume that the uncertainty results from deciding behind the veil of ignorance, i.e., from not knowing (yet) one's role in a society with several potential roles. Then state-specific payoffs represent what one would get in the different roles of society and optimality in our sense is equivalent to (Pareto) efficiency.

If $c^* \in C$ is an optimal choice in the sense defined above, we say that the payoff profile $U(c^*) = (U_i(c^*))_{1 \leq i \leq n}$ generated by it is an optimal aspiration profile. The set of satisfiable aspiration profiles obviously contains the set of optimal aspiration profiles as a proper subset. Optimality is thus a refinement of bounded rationality in the sense of satisfiability.

It is one thing to define what is meant by (un)bounded decision rationality but quite another task how to derive behavior which is (un)boundedly rational. Here we simply abstract from computational (optimal choices can be derived by assuming sufficiently modest payoffs for $n - 1$ states and maximizing the payoff for the remaining state) or procedural (like aspiration formation, search for satisficing choices, aspiration adaptation, see for the latter Sauermann and Selten, 1962) aspects of optimal or boundedly rational choice making (for a much broader discussion, see Simon, 1955, Selten, 1998, Güth, forthcoming), Berninghaus, Güth and Kliemt, 2006).

3. Discussion

One main advantage of our more basic definition of (un)bounded rationality is its non-Bayesian aspect. Although it is essential that we deal with uncertainty, when $n \geq 2$, no prior probabilities for the states in S are required. Another advantage is that our definition of (un)bounded rationality can be tested more easily. If the decision maker uses some choice $c \in C$ which is not optimal, i.e., there exist $\hat{c} \in C$ with $U(\hat{c}) \geq U(c)$ and $U(\hat{c}) \neq U(c)$ (at least one component of $U(\hat{c})$ is larger and no component of $U(\hat{c})$ is smaller than the corresponding component of $U(c)$), this contradicts optimality.

Satisfiability, of course, requires aspiration data $A = (A_i)_{1 \leq i \leq n}$ rather than choice data. If there exists no $c \in C$ such that $U_i(c) \geq A_i$ for all $i = 1, \dots, n$, satisfiability is clearly rejected. To test satisficing, we cannot only rely on aspiration data but need also choice data. Here we would reject the satisficing hypothesis when either

A is not satisfiable or, when it is satisfiable, the actual choice $c \in C$ does not guarantee $U_i(c) \geq A_i$ for all states $i = 1, \dots, n$.

To rely on aspiration data $A = (A_i)_{1 \leq i \leq n}$ rather than choice data may be considered as strange. Earlier empirical, usually experimental studies of satisficing behavior have mostly estimated aspiration levels from choice data rather than testing satisfiability with the help of A -data or even the satisficing hypothesis with the help of aspiration and choice data. But the fact that A -data were hardly ever elicited directly does not mean that this cannot be done. Let us therefore close our discussion by briefly reporting how one can experimentally elicit aspiration and choice data.

Consider a stochastic choice task as described above and assume that this is experimentally implemented, i.e., the participant knows the sets S and C and the payoff function $U(c, S_i) = U_i(c)$ for all $i = 1, \dots, n$ and $c \in C$. To elicit aspiration data, the participant is asked for both

- an aspiration profile $A = (A_i)_{1 \leq i \leq n}$ and
- a choice $c \in C$.

Given these decisions (A, c) , he is paid as follows: if state $i = 1, \dots, n$ results, his monetary earning is A_i if $U_i(c) \geq A_i$, otherwise he earns nothing (where we assume $U_i(c) > 0$ for all $i = 1, \dots, n$ and $c \in C$).

Clearly, rationality would require an optimal choice $c^* \in C$ and the corresponding optimal aspiration profile $A = U(c^*)$, i.e., we can test the rationality hypothesis either by aspiration or by choice data whereas to test satisfiability one has to rely on aspiration data. In case of satisfiability, one additionally needs choice data to test satisficing.

This shows that employing the idea of state-specific goals, in the sense of utility or aspiration levels, not only allows for a more basic notion of (un)bounded decision rationality but also for new ways of testing such concepts of (un)bounded

rationality. For actual experimental studies, we refer the reader to Güth et al. (mimeo) who explore a stochastic choice task, using the incentivizing method described above, and Berninghaus et al. (2006) who analyze a strategic setting with uncertainty.

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