Bounded Rationality and Macroeconomics

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Session 1

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OFFICE HOURS Tuesday, 2:15–3:45 p.m., room 334

Overview

Part 1: Discussion of the article by Conlisk (1996)

Part 2: Introduction

1. The origins of "bounded rationality"
2. Some background information on Herbert A. Simon

Part 3: Review of the standard rationality concept in economics

1. Decision making *process* is not being modelled, only its outcome
2. The "as if" justification

Part 2 Introduction

The term "bounded rationality" was coined in the 1950s by Herbert A. Simon (1916–2001).

Seminal articles: Simon (1955 and 1956).

Studied political science at the University of Chicago (B.A., 1936; Ph.D., 1943). However, educated himself also in economics, advanced mathematics, symbolic logic, and mathematical statistics (see Simon, 1992).

Researcher in artificial intelligence, psychology, administration and economics—which won him numerous prizes, among them the most renowned ones of the respective disciplines:

On Herbert A. Simon

1975 A.M. Turing Award in computer science;
1978 Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel ("Nobel Prize in Economics");
1986 National Medal of Science;
1993 American Psychological Association Award for Outstanding Lifetime Contributions to Psychology.

Simon held research and faculty positions at the University of California, Berkeley); Illinois Institute of Technology; and since 1949, Carnegie Mellon University.

At CMU, he was Richard King Mellon University Professor of Computer Science and Psychology.

On the usage of the term "bounded rationality"

Over the last 50 years the term "bounded rationality" has been used to denote many, vastly different modes of behaviour—modes of behaviour that do not resemble what Simon had in mind.

Take, e.g., the book *Bounded Rationality in Macroeconomics* by Sargent (1993). In this book, the representative-agent utility maximisation approach is retained, with rational expectations being replaced by least-squares learning. That is, "one is forced to assume that ordinary people have the computational capabilities and statistical software of econometricians" (Gigerenzer and Selten, 2001).

This is totally at odds with Simon's view of "bounded rationality", as the following quotes show:

Some quotes from Simon (1955 and 1956)

Simon (1955, p. 99):

"… I shall assume that the concept of 'economic man' (…) is in need of fairly drastic revision, and shall put forth some suggestions as to the direction the revision might take.

"Broadly stated, the task is to replace the global rationality of economic man with a kind of rational behavior that is compatible with the access to information and the computational capacities that are actually possessed by organisms, including man, in the kinds of environments in which such organisms exist."

Some quotes from Simon (1955 and 1956)

Simon (1955, p. 100):

"The problem can be approached initially either by inquiring into the properties of the choosing organism, or by inquiring into the environment of choice. In this paper, I shall take the former approach. I propose, in a sequel, to deal with the characteristics of the environment and the interrelations of environment and organism."

Some quotes from Simon (1955 and 1956)

Simon (1956, p. 129):

"A comparative examination of the models of adaptive behavior employed in psychology (e.g., learning theories), and of the models of rational behavior employed in economics, shows that in almost all respects the latter postulate a much greater complexity in the choice mechanisms, and a much larger capacity in the organism for obtaining information and performing computations, than do the former. Moreover, in the limited range of situations where the predictions of the two theories have been compared (…), the learning theories appear to account for the observed behavior rather better than do the theories of rational behavior."

Some quotes from Simon (1955 and 1956)

Simon (1956, p. 129):

"Both from these scanty data and from an examination of the postulates of the economic models it appears probable that, however adaptive the behavior of organisms in learning and choice situations, this adaptiveness falls far short of the ideal of 'maximizing' postulated in economic theory. Evidently, organisms adapt well enough to 'satisfice'; they do not, in general, 'optimize.'"

Part 3 The standard rationality concept

Let $\mathbf{X}$ be a set of mutually exclusive alternatives.

Economic agents are assumed to have preferences, denoted by $\succeq$, on this set $\mathbf{X}$:

$x \succeq y$ means "x is at least as good as y".

The preference relation $\succeq$ is called *rational* if it satisfies the following two properties.

1. *Completeness:* For all $x, y \in \mathbf{X}$, $x \succeq y$ or $y \succeq x$.
2. *Transitivity:* For all $x, y, z \in \mathbf{X}$, $x \succeq y$ and $y \succeq z$ implies $x \succeq z$.

The choice rule

Let $\mathcal{B}$ be a family of non-empty subsets of $\mathbf{X}$ ("budget sets"). We call $C(\mathbf{B})$ a *choice rule* if, for all $\mathbf{B} \subseteq \mathcal{B}$,

$$C(\mathbf{B}) \subseteq \mathbf{B} \quad \text{and} \quad C(\mathbf{B}) \neq \emptyset.$$

Then, $(\mathcal{B}, C(\cdot))$ is called a *choice structure*.

Given $\succeq$, rational choice theory specifies the choice rule to be

$$C^*(\mathbf{B}, \succeq) = \{x \in \mathbf{B} : x \succeq y \text{ for all } y \in \mathbf{B}\}.$$

That is, $C^*(\mathbf{B}, \succeq)$ picks the best elements in $\mathbf{B}$ (*preference optimisation*). Assumption: $C^*(\mathbf{B}, \succeq)$ is non-empty for all $\mathbf{B}$.

The "as if" question

Imagine we observed someone's choices $C(\mathbf{B}_i)$ for different $\mathbf{B}_i$, $i = 1, \ldots, n$. We collect all $\mathbf{B}_i$ and call the result $\mathcal{B}$. Under what circumstances can we find a preference ordering $\succeq$ such that

$$C^*(\mathbf{B}, \succeq) = C(\mathbf{B}) \quad \text{for all} \quad \mathbf{B} \in \mathcal{B}?$$

That is, knowing the agent's choices $C(\mathbf{B})$ but *not knowing how* the agent derived them, can we present her behaviour *as if* she were preference-maximising?

Yes, we can—if $(\mathcal{B}, C(\cdot))$ fulfils the weak axiom of revealed preference (WARP).

The weak axiom of revealed preference

Let $\mathbf{B}_1, \mathbf{B}_2 \in \mathcal{B}$ and $x, y \in \mathbf{B}_1, \mathbf{B}_2$. The choice structure $(\mathcal{B}, C(\cdot))$ satisfies the *weak axiom of revealed preference* if

$$x \in C(\mathbf{B}_1) \text{ and } y \in C(\mathbf{B}_2) \Rightarrow x \in C(\mathbf{B}_2).$$

One can show that if

— $(\mathcal{B}, C(\cdot))$ fulfils the weak axiom and
— $\mathcal{B}$ contains all subsets of $\mathbf{X}$ up to three elements,

the choice rule $C(\cdot)$ can be *rationalised* uniquely by the preference-maximising choice rule $C^*(\mathbf{B}, \succeq)$. This is achieved through choosing the preference ordering $\succeq$ such that

$x \succeq y$ if and only if there is a $\mathbf{B} \in \mathcal{B}$ such that $x, y \in \mathbf{B}$ and $x \in C(\mathbf{B})$.

Checking consistency of people's behaviour empirically?

The argument on the previous slides was a mere thought experiment: "Imagine we observed someone's choices $C(\mathbf{B}_i)$ for different $\mathbf{B}_i$, $i = 1, \ldots, n$. …"

Could we indeed equip subjects with various budget sets and watch them choose?

Hardly! We can, however, examine whether different choice heuristics that we suspect people to use in actual decision-making fulfil the weak axiom.

Heuristics that (do not) fulfil the WARP

From now on, assume for simplicity that $C(\mathbf{B})$ is a *single element* in $C(\mathbf{B})$.

Rubinstein (1998, p. 11) states that then the following *consistency condition* is necessary and sufficient for a choice function to fulfil the rationality requirements:

> For all $\mathbf{B}_1 \subseteq \mathbf{B}_2 \subseteq \mathbf{X}$,
> If $C(\mathbf{B}_2) \in \mathbf{B}_1$, then $C(\mathbf{B}_1) = C(\mathbf{B}_2)$.

This condition is also referred to as the "independence of irrelevant alternatives".

Heuristics that (do not) fulfil the WARP

Example 1: The satisficing procedure due to Simon (Rubinstein 1998, p. 12)

Define a set of satisfactory alternatives, $\mathbf{S} \subseteq \mathbf{X}$. Apply an ordering O to the entire set $\mathbf{X}$. For any decision problem involving a subset $\mathbf{B}$ of $\mathbf{X}$, examine the elements in $\mathbf{B}$ sequentially (according to O), until you confront an alternative that is an element of $\mathbf{S}$. Stop and pick this alternative.

Add a tie-breaking rule—needed for the case that no element of $\mathbf{B}$ is an element of $\mathbf{S}$. One possibility which satisfies the consistency requirement: choosing the last element in $\mathbf{B}$.

Heuristics that (do not) fulfil the WARP

Example 2: Choice via exclusion of alternatives

Imagine a person who likes fat food but at the same time is on diet. The person seeks a compromise between the two objectives: to enjoy the food and to keep the diet. He comes up with the behavioural rule:

> "I won't choose the fattest meal on the menu."

Assume that there are two restaurants with the following menus (items ordered by fat content), respectively:

$\mathbf{B}_1$ = {salad, steak, pizza};
$\mathbf{B}_2$ = {salad, steak}.

Does ordering the second-fattest meal on the menu fulfil the WARP?

Heuristics that (do not) fulfil the WARP

Example 3: Budget allocation
(Rubinstein 1998, p. 10)

Imagine a consumer who has to allocate her income M to n goods, $x_1, \ldots, x_n$. She faces prices $p_1, \ldots, p_n$.

The consumer follows a rule of thumb and simply allocates fractions $\alpha_1, \ldots, \alpha_n$ of her income to the respective goods.

Can this behaviour be represented as preference maximisation?

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