Bounded Rationality and Macroeconomics

Winter term 2005/06
Session 2

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Overview

Review of the last session

1. The standard rationality concept
2. A "definition" of bounded rationality

Outlook to the upcoming sessions

1. What does this mean for *macro*economics?
2. Topics of the next five sessions

Part 4: Some suggestions for modelling bounded rationality

1. Rubinstein (1998)
2. Gigerenzer and Selten (2001)

Review of the last session

Definition of "rational" preferences: $\succeq$ is called *rational* if it satisfies *completeness* and *transitivity*.

Rational choice rule:

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

called *preference optimisation*.

The "as if" approach: works in some cases, *but not in general!*

Hence, it may be fruitful for economists to look at "non-rational" decision rules. The task is to find out *which* decision rules are applied *under which circumstances*.

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?

A "definition" of bounded rationality

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."

Outlook on the upcoming sessions

We have thus far considered only the very basis of rational choice theory (e.g., we have not yet introduced utility functions, uncertainty etc.). At this point, the theory is falsifiable, but still *empirically empty*.

To gain *empirical content*, the theoretical framework has to be *applied* in the form of a *model*.

That is, the empirical content of rational-choice theory stems from the numerous *additional assumptions* which actually constitute the model.

Assumptions common to rational choice models

In almost any economic rational-choice model, assumptions are (sometimes only implicitly) made on:

- the shape of the utility function [curvature, separability, (non-)differentiability];
- the number and kind of goods included;
- the available information set and the ways in which agents communicate;
- costs for and limits on acquiring and processing new information;
- expectations formation under risk/uncertainty;
- *correct* interpretation of the available information;
- anonymity of the market participants;
- and many other things …

Many ways to fine-tune models …

Consequently, also models based on "full rationality" derive widely different conclusions.

On this background, one should not expect a *unified* economic theory incorporating bounded rationality to develop (at least within the next two decades …).

Still, it is in many cases legitimate to wonder whether economics is focussing on the right components!—"It all depends …" on *what* you want to explain.

If the set of possible choices is rather obvious (e.g., only a "yes"/"no" choice) and if the set of consequences is equally clear, the standard theory may do fairly well. *Example: the tragedy of commons.*

Many ways to fine-tune models …

If, in contrast, the problem includes

- choice between numerous alternatives,
- calculation or processing of probabilities,
- uncertainty (rather than risk),
- benefits to better information,
- the possibility to communicate with other agents or
- a complicated environment (e.g., with multiple equilibria, strategic interaction, many interacting agents),

the standard model frequently runs into trouble:

- predictions do not fit field data;
- experimental evidence suggests that people's behaviour systematically violates the "rationality" axioms.

Example: Relevance of information processing

Odean (1999): "Do Investors Trade Too Much?"

1998 turnover at NYSE: 76 percent. Too high?

Theoretical models: trading volume ranges from zero (e.g., in rational expectation models without noise) to infinite (e.g., when traders dynamically hedge in the absence of trading costs).

Therefore, real-market trading cannot be simply compared to a number popping out of the model. A different way of assessing whether it is too high must be found.

Example: Relevance of information processing

The possibility used by Odean (1999): Trade is beneficial only if the return of the purchased asset is at least as high as the return of the sold asset plus trading cost. (Here, one has to exclude other motives for trade, see below.)

"The surprising finding is that not only do the securities that these investors buy not outperform the securities they sell by enough to cover trading costs, but on average the securities they buy underperform those they sell. This is the case even when trading is not apparently motivated by liquidity demands, tax-loss selling, portfolio rebalancing, or a move to lower-risk securities" (p. 1280).

Example: Relevance of information processing

"While investors' overconfidence in the precision of their information may contribute to this finding, it is not sufficient to explain it. These investors must be systematically misinterpreting information available to them. They do not simply misconstrue the precision of their information, but its very meaning" (p. 1280).

This is remarkable, since the traders examined in Odean's analysis are professionals—and not greenhorns who don't know yet what they are doing—and they are obviously not "disciplined" by the market.

Odean's (1999, p. 1284) empirical findings are presented in the table on the next slide:

Example: Relevance of information processing

Panel A: All transactions

	n	84 trading days later	252 trading days later	504 trading days later
Purchases	49,948	1.83	5.69	24.00
Sales	47,535	3.19	9.00	27.32
Difference		–1.36	–3.31	–3.32
N1		(0.001)	(0.001)	(0.001)
N2		(0.001)	(0.001)	(0.002)

Panel B: After excluding "not-for-profit" trading motives

	n	84 trading days later	252 trading days later	504 trading days later
Purchases	7,503	0.11	5.45	22.31
Sales	5,331	2.62	11.27	31.22
Difference		–2.51	–5.82	–8.91
N1		(0.001)	(0.001)	(0.001)
N2		(0.002)	(0.003)	(0.019)

Example: Relevance of information processing

A remark on "market discipline":

"It has been suggested that investors who behave nonrationally will not do well in financial markets and will not continue to trade in them. There are reasons, though, why we might expect those who actively trade in financial markets to be more overconfident than the general population. People who are more overconfident in their investment abilities may be more likely to seek jobs as traders or to actively trade on their own account" (p. 1279–80).

What does this mean for *macro*economics?

Last week: Motivation

- Why bounded rationality matters for economics.

Today: Individual decision making

- Odean's field study; findings from neuroscience.
- Suggestions by Rubinstein (1998) and Gigerenzer and Selten (2001) on modelling bounded rationality.

How?

From next week on: Application of these ideas to *macro*economic questions, e.g.

- asset pricing, portfolio diversification (weeks 3, 4);
- price setting by firms (week 5);
- Lettau and Uhlig (1999): "Rules of Thumb versus Dynamic Programming", *AER* 89(1) (week 6).

What does this mean for *macro*economics?

Open questions:

Will we really succeed to model individual decision making *processes* together with the *evolution* of the economic environment (markets, institutions)?

How do we deal with the *endogenity of institutions* (i.e., collective actions and institutions that limit or exploit mistakes made by agents)?

Example: Regulation of financial markets.

What does this mean for *macro*economics?

Open questions (cont.):

Could it be that there is *no* theory of aggregate economic activity that is empirically accurate and at the same time general, in the sense of being valid over longer periods of time as well as over many different states of the economy?

In this case, we would have to be satisfied with theories that only apply to specific situations.

Example (from Camerer, 2003): A trading firm observing that its employees exhibit the "disposition effect" swaps the traders' positions on a daily basis.

Part 4 Concepts of bounded rationality

Note that we haven't even introduced utility functions yet, not to speak of specific characteristics of these functions! (Rationality alone is not sufficient for representing preferences via a utility function.)

Still, Rubinstein (1998, p. 8) criticises the up to now rather weak requirements of rationality as already too strong, mainly based on the observation that some implicit assumptions have been made:

"Let us uncover some of the assumptions buried in the rational man procedure:

Rubinstein's criticism of the rationality concept

"*Knowledge of the problem* The decision maker has a clear picture of the choice problem he faces: he is fully aware of the set of alternatives from which he has to choose .... He neither invents nor discovers new courses of actions (the chosen x^* cannot be outside the set [of alternatives] A).

"*Clear preferences* The decision maker has a complete ordering over the entire set of alternatives.

"*Ability to optimize* The decision maker has the skill necessary to make whatever complicated calculations are needed to discover his optimal course of action. His ability to calculate is unlimited, and he does not make mistakes.

Rubinstein's criticism of the rationality concept

"*Indifference to logically equivalent descriptions of alternatives and choice sets* The choice is invariant to logically equivalent changes of descriptions of alternatives. ..."

In short, the traditional approach is being criticised for focussing solely on the outcome of decision making, totally neglecting the way by which agents arrive at their decisions. It fails to see decision making as a process; it thus fails to take into account elements of decision making that are crucial for explaining and predicting its outcomes.

Examples of this are presented on the following slides.

Experimental evidence

Rubinstein emphasises that the following examples "seem to me especially strong in the sense that they not only demonstrate a deviation from the rational man paradigm, but they also offer clues about where to look for systematic alternatives" (p. 16).

From Tversky and Kahneman (1986):

Subjects were told that the outbreak of a disease will kill 600 people, if no counteraction is taken. Half of the subjects were asked to choose between the following mutually exclusive vaccination programmes:

"*A*. Two hundred people will be saved.
"*B*. With a probability of ⅓, six hundred people will be saved; with a probability of ⅔, none will be saved."

Experimental evidence

The other half were asked to choose between:

"*C*. Four hundred people will die.
"*D*. With a probability of ⅓, no one will die; with a probability of ⅔, all six hundred will die."

Result:

72% chose *A* from {*A*, *B*}, while
78% chose *D* from {*C*, *D*}.

So-called "framing effect", in this case changing the attitude towards risk.

Experimental evidence

Further example from Tversky and Kahneman (1986):

Choose from the following lotteries:

Lottery A

Colour	*white*	*red*	*green*	*yellow*
Prob. (%)	90	6	1	3
Prize ($)	0	45	30	−15

Lottery B

Colour	*white*	*red*	*green*	*yellow*
Prob. (%)	90	7	1	2
Prize ($)	0	45	−10	−15

Experimental evidence

Now choose from the following lotteries:

Lottery C

Colour	*white*	*red*	*green*	*blue*	*yellow*
Prob. (%)	90	6	1	1	2
Prize ($)	0	45	30	−15	−15

Lottery D

Colour	*white*	*red*	*green*	*blue*	*yellow*
Prob. (%)	90	6	1	1	2
Prize ($)	0	45	45	−10	−15

Experimental evidence

Interpretation:

People make choices on similarity considerations. Such considerations can override other modes of deliberation (e.g., mathematical calculations).

The question, thus, is: *When* do they do so? Does learning diminish the influence of similarity considerations vis-à-vis other deliberations?

Potential application: choice under Knightian uncertainty.

Procedural rationality

Rationality is not replaced by irrationality!

Rubinstein (1998, p. 21): "Simon distinguishes between *substantive rationality* and *procedural rationality*: on one hand, substantive rationality refers to behavior that 'is appropriate to the achievement of given goals within the limits imposed by given conditions and constraints'; on the other hand, 'behavior is procedurally rational when it is the outcome of appropriate deliberation.' That is, procedurally rational behavior is the outcome of some strategy of reasoning, whereas irrational behavior is an outcome of impulsive responses without adequate intervention of thought. In this book, we will drop the assumption of substantive rationality but retain that of procedural rationality."

Gigerenzer's and Selten's position

"[M]any contemporary [mid-20th century] researchers attempted to resolve discrepancies between description and prescription by tinkering with the utility or probability function, while at the same time retaining the idea of maximization or optimization.

"In this book, we pursue a more radical alternative …. The theory of bounded rationality, as we understand it, dispenses with optimization, and, for the most part, with calculations of probabilities and utilities as well" (Gigerenzer and Selten, 2001, p. 3).

Gigerenzer's and Selten's position

"We mentioned at the beginning that, so far, there is no complete theory of bounded rationality. Nevertheless, we can specify three classes of processes that models of bounded rationality typically specify:

"1. *Simple search rules.* … step-by-step procedures …

"2. *Simple stopping rules.* Search is terminated by simple stopping rules, such as to choose the first object that satisfies an aspiration level. The stopping rule can change ….

"3. *Simple decision rules.* … [A] simple decision rule is applied, like choosing the object that is favored by the most important reason—rather than trying to compute the optimal weights for all reasons …"

Literature

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