The Sea Battle Tomorrow:
The Identity of Reflexive Economic Agents

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The identity of reflexive economic agents

What are reflexive economic agents?

In a continually changing world, reflexive economic agents continually revise their expectations of the future and continually adjust their behavior to those changing expectations

I thus explain their individual identities in terms of adjustment, in terms of how they adjust to change, rather than in terms of fixity, or fixed preferences

My view is motivated by Simon's 'two blades of a scissors' view of behavior and his idea that evolving complex systems are homeostatic and self-organizing

I thus explain reflexive agents' individual identities, and how they adjust to change, in terms of how they self-organize themselves in changing circumstances

Bounded rationality and bounded individuality

Since the utility function representation of agents derives from the axiomatic representation of preferences, bounded rationality suggests individuality is also 'bounded'; but how?

One view – Infante, Lecouteux, and Sugden/Hausman symposium (*Journal of Economic Methodology* March 2016) – individuality is bounded by bounded rationality

◦ An 'inner rational agent trapped in an outer psychological shell' – perhaps escaping that shell?

◦ They thus ask, do agents weigh their options rather than simply respond to them?

◦ So I ask, if agents weigh their options, do they reflexively self-organize themselves?

Organization of the paper

I first discuss *two conceptions of the economy as a whole*, since not only do they frame our views of agents, but these framing effects on agent conceptions are often neglected; then I discuss *their corresponding agent conceptions*

◦ My focus: how our conceptions of the economy and agents address before-and-after time

Sections:
◦ I Standard theory's equilibrium-shock model and time
◦ II The reflexive economic process conception and time
◦ III The utility conception of the agent and the completeness assumption
◦ IV The behavior and identity of reflexive economic agents

I Standard theory's equilibrium-shock model and time

If the Nash idea is that of a state of affairs fully at 'rest', does the standard equilibrium view allow for anything more than a nominal reference to time?

Sonnenschein-Mantel-Debreu demonstrates Walrasian equilibria are generally not stable and so cannot account for movements from out-of-equilibrium *into* equilibrium

◦ The framework thus lacks an *internal* principle of motion

The equilibrium-shock model says what happens when equilibria are disturbed and at least aims to explain movements from equilibrium to *out*-of-equilibrium

◦ Does it contain an *externally*-caused principle of motion?

Aristotle's famous sea battle tomorrow problem

A problem of explaining truth in relation to time in connection with future contingents, or future states of affairs, statements about which are neither true nor false today

Aristotle's argument:

◦ Suppose at this moment it is believed a sea battle will not be fought tomorrow

◦ If a sea battle will not be fought tomorrow, then it was true yesterday that it will not be fought tomorrow

◦ But all past truths are necessary truths, so it is necessarily true today a sea battle will not be fought tomorrow

◦ But this fatalistic conclusion offends our view of the future as open so there is something deeply problematic about how we understand truth and the future

The equilibrium-shock model again

A shock is an event in time – a future contingent state of affairs – that differentiates before and after

For the equilibrium-shock model to include an account of externally-caused motion and be in time, a shock should be a future contingent state of affairs – an 'after'
◦ But shocks are only possible parameter changes, not future contingent states of affairs

The post-shock 'after' is not a temporal concept and equilibrium theory does not explain externally-driven motion

Equilibrium, as the solution to a set of equations, is a non-temporal idea of 'existence'

What is true 'before' in equilibrium – that there are no shocks – that there will be no sea battle tomorrow – *must* be true tomorrow as well

Closed versus open conceptions of the economy

The standard equilibrium-shock model fails to account for the before-and-after meaning of time because it is a based on a closed system, out-of-time representation of the economic process

The before-and-after time meaning of time, and Aristotle's problem of future contingents, requires the economy be represented as an in-time open process

There are many views regarding why the economy should be explained as an open process

I explain the economy as open in virtue of it being a reflexive, endogenous process that is driven by the behavior of reflexive economic agents

II The reflexive economic process conception and time

A reflexive economic process is one in which agents form expectations and beliefs about the future, this influences their actions in the present, which in turn influences the future

- A conception framed in terms of our most basic sense of time as before-and-after

This conception actually underlies *all* accounts of agent behavior in economics, but with rational expectations and optimal Bayesian learning agents' expectations and beliefs about the future only influence agents' actions in a benign way, so that time plays only a nominal role

Consider the the causal model for a reflexive economic process, first for a closed system representation of the economy, then for the open process view

The causal model for a *closed* reflexive economic process: the special case

Agents' actions *a* have direct causal effects on the world *b*, and agents' model of the world is:

$$a \rightarrow b \qquad [1]$$

When expectations are rational and learning is optimal, [1] acts reflexively on itself (a feedback channel from expectations to action) in such a way as to reproduce the model in a self-confirming way:

$$a \rightarrow b \rightarrow (a \rightarrow b) \qquad [2]$$

Then the direct and reflexive causal effects together give the total causal effects of agents' actions as:

$$a \text{ and } a \rightarrow b \text{ and } a \rightarrow b \rightarrow (a \rightarrow b) \Rightarrow b \text{ and } (a \rightarrow b) \qquad [3]$$

Since *a* -> *b* and (*a* -> *b*) exhibit the same direct effect of a on b, the feedback channel plays only a nominal role that can be ignored, the process is closed, and time is effectively negated.

The causal model for an *open* reflexive economic process: the general case

Agents' actions a still have direct effects on b as in [1], but without rational expectations and optimal learning the feedback channel changes, and [2] is replaced as follows:

$$a \rightarrow b \rightarrow (a \rightarrow b)' \qquad [4]$$

Replacing the ($a \rightarrow b$) relation from [2] by the ($a \rightarrow b$)' relation then means that [3]'s expression of total effects is replaced as follows:

$$a \text{ and } a \rightarrow b \text{ and } a \rightarrow b \rightarrow (a \rightarrow b)' \Rightarrow b \text{ and } (a \rightarrow b)' \qquad [5]$$

Now time operates in a real, before-and-after way because the reflexive feedback channel does not operate in the self-confirming special case way

Character of the economy as an open process

The economy as an open process is:

◦ Non-ergodic in that generally the phenomena are distributed in non-stationary way and tend to be non-homogeneous (the character of the world)

◦ Endogenous or path-dependent because its dynamic derives from how reflexive behavior connects before-and-after time (the source of this character)

Yet such an economy could still *appear* stationary should the effects of agents' expectations on their behavior be sufficiently modest that $a \rightarrow b \rightarrow (a \rightarrow b)$ often *seems* to better represent the feedback channel than $a \rightarrow b \rightarrow (a \rightarrow b)'$

To show that $a \rightarrow b \rightarrow (a \rightarrow b)'$ represents the feedback channel, consider how reflexivity operates in the self-fulfilling prophecy (SFP) phenomenon, as in Merton (1948)

Merton's SFP reflexivity analysis of bank runs

A bank examiner mistakenly judges a bank insolvent, a bank run occurs when depositors react to this evaluation and withdraw their funds, and the bank then actually becomes insolvent – a SFP

A false statement about the bank's solvency becomes a true statement, because the change in depositors' expectations changes their behavior in such a way as to change what is true about the bank – a reflexive 'truth reversal'

What is true thus depends on action, so $a \rightarrow b \rightarrow (a \rightarrow b)'$ correctly represents the feedback channel

Since 'truth-reversing' SFPs are an extreme case, consider Merton's truth-action reflexivity analysis as an instance of structure-agent theory

Structure-agent theory

Structure-agent theory explains the economy's pathway as open in virtue of how social structure and agents continually, reflexively transform each other

For Merton, a social structure of interaction (the examiner and the depositors) is affected by the actions of an agent (the examiner's evaluation) that produce further agent actions (depositors' withdrawals), this acts on social structure (the relation between examiners and depositors), and possibly also acts on the institutional context in which this structure-agent relation is embedded

More dramatically, as in the financial crisis, 'the big short,' and its aftermath

It is ultimately changes in the relationship between social structure and agency that determine what is true in the world, so what is true depends on action in this wider way

Solving Aristotle's sea battle problem

Whether there is a sea battle tomorrow, b, depends on people's actions today, a, or the direct causal effects of their actions, $a \to b$

That a sea battle could occur tomorrow affects many people who thus form expectations and beliefs about the causal model $a \to b$

These expectations and beliefs reflexively affect their actions and what happens through the feedback channel $a \to b \to (a \to b)'$

If there is no sea battle tomorrow, it is because people's actions produced this outcome

For Aristotle the truth of future contingents depends on present action, action usually depends on complex structure-agent relationships, and the world is always open

III The utility conception of the economic agent and the completeness assumption

The axiomatic foundations of the utility conception prescribe in a *top-down* way not only consistent choice behavior but also choice behavior consistent with a closed equilibrium conception of a competitive economy

Given behavioral economics doubts about the axioms, especially vagueness in regard to completeness, one strategy, the 'preference purification approach,' asks how completeness or some correlate assumption might be retained, in order, ultimately, to secure a closed equilibrium analysis

Alternatively, in an open economy process view, incompleteness should be assumed, and choice behavior is explained in a *ground-up* way in terms of reflexive adjustment to continually changing conditions of choice

Incomplete preferences

Since the feedback channel $a \to b \to (a \to b)'$ shows alteration in the relation of a and b, the b terms in $a \to b$ and $(a \to b)'$ may be only vaguely comparable

- A reflexivity interpretation of incompleteness, not a psychological one

In an open non-ergodic world, supposing that agents have some (unexplained) power to always accurately compare new states of the world is heroic at best

Another view of 'preference purification' and agents 'weighing' their options is Searle's *Rationality in Action* idea that complete preferences are a product of practical reasoning (a weighing of one's options)

Completeness is then the outcome of an adjustment process the agent undergoes that in individuality terms is self-organizing

IV The behavior and identity of reflexive economic agents

An open, endogenous reflexive economic process in before-and-after time has its basis in the behavior of reflexive economic agents

I explain this behavior in two connected steps:

- In terms of how the changing conditions for action produce a process of adjustment that comes to a stopping point
- In terms of how when agents' identities are disrupted by changing conditions, this leads them to self-organize their identities in ways appropriate to their changed conditions

Four models of adjustment and identity change are outlined here out of many possible types

First, Simon on adjustment behavior

Simon's satisficing behavior involves reaching an aspiration level stopping point

How does one know when it is achieved? What stops an adjustment process?

Consider Merton's bank run case:

◦ The bank examiner upsets depositors' view of bank solvency (an endogenous shock), this feeds back on their causal model of the bank producing action in terms of their withdrawal of funds, and this adjustment stops when all funds are withdrawn

◦ In structure-agent terms adjustment to an aspiration level is framed by the social interaction of the examiner and depositors that is transformed by the agency of the examiner, all in the institutional context of the banking system

◦ When the process runs it course, the adjustment process stops

The role of identity self-organization in the Merton case

Before the examiner report depositor identities are tied to their individual interests alone associated with them having individual bank deposits

After the report they see they *also* have social identities as depositors, and act as representative agents of those identities in the ensuing bank run

After the withdrawal of their funds (and the adjustment process is complete) their social identities drop away and only their individual interests again determine their identities

The identity self-organization and adjustment process together can be represented as: I -> I/SD -> I'

Don Ross's neurocellular account of individual identity

Individuals are made up of collections of sub-personal neural agents/multiple selves that interact in coordination games to produce individual identity

- These coordination games are influenced by the non-cooperative games individuals play

The human body regularly experiences psycho-physical events (endogenous shocks) that influence the basis on which this sub-personal coordination occurs

The ensuing adjustment process continues until there is a new coordination equilibrium of the individual's neural multiple selves

This individual identity/sub-personal multiple selves identity self-organization process can be represented as: I/MS -> I'/MS'

Brian Arthur et al on the Santa Fe artificial stock market

Profit-maximizing individuals invest in a single asset, have multiple subjective expectation models/rules for what determines its price, and order those models according to their predictive success over multiple investment rounds

These models/rules 'inhabit' individuals like sub-personal agents/multiple selves and individuals' identities are determined by their ordering of these models/rules

Changes in the asset price across investment rounds function as shock events which disrupt a given ordering of an agent's models/rules changes and set off a re-ordering of these models/rules

The individual identity self-organization process can be represented as in Ross's neurocellular case as: I/MS -> I'/MS'

Alan Kirman et al on the Marseille fish market

The Marseille fish market was reorganized in the 1980s to function as an arm's length auction process as in standard competitive theory

But buyers and sellers interacted directly in networks and formed loyalty ties to one another that functioned as social identities

The market reorganization acted as a shock event intended to align individual identities with individual interests but the formation of loyalty ties aligned individual interests with social identities

The individual identity self-organization process can be represented as I-> I/SD

Self-organization as a self-defeating prophecy (SDP)

SFPs are disruptive social processes that initiate agent adjustment behavior

SDPs involve adjustment/reorganizing processes that respond to disruptions

◦ The Y2K case: instantiating a new ($a \rightarrow b$)' model to secure computer systems and replace the old ($a \rightarrow b$) model in which they break down

◦ Or securing the identity of computer systems (a type of agency) on a new basis

'Preference purification' as an SDP: re-securing the utility function identity of agents (as sets of 'own' preferences) when disrupted by behavioral shocks (e.g., others' alteration of menus) by adjusting the preference basis on which agents act in order to defeat the effects of those behavioral shocks

The paper's main objectives and argument

Link bounded rationality to a bounded individuality and explain the latter in terms of reflexive adjustment to change and identity self-organization

Argue for an open process conception of the economy as able to accommodate before-and-after time

Explain an open process in causal terms as a reflexive process involving reflexive economic agents

Explain the adjustment behavior of reflexive economic agents in terms of episodes of identity self-organization