

## MACRO COORDINATION: MORE GENERAL CONSIDERATIONS

In previous course readings it has been shown how equilibrium conceptions can be formulated for an economy that do not entail Walrasian market clearing, i.e., notional demand equals notional supply. So far, however, these “post-Walrasian” conceptions of equilibrium have emphasized the static properties of an economy at a point in time. We have not yet considered either the feasibility or the desirability of attempting to formulate a post-Walrasian conception of equilibrium for a decentralized market economy *over* time.

Shifting to a dynamic perspective, a fundamental question is how a decentralized market economy can manage to stay even approximately coordinated over time, let alone on any kind of optimal path. For example, how is it that the rates of inflation and unemployment in the U.S. over the past sixty years have tended to fluctuate within relatively narrow bands?

This is an extraordinarily difficult question to answer because of the complex nature of decentralized market economies. Indeed, decentralized market economies are examples of what are known as *complex adaptive systems*. They consist of large numbers of heterogeneous buyers and sellers engaged in massively parallel local interactions, capable of learning, but with no global top-down controller. Until recently, economists have simply not had the tools to tackle this complexity head on. Consequently, a common tactic in quantitative economic modelling has been to side-step this complexity by resorting to various externally imposed coordinating devices such as representative agents and market clearing conditions.

For example, as discussed in previous lectures, the quantitative models used by Walrasian macroeconomists typically incorporate the following core of assumptions:

- A fixed number of agents exist in an environment that is stationary (or at least statistically predictable) over time;
- The choice environment of each agent is specified in a highly simplified way;
- Each agent has a well-defined objective, e.g., utility maximization and/or profit maximization;
- Each agents makes rational use of his available information in an attempt to achieve his objective.

In short, rational agents act atomistically in simplified stationary environments to choose strategies (complete contingency plans) for the achievement of an optimal solution subject to variously specified physical, financial, and informational constraints. The basic tool used by macroeconomists to model systems of this form is stationary stochastic differential or difference equations. This approach thus views decentralized market economies as akin to the systems studied in classical mechanics.

With the recent development of more powerful computational tools, it is now becoming increasingly feasible to study decentralized market economies as complex adaptive systems. Researchers taking this approach argue that such economies are more akin to the systems studied in evolutionary biology. In particular, they argue that decentralized market economies should be modelled as evolutionary systems whose global regularities arise from the local interactions of heterogeneous autonomous agents whose behavior evolves over time.

Recently a number of economic researchers pursuing the latter approach have begun to refer to their work as “agent-based computational economics.” Roughly characterized, *agent-based computational economics (ACE)* is the computational study of economies modelled as evolving decentralized systems of autonomous interacting agents. A central concern of ACE researchers is to understand the apparently spontaneous appearance of global regularities in economic processes, such as the unplanned coordination of trade in decentralized market economies that economists associate with Adam Smith’s invisible hand. The challenge is to explain constructively how these global regularities arise from the bottom up, through the local interactions of autonomous agents tempered by currently existing social norms and institutions, rather than through fictitious top-down coordinating mechanisms such as a Walrasian auctioneer or a single representative consumer.

A brief overview of recent ACE research will next be presented.