

The crisis of economics and Agent Based Models

Di Mauro Gallegati

Agent based models (ABM) is a methodology that can be applied to any model. It is valid for the DSGE as well as for “amateurs”: the Walras model is model of agents arranged on a star network, while the DSGE [e.g. Smets; Wouters, 2003] has identical agents, or non-interacting heterogeneous ones - that is, without networks. While the former do not show those aspects of complexity which are related to the real world, the present work is dedicated to the ones where the HIA generate complexity.

“Agent based models” make it possible to overcome some of the many contradictions of the axiomatic model, whether it be reconciling reality and theory, or making the construction a dynamic one: innovation, for example, becomes the engine of the economy and not a stumbling block. Paradoxically, the axiomatic theory, instead of acknowledging the numerous cases of market failure, always prescribes further market expansion as a way to restore the mainstream economics. Although this theory admits that in reality the market fails to be efficient, nothing is done to review the regulatory requirements which give the market itself the function to act as a tool to reach that “optimality” of which we spoke. Because, according to the mainstream theory, if the Pareto principle is an efficiency that cannot be obtained in reality it is only because the markets aren’t widespread enough. An excellent example of confusion between dreams, reality and the wishes of numerous small make-believe Napoleons who are convinced they can fight the battle of Austerlitz again. Better not fall into the trap of discussing military strategies with them, because it would be like acknowledging that we really are in front of Bonaparte, as Robert Solow (1984) says.

Economics is in crisis from at least two different perspectives.

The first is the crisis of the GDP growth concept as a means of spreading economic well-being by means of increased employment. Job-less growth is a phenomenon now common to all economies since the mid-90s and this has led to talk about agrowth. Furthermore - as Pijpers notes, 2018: 3-4 - “Within complex systems there is a known phenomenon referred to by the term “self-organized criticality”. It appears that many systems have the property that, through the interactions of the elements within the system, they reach a critical state. As long as there is no external stimulus or disruption to this system, it appears to be in a stable equilibrium. However, a very small disturbance of the system in this critical state can cause very far-reaching changes. In this case a traditional approach, where the behaviour over the recent past is used as an indicator of future stability or robustness, is clearly not suitable. Some small stimuli might cause widespread disruption, and others none at all. An arbitrary external stimulus of a system that is in such a critical condition will not as a matter of course produce an instability or other “catastrophic” behavior. Modelling is a means of assessing in what ways, i.e. for which incentives or stimuli, an economy is vulnerable/fragile and which stimuli are harmless, i.e. leave the economy robust or sustainable.”

Then, the economic crisis, which has been on-going since 2007 with GDP slumps,

bankruptcies, deflationary phenomena and levels of unemployment not seen since the Great Depression questioned about the relevance of the current mainstream. And it seems as if the only way to tackle it, is with exceptional measures. This aspect is intertwined with the fact that the dominant macroeconomic model was unable to predict the crisis because it didn't contemplate a priori any possibility of a long, deep crisis, like the one we are currently experiencing. This is why the crisis has also affected the paradigm, just like the Depression of 1929 did. That crisis was resolved with the New Deal and, at the same time, also with the Keynesian revolution.

Perhaps it's not true that the future enters us, to be transformed already within us, long before it actually happens, but if we continue with the same demographic and production trends, in 2030 we will need the resources of two Earths. So we must either prepare ourselves to colonize the Universe or to immediately start redistributing resources and thinking about sustainability.

The crisis of mainstream economics is well documented by academic works and central bankers' contributions. In my opinion, a fundamental feature of macroeconomic modelling resides in the ability to analyze evolutionary complex systems like the economic one. What characterizes a complex system is the notion of emergence, that is the spontaneous formation of self-organized structures at different layers of a hierarchical system configuration. Agent Based Modelling is a methodological instrument – that can be use- fully employed by both neoclassical or Keynesian economists, or whatever theoretical approach. [Reconciling DSGE and complex ABM seems like the calculation of Tycho Brahe who proposed a model that replaced the Ptolemaic one among all those astronomers who did not want to accept the Earth's movement. From a cinematic perspective, the Tychonic model is identical to the Copernican one. The two models differ only by their chosen reference system: the Earth for Brahe, the Sun for Copernicus.] – which is appropriate to study complex dynamics as the result of the interaction of heterogeneous agents (where a degenerate case would be a “representative agent” model in which the degree of both heterogeneity and interaction is set to zero, that is a situation that reduces holism to reductionism in a hypothetical world without networks and coordination problems). Even when fluctuations of agents occur around equilibrium which we could calculate using the standard approach, the ABM analyses would not necessarily lead to the same conclusions. This is because the characteristics of the fluctuations would depend on higher moments of the joint distribution and often on the properties of the tails, or three kurtosis of the distribution.

For the last couple of decades ABM have seriously taken to heart the concept of economy as an evolving complex system [Anderson et al., 1988]. Two keywords characterize this approach: Evolving, which means the system is adaptive through learning; and ABM complex, i.e. a methodology that allows to construct, based on simple (evolving) rules of behavior and interaction, models with heterogeneous interacting agents, where the resulting aggregate dynamics and empirical regularities not known a priori and not deducible from individual behavior.

Agents' behavioral rules are not fixed (this does not mean that it is not legitimate to build ABMs with fixed rules, for example, to understand what the dynamics of an economic system would be if agents behaved in an “optimal” way), but change adapting to variations of the economic

environment in which they interact. The traditional approach which assumes optimizing agents with rational expectations has been and is a powerful tool for deriving optimal behavioral rules that are valid when economic agents have perfect knowledge of their objective function, and it is common knowledge that all agents optimize an objective function which is perfectly known. If agents are not able to optimize, or the common knowledge property is not satisfied, the rules derived with the traditional approach lose their optimality and become ad hoc rules. Research is still far from being complete, above all where empirical verification of aggregate models is concerned, but it is already more effective in explaining reality than what has been done so far and continues to be done by the DSGE models that dominate the economic scene. Although ABM certainly do not constitute a panacea for the crisis, it is indisputable that they provide suggestions of economic policy unknown in traditional models (network, domino effects, resilience and fragility, etc.). Freed from the straightjacket of equilibrium and representative agent hypothesis, that only works with a single good and a single market, we can finally dedicate time to investigate the potentiality of interactive agents and their emergent properties.

The complex ABM approach can offer new answers to new and old unsolved questions, although it is still in a far too premature stage to offer definitive tools. This book shows that this new tool has already yielded interesting results and also that this approach does not say different things in simple situations where the comparison with the standard models is possible. It enables analysis of complex situations that are difficult to analyze with the models most in use today.

We need a paradigm that knows how to conjugate economic, social and environmental aspects. A secular paradigm, free from that axiomaticism which is characteristic of the current economic mainstream. I don't want to affirm that complex ABM models will be the starting point of future economic theory. But nearly.

Tratto da Gallegati M., "Complex Agent Based Models", Springer, June 2018