Contribution of Agent-Based Modeling to Economics[1]

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1. In these remarks, I shall assume that agent-based modeling (ABM) has economics as its end objective and end result.

2. Economics is a social science which concerns the behavior and properties of communities or institutions populated by real live human beings.

3. How does ABM help advance economics? What are these advances and what could they be?

4. I believe ABM has contributed, and can continue to contribute, to economics in spite of the fact that the ABM label itself emphasizes neither the human nature of the agents, nor the communitarian nature of economic phenomena.

5. To the contrary, I shall argue that ABM's contribution to economics arises precisely because of these differences. But it is important that my perspective on ABM is one of contributions to economics through use of this technology and not on this fascinating technology itself. I understand that for many scholars, the ABM discipline is of deep interest in itself for many reasons.

6. Allow me to use a parallel to clarify my point. Like ABM, statistics is a deep discipline with a long history and extensive literature of its own.

7. Application and use of statistical reasoning and modeling to economic questions has contributed greatly to accomplishments of economics; and these contributions have been widely recognized.

8. In addition, attempts to use statistics for addressing substantive economic question has led, over the past century, to the evolution of a new cross-discipline of econometrics which has developed a tradition and extensive literature of its own.

9. Today, statistics, econometrics, and economics coexist with parallel, partially overlapping yet distinct identities. While there are plenty of scholarly contributions which could go either to economics or to econometrics journals (and the same is true of econometrics and statistics journals), the same is not true for economics and statistics. For economics, statistics is and will remain an instrument of research, no matter how valuable its applications to economics become.

[1] Remarks prepared for panel on The Future of Agent-Based Research in Economics, Eastern Economic Association, Boston MA, March 8, 2008.

10. The same is also true of economics and mathematics with mathematical economics being the bridging sub-discipline between the two. I am not qualified to assess the contributions of econometrics and mathematical economics to statistics and mathematics respectively. However, it is clear that the importance of these bridging sub-disciplines to economics arose from their contributions to substantive problems of economics.

11. Perhaps it is not inappropriate to think of a parallel relationship among economics, agent-based economics and agent design. The last of the three draws from, perhaps even lies substantially in, the domain of computer science and artificial intelligence, and draws on their knowledge base and technologies.

12. Agent-based economics could be thought of, like econometrics, as a bridging sub-discipline between ABM and economics.As a specialized branch of ABM, ABE focuses on agent models developed specially to address the problems of economics. When we use ABM to address problems of general interest in economics, they are contributions to economics itself

13. The future of ABM in economics will depend on our ability and willingness to address substantive problems in economics. Statistics and its economics specific branch econometrics have found an important place in economics, not just because they developed better estimates and discovered their properties (that is development of the method itself) but because they were better able to estimate, for example, the effect of education on productivity of labor.

14. I think it is reasonable to say that the general body of economists has a similar attitude to ABM and other methods. The future place of this method depends on contributions of the ABM technology to address substantive problems of economics as a social science. The more successful we are in this endeavor; greater will be the acceptance of the method in economics.

15. In making this assertion, I have said nothing new; because this applies to all disciplines.

16. So, what is the general area of economics to which ABM can make substantive contributions?

17. Physical sciences deal with discovering the universal laws of nature that apply across time and space and concern the behavior of inanimate objects or symbols.[2]

18. At the opposite end from the Science Hill on the Yale campus lie the humanities departments of literature, religion, philosophy, art and music, etc. Literature looks not for universal laws that govern the behavior of humans but eternal truths about our nature. Even though each human being is unique, endowed with free will to do as we wish, yet the eternal truths of love, hate, courage, greed, fear, jealousy and fear appear repeatedly throughout human history and literature.

19. Social sciences try to create a space for themselves between the sciences and the humanities. Since the object of study in social sciences is our own sentient selves, we remain uncertain about the ground under our feet. We are not quite sure of exactly what we humans are.

20. On one hand, we wish to have the honor of being a science and accordingly we seek universal laws that might explain and predict what we do. This pursuit leads us to model ourselves as a stone rolling down the hill under external force of gravity or a leaf blown about by wind. For the stone, the leaf, as well as the *homo economicus*, universal laws applied to fixed characteristics of the objects of study help us understand what happens to them.

21. On the other hand, we are reluctant to believe that we are like a rock or a leaf, and let go the belief that we have free will to choose what we eat, and where we go. Is our behavior simply driven for external forces and our own predefined properties? Unfortunately, free will so essential to our sense of self, and universality of laws we seek to become a science do not mix well.

22. That is where the "social" part of social science comes to help. It is possible that even as individual free will may preclude the possibility of predicting individual behavior, aggregate level outcomes of larger groups of individuals may be subject to fixed and discoverable laws.

23. It is this possibility that holds a rich promise of substantive and substantial contributions of ABM technologies applied to the problems of economics as a social science.

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[2] Sunder, Shyam. "Determinants of Economic Interaction: Behavior or Structure." *Journal of Economic Interaction and Coordination* 1, no. 1 (May 2006): 21-32. (http://www.som.yale.edu/faculty/Sunder/Research/Experimental%20Economics%20and%20Finance/Published%20Papers/130.Determinants%20of%20Economic%20Interaction/DeterminantsofEconomicInteraction.pdf).

24. As our friends in psychology examine individual behavior, ABM has already yielded some interesting results in identifying systematic properties of market institutions populated by simple agents.

25. So my hope and expectation is that ABM can and will flourish as a method of making contributions to problems and economics by serving as a bridge between individual behavior (the domain of psychology, and captured by ABM technology) on one hand and aggregate outcomes (which is the primary topic of interest in economics) on the other.

26. In summary, I am optimistic about the role of ABM in economics as a method of addressing substantive problems of economics – especially understanding the properties of social and economics institutions populated by agents of various kinds - something we can design, manipulate and examine using ABMs.