Journal of Economic Behavior & Organization
Vol. 61 (2006) 599–616

JOURNAL OF
Economic Behavior
& Organization

www.elsevier.com/locate/econbase

Technical trading in the Santa Fe Institute Artificial Stock Market revisited

Norman Ehrentreich

Martin Luther University Halle-Wittenberg, Department of Banking and Finance, Große Steinstraße 73, 06099 Halle/Saale, Germany

Received 28 September 2003; accepted 21 July 2004
Available online 26 July 2006

Abstract

This paper reconsiders evidence of technical trading in the Santa Fe Artificial Stock Market in light of an upwardly biased mutation operator. While an alternative mutation operator points to no technical trading, two tests other than the inappropriate investigation of the aggregate bit level establish the existence of technical trading beyond a doubt. The following analysis of the two mutation operators identifies genetic drift as an important evolutionary force and provides tools to judge the relative importance of selection and genetic drift with arbitrary mutation operators. It also finds that when selective forces are weak, the continued existence of technical trading can be reconciled with the Efficient Market Hypothesis.

JEL classification: C63; D83; G14

Keywords: Agent-based simulations; Technical trading; Genetic algorithms; Classifier systems; Genetic drift

1. Introduction

In the last decade, the use of agent-based simulations of markets has gained more and more acceptance among social scientists. This methodology has been heavily used by physical scientists who simulate complex systems of many interacting particles. In financial economics, such a 'particle' is represented by an investor who interacts with other investors. A major advantage is that these models allow the removal of many restrictive assumptions that are required by analytical models for tractability. For instance, all investors could be modeled as heterogeneous with respect to their preferences, endowments, and trading strategies.

E-mail address: ehrentreich@wiwi.uni-halle.de.

0167-2681/$ – see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.jebo.2004.07.022

Among the numerous agent-based simulations of financial markets (e.g., Levy et al., 1994; Lux and Marchesi, 1999; Cont and Bouchaud, 2000), the Santa Fe Institute Artificial Stock Market (SFI-ASM) is one of the pioneering models and thus probably the most well-known and best studied. According to Waldrop (1992), it emerged from a debate between Ramon Marimon and Thomas Sargent on one side, and John Holland and W. Brian Arthur on the other. Marimon and Sargent claimed that artificially intelligent agents in such a stock market simulation would quickly learn the neoclassical rational equilibrium solution.[1] Since Holland and Arthur could not agree with this hypothesis, they started to develop the SFI-ASM in 1989 which has been described by Palmer et al. (1994), Arthur et al. (1997), and LeBaron et al. (1999).[2]

Within the framework of the SFI-ASM, the Marimon–Sargent Hypothesis comprises two parts. First, there should be no significant use of fundamental or technical trading information, and second, the price series should behave “nicely”, i.e., as predicted by the standard neoclassical solution. However, the model’s main result is the identification of a single parameter, the learning speed of agents, which is able to shift the model either to a regime that is close to the homogeneous rational expectation equilibrium (hree) or to a more complex regime that better fits the empirical facts. The complex regime emerges for fast learning rates and is characterized by more complicated price time series and by substantial levels of technical trading. Thus, both parts of the Marimon–Sargent Hypothesis are rejected for fast learning speeds.

The following section briefly describes the basic model structure of the SFI-ASM. Section 3 then raises the possibility of emergent technical trading being a design artifact due to an upwardly biased mutation operator. Simulation results with an alternative mutation operator support the Marimon–Sargent Hypothesis with respect to bit usage for all learning speeds. Section 3 also exposes the aggregate bit level as inappropriate in detecting technical trading in the model. By analyzing the number of bit fixations and the fitness information of trading rules, the existence of technical trading in the model is finally established beyond a doubt. The question of why the two mutation operators lead to different model behaviors is analyzed in Section 4. It identifies random genetic drift as an important evolutionary force that cannot be neglected in genetic learning algorithms. The analysis of the two mutation operators with models taken from population genetics enables us to judge the relative importance of selection and genetic drift and to determine minimum population sizes when designing classifier systems or genetic algorithms. The insights gained from this evolutionary perspective also shed new light on the longstanding debate about whether natural selection will result in rational actors and the absence of technical trading in efficient capital markets.

[1] They were led to this statement through their own research (Marimon et al., 1990) in which they assigned adaptive classifier agents to solve Wicksell’s triangle in a Kiyotaki and Wright (1989) type model. There, they found that the agents always discovered the neoclassical solution: the good with the lowest storage cost emerged as a medium of exchange.

[2] There are, in fact, several ‘generations’ of the SFI-ASM on different programming platforms. An overview of the SFI market history can be found in LeBaron (2002) and Johnson (2002). A current Objective-C version using the Swarm package is currently hosted by Paul Johnson at http://ArtStkMkt.sourceforge.net. The design of the original SFI-ASM model as reported in Section 2 is based on the Objective-C version 7.1.2 which also served as a blueprint for the author’s own reprogrammed Java version using the Repast library. The source code is available upon request.