Chapter 8
Agent-Based Modeling Bridges Theory of Behavioral Finance and Financial Markets

Hiroshi Takahashi¹
Keio University, Japan

Takao Terano²
Tokyo Institute of Technology, Japan

ABSTRACT
This chapter describes advances of agent-based models to financial market analyses based on our recent research. We have developed several agent-based models to analyze microscopic and macroscopic links between investor behaviors and price fluctuations in a financial market. The models are characterized by the methodology that analyzes the relations among micro-level decision making rules of the agents and macro-level social behaviors via computer simulations. In this chapter, we report the outline of recent results of our analysis. From the extensive analyses, we have found that (1) investors’ overconfidence behaviors plays various roles in a financial market, (2) overconfident investors emerge in a bottom-up fashion in the market, (3) they contribute to the efficient trades in the market, which adequately reflects fundamental values, (4) the passive investment strategy is valid in a realistic efficient market, however, it could have bad influences such as instability of market and inadequate asset pricing deviations, and (5) under certain assumptions, the passive investment strategy and active investment strategy could coexist in a financial market.

INTRODUCTION
Financial Economics researches have become active since 1950’s and many prominent theories regarding asset pricing and corporate finance have been proposed (Markowitz, 1952; Modigliani, Miller, 1958; Sharpe, 1964; Shleifer, 2000). The assumption of the efficiency of financial markets plays an important role in the literature in traditional financial theory and many research have been conducted based on the assumption (Friedman, 1953; Fama, 1970). For example, CAPM (Capital Asset Pricing Model), one of the most popular asset pricing theory in the traditional financial literature, is derived based on the assumptions of the efficient market and rational
investors. CAPM indicates that the optimal investment strategy is to hold market portfolio (Sharpe, 1964).

However, conventional finance theory meets severe critiques about the validities of the assumptions on the markets, or the capabilities to explain real world phenomena. For example, the worldwide financial crisis in 2008 was said to be the one, which would occur per ten decades. Recently, N. N. Taleb describes the role of accidental effects in a financial markets and human cognitions about the effects (Taleb, 2001). Also, researchers in behavioral finance have raised some doubts about the efficient market assumption, by arguing that an irrational trader could have influences on asset prices (Shiller, 2000; Shleifer, 2000; Kahneman, Tversky, 1979; Kahneman, Tversky, 1992).

To address the problems, we employ agent-based model (Arthur, 1997; Axelrod, 1997) in order to analyze the relation between micro-rules and macro-behavior (Axtell, 2000; Russell, 1995). In the literature, they have frequently reported that a variety of macro-behavior emerges bottom-up from local micro-rules (Epstein, 1996; Levy, 2000; Terano, 2001; Terano, 2003; Arthur, 1997; Tesfatsion, 2002). We have developed an artificial financial market model with decision making agents. So far, we have reported on micro-macro links among agents and markets, investors’ behaviors with various mental models, and risk management strategies of the firms (Takahashi, 2003; Takahashi, 2004; Takahashi, 2006; Takahashi, 2007; Takahashi, 2010). In this chapter, based on our recent research, we will describe the basic principles and architecture of our simulator and explain our main findings. The objective of the research is to investigate (1) the influences of micro- and macro-level of investment strategies, (2) roles of the evaluation method, and (3) financial behaviors, when there are so many investors with different strategies.

The next section of this chapter describes the model utilized for this analysis, then analysis results are discussed in sections 3 and 4. Section 5 contains summary and conclusion.

DESCRIPTION OF AN AGENT-BASED FINANCIAL MARKET MODEL

Basic Framework and Architecture of Models of a Financial Market

In our research, first, we have observed the macro level phenomena of a real financial market, then, second, we have modeled the phenomena in an artificial market in a computer. To model the market, third, we have introduced micro level decision making strategies of human investors based on the recent research on behavioral financial theory and cognitive science (Shleifer, 2000). Forth, we have designed micro-macro level interactions in the artificial market, which are not able to be examined in the real world. Therefore, our method is a constructive approach to bridge the state-of-the art financial theory and real behaviors in a market through agent-based models. The framework is summarized in Figure 1.

Based on the framework, we have implemented a common artificial market model depicted in Figure 2. The market model is characterized as follows: (1) benefit and/or loss of a firm is randomly determined, (2) the information is observed by investor agents to make their investment decisions, (3) based on the decisions, agents trade the financial assets in the artificial market, and the market prices are determined, and (4) the determined prices of the market again give the effects of decision making of the agents. The detailed descriptions of the model are given below.

A agent-based simulator of the financial market involving 1,000 investors is used as the model for this research. Several types of investors exist in the market, each of them undertakes
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