Chapter 7

Evolution of Agents in a Simple Artificial Market

Hiroshi Sato
National Defense Academy, Japan

Masao Kubo
National Defense Academy, Japan

Akira Namatame
National Defense Academy, Japan

ABSTRACT

In this chapter, we conduct a comparative study of various traders following different trading strategies. We design an agent-based artificial stock market consisting of two opposing types of traders: “rational traders” (or “fundamentalists”) and “imitators” (or “chartists”). Rational traders trade by trying to optimize their short-term income. On the other hand, imitators trade by copying the majority behavior of rational traders. We obtain the wealth distribution for different fractions of rational traders and imitators. When rational traders are in the minority, they can come to dominate imitators in terms of accumulated wealth. On the other hand, when rational traders are in the majority and imitators are in the minority, imitators can come to dominate rational traders in terms of accumulated wealth. We show that survival in a finance market is a kind of minority game in behavioral types, rational traders and imitators. The coexistence of rational traders and imitators in different combinations may explain the market’s complex behavior as well as the success or failure of various trading strategies. We also show that successful rational traders are clustered into two groups: In one group traders always buy and their wealth is accumulated in stocks; in the other group they always sell and their wealth is accumulated in cash. However, successful imitators buy and sell coherently and their wealth is accumulated only in cash.

INTRODUCTION

Economists have long asked whether traders who misperceive future prices can survive in a stock market. The classic answer, given by Friedman, is that they cannot. Friedman argued that mistaken investors buy high and sell low and as a result lose money to rational traders, eventually losing all their wealth.
On the other hand, Shleifer and his colleagues questioned the presumption that traders who misperceive returns do not survive (De Long, 1991). Since noise traders who are on average bullish bear more risk than do investors holding rational expectations, as long as the market rewards risk-taking, noise traders can earn a higher expected return even though they buy high and sell low on average. Because Friedman’s argument does not take into account the possibility that some patterns of noise traders’ misperceptions might lead them to take on more risk, it cannot be correct as stated.

It is difficult to reconcile the regular functioning of financial markets with the coexistence of different populations of investors. If there is a consistently winning market strategy, then it is reasonable to assume that the losing population will disappear in the long run. It was Friedman who first advanced the hypothesis that in the long run irrational investors cannot survive because they tend to lose wealth and disappear. For agents prone to forecasting errors, the fact that different populations with different trading strategies can coexist still requires an explanation.

Recent economic and finance research reflects growing interest in marrying the two viewpoints, that is, in incorporating ideas from the social sciences to account for the fact that markets reflect the thoughts, emotions, and actions of real people as opposed to the idealized economic investors who underlie efficient markets (LeBaron, 2000). Assumptions about the frailty of human rationality and the acceptance of such drives as fear and greed underlie the recipes developed over the decades in so-called technical analysis. There is growing empirical evidence of the existence of herd or crowd behavior. Herd behavior is often said to occur when many people take the same action, because some mimic the actions of others (Sornette, 2003).

To adequately analyze whether noise traders are likely to persist in an asset market, we need to describe the long run distribution of wealth, not just the level of expected returns. The question of whether there are winning and losing market strategies and how to characterize them has been discussed from a practical point of view in (Cincotti, 2003). On the one hand, it seems obvious that different investors exhibit different investing behaviors that are responsible for the movement of market prices. On the other hand, it is difficult to reconcile the regular functioning of financial markets with the coexistence of heterogeneous investors with different trading strategies (Levy, 2000). If there exists a consistently winning market strategy, then it is reasonable to assume that the losing trading strategies will disappear in the long run through the force of natural selection.

In this chapter we take an agent-based model approach for a comparative study of different strategies. We examine how traders with various trading strategies affect prices and their success in the market measured by their accumulation of wealth. Specifically, we show that imitators may survive and come to dominate rational investors in wealth when the proportion of imitators is much less than that of rational traders.

The chapter is organized as follows: In Section 2 we survey the related literature. Section 3 describes the relationship between the Ising model and the Logit model. Sections 4 and 5 describe an artificial stock market as the main ingredient in our agent-based financial market. The simulation results and discussion are shown in Sections 6 and 7 respectively. Section 8 concludes the chapter.

RELATED LITERATURE

One can distinguish two competing hypotheses by their origins, one derived from the traditional Efficient Market Hypothesis (EMH) and a recent alternative that is sometimes called the Interacting Agent Hypothesis (IAH) (Tesfatsion, 2002). The EMH states that the price fully and instantaneously reflects any new information: The market is, therefore, efficient in aggregating available information.