Market efficiency and learning in an artificial stock market: A perspective from Neo-Austrian economics

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ABSTRACT

An agent-based artificial financial market (AFM) is used to study market efficiency and learning in the context of the Neo-Austrian economic paradigm. Efficiency is defined in terms of the "excess" profits associated with different trading strategies, where excess is defined relative to a *dynamic* buy and hold benchmark in order to make a clean separation between trading gains and market gains. We define an Inefficiency matrix that takes into account the difference in excess profits of one trading strategy versus another (signal) relative to the standard error of those profits (noise) and use this statistical measure to gauge the degree of market efficiency. A one-parameter family of trading strategies is considered, the value of the parameter measuring the relative informational advantage of one strategy versus another. Efficiency is then investigated in terms of the composition of the market defined in terms of the relative proportions of traders using a particular strategy and the parameter values associated with the strategies. We show that markets are more efficient when informational advantages are small (small signal) and when there are many coexisting signals. Learning is introduced by considering "copycat" traders that learn the relative values of the different strategies in the market and copy the most successful one. We show how such learning leads to a more informationally efficient market but can also lead to a less efficient market as measured in terms of excess profits. It is also shown how the presence of exogenous information shocks that change trader expectations increases efficiency and complicates the inference problem of copycats.

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1. Introduction

In recent years it has become ever more popular to consider financial markets from other than a neoclassical rational expectations point of view. The latter considers financial markets to be in continuous equilibrium with informationally efficient prices. Empiricists have questioned the validity of this model, pointing to evidence of inefficiencies. Alternative views have been presented to better match the empirical evidence. One with a distinguished history, that will be the focus of this paper, is the Neo-Austrian theory of financial markets.

Based on a recent rereading of the ideas of Friedrich Hayek and the Neo-Austrian theory of market processes (see, e.g., Hayek (1937, 1945, 1948, 1978), Littlechild (1982), Rizzo (1990), Kirzner (1992, 1997)), Benink and Bossaerts (2001) presented the first formal application of Neo-Austrian theory to financial markets. In the Neo-Austrian interpretation financial markets are continuously evolving from one inefficiency to another, never attaining the perfect, efficient equilibrium, yet strongly attracted towards it. Creative

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investors track and exploit profit opportunities generated by continuous shocks in a never-ending cycle. The result would be a stable process with pronounced regularities. According to Neo-Austrian theory, a competitive market provides a systematic set of forces, put in motion by entrepreneurial alertness (i.e. eagerness to make money), which tend to reduce the extent of ignorance among market participants.

The resulting knowledge is not perfect; neither is ignorance necessarily invincible. Equilibrium–read: market efficiency–is never attained, yet the market does exhibit powerful tendencies towards it. The fact that equilibrium is never attained is attributed to an erratically changing world where traders realize that their knowledge is imperfect. At the same time, the changes are never so extreme as to frustrate the emergence of powerful and pervasive economic regularities. Although traders can exhibit fully rational behaviour, in the sense that they try to optimize their financial position and wealth, the market process is not generating a rational expectations equilibrium (REE) and informationally efficient prices. Rational behaviour does not necessarily imply rational expectations.[1]

Imperfect knowledge is a key characteristic of Neo-Austrian thinking. According to Hayek, the problem of economic choice and ultimately the analysis of economic behaviour in neoclassical theory is oversimplified, because it has been reduced to optimal behaviour under constraints that agents are supposed to be very familiar with. These constraints concern: (1) preferences, (2) production and market technology, and (3) resources. In contrast, the Neo-Austrian view stresses that fundamental uncertainty and ignorance exist regarding these constraints. This uncertainty and ignorance is claimed to lead to disequilibrium, and disequilibrium itself generates further uncertainty and ignorance regarding the constraints. Disequilibrium thereby becomes self-enforcing and permanent.

However, alert participants in the market process, whom the Neo-Austrians define as entrepreneurs, try to get a–necessarily incomplete–picture of the nature of the disequilibrium in the marketplace, because disequilibrium generates profit opportunities. The actions of these entrepreneurs produce the very signals that are needed to reduce disequilibrium. What renders the market process a systematic process of coordination is the circumstance that each gap in market coordination expresses itself as a pure profit opportunity. The profit-grasping actions of successful entrepreneurs dispel the ignorance which was responsible for the profit opportunities, and thus generate a tendency towards coordination among market decisions. However, due to continuous change in the constraints, equilibrium is never reached.

In their paper Benink and Bossaerts (2001) construct an example of an economy with a continuously inefficient financial market. They adjust the memory of investors' trading rules in order to generate a market process that can be characterized as stable, cycling from one inefficiency to another. Despite the stability (stationarity), rational, risk-averse investors are unable to exploit all inefficiencies because they cannot make reliable inferences about them. This would be the case, for instance, if the memory of the return process is sufficiently long for statistics not to display their usual distributional properties needed to construct confidence intervals. Based on an analysis of average price changes, an investor will with high likelihood reject efficiency, yet the sign of the average is unreliable in predicting the sign in independent future replication. As a consequence, classical statistics cannot reliably assess the inefficiencies.

As a follow-up to Benink and Bossaerts, this paper places more emphasis on, and studies in detail, the learning processes and dynamics of a Neo-Austrian inefficient financial market. As mentioned above, the neoclassical rational expectations point of view considers financial markets to be in continuous equilibrium with informationally efficient prices. Pesaran (1989) notes that the idea of a REE involves much more than the familiar concept of the equilibrium of demand and supply. A REE can be characterized by three main features: (1) all markets clear at equilibrium prices, (2) every agent knows the relationship between equilibrium prices and private information of all other agents, and (3) the information contained in equilibrium prices is fully exploited by all agents in making inferences about the private information of others. Thus, in a REE prices perform a dual role — apart from clearing the markets they also reveal to every agent the private information of all the other agents. In effect, the concept of the REE requires that everybody knows (in a probabilistic sense) everything about the way the market economy functions. But as Hayek (1937) puts it:

> "The statement that, if people know everything, they are in equilibrium is true simply because that is how we define equilibrium. The assumption of a perfect market in that sense is just another way of saying that equilibrium exists, but does not get us any nearer an explanation of when and how such a state will come about. It is clear that if we want to make the assertion that under certain conditions people will approach that state we must explain by what process they will acquire the necessary knowledge".

The preceding implies that, for the REE to have any operational meaning, it is necessary that the processes by means of which people learn from experience and acquire the common knowledge necessary for the achievement of the REE, are specified fully and explicitly.[2]

In this paper we use an agent-based artificial financial market (AFM) to generate simulations of inefficiencies and learning and investigate to what extent a Neo-Austrian interpretation of the resulting market dynamics is the most natural.[3] Agent-based

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[1] Note that in the Neo-Austrian view the failure of markets to reach the informationally efficient equilibrium ought not to be attributed to costs of any nature (adjustment costs, information costs, trading costs, etc). As mentioned, the non-convergence has its origin in limitations of knowledge.

[2] For a recent discussion of these issues, see Pesaran (2006).

[3] The results of AFMs in the past have mainly been analysed using an "evolutionary" as opposed to neoclassical view of markets (see, for instance, Farmer and Lo (1999) and Farmer (1998)).