



# A consolidated model of self-fulfilling expectations and self-destroying expectations in financial markets

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## ABSTRACT

Self-fulfilling expectations, where people's expectations may enable some 'pattern' to arise, and self-destroying expectations, where people's expectations could also induce the arisen 'pattern' to disappear, are two attracting phenomena in financial markets. We hold that these two seemingly conflicting phenomena originally arise from the intertemporal payoff structure of investors and build a consolidated model to systemically explore their underlying mechanisms. Based on individuals' investments, with trend-following and trend-reversing expectation rules, our model exhibits the process in which one expectation rule goes from showing superior performance to being unprofitable, as it is gradually exploited, realized, and taken advantage of. Adding the fundamentalist rule, we find that the fluctuation of fundamentalists' impacts on prices, driven by individuals' real payoffs, is the crucial factor that enables their wished 'pattern' that prices fluctuate around the supposed fundamental value to arise as well as induces this emerging 'pattern' to disappear.

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## 1. Introduction

As a bridge from the past to the future, expectation is an unavoidable and important factor in economic systems. Individuals' expectations guide their actions, which aggregate the macro outcome that they make their best to predict. In turn, the new outcome updates individuals' information, which renews their expectations. Peoples' expectations and the aggregate outcome coevolve, which exhibits the complexity of the system as Arthur (1999) describes: multiple elements adapt or react to the pattern they create by themselves. During this process, we focus on two fundamental questions: how does the aggregate outcome, guided by people's expectations, evolve? Additionally, if we simplify individuals' diverse expectations as different expectation rules, how do these different rules evolve among each other and over time?

To answer the above questions, two important factors should not be ignored: strategy, that is, how people base their actions from their expectations, and learning, that is, how people renew their expectation rules according to the aggregate realizations. People make strategies according to the economic environment they are involved in and take actions based on strategies and expectations. Their aggregate actions form demand and supply and build the relationship between the average expectation and the realized aggregate outcome, that is, the static inner structure of the system. People's learning determines the way in which they adapt to the system that they create by themselves, that is, the dynamic evolution of the system. In economic systems, the underlying element to determine the two factors is people's payoff. For individuals,

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maximizing payoffs is the basis of making decisions and the motivation of updating expectation rules. In short, the payoff structure is the key.

If people's payoff only contains the information of one period, such as the difference between the realized aggregate outcome and individual's expectation on it, the two questions are relatively clear and can be classified as two cases according to different strategic environments. There are two basic environments: strategic complementary environment, where an individual has the incentive to act similarly with others, and strategic substitutability environment, where an individual has the incentive to act differently from others. From the aspect of the relationship between people's average expectation and the aggregate outcome, the related conceptions are positive expectation feedback and negative expectation feedback, respectively. Corresponding to the two feedbacks, Heemeijer et al. (2009) designed two experimental market environments, with the other settings equivalent, to investigate how different economic environments affect the aggregate market outcome as well as individual forecasting behavior. They find that the market with negative expectation feedback quickly converges, whereas the market with positive expectation feedback converges very slowly (or oscillates) and exhibits significant excess volatility. Meanwhile, the coordination of individuals' expectation rules is extremely quick in the market with positive expectation feedback, whereas heterogeneity in individuals' expectations persists (until the market converges to its steady state) in the negative expectation feedback environment. Their conclusions are consistent with the early study, proposed by Fehr and Tyran (2008), about the impacts of different strategic environments (strategic complementary and strategic substitutability) on individual rationality and aggregate outcomes.

However, the financial market is more complicated. On the one hand, if many individuals expect the price of an asset to rise (fall) and therefore start buying (selling) it, the aggregate demand will increase (decrease) and so will the asset price. Bubbles and crashes could arise simply due to people's expectations. Also, excess volatility is observed as one stylized fact (Cont, 2001). It thus seems that financial market belongs to strategic complementary environment (positive expectation feedback). On the other hand, the market also has the property of strategic substitutability environment (negative expectation feedback): there is no common expectation rule that could bring money to all the traders. The coordination of individuals' expectations and actions could erode profits and yield losses. Any coordination of individuals' expectations is temporary, as is the price 'pattern' implied by it. Bubbles and crashes are always turning. Most previous anomalies that contain arbitrage opportunities, such as the small-firm effect, and the holiday effect, among others, disappear after they are published. Strong evidence is provided by Wessel et al. (2006), who attribute the self-destruction property of anomalies to more and more practitioners' anticipating and implementing strategies to take advantage of them. Timmermann (2008) also expresses a similar idea, which is not only limited to the anomalies, but also refers to the predictability of stock market returns by some variables such as the inflation rate as well as the superior performance of some forecasting models. Moreover, Timmermann introduces a life cycle pattern called 'creative self-destruction' to describe the process in which a particular forecasting method goes from being seldom realized to being gradually and widely found and adopted to being incorporated into prices and disappearing. As a result, coordination (if it arises), which could dispel individuals' payoffs, is just one state in the evolution of people's expectations and individuals need heterogeneity to earn money.

In our opinion, the two seemingly conflicting phenomena in financial markets are due to people's more complex payoff structure. People invest in one stock because they believe it could bring money to them and increase their wealth by buying at a low price and selling at a high price. Therefore, the payoff structure contains two actions and is intertemporal. On the one hand, if an individual expects the price will rise, he/she opens or holds a long position; otherwise, he/she opens or holds a short position. That is, people take actions following their expectations. Prices increase with the excess demand, which is guided by the majority's expectation. On the other hand, there is a time lag between an individual's expectation and his/her action. When individuals make decisions to buy or sell, they just have the information up to the last period and do not know at which price they could buy or sell the stock. In other words, their expectations for the price trend of the next period determine their actions in the current period. They want prices to evolve as they desire after they take their actions, but the coordination of their expectations could lead their wish to come true in advance, which induces them to buy (sell) at a high (low) price and decreases the profitability of the prevailing expectation rule. Therefore, the coevolution of different expectation rules and prices becomes more complicated. Prices could evolve as the majority do, which provides an opportunity for the 'pattern' implied in one expectation rule to show up if it is becoming attractive and adopted by more and more people. When the 'pattern' shows up, which hints that the information provided by the prevailing expectation rule has been appropriately incorporated into prices, the profitability of this rule decreases until it is negative due to the consistent actions of its supporters, which further destroys the 'pattern'. In short, due to people's expectations, one 'pattern' implied in a certain expectation rule could arise, and this 'pattern' could also be destroyed by being explored and taken advantage of. In this paper, we name the two phenomena 'self-fulfilling expectations' and 'self-destroying expectations' and build a simple multi-agent model to present the two coexisting phenomena and systemically explore their underlying mechanisms.

An artificial financial market is constructed based on individuals' investment process. One investment contains a pair of actions: buy and sell. Agents choose the expectation rules, observe the market, take actions, and evaluate the rules in use. Their aggregate actions form the excess demand, which guides the movement of prices, and their aggregate selections of different expectation rules form their distribution. Driven by individuals' realized payoffs, prices and different expectation rules coevolve in the system. Under this structure, with trend-following and trend-reversing expectation rules, we roughly exhibit the life cycle, as Timmermann mentioned, that both of the rules experience the process from bringing money to adopters to leading them to big losses, going through the process from being seldom realized to being widely found and employed. Adding the fundamentalist rule, the emergence of the 'pattern' in which prices fluctuate around a supposed

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