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RESEARCH ARTICLE

The profitability of interacting trading strategies from an ecological perspective

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Abstract

Objective To study the interactions among trading strategies and their profitability from an ecological perspective.

Methods A market ecosystem model is established, and simulations are conducted to examine the interactions and profitability of trading strategies in different market ecologies.

Results Strategies compete with themselves, and different time-window trend strategies exhibit competition and predator–prey relationships. Value and trend strategies demonstrate both symbiosis and predator–prey relationships. The profitability of a strategy depends on the balance of supporting and inhibiting effects, with greater supporting effects leading to higher maximum profit and market capacity, while greater inhibiting effects result in losses. The model suggests that fundamental analysis has a larger market capacity than technical analysis.

Keywords Market ecology · Trading strategies · Efficient market · Artificial market

JEL Classification C63 · G12

1 Introduction

The Efficient Market Hypothesis (EMH), proposed by Fama in 1970 and serving as a cornerstone of modern financial theory, suggests that markets are efficient, with prices reflecting all available information. This hypothesis challenges the feasibility

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of consistently generating excess returns through active investment strategies. Despite this theoretical stance, related surveys reveal that financial practitioners indeed utilize fundamental analysis strategies, such as value strategies, and technical analysis strategies, such as trend strategies, indicating a practical deviation from the theoretical implications of the EMH (Cheung and Chinn 2001; Gehrig and Menkhoff 2004; Lui and Mole 1998; Taylor and Allen 1992). Furthermore, the success stories of Warren Buffett, Renaissance Technologies, and George Soros have underscored the potential to achieve sustained excess returns under real-market conditions through specific active investment strategies, presenting a challenge to the EMH's assertions.

Critics of the EMH have argued that it overlooks the irrational behaviors and biases of investors. Some economists, such as Grossman and Stiglitz (1980), express skepticism towards the notion of a fully information-efficient market. In response to these disputes, scholars like Farmer and Lo (1999) advocate for a biological perspective on financial markets, suggesting it as a promising avenue for reconciling these differences. Building on this idea, Farmer (2002) has introduced the concept of "market ecology," drawing parallels between trading strategies in financial markets and biological species, where the capital invested in strategies is analogous to the population of species, forming a dynamic market ecosystem. This perspective is further developed by Lo (2004) with the adaptive markets hypothesis, which posits that price results from the interactions between market environments and trading strategies, and that strategies themselves interact through mechanisms akin to competition, predator–prey, and symbiosis, as defined by Farmer (2002) and Farmer and Skouras (2013). This ecological or biological viewpoint highlights the importance of interactions between trading strategies for understanding market dynamics. Scholl et al. (2021) provide examples of competition, predator–prey, and symbiosis among strategies. However, the literature has not yet comprehensively explored the interactions between the two most commonly used trading strategies: value strategies and trend strategies. Following the framework set by Farmer and Skouras (2013), our study systematically investigates these interactions, offering novel insights into the functioning of financial markets from an ecological perspective.

From an ecological perspective, trading strategies continue to explore profit opportunities in the market. The interaction between trading strategies is essentially the impact of one strategy on the profitability of another strategy. Naturally, we can explore the profitability of trading strategies within the framework of market ecology. Friedman (1953), Fama (1970), and the rational expectations hypothesis (Lucas Jr, 1972; Muth 1961) predict that irrational speculators will eventually be driven away by rational arbitrageurs. However, rational value strategies are not always profitable. Meese and Rogoff (1983) find that fundamental analysis is not superior to a simple random walk forecast at short horizons; in the mid-1980s, when currency prices deviated significantly from their fundamental values, Frankel and Froot (1990) show that the predictions given by fundamental analysis were consistently wrong. In addition, many studies have shown that technology trading is profitable during the sample period (Brock et al. 1992; Hudson et al. 1996; Lo et al. 2000; Schulmeister 2008; Sullivan et al. 1999). Finally, the adaptive markets hypothesis also implies that investment strategies perform well in certain environments and underperform in others (Lo 2004). The abovementioned literature indicates that, regardless of technical trading strategies or value strategies, they may have a profitable range, and outside the range, these once successful trading strategies may fail. On the other hand, some scholars have studied the influence of market states on the profitability of momentum strategies (Cooper et al. 2004; He and Li 2015; Hou et al. 2009). However, most of the above articles are based on empirical research. In this paper, we theoretically analyze the profitability of commonly used strategies. We explore the profit mechanism of strategies and the impact of their interactions on their profitability: How does a strategy's supporting (inhibiting) strategy affect its profitability? Furthermore, will there be a profitable range for the two strategies in a market consisting of a value strategy and a trend strategy? If so, what is the difference between the two ranges?

This paper studies the interactions between trading strategies and the profitability of trading strategies by constructing a market including value strategies and trend strategies. We find a competitive relationship between the same strategies, consistent with Scholl et al. (2021); competition and predator–prey are found between the trend strategies with different time windows; there are symbiosis and predator–prey between value strategies and different trend strategies. From an ecological perspective, the profit mechanism of a trading strategy lies in the aggregation between the support and inhibition experienced by the strategy. In addition, our results show that the supporting strategies of a trading strategy can increase its profit; conversely, the inhibiting strategies can enlarge its loss.

Our model can also provide insights into the profitability of trading strategies. In a market where a value strategy and a trend strategy coexist, both strategies have a profitable capital range due to the symbiotic interaction. This is consistent with De Zwart et al. (2009), whose empirical results report that the two types of strategies are profitable. In addition, the profit range of the value strategy is much larger than the profit range of the trend strategy. Lui and Mole (1998) show that traders are less dependent on technical analysis with the increase in transaction size, and our model can explain the survey result to some extent.

The structure of this paper is as follows. In Sect. 2, we introduce the modeling process and details. In Sect. 3, the interaction between strategies and themselves is demonstrated, and we explore the interactions between different trend strategies and the interactions between trend strategies and value strategies in Sect. 4. Section 5 discusses the impact of the interactions between strategies on the profitability of strategies before concluding this paper in Sect. 6.

2 The model

We consider a market with N agents, and there is only one risk asset in the market. At time t, agent i determines the position x^i_{t+1} of the risky asset based on its own capital c^i_t and trading strategy. If the risky asset is a stock, the position indicates the agent's number of stocks. After the determination of x^i_{t+1}, agent i's excess demand for this risky asset will be determined accordingly, and an order with a quantity of z^i_t will be submitted, where $z^i_t = x^i_{t+1} - x^i_t$. After all the agents in the market submit orders, the total excess demand of the market in period t can be derived: $e_t = \sum_{i=1}^{N} z_t^i$. Assume that there is only one risk-neutral market maker in the market to provide liquidity and generate the price of the risky asset:

$$p_{t+1} - p_t = \lambda e_t + \varepsilon_t,\ \ \varepsilon_t \sim N\left(0, \sigma_\varepsilon^2\right) \tag{1}$$

where p is the natural logarithm of asset price P, and λ represents the impact of total excess demand on price change (which also reflects market liquidity). The noise ε_t of the independent normal distribution reflects the influence of noise traders and external information on price changes. In this paper, we do not specifically model noise traders, but include them in the noise term.

This model considers the strategies often used in the actual market: value strategies and trend strategies. Traders using value strategies (value investors) believe that the market price of a risky asset fluctuates around a fundamental value v_t and eventually converges to the fundamental value. We do not pay attention to how to specifically determine the fundamental value but roughly think that it is a random variable subject to geometric Brownian motion:

$$v_t - v_{t-1} = \eta_t,\ \ \eta_t \sim N\left(0, \sigma_\eta^2\right) \tag{2}$$

The position of a value investor i in the next period is positively correlated with the current capital c_t^i(naturally, the more capital held by traders, the more capital invested in the risk asset) and is also positively correlated with the deviation $v_t - p_t$ of the current price from the current fundamental value. In this model, the position of the value investor i is determined as follows:

$$x_{t+1}^i = bc_t^i(v_t - p_t) \tag{3}$$

where b is a sensitive parameter, which can reflect the impact of traders' capital on the market.

Trend strategies users hold that there is inertia in price dynamics; that is, price trends will continue. We use the moving average $m_{t-1}^\theta = \frac{1}{\theta}\sum_{\tau=t-\theta}^{t-1} p_\tau$ of the price over past θ periods as the reference indicator of the historical price trend. Different trend strategies use different smoothing time windows of θ. The position held by a trend follower i in the next period is positively correlated with the capital c_t^i and the deviation $p_t - m_{t-1}^\theta$ of the current price from the moving average. The position of the trend follower i is of the form:

$$x_{t+1}^i = bc_t^i\left(p_t - m_{t-1}^\theta\right) \tag{4}$$

where b is a sensitive parameter, which can reflect the impact of traders' capital on the market.

In the above modeling process, we do not impose restrictions on the positions of traders. That is, our model allows shorting. Given the existence of the market maker, orders submitted by traders can always be filled. After the transaction price p_{t+1} is generated, the profit R_t^i of trader i in period t is the product of the actual price change and the trader's position:

$$R_t^i = x_t^i (P_{t+1} - P_t) \tag{5}$$

Of course, the profit here is "unrealized" because the most recent price determines it.

For the change in traders' capital, we use the following form:

$$c_t^i = c_{t-1}^i \tag{6}$$

The above equation means that the amount of money that traders invest in a certain strategy in each period remains unchanged. In a complex market environment, this investment method can test the average profit of a strategy.

We follow the method of Scholl et al. (2021), which uses the heterogeneous representative agent hypothesis and treats each strategy as a separate fund. This means that there are two types of strategic players in our market, yet they represent all investors who use these two types of strategies.

Below, we introduce the specific expression of the interactions between trading strategies. If we regard trading strategies as the "species" in biology and the capital invested in strategies as the number of species, the relationships between species can be used to describe the relationships between strategies. Specifically, denote the average profit of strategy A as R^A and the capital of strategy B as c^B; then, the partial derivative $G^{AB} = \partial R^A / \partial c^B$ can be defined. $G^{AB} > 0$ indicates that the existence (increase) of strategy B promotes the "proliferation" of strategy A; $G^{AB} < 0$ indicates that the existence (increase) of strategy B inhibits the "proliferation" of strategy A. According to the sign of a pair of partial derivatives, the relationships between trading strategies are expressed as follows:

$G^{AB} < 0,\ G^{BA} < 0$: competition between strategy A and strategy B.

$G^{AB} < 0,\ G^{BA} > 0$: predator–prey between strategy A and strategy B and B is the predator.

$G^{AB} > 0,\ G^{BA} > 0$: symbiosis between strategy A and strategy B.

In the simulations, initial asset price $p_0 = 1$, initial fundamental value $v_0 = 1$, price and fundamental value fluctuation levels $\sigma_\varepsilon^2 = 0.01,\ \sigma_\eta^2 = 0.001$, the degree of risk aversion $b = 0.1$, the number of simulation periods is 2000, and each experiment is repeated 400 times.

3 The interaction in the single strategy market

Because of the existence of the market maker, orders submitted by trading strategies can always be filled, which provides convenience for studying the interaction between a strategy and itself. In this section, there is only one strategic agent in the market.

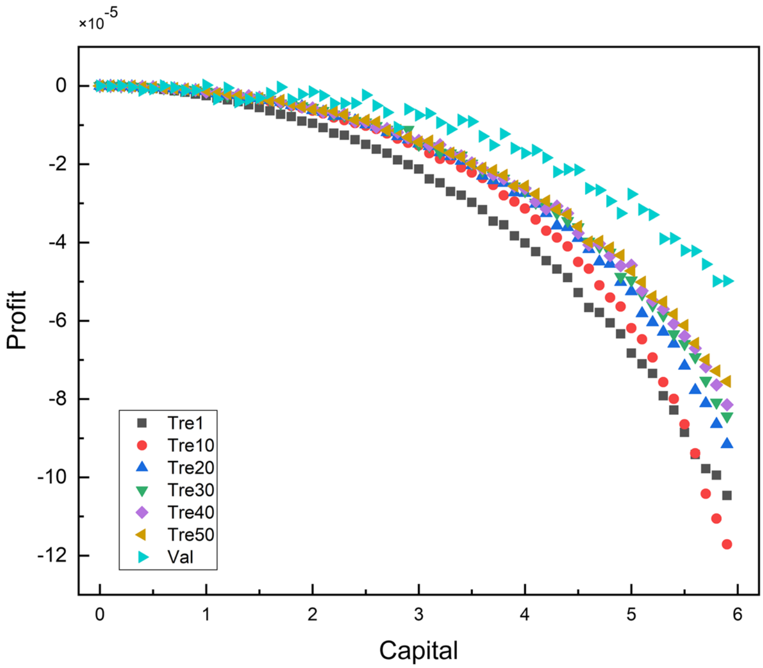

Fig. 1 How the capital of a trading strategy affects its profit in the single strategy market. Treθ represents a trend strategy with a time window of θ; Val represents a simple value strategy, and the signs below have the same meaning

First, we explore how the capital of a single strategy affects its profit. As shown in Fig. 1, when there is only a value strategy (or trend strategy) in the market, the strategy's profit decreases with the increase of its capital, which indicates that each strategy competes with itself. This is consistent with Farmer (2002) and Scholl et al. (2021). This phenomenon is called the crowding effect by practitioners. This result can also support Khandani and Lo (2011), who argue that too many quantitative fund managers investing in the same strategy is one of the reasons for the quantitative crisis. In addition, in the single strategy market, the profit of a strategy has an obvious nonlinear relationship with its capital: when the capital is small, the profit changes slowly; when the capital is large, the loss of the strategy increases rapidly. This illustrates that the more capital a strategy has, the stronger the crowding effect the strategy suffers. Finally, under most capital levels, the loss of the value strategy is smaller than the loss of these trend strategies, which implies that the crowding effect suffered by the value strategy is weaker than that of the trend strategy.

The strategy has almost no positive profit in the single strategy market, which is in line with the actual market because no trading strategy can unilaterally profit from the market maker. The above results show that even if there is no other strategy, a strategy will suffer losses due to competition with itself. This mechanism that hinders capital growth is endogenous.

4 The interactions in the two strategies market

Just as there are competition, predator–prey, and symbiosis between species, similar interactions exist between trading strategies. In nature, energy flows among species; in the financial market, capital flows among strategies. In a market composed of two strategies, we can judge the interactions between the two strategies according to how the capital of one strategy affects the profit of the other strategy. We first show the relationships between trend strategies with different time windows.

4.1 The interactions between trend strategies

Farmer and Skouras (2013) infer that short-term trend strategies are profitable at the expense of long-term trend strategies, while the existence of short-term trend strategies reduces the profits of long-term trend strategies. Trend strategies with different time windows have a predator–prey relationship, and short-term strategies prey on long-term strategies. In contrast, trend strategies with similar time windows are competitive. We argue that Farmer and Skouras (2013) ignore the important role of the capital. Our simulation results show that the interactions between trend strategies are determined by the time window difference and the capital.

To understand the relationships between trend strategies, we first observe the profits of long-term strategies (in the two strategies market, we call the trend strategy with a longer time window the long-term strategy and with a shorter time window the short-term strategy). As shown in Figs. 2 and 3, on the one hand, the profit of the long-term

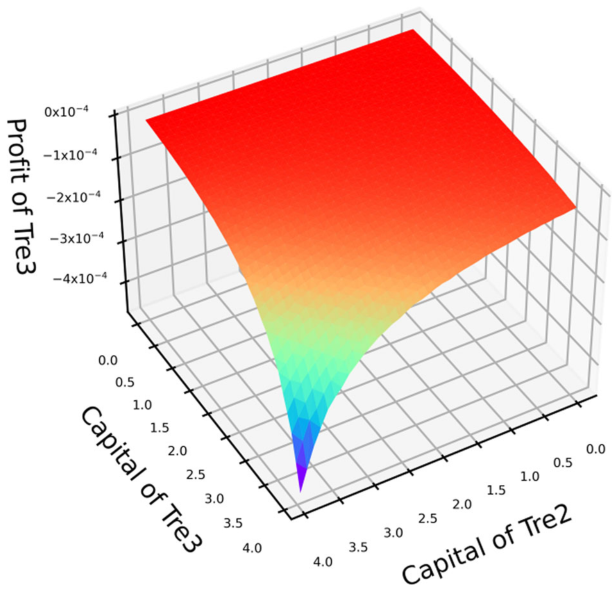

Fig. 2 In the market composed of two trend strategies (θ = 2, θ = 3), the relationship between the profit of the long-term strategy (θ = 3) and the capital of the two strategies

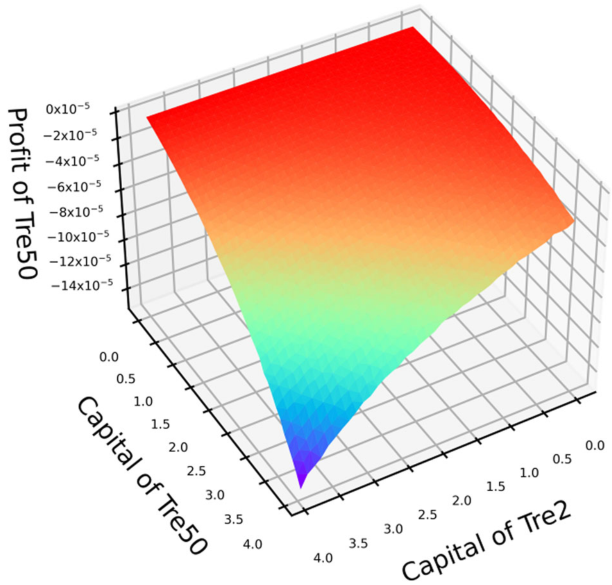

Fig. 3 In the market composed of two trend strategies ($\theta = 2, \theta = 50$), the relationship between the profit of the long-term strategy ($\theta = 50$) and the capital of the two strategies

strategy decreases with the increase of its capital, and on the other hand, the loss is aggravated by the increase of the short-term strategy. This illustrates that short-term trend strategies always reduce the profits of long-term trend strategies, which is in line with Farmer and Skouras (2013).

We next explore the profits of short-term trend strategies. In Fig. 4, the time windows of the two trend strategies are similar. Regardless of the capital of the short-term trend strategy, its profit is negatively correlated with the capital of the long-term trend strategy. Combining the relationship between the profit of the long-term strategy and the capital of the short-term strategy, in this case, the two trend strategies are typically competitive. This is because the trend strategies with similar time windows use almost the same price information. They buy and sell the asset almost simultaneous-ly, and the increase in one strategy's capital compresses the "living space" of the other. This means that there is also a crowding effect between similar strategies.

The profits of short-term trend strategies are relatively complex in these cases in which the time window difference between the two trend strategies is medium. In Fig. 5a, b, and c, as the long-term strategy's capital increases, the short-term strategy's profit with small capital first decreases and then increases. This shows that the increase of the capital of the long-term strategy first inhibits and then promotes the profit of the short-term strategy. In other words, the relationship between the two strategies changes from competition to predator–prey, in which the short-term trend strategy is the predator.

In Fig. 5b and c, we mark the minimum profit of the short-term strategy (red dot). At this point, we roughly think that the relationship between the two strategies has

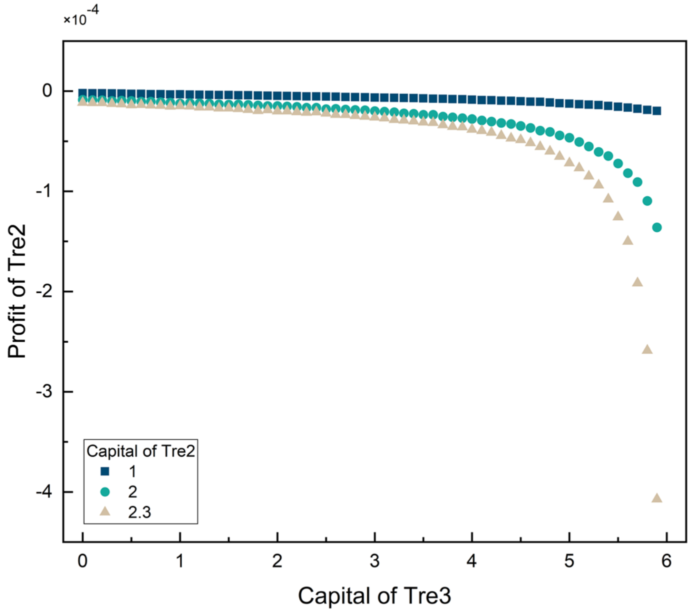

Fig. 4 In the market composed of two trend strategies (θ = 2, θ = 3), the relationship between the profit of the short-term strategy (θ = 2) and the capital of the long-term strategy (θ = 3). The time windows of the two trend strategies are similar

changed. As the capital of the short-term trend strategy increases from 1 to 2, the capital of the long-term strategy increases from 3.5 to 4.4 at the changing point. This is because the short-term strategy competes with itself more intensely as its capital increases, and it requires more long-term strategy capital to overcome crowding. When the capital of the short-term strategy increases to 2.3, its loss is greater with the increase of long-term strategy capital (Fig. 5d). At this time, there is a complete competitive relationship between the two strategies. These results indicate that the interaction of the two trend strategies is in a critical state with the time window difference of them of median size. Changes in the capital of the two strategies may change the form of system interaction, which is called density dependence (Scholl et al. 2021).

When the time windows of the two trend strategies are extremely different, there is only a predator–prey relationship between the two strategies, in which the short-term trend strategy is the predator. In Fig. 6, no matter how much the capital of the short-term trend strategy is, its profit increases as the capital of the long-term trend strategy increases. In this case, the short-term trend strategy can benefit from the slow response of the long-term trend strategy to the market. Finally, when the trend strategy with a time window of 50 has a lot of capital, the trend strategy with a time window of 2 with more capital makes more profit. This indicates that the number of predators is the key factor limiting population growth when prey is sufficient.

In general, the interactions between two trend strategies are affected by the difference in their time windows and their capital. When the time windows of the two trend

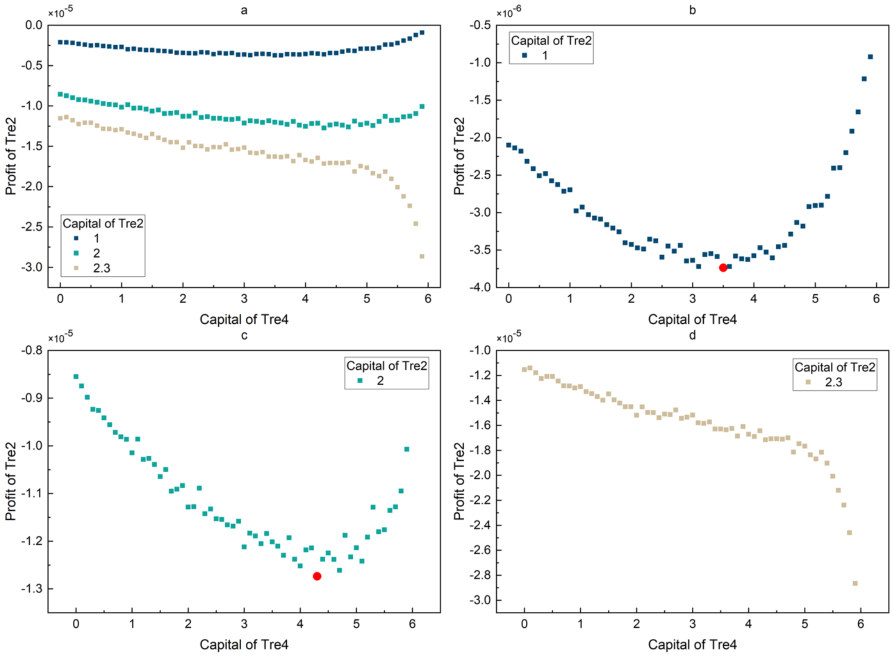

Fig. 5 In the market composed of two trend strategies (θ = 2, θ = 4), the relationship between the profit of the short-term strategy (θ = 2) and the capital of the long-term strategy (θ = 4). **a** is a synthesis of **b**, **c**, and **d**, showing the profits of the short-term strategy under different capital levels. The time window difference between the two trend strategies is medium (colour figure online)

strategies are similar, there is only a competitive relationship between the strategies. When the time window difference is medium, the changes of the strategies' capital will lead to a transformation in the interaction between the two (for example, from a competitive relationship to a predator–prey relationship). When the time windows are very different, there is only a predator–prey relationship between the two strategies, and the short-term trend strategy is the predator.

The reason for these results is that the competitiveness of a trend strategy depends on the size of its time window and capital. The competitiveness here refers to the profitability of a trend strategy in the process of trading with other trend strategies. The smaller the time window of a trend strategy is, the greater competitiveness it has (Combined with the above three experiments, when the short-term strategy is fixed, the larger the time window of the long-term strategy, the smaller the competitiveness relative to the short-term strategy). The more capital a strategy has, the less competitive it is, and the size of the time window of a trend strategy has a greater impact on its competitiveness than its capital. When the time windows of the two trend strategies are similar, their competitiveness is very close. Even if the capital of the two strategies changes, their competitiveness gap is also in the scope of competition. When the time window difference between the two trend strategies is medium, their competitiveness gap is near a critical value. For example, in Fig. 5b and c, when the short-term

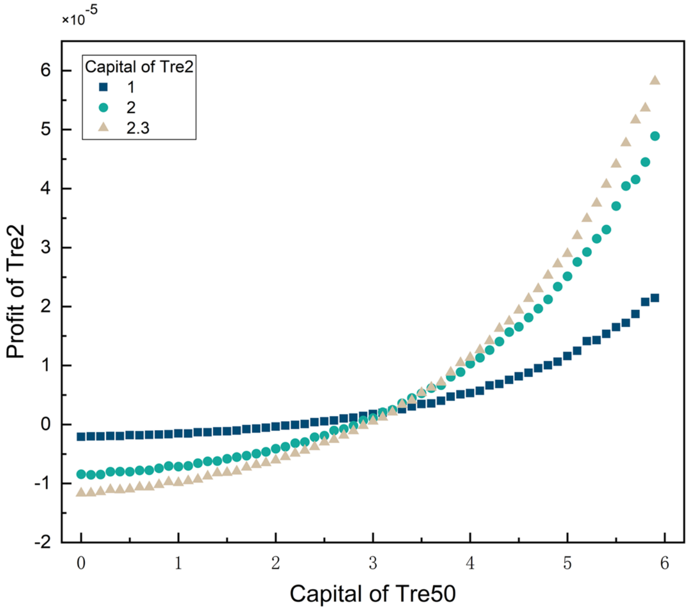

Fig. 6 In the market composed of two trend strategies (θ = 2, θ = 50), the relationship between the profit of the short-term strategy (θ = 2) and the capital of the long-term strategy (θ = 50) is shown. The time windows of the two trend strategies are extremely different

strategy's capital is fixed, the long-term strategy's competitiveness decreases with the increase of its capital, and the competitiveness gap between them increases from the competition range to the predator–prey range. Similarly, in combination with Fig. 5c and d, in the range with large capital of the long-term strategy (after the red dot), the competitiveness of the short-term strategy fades with the increase of its capital, and then the competitiveness gap between the two strategies decreases from predator–prey range to competition range. Finally, when the time window difference between the two trend strategies is extremely large, the competitiveness gap is very large and deep in the predator–prey region. The changes in the strategies' capital cannot make the relationship between the two strategies escape from this region.

The above analysis suggests that the trend strategy with a time window of 1 may perform best because it is easier to make profits in trading with other trend strategies. At the same time, the longer the time window is, the worse the performance of the trend strategy may be. These results are consistent with He and Li (2015) and Jackson and Ladley (2016), who find that the return of a trend strategy is negatively correlated with the size of its time window.

4.2 The interactions between trend strategies and value strategies

There are generally three interactions between species for an ecosystem: competition, symbiosis, and predator–prey. Our above analysis shows no obvious symbiotic relationship between trend strategies. We adjust our perspective to study the relationships between different trend strategies and a simple value strategy.

First, we clarify the relationship between a value strategy and a trend strategy with a time window of 1. Our results show that when the capital of the trend strategy with a time window of 1 is very small, its profit increases with the increase of the capital of the value strategy (Fig. 7a); when the capital of the trend strategy is large, its profit first decreases and then increases with the increase of the capital of the value strategy (Fig. 7b). On the other hand, the profit of the value strategy increases with the increase in the trend strategy's capital (Fig. 7c). This reflects the symbiosis and predator–prey relationship between the two strategies. In Fig. 7d, we fix the capital of the trend strategy, search for the capital of the value strategy corresponding to the smallest profit of the trend strategy, and mark these points in blue. All blue dots constitute the rough dividing line of the interactions between the trend and value strategies. The value strategy preys on the trend strategy in the upper left area of Fig. 7d. There is a

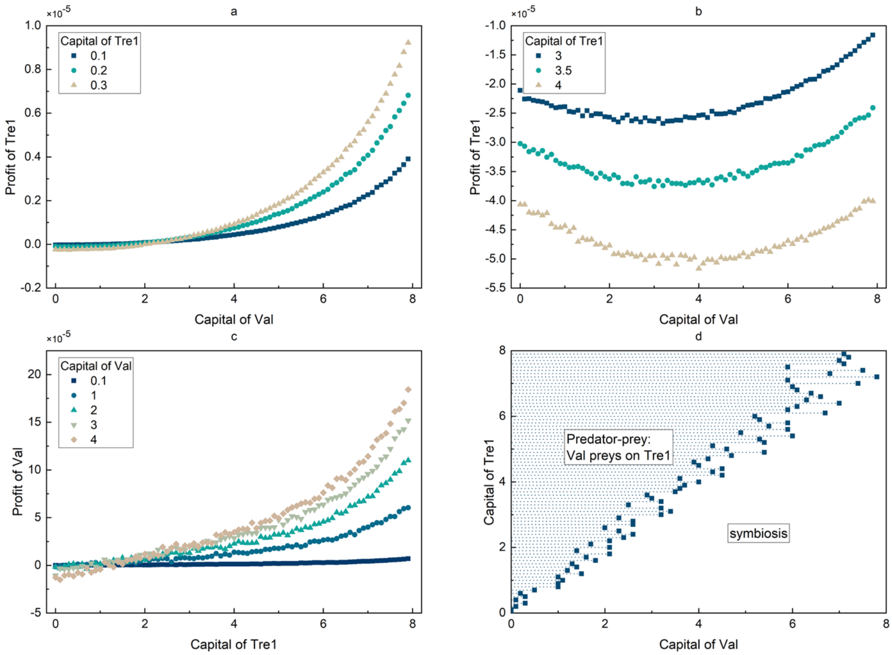

Fig. 7 In the market composed of a value strategy and a trend strategy ($\theta = 1$), the impact of the capital of one strategy on the profit of another strategy and the interactions between the two strategies. **a** When the trend strategy's capital is very small, the relationship between its profit and the capital of the value strategy; **b** when the trend strategy's capital is large, the relationship between its profit and the capital of the value strategy; **c** The relationship between the profit of the value strategy and the capital of the trend strategy; **d** The type of interaction between the two strategies at different levels of capital (colour figure online)

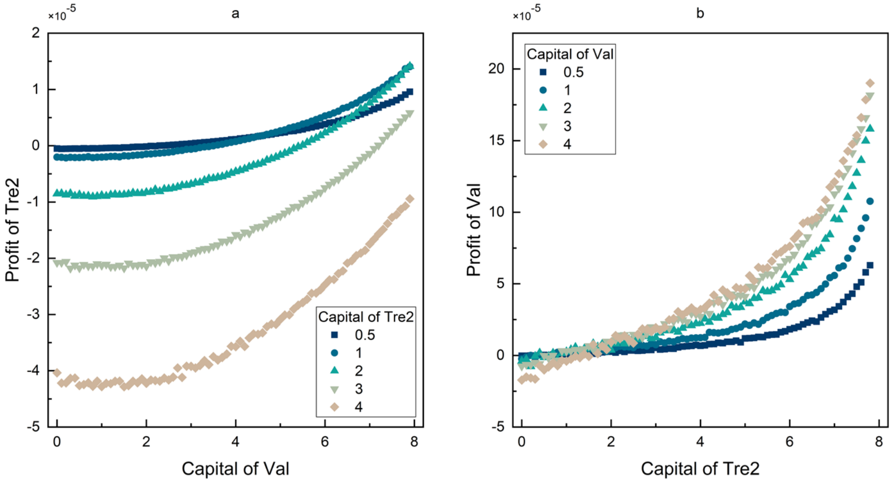

Fig. 8 In the market composed of a value strategy and a trend strategy ($\theta = 2$), the impact of the capital of one strategy on the profit of another strategy. **a** The relationship between the profit of the trend strategy and the capital of the value strategy; **b** The relationship between the profit of the value strategy and the capital of the trend strategy

symbiotic relationship between the two strategies in the lower right area. This means that when the capital of the trend strategy with a time window of 1 is large, it not only has the crowding effect to prevent its profit but also has the predation of a value strategy to reduce its profit.

The above results naturally lead us to the following question: what is the interaction between the trend strategy with a longer time window and the value strategy? We take the trend strategy of a time window of 2 as an example. In Fig. 8, for a market composed of a value strategy and a trend strategy with a time window of 2, the profits of both increase with the increase in the other's capital. In other words, there is only a symbiotic relationship between the two strategies. Combined with Fig. 7a, b and c and Fig. 8a and b, we also observe that the supporting effect of the trend strategy on the value strategy is greater than that of the value strategy on the trend strategy, which is very interesting. Finally, we increase the time window length of the trend strategy, and the symbiotic relationship between the trend strategy and the value strategy remains unchanged (not shown here).

5 Further discussion on the profitability of interacting strategies

In nature, assuming that the number of sheep increases, the number of wolves will also increase, and there is a similar positive effect among trading strategies. The market, including the trend strategies with a time window of 2 and 50, is shown in Fig. 9a. On the one hand, as the capital of the former increases, the profit of the former increases first and then decreases, which is consistent with Farmer (2002); on the other hand, as the capital of the latter increases, the capital range in which the former has a positive

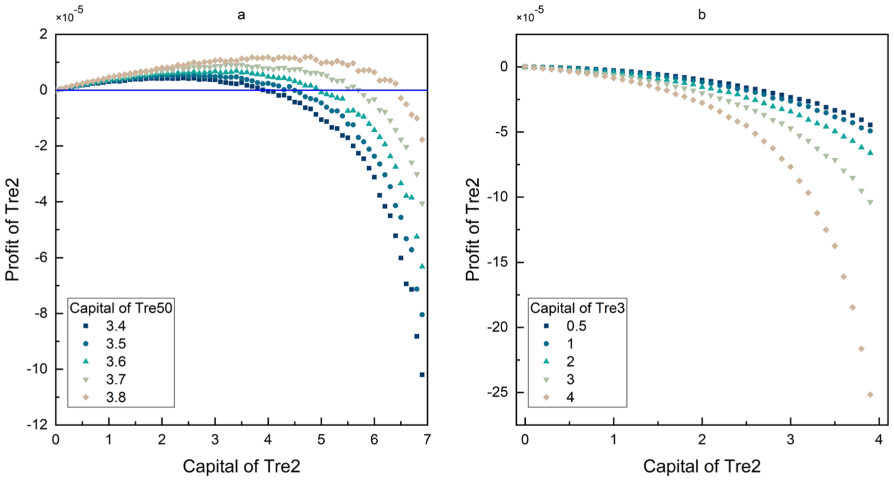

Fig. 9 The relationship between the profit of the trend strategy with a time window of 2 and the capital of itself and its **a** supporting/**b** inhibiting strategy (the trend strategy with a time window of 50/3), and the profit corresponding to the points on the blue line is 0 in (**a**) (colour figure online)

profit increases (the length of this range increases from 4 to 6.4), while the former also has a greater maximum profit. According to the previous results, the trend strategy with a time window of 50 can promote the profit of the trend strategy with a time window of 2, while the strategies compete with themselves. Therefore, the profit mechanism of the trend strategy with a time window of 2 lies in the balance between the supporting and inhibiting effect it experiences: when the supporting effect is greater than the inhibiting effect, it gains; when the inhibiting effect is greater than the supporting effect, it fails. In addition, this result also means that the supporting strategy of a trading strategy can expand its profitability, specifically increasing the market capacity and maximum profit of the strategy. The strength of this supporting effect is positively related to the capital of the supporting strategy.

In addition, the inhibiting effect between species is also reflected between strategies. As shown in Fig. 9b, the profit of the trend strategy with a time window of 2 decreases with the increase of its capital; at the same time, because of the crowding of similar strategies, as the capital of the trend strategy with a time window of 3 increases, the loss of the trend strategy with a time window of 2 increases. This shows that the inhibiting strategy of a strategy aggravates its loss. The strength of this inhibiting effect is also positively related to the capital of the inhibiting strategy.

Next, we explore the impact of the interaction between a trend strategy and a value strategy on their profitability. We pay special attention to the difference in profit space between the two strategies. From the perspective of market ecology, our model can provide insights into the profitability of value strategies and trend strategies. We use a value strategy and a trend strategy with a time window of 2 to show the results, and the results of other trend strategies are similar.

In Fig. 10a, the profit of the trend strategy in the upper right region is greater than 0, the profit of the value strategy in the lower left region is greater than 0, and the

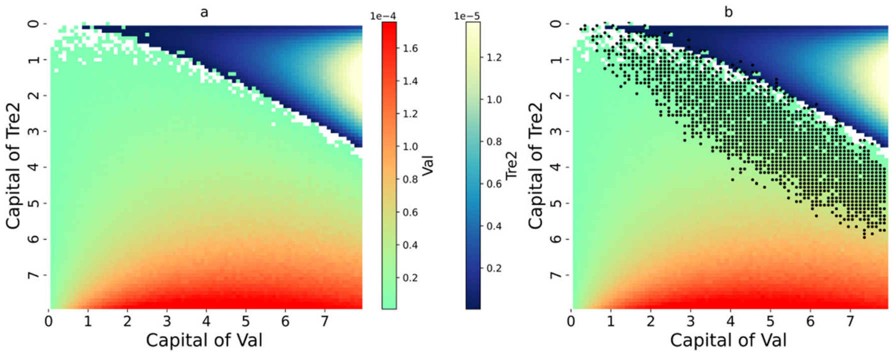

Fig. 10 In the market composed of a value strategy and a trend strategy ($\theta = 2$), the profitability of the two strategies in the capital landscape. **a** The profit of the trend strategy in the upper right region is greater than 0, the profit of the value strategy in the lower left region is greater than 0, and the profits of both strategies in the middle white region are less than 0; **b** based on **a**, we add the region (black spot) where the sum of the profits of the two strategies is greater than 0 (colour figure online)

profits of both strategies in the middle white region are less than 0. Both strategies have a profit range, but the profit range of the value strategy is much larger than that of the trend strategy, which indicates that the value strategy has greater market capacity. It is not surprising that both strategies can be profitable because there is a symbiotic relationship between the two strategies. When the supporting effect of the value strategy on the trend strategy is greater than the competitive effect of the trend strategy itself, the trend strategy is profitable. Similarly, the profit mechanism of the value strategy lies in the balance between the supporting effect of the trend strategy and its crowding effect. As in our previous results, the crowding of the trend strategy is greater than that of the value strategy, and the support of the value strategy to the trend strategy is less than the support of the trend strategy to the value strategy. Therefore, in the market composed of the two strategies, the profit range of the value strategy is greater. Finally, the market capacity and maximum profit of the two strategies are positively correlated with the capital of the supporter, which is consistent with our result above.

De Zwart et al. (2009) find that both value and technical trading strategies are profitable by testing the samples of 21 emerging markets with floating exchange rate systems from 1997 to 2007. The questionnaire survey conducted by Lui and Mole (1998) shows that as the size of transactions increases, traders rely less on technical analysis. Ratcliffe et al. (2017) estimate the asset management capacity of different styles of funds and find that the capacity of funds in momentum strategies is much smaller than that of funds in value strategies. Our model can explain the above empirical results to some extent.

We use black dots to mark the capital range where the sum of the profits of the two strategies is greater than 0 in Fig. 10b. The appearance of this region is caused by the symbiotic relationship between the trend strategy and the value strategy. Our above results show that a single trend or value strategy cannot make a profit when trading with a market maker (Sect. 3), but there is a profitable region when the two strategies are used in combination, which is very interesting. This is consistent with the empirical results of De Zwart et al. (2009) and is also in line with the questionnaires (Cheung and Chinn 2001; Gehrig and Menkhoff 2004; Lui and Mole 1998; Taylor and Allen 1992), which find that foreign exchange traders use both technical information and fundamen-tal information.

In addition, we find that the region where the sum of the profits of the two strategies is greater than 0 is mostly in the region where the profit of the value strategy is greater than 0, and the profit of the trend strategy is less than 0. This means that the profit of the combined strategy is rooted in the profit the value strategy gains. Finally, the profit of the value strategy is greater than the profit of the trend strategy near the middle white region (corresponding to the filled state of the market capacity of the two strategies in reality). These results all illustrate the advantages of fundamental analysis. However, please note that the profit regions of the two strategies are not stable. If the profits of the strategies are used for reinvestment, the capital of the two strategies will move to the white region in the middle until their profits are almost 0.

6 Conclusion

Some scholars have proposed studying the financial market from an ecological perspective to reconcile market efficiency theory and the real world. One of the fundamental questions is: How do financial strategies interact via price? Scholl et al. (2021) demonstrate the interactions of three fixed strategies, and we further test the interactions between different strategies. We find that strategies compete with themselves, and the crowding effect suffered by trend strategies is stronger than a simple value strategy. There are competition and predator–prey interactions between different trend strategies. As the time window difference between the two trend strategies increases, the relationship between the two strategies experiences three states: pure competition, competition and predator–prey coexistence, and pure predator–prey. The interaction between the value strategy and the trend strategy with a time window of 1 is symbiosis or predator–prey depending on their capital, while there is only a symbiotic relationship between it and other trend strategies.

From an ecological perspective, the profit mechanism of a trading strategy lies in the aggregated effect of the supporting and inhibiting effect experienced by the strategy. The greater the supporting effect, the greater the maximum profit and market capacity of the strategy, and vice versa, the greater the inhibiting effect, the greater the loss. In a market where a value strategy and a trend strategy coexist, due to their interactions, both the value strategy and the trend strategy have a profitable capital range, but the market capacity of the value strategy is greater.

Although our model is very simple, it provides new insights into the effectiveness of fundamental analysis and technical analysis in the real world. Our model can accommodate some interesting extensions, such as exploring the relationship between the diversity of strategies and market stability. In addition, we also expect to introduce strategy innovation into market ecology theory, and on this basis, we can study the evolution of the interactions between strategies and market efficiency. We leave these works for future research.

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Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

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