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The pursuit of rational action leads to herding behavior

University of Hamburg
Research Group Climate Change and Security

Working Paper
CLISEC-8

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Abstract

In their award winning study, Beunza and Stark observe traders who use reflexive modeling to increase the rational basis of their decisions. In this process, the traders gather information, create financial models, and then check their own results against specially aggregated market data of actions of competitors and other market participants. If simulation results and observational data do not match, they go back to gathering information, explain the dissonance and adjust their models accordingly. In this paper, the reflexive modeling decision making process is simulated in an agent-based model and further analyzed. It is shown that an increasing pursuit of rationality more and more leads to herding behavior, which is reinforced in a positive feedback loop. While locally each step of decision-making and action still seems rational to the involved actors, the overall decision-making process tends to resemble herding instead. Finally, path dependency theory is used to propose an escape from the loop and reduce the impact of positive feedback within the decision making process.

Keywords

Rational choice, reflexive modeling, path dependency, herding, decision-making, behavioral economics, arbitrage trading

Introduction

In their award winning empirical research paper, Beunza and Stark assess the decision behavior in a New York trading office (Beunza & Stark, 2004; 2010; 2012; Stark, 2009). Combining ethnographical and historical research, they discover that merger traders not only approach trading options in a rational way using financial models instead of gut feelings. Also, traders are aware of the limitations of their models and their still bounded rationality (Simon 1983), which persists despite enhanced computer data mining systems. This is why traders apply a way of reflexive modeling behavior: Before actually using their just composed models for trading, and thus relying on their own computed probabilities, they cross-check their results with an average implied probability calculated from current market data. Mismatches then prompt further searches for information to explain or interpret this ‘dissonance’ and to expand the models to match the simulation results with the analyzed market data. But although the observed merger arbitrage traders aim at rationalizing and optimizing their decision-making procedures, examples give evidence of bad trading decisions, which have produced severe losses in the past.

It is already known that rationality is bounded by the locality of information, intuitive weights or interpretations of information and the necessity to actually make decisions within short time frames to be able to act (Simon 1983). Therefore, it is important to use concepts of procedural rationality (Simon 1983) or action rationality (Brunsson 1982) to frame rational decision-making processes adequately. In the case of the New York trading office the pursuit of rationality is aimed at optimizing the quality of decision-making processes and hence is not a mere source of action justification (Brunsson 1995). Although decision-making by following the masses is not defined as rational, herding behaviour has already been largely observed on financial markets (Scharfstein & Stein 1990).

Despite the traders' awareness of bounded rationality and their attempts to bridge information gaps, wrong trading decisions occur and thus great losses are incurred. Searching for explanations Beunza and Stark (2012, p. 409) state that the reason for these losses can be found in the reflexive decision-making process itself: Applying the reflexive modeling the merger arbitrage traders gained confidence that their own estimations of the probability of the considered merger's occurrence were true. They therefore expanded their positions and suffered even greater losses when the merger was canceled.

To further analyze these negative side effects of the reflexive decision-making process, in which the traders intend to be very rational an analytical methodology will be used in this paper. First, the algorithm of the reflexive decision-making process is described formally and simulated in an agent-based model. The gained results are further explained by an analytical assessment of the structure of the reflexive decision-making process in comparison to non-reflexive, rational, intuitive, or herding decision-making processes. In the end, path dependency theory is used to describe how the pursuit of rational action reinforces herding behavior. Finally, an escape from the unintended positive feedback loop is suggested.

The model

Merger arbitrage trading

> We focus on arbitrage because it is the trading strategy that best represents the distinctive combination of connectivity, knowledge and computing that we regard as the defining feature of the quantitative revolution in finance. ... if we are to understand the organization of trading in the era of modern finance, we must examine all three pillars of the quantitative revolution: network connectivity, mathematical formulae and computing. It is precisely this combination that gives the study of modern arbitrage - the trading strategy that most powerfully and, to date, most profitably exploits the mathematics and the machines of modern market instruments - such analytic leverage.
> (Beunza & Stark, 2004, pp.370-371)

Beunza and Stark's empirical study, which is used as basis for the secondary analysis in this paper, concentrates on merger arbitrage, which is a special form of arbitrage. The standard arbitrage is defined by Miyazaki (2007) in the following way:

> Arbitrage is ideally risk-free or low-risk trading that aims to capitalize on differences in price between what in theory are economically equivalent assets by buying low and selling high. Typically, arbitrage entails the simultaneous buying and selling of a single security at two different geographical locations or of two economically related securities, such as a basket of

stocks traded in the cash market and futures contracts on those stocks, when there is a significant price difference between them. (Miyazaki, 2007, p.397)

Apart from this basic understanding of arbitrage strategies that result in convergence trades, Beunza and Stark (2012) describe merger arbitrage as an “event-driven” strategy. “It boils down to informed speculation about a specific event – the completion of a corporate merger” (p. 391). Unlike in basic arbitrage trading, merger arbitrage traders do not focus on two different prices for the same product in order to buy at the cheaper price on one market just to sell at the higher price on the other market and thus to earn the arbitrage amount. Instead, they operate with probabilities, which they compute in different ways and which are based on financial market data, company information, or basically all information that the trader or the computer data mining system associates with the merger:

In the case of mergers, the ambiguity arises from the fact that a company is being bought. The acquiring firm typically buys the target company at a price well above its market capitalization, leading to two possible valuations: if the merger is completed, the price of the company will rise up to its merger value; if it is not, the price will drop back to the level before the merger announcement or lower. Arbitrageurs exploit the ambiguity as to which of the two will apply by speculating on the probability of merger completion. To the arbitrageurs, therefore, profiting from mergers boils down to successfully estimating a probability. (Beunza & Stark, 2012, p. 395)

To fulfill this duty of successfully estimating the probability of the merger, the observed traders combine two approaches: a searching procedure to identify valuable information and mathematical modeling to compute probabilities out of gathered information. In their overall decision-making process the traders have to decide frequently whether they have to search for more information or whether their models are already accurate enough to trade. Therefore, the observed traders cross-check their model results with a probability they generate from aggregated market data.

The algorithm

Beunza and Stark (2010) highlight the key aspects of the reflexive modeling decision process of merger arbitrage traders they observed in their studies as follows:

The core finding from these observations is that traders cast a skeptical eye on their own models by exploiting the fact that other traders, equipped with their own models, have also taken positions on the merger. In effect, arbitrageurs back out from the stock prices of the merging companies, thus getting at the “implied probability” of the merger – that is, at the aggregate probability that other arbitrageurs attribute to the merger. This practice gives arbitrageurs the opportunity to check their own estimates. Gaps, disparities, differences, and mismatches produced positive friction that stimulates re-search. The lack of them gives traders greater confidence that their views are correct. (Beunza & Stark, 2010, pp. 6-7)

Thus, the iterative algorithm of how the merger arbitrage traders in the observed New York trading office have prepared their models to make trading decisions can be described in the following way:

1. They gather information on what is in the news about the mergers they observe.
2. They create models on the likelihood of the actual occurrence of the merger.
3. They check their own model results against a probability gained from aggregated market data that they consider to be related to the merger or failure of the merger.
-> If the model results are close enough to the probability created from the aggregated and averaged market data, they 4. trade (end of the algorithm).

-> If the model results are not close enough to the probability created from the aggregated and averaged market data, they assume that they may have missed out some valuable information and therefore go back to gathering information (1.).

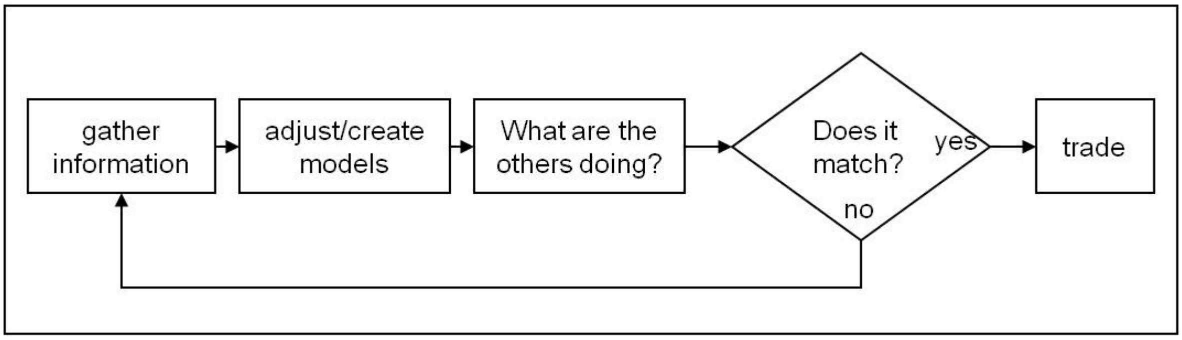

Figure 1. Schematic overview over the algorithm of the merger arbitrage traders' decision making process. A reflexive modeling decision process (in the order of consideration).

To analyze and visualize the trader's decision-making behavior within the process observed by Beunza and Stark (2004, 2010, 2012), I have created an agent-based simulation model, which has been coded in NetLogo (cf. Figure 2). In the center of the plotscreen there is a merger arbitrage trader who has to make a trading decision (default shape). Around him are other agents in blue (dark) or yellow (light) (person shapes) who represent the information for or against the considered merger. The trader has a certain radius of vision (green (center field) background), in which he can see the information and which he can thus embed in his model. However, if his vision is tight there is also information out of his reach. The probability created from the spreadplot in the New York merger arbitrage trading office is represented by the probability created from the average of all information on the plotscreen in the model, thus, of the information within the vision of the trader and of that out of his reach.

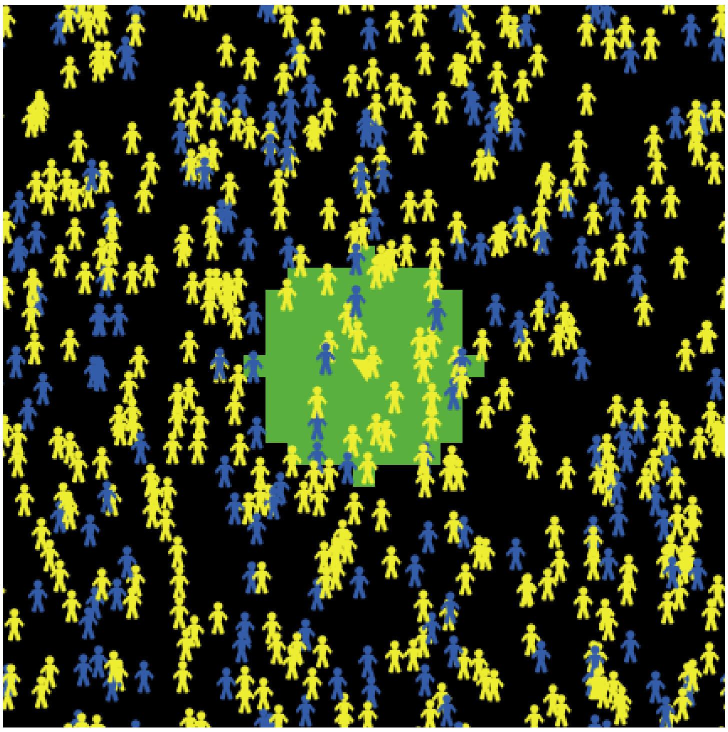

Figure 2. The end of the simulation run with 500 agents, 70 percent yellow (light) agents and a model accuracy of 92% after the vision has been enlarged for 3 times.

To prepare a model run, the setup vision of the trader can be chosen, the number of pro and contra merger information, and the accuracy the trader would like to reach with his model. Then the trader is positioned in the middle of the plotscreen and the information is spread randomly around him. Within the reach of his vision he can calculate the information on the merger around him, build a model, which is represented as averaging the information in reach, and come to a preferred position he would like to take. In his decision whether he wants to place a trade or not, he compares his model result with the total average probability, which represents the spreadplot information. If the two probabilities are closer than the preset model accuracy, the trader takes the position and places a trade. But if the accuracy is not reached yet, the trader searches for further information, which is represented by the enlarging of his radius of vision. Using the enlarged radius, a new average is calculated from the given information. This corresponds to the improved model. The new average is checked against the overall average probability to determine the accuracy of the improved model and to repeat the steps of searching for additional information and further improving the model if necessary. If the preset model accuracy is reached the run of the simulation is terminated.

Model results and interpretation

The model is run with 500 agents and 1000 runs for each combination of yellow (light) agents (50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%) and model accuracy (83%, 86%, 89%, 92%, 95%, 98%). When the algorithm stops a trading decision has been reached and besides other statistics the final decision is noted. From this, the merger arbitrage trading decision can be derived, in favor of or against a merger as summarized in Table 1.

If the model accuracy is high enough, the use of the algorithm enables the trader to based on the actually available information but only having to access the amount within a relatively small radius. Thus, using the reflexive decision-making algorithm helps to efficiently process and use available information in combination with information only available in an aggregated format.

Table 1. Which percentage of the simulated trading decisions end in pro merger (yellow (light)) or contra merger (blue (dark))? Percentage of the pro merger decisions of all resulting decisions, which resulted from 1000 runs for each combination at a total number of 500 agents in the simulation.

model accuracy horizontally vs. percentage of yellow (light) agents vertically

	83	86	89	92	95	98
50	49,95	50,35	49,30	51,35	49,45	51,30
55	74,45	81,35	87,60	100	100	100
60	100	100	100	100	100	100
65	100	100	100	100	100	100
70	100	100	100	100	100	100
75	100	100	100	100	100	100
80	100	100	100	100	100	100
85	100	100	100	100	100	100
90	100	100	100	100	100	100
95	100	100	100	100	100	100

The higher the model accuracy, the better the approximation of the market information, thus the higher the likelihood that all relevant information is included in the decision-making process. The line shows the decision when herding behavior is applied. Thus, the higher the accuracy the more closely the final decision resembles a herding decision.

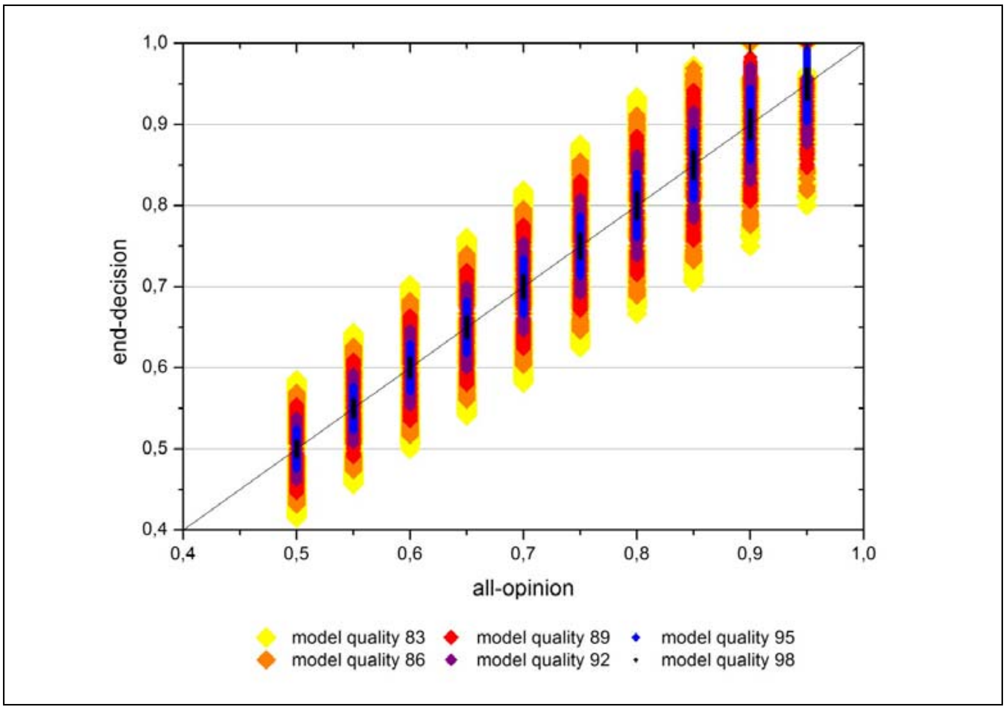

Figure 3. Model results for the final trader decisions (end-decision) vs. share of yellow (light) agents. For symmetry reasons only the upper half, which includes a share of 50 percent or more, is considered (all-opinion ≥ 0,5). The model is run with 500 agents and 1000 runs for each combination of yellow (light) agents (50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%) and model accuracy (83%, 86%, 89%, 92%, 95%, 98%).
(all-opinion = share of yellow (light) agents; represents the likelihood of the merger calculated as the average probability (spreadplot) gained from aggregated market information)
(end-decision = averaged share of market information within reach (within the radius) of the trader when positioning his trade).

Therefore, the more intense the traders apply the algorithm, the more they approach a herding decision with their decisions. Consequently, it would have been even more efficient for the traders to directly apply herding without the need to create complicated algorithms and decision-making processes to reach the same decisions in the end.

Schematic analysis of the decision-making processes

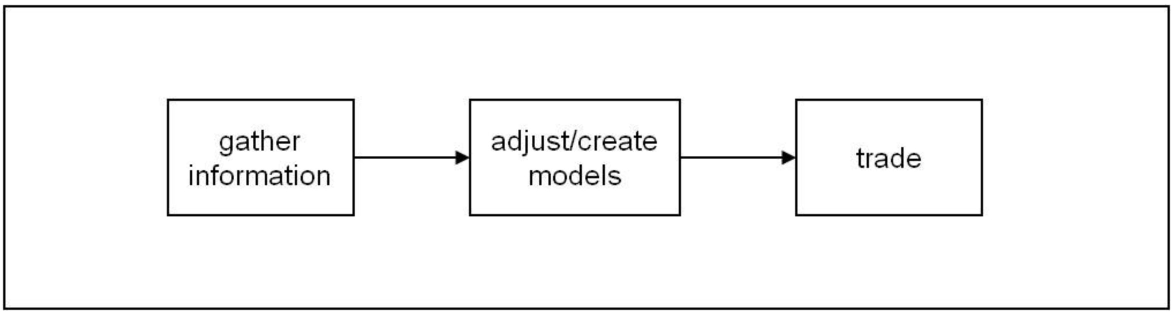

Figure 4. A non-reflexive modeling decision process.

To visualize the structure of the merger arbitrage trader's decision-making process in a schematic way, first a plain non-reflexive modeling version is shown in Figure 4. It consists of three steps. In the first step, actors gather information, then they create or adjust models and in the third step they finally conduct the trade (in one way or another), if the process is completed. Other possible decision-making processes include for example an intuitive process (Figure 5). In this scheme, the trade in the third step is based on intuition during the second step instead of the application of models. A third possibility consists of herding, where the information gathered in the first step reflects what the others are doing and the processing of this information in the second step tells the actor to follow the mass (Figure 6). These decision-making processes also can be combined (Figure 7). This combined strategy is based on a first step that identifies what the others are doing. From this, the actor can either conclude in the second step to follow the masses or to do the opposite or perhaps even to follow his own intuition.

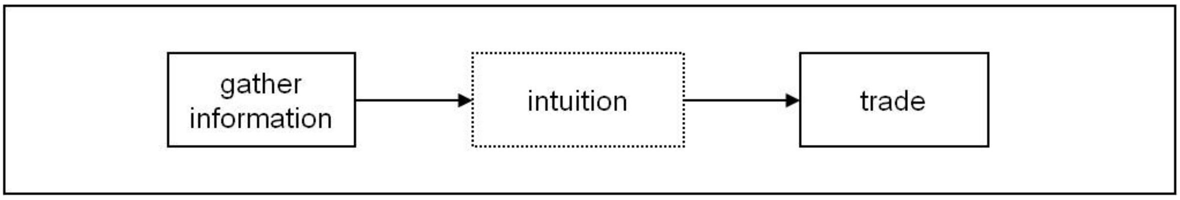

Figure 5. An intuitive decision process.

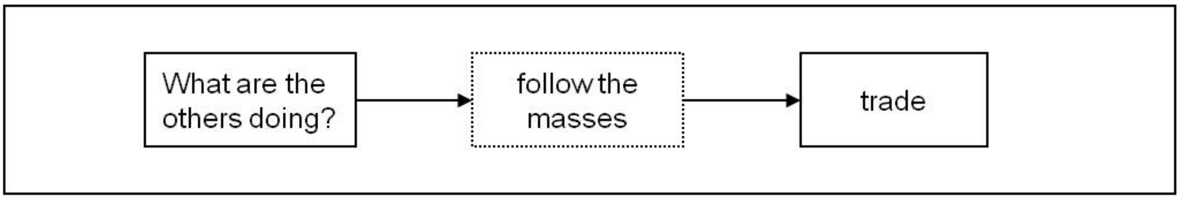

Figure 6. Herding (or 'intelligent-herding' if the central action is not simply 'follow the masses' but: 'go where you think the others will go' instead).

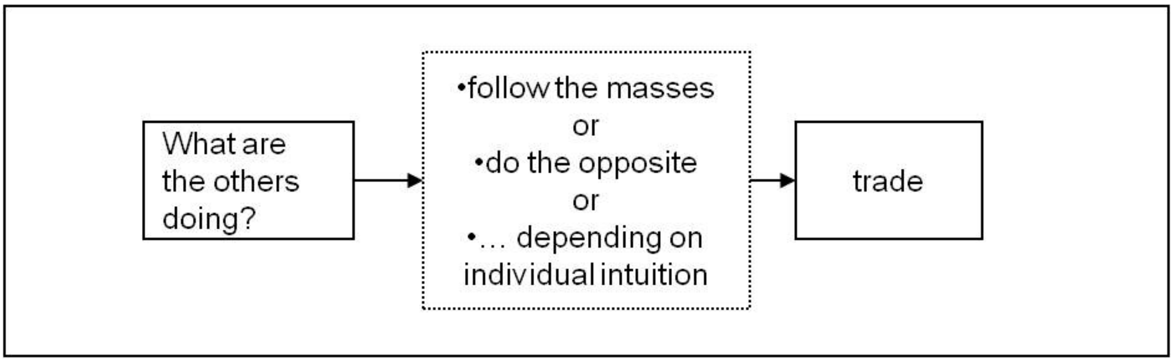

Figure 7. Combination of herding and an intuitive decision process.

If comparing two traders with the same second step action, the trader with the better information gathered during the first step is likely to outperform the other one. Therefore, it appears to be sensible to observe what the competitors are doing in order to be aware of possible additional information that could keep the actor from being the loser in the end. Thus, it is rational to include a reflexive component in the decision process, in which the own results are cross checked against the actions of competitors on the market. As Beunza and

Stark (2012) state:

> This confrontation pits a trader's estimates against those of his or her rivals, thereby introducing dissonance in his or her calculations. ... Reflexive modelling thus denotes a heightened awareness on the part of the arbitrageurs about the limits of their own representations of the economy. (Beunza & Stark, 2012, p.403)

> In our view, a satisfactory explanation needs to focus on the interdependence between the social and the calculative. That is, we take as our starting point the observation that financial actors go back and forth between models, their understanding about what is being traded, and their ability to figure out what their competitors are doing. (Beunza & Stark, 2010, p.4)

In Figure 1, a reflexive modeling decision process has been shown that reflects the traders' behavior in first gathering information, then creating or adjusting mathematical models, and finally checking the competitors' actions using aggregated plots or personal contacts. If the implied probability that actors obtain from the information about what the others are doing matches what they have computed from their own information before, they can reach a profound trading decision. Otherwise, they go back to gathering additional information to find explanations for the dissonance between their model results and the observed actions of other actors in the market.

> A trader's ability to mobilize prices for greater precaution hinges on the encounter between the probability of the merger (estimated at the desk) and implied probability (derived from the spreadplot). This comparison provides an invaluable advantage: it signals to traders the extent of their deviation from the market, warns against missing information, motivates additional search, prompts them to activate their business contacts, and provides the necessary confidence to expand their positions. (Beunza & Stark, 2012, p. 403)

While the reflexive modeling decision process in Figure 1 is outlined in a chronological way along the arrows, it also can be viewed slightly differently, indicating the position 'what are the others doing' as an influential aspect that deviates from the initially gathered information. Thus, it serves as a separate source for checking whether the actors need to gather more information or whether their models are already sufficient for trading (Figure 8).

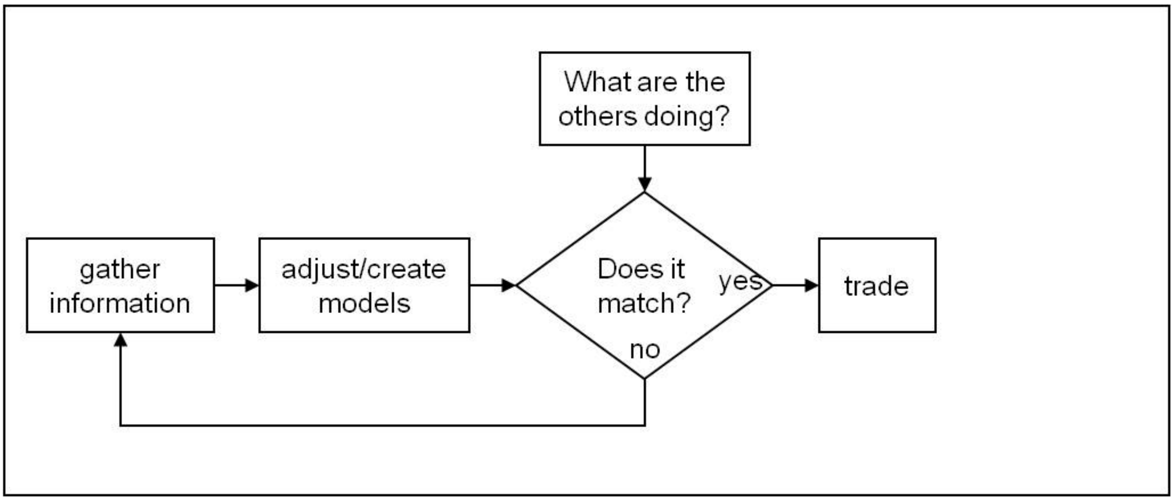

Figure 8. A reflexive modeling decision process (in the order of influence).

But this implies that in each reflexivity step in the process of reflexive modeling the merger traders adjust their models to what the others are doing.

Our analysis so far has established that the arbitrageurs deploy sophisticated quantitative tools. But as we shall see, no matter how sophisticated their tools, arbitrageurs are acutely aware that their models are fallible. Traders confront their own fallibility by distancing themselves from the categories and procedures that guided them to an initial position. … Traders, we found out, gain cognitive distance from their categories by exploiting the fact that other arbitrageurs have also taken positions on this trade. … The spreadplot reduces that cognitive complexity by representing the aggregate of the expectations of other traders. (Beunza & Stark, 2012, pp.397-399)

So the question arises: to what extent do the actors' own models and any confidential information influence their trades and how much do actions of other actors influence the merger traders' final decisions (Figure 9)?

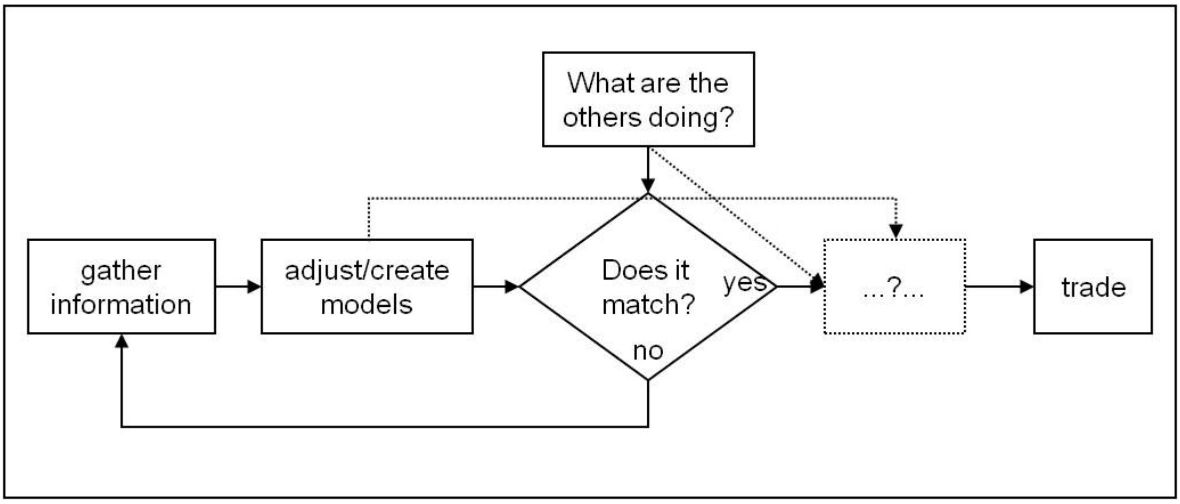

Figure 9. The question is how the actual decision is finally reached and by what aspects/ mechanisms it is influenced.

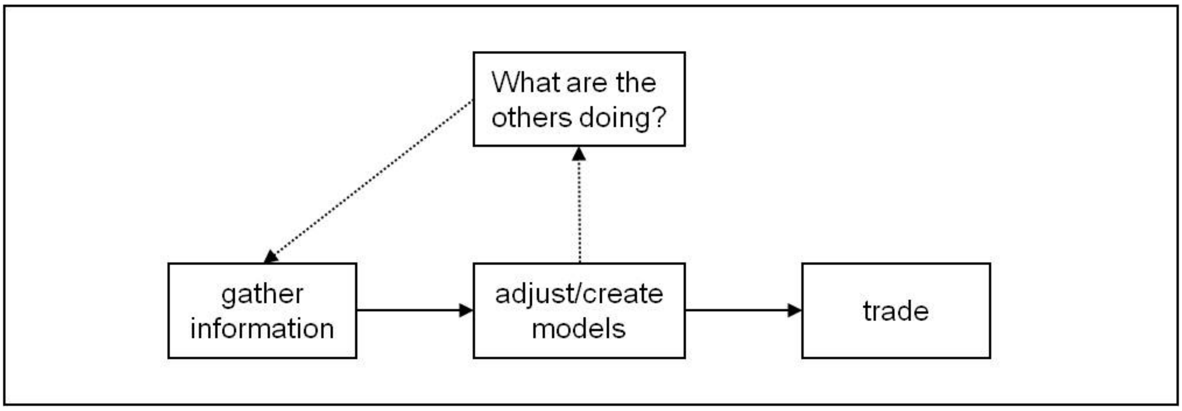

Figure 10. Is the actual trading process more like a basically non-reflexive process, in which only from time to time a reality-check is used to decide whether the models applied are already of sufficient quality or whether more information is needed?

The opportunity that Max saw, then, was not the result of privileged information. As Max said, "right now, the data is all on the Internet, even the SEC filings." Being widely available, information does not confer any advantage. To him, it resulted from his desks' distinct interpretation of publicly available data. … Because arbitrageurs use models to check their

positions against the rest of the market, the diffusion of reflexive modeling creates cognitive interdependence between otherwise independent rivals.
(Beunza & Stark, 2012, p. 405)

Thus, if the specialty is the weighting and the interpretation of available data, the critical part that makes the difference in present day trading is not the information itself but the models that weight it and that in a reflexive process are adjusted based on how the other actors weight the information (Figure 10). Still there also is an intuitive component implemented in the interpretation of the match or mismatch of information left to the specific traders in their decision-making process.

The persistently wide spread, in short, was an ambiguous signal: it could be signalling incorrect modelling or a profit opportunity. … Max and his colleagues responded to the discordant spread by plunging into a search for possible merger obstacles that they might not have anticipated. "Are we missing something," Max asked the traders. … Having observed the dissonance between their own probability estimates and the implied probability, the traders went back to search for missing information.
(Beunza & Stark, 2010, pp. 32-33)

But is the actual trading process more like a basically non-reflexive process, in which only from time to time a reality-check is used to decide whether the models applied are already of sufficient quality or whether more information is needed? Or do the traders rather use their models to mirror what the others are doing?

… knowledge of the spread stimulated the arbitrageurs to search more. … The material tools allow traders to come up with more sophisticated answers than traditional investors precisely by inducing skepticism about the tools. Arbitrageurs, in this sense, are persistent but skeptical users of calculative devices.
(Beunza & Stark, 2012, p.402)

The traders' limit to their skepticism is either a perfect match with what the spreadplot tells them about the other traders' actions or that their own intuition tells them that the model is sufficiently close and all necessary information is weighted and used appropriately. Thus, their own skepticism about their models may lead the traders through an intense reflexivity to a considerable adjustment to the competitors' actions, leaving just enough space for an intuitive component (the box with the question mark in Figure 11) before the actual trade is made (Figure 11).

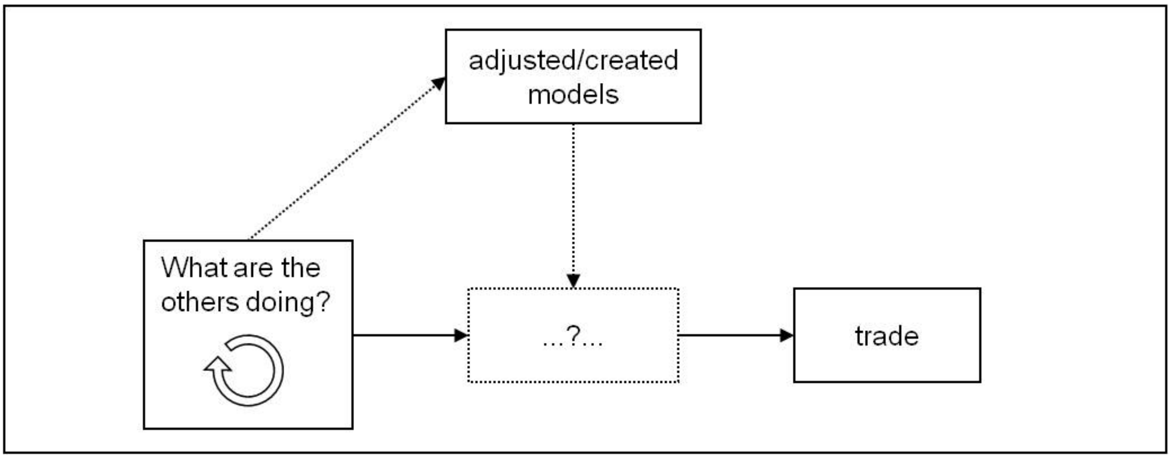

Figure 11. Traders follow their models but also create their models to mirror what the others are doing. Therefore, they follow what the others are doing, which is the definition of herding.

A comparison of Figure 11 with the Figures 5 to 7 indicates that the traders' decision-making process is obviously somewhat more complicated but basically an intuitive or herding one, depending on how the actual decision is then reached at the position of the question mark.

> To clarify the precise mechanism that led to these losses, we interviewed the senior merger trader and the manager of the trading room. The latter made clear that the bank was reacting to the spreadplot. It increased its position, making things worse for itself. According to the manager of the trading room, "Max traded it … everyone’s database lacked a field, and the field was 'European regulatory denial.' … I encouraged him [Max] to increase his size … you have confidence, all of your fields are fine… so instead of four million, I said six million." In other words, the desk lost $6 million because it increased its exposure to the trade, and the increased exposure was a reaction to the spreadplot.
> (Beunza & Stark, 2012, p. 409)

In the observed example the crucial element in the trading decision-making process has been the spreadplot and therefore, what the others are doing. The created and adjusted models have been well suited for the aggregated information ("all of your fields are fine"). Therefore, in the observed example, Figure 11 describes the intensity and importance of the reflexivity better than Figure 10. Thus, the decision process in that case can be considered to be herding behavior, which has lead to a strongly negative result for the trading room.

> Our analysis, however, suggests that GE-Honeywell ... was, we contend, an unintended consequence of reflexive modeling. … Our interviews suggest that the size and magnitude of the disaster was an outcome of a subsequent move: the traders’ reaction to the initial confidence. It was the social activity, coupled to the model that produced such losses. ... First, the arbitrageurs at International Securities independently underestimated the risk of regulatory opposition (their competitors did too). Second, when the arbitrageurs checked the spreadplot to confront their estimates against the rest of the market, they found confirmation: the spread was narrow, and was not moving with news of Monti. Thus reinforced, the traders then engaged in a third move: given their greater confidence, they increased their exposure. The combined result of these three steps was a reinforcement of the overconfidence of the various arbitrage funds, via the spreadplot. The spreadplot was thus the source of cognitive interdependence. Were it not for this device and the practice of reflexive modelling, trading losses would have been far less profound and widespread. (Beunza & Stark, 2012, pp. 406-410)

Consequently, the herding behavior resulting from the use of the spreadplot and intensive reflexive modeling has been the cause of the severe losses. While a mere herding behavior in following others would have resulted in the same losses as for others, the overconfidence the traders gained from their belief in applying a more rational process via their reflexive modeling has lead them to even take an overproportionally large share of the losses.

An explanation and discussion of how to avoid rationality-induced herding

One possible explanation for this existence of herding in the described way is path dependency. Path dependency theory describes effects of locally rational processes producing outcomes, which would not have been considered a rational choice in the beginning (Arthur 1989, 1994; David 1985, 2000, 2007). It has been discussed whether the outcomes of path dependency necessarily need to be inefficient or whether the mere existence and survival of persistent solutions on markets indicate their efficiency (Libowitz & Margolis 1990, 1995). To apply the criticism of path dependency theory and thus the efficiency argument on the example of the New York merger arbitrage trading office one would need to analyze the overall decision quality in general, i.e. aggregated wins and losses over a certain time period, and compare them to the performance of other possible decision-making processes such as direct herding (without reflexive modeling) or only mathematical modeling without the reflexive part. Such an analysis may indicate that overall the performance of a reflexive modeling process is successful and therefore, it would be rational to choose the reflexive modeling process for merger arbitrage trading. But comparing the results of a reflexive modeling decision-making process to a herding one (like in the results of the agent-based model in this paper), indicates that even though the efforts of the reflexive modeling process are much higher than mere herding would be, the decisions, and thus the decision quality, are more or less the same. Therefore, in the direct comparison of decision-making processes it would be more rational to directly prefer the herding decision-making process instead of reflexive modeling.

This may explain, why herding is largely present on financial markets (Scharfstein & Stein 1990) enhancing or even causing financial bubbles. But the existence of rationality-induced herding complicates their prevention: A common sense advice to get away from herding behavior, which is referred to as more or less blindly following the mass, would be to use more individual preferences and local information and to decide rationally (Surowiecki 2004). But the pursuit of rationality would again reinforce herding in the case of rationality-induced herding. Therefore, rationality-induced herding could be manifested in a vicious circle.

To apply traditional path dependency theory on the situation of rationality-induced herding, the process of optimizing the traders' own decision-making and trading can be framed as the process along which self-reinforcing mechanisms increasingly shape the outcomes (Sydow, Schreyögg & Koch, 2005; 2009). Then, the rationality-induced herding decision-making would be the situation of the lock-in while the pursuit of rationality would work as a logic of assuring continuity (Beyer 2005). The more the traders increase their losses, the more they thrive for more rationality in their decision-making process. Thus, they increasingly apply reflexive modeling with an increasingly high model accuracy, which results in the same trading choices as with herding. But in cases of losses, the high model accuracy and thus the high confidence on the choice increases the amount of money lost. Considerable losses would again result in the thriving for even more rationality, which closes the reinforcing spiral leading to the lock-in.

Then the critical juncture (Collier & Collier 1991) might have been the introduction of the spreadplot as basis for the reflexive modeling process, which directly connected the model design, and consequently the fundamental basis of the traders' decision-making, to aggregated market information. To avoid the rationality-induced herding behavior a reduction of the pursuit of rationality could help to reduce the reinforcing mechanism and thus the manifestation of the process. But the process could already be in the lock-in phase (Sydow, Schreyögg, & Koch 2005; 2009), which would mean that the reflexive modeling would be performed in the same intensity even though the traders would not aim at being particularly rational anymore. To escape herding, a switch to a different decision-making procedure would be necessary (e.g. path creation Garud & Karnøe 2001). For example, if the spreadplot information was very local information rather than aggregated on a large scale, the result of the decision-process might resemble swarming rather than herding.

A new path dependency approach can be applied here using the concept of path dependency on the micro level, which answers the question how agents act when being affected by path dependency (Kominek 2009, 2012; Kominek & Scheffran 2012). The empirical studies (Beunza & Stark 2004, 2010, 2012) indicate that in their jobs the merger arbitrage traders' behavior is largely framed by personal routines and standards such as checking the news in the early morning or throughout the day and writing the same type of mathematical models every day. And also the decision-making process via reflexive modeling can become such a routine. Therefore, the merger arbitrage traders are likely to behave like ideal type path dependent agents who rather follow routines and other external decision instances instead of independently optimizing their own decision criteria. Thus, it is not by contingency that the merger arbitrage traders end up in following the others in a form of herding. Instead, the more the traders are affected by path dependency, the more they are likely to follow others and perform herding or swarming instead of reaching independent rational choices. Of course, herding or swarming can be very successful and efficient decision-making. But Beunza & Stark (2012) have documented that this behavior can also lead to large losses if the followed people all lack the same information. So how could such losses be avoided? To reduce the likelihood of more or less blindly following others and to increase the likelihood that the merger arbitrage traders decide rationally instead, it would be necessary to reduce path dependency. Thus, throughout the day and job, routines and processes need to be interrupted and especially in the decision-making processes the frequency and flexibility of new approaches need to be enhanced and new and diverse perspectives should be taken into account. If, for example, one agent in the New York merger arbitrage trading office would have sat there offline from all market information and mathematical models, just conducting a brainstorming on what potentially might influence the merger, he might have come up with a connection to "European regulatory denial" (Beunza & Stark, 2012, p. 409).

Conclusion

Concluding from their empirical studies, Beunza and Stark (2012) state: "Yet financial models, we contend, create a distinct form of interdependence that needs to be understood in its own terms. Once traders rely on anonymous competitors for crucial insight, a novel mechanism of social influence has been created. What potential pitfalls does it pose?" (p. 390).

This paper shows that intensely applied reflexive modeling shapes traders' decision-making processes to resemble herding. Although the aim of including reflexivity in the decision-making process is to increase the rationality of their decision procedure (Beunza & Stark 2012: 403), it makes the analyzed merger arbitrage traders merely follow aggregated market information (Beunza & Stark 2012: 409).

The vicious cycle of trying to escape herding or the bounded rationality by increasing reflexivity and ending up in mimicking herding decisions to an even greater extend can be explained by path dependency theory. A possible solution to this dilemma is to reduce path dependency and increase the variety of perspectives included in the investment decision-making process.

The combination of path dependency theory as presented in this paper with assessments of overall decision-making processes, including the observation of reflexive components and what that reflexive process framing actually results in, can help to understand and improve future trading decisions and reduce the likelihood of the occurrence of financial bubbles.

Funding

Research for this study was funded in part by the German Science Foundation (DFG) through the Cluster of Excellence "CliSAP" (EXC177).

Acknowledgments

Many thanks to David Stark for our discussions in summer 2009 in Berlin, to discussions at

EGOS 2011, to Jürgen Beyer, Jürgen Scheffran, and Michael Link for valuable comments.

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