Ostfalia
Hochschule für angewandte
Wissenschaften

Wolfsburg

Fakultät Wirtschaft

WWP

Wolfsburg Working Papers No. 05-03

Informational Cascades in the Laboratory: Are These Merely a Fata Morgana?

Markus Spiwoks, Kilian Bizer and Oliver Hein, 2005

Informational Cascades in the Laboratory: Are These Merely a Fata Morgana?

Experimental research found contradictory results regarding the occurrence of Informational Cascades. While Anderson and Holt (1997) through lab tests confirm the model of Banerjee (1992), and Bikhchandani, Hirshleifer, and Welch (1992) resp., Huck and Oechssler (2000) come to controversial results for crucial issues. This study is an extensive (227 test persons) and as regards contents expanded repetition. It becomes obvious that less than 10% of subjects are able to make deductions from predecessors´ actions regarding their private signals, to consider the reliability of the signals and the a priory probability, to accurately use Bayes´ Rule, and to thus reach rational decisions. (*JEL* C91, D82)

If the summers in Scandinavia are warmer than average, Lemmings often have a tendency to mass reproduction. Big groups of these voles then migrate to find new biospheres, and many times they do not even stop at the shoreline. They swim out into the open sea and the whole lot drowns if they don´t land upon firm ground after a while. Behavioral scientists believe that the reason for this bizarre natural phenomenon is the fact that each Lemming is only oriented at its immediate neighbor. This way the mass migration gathers a momentum which can not be controlled by any of the participants. This phenomenon is often used as a simile for the behavior of stock market agents: Many people feel more comfortable when they find their estimations and deeds in accordance with those of their peer group (conformity preference). In extreme cases they can even completely cease to review if what they do is rational and advantageous. This behavior, called irrational herding, is often used to explain the building of bubbles in capital markets.

Financial analysts often act in stricing conformity. As their forecasts usually are based upon methodological analyses of capital markets, and are subject to a throrough, internal review, it seems hard to explain this conformity with irrational herding, too. Keynes (1936) provides two possible patterns of explanation for rational herding behavior of financial analysts: Reputational Herding and Investigative Herding.

Most of all financial analysts shy away from the so-called Maverick Risk (the risk of being wrong and all alone).[1] Let us assume that an analyst delivers a financial market forecast which proves incorrect. Let us further assume that other analysts at the same time deliver correct estimations of the future. In this situation the reputation of the unsuccessful analyst will suffer badly; he can even lose his job. For this analyst the situation would be totally different if he delivers a forecast which is to a large degree in accordance with the forecasts of most of his fellow analysts. Should the forecast prove incorrect, his reputation would hardly suffer. As almost all analysts made the same wrong assumption, the actual capital market situation would have been regarded as unforeseeable. Therefore the incentive is strong to always adjust one´s own forecasts to those of the other analysts: to avoid the Maverick Risk. Analysts make use of an information asymmetry in relation to their clients: these do not know if the analysts are really convinced of their forecasts, or if they merely followed their personal strategic thinking. This form of rational herding behavior is called reputational herding.

[1] „Maverick Risk“ see Arnott (2003).

When analysts have to make short-term decisions they usually have to waive medium-term, fundamental analyses. To them it is not crucial which investment is the most worthwhile. To them it is only decisive which investment the fellow market agents regard as the most worthwhile in the short run. That is why they orient their forecasts at the suspected following estimations of the other market agents (as in the beauty contest example of Keynes). In this case the honest efforts of the analysts to achieve the best possible short-term forecast lead to a strong conformity of the forecasts. This form of rational herding behavior is called investigative herding.

These two approaches of rational herding behavior were roughly described by Keynes in 1936 already, and were further differentiated and advanced by a number of following studies. Only 56 years later a completely new explanatory approach was developed. Bikhchandani, Hirshleifer, and Welch (1992) as well as Banerjee (1992) simultaneously developed the theory of Informational Cascades.

Informational Cascades mean that subjects orient their decision making at the visible decision making behavior of other subjects and thereby disregard their own signals. Initially it does not matter which mechanism triggers the ignoring of the own private signals. In so far the theory of Informational Cascades is a generic approach to describe herd behavior, into which various explanatory approaches (e. g. sanctions on deviants, positive pay-off externalities, conformity preference) can be integrated. Special attention has been given to a kind of Informational Cascades which the authors especially highlighted, and which shall be called “Bayesian“ Informational Cascades.

Hereby the acting subjects try hard to make rational decisions. They have private signals which are not absolutely reliable, though. They suppose that the private signals of the other agents are usually not more reliable then their own private signals. If there are more signals available (their own private signal and further foreign, private signals) a sounder decision can be deduced with the help of Bayes´ Rule than if only the own private signal was considered. The economic agents can only watch the decisions other subjects make, but not the other agents´ private signals. As the model claims that the decision making process of all involved subjects does not happen simultaneously, but successively, those subjects making their decisions later on are trying to learn from the decisions made by their predecessors by deducing their predecessors´ private signals.

A sketch of the restaurant example of Banerjee (1992) shall serve to clarify this. One hundred people cross a very narrow bridge towards a small island on which there are two restaurants. As the bridge is so narrow, one after the other arrives and has to choose between restaurant A and restaurant B at once. Each of the involved persons has a private signal indicating which restaurant would probably be better. The private signals correspond regarding the reliability of, e. g., 0.65. Out of the 100 persons 99 have the private signal that restaurant A is better. Only one person, Mr X, has the signal that restaurant B is better. Further to this everybody knows that there is the a priori probability of 0.51 that restaurant B is better, and of 0.49 that restaurant A is better. Communication between the protagonists is not possible, but each decision can be seen from all following persons on the brigde. It so happens that Mr X crosses the bridge first. According to his private signal he chooses restaurant B. The second participant sees this decision and can now calculate as follows: The fact that his predecessor chose restaurant B shows that he has received the signal that B is the better alternative. Although the second one has the contrary private signal, he still considers the private signal of his predecessor to be as reliable as his own. These two private signals neutralize each other. So now he has to orient himself at the a priory probability, which prefers restaurant B. Thus the second participant follows the first one into restaurant B. The third protagonist knows that the decision made by the second one reveals nothing about his private signal. Nevertheless he, too, will enter restaurant B, because for him the situation in which he has to make his decision is just like it was for the second one. In the end all 100 persons sit in restaurant B, although 99 of them had the private signal that restaurant A was better.

These and further similar model designs of Banerjee (1992) and Bikhchandani, Hirshleifer, and Welch (1992), which are called here "Bayesian" Informational Cascades, caused a sensation, because with this approach it can be shown how it is possible that subjects who are acting absolutely rational can tend to herding behavior, even although there need be no principal-agent relation as with reputational herding. The new explanatory approach is simple, original, convincing, and elegant. Correspondingly it has initiated broad discussions, which have greatly enriched the examination of the herding behavior phenomenon.

Still the question needs to be answered if this is merely an interesting theoretical innovation, or whether this model can further describe reality correctly. Now empirical research is wanted. The actual decision making behavior of subjects in similar layouts can be examined within the framework of experimental business research.

Anderson and Holt (1997) presented the first experimental study which examines if this new approach mirrors reality. It becomes obvious that Informational Cascades regularly occur. Also the so-called Reversal Informational Cascades[2] (as in the described restaurant example) can be seen. Anderson and Holt draw the conclusion that at least a big part of the experimentees is able to correctly interpret their predecessors´ decisions as regards their private signals, and to make the most favorable decision while correctly using Bayes´s Rule. Thus they see the theoretic innovation of Banerjee and Bikhchandani, Hirshleifer, and Welch resp. as empirically confirmed. Further experimental studies which analyze various model expansions confirm Anderson and Holt´s results at least by and large. Hung and Plott (2001) introduce a comparison to majority decisions and a comparison to conformity rewarding decision making situations. Sgroi (2003) allows individual delays in the decision finding. Celen and Kariv (2004) consider continuous instead of binary signals. Partly explicity, partly at least regarding various marginal aspects these studies support the results of Anderson and Holt.

Huck and Oechssler (2000), though, come to a different result. Acccording to their understanding the correct use of Bayes´ Rule is levered out by a systematic overrating of the respective private signals. Therefore Informational Cascades are generated accidentally, but not because of the rational thinking of the subjects. Before the background of their findings they recommend a new interpretation of Anderson and Holt´s findings. It becomes obvious that important parts of Anderson and Holt´s census do not allow a differentiation between rational use of Bayes´ Rule and an excessive orientation at the respective private signal. It seems that Huck and Oechssler interpreted the data like this only after much hesitation and after they carried out their own census, because their experiments, too, do not always allow a clear distinction between the two explanatory patterns.

The objective of this study is to determine through an extended repetition whether Anderson and Holt´s interpretation should be followed, or rather Huck and Oechssler´s interpretation. A big number of experimentees shall also help to find out if the inconsistent results of the two studies can at least partly be explained by accidental differences within the make-up of the experimentee population. Anderson and Holt´s study is based on 72 participants, Huck and Oechssler´s study on 63 participants. This study includes 227 experimentees.

The study is structured as follows: Chapter I presents the experimental design. The census results are described in Chapter II. The third chapter gives a summary of the research results and conclusions.

[2] Also known as „wrong Informational Cascades“.

I. Experimental Design

It does not make sense to make Informational Cascades, which is the generic term for all manifestations where subjects disregard their private signals and orient themselves at the actions of others, the topic of an experimental study. The fact that there is herding behavior – especially among financial analysts – is probably not disputed and can be confirmed by a number of empirical studies.[3]

Therefore this study focusses on the specific case of "Bayesian" Informational Cascades. It examines if subjects, when they face an unreliable private signal, are able to make deductions from their predecessors´ decisions as regards their private signals, and with this information to find the best possible decisions based on Bayes´ Rule. Within the framework of an experimental census a total of eight hypotheses shall be examined.

Strictly speaking one should expect that all experimentees are able to infer from the others´ decisions their private signals (if the concrete situation allows this), and can make the best possible decision while using Bayes´ Rule correctly. In the end the model of "Bayesian" Informational Cascades (as with the restaurant example) only works when the successors can be sure that the predecessors make rational decisions. Should it be feared, though, that for example the first decision-maker choses B although he has the private signal A, the successors can not infer from the decision the basic private signal of the predecessor. But when the decisions of the predecessors allow no conclusion as regards their private signals, each one must be oriented at their own signal. Thus "Bayesian" Informational Cascades would be highly impossible. Hypothesis 1 therefore claims:

H1: All experimentees observe the decisions of their predecessors, they draw correct conclusions – as long as this is possible in the present situation – regarding the basic private signals of the predecessors, and then make a rational decision while correctly using Bayes´ Rule.

To be realistic one probably must suppose that not 100% of the experimentees act this way. Under certain circumstances "Bayesian" Informational Cascades can even occur when the subjects can at least depend on the fact that the majority of their predecessors is able to correctly use Bayes´ Rule and to make rational decisions. Therefore the second hypothesis, which is only a toned down variant of the first hypothesis, reads as follows:

[3] As important empirical studies on rational herding behavior of stock market analysts see Trueman (1994), Olsen (1996), Graham (1999), Welch (2000), Hong, Kubik, and Solomon (2000), Cooper, Day, and Lewis (2001). Rational herding behavior of bond market analysts is described in following studies: Bewley and Fiebig (2002), Spiwoks (2004), Spiwoks, Bizer, and Hein (2005).

H2: The majority of the experimentees observes the decisions of their predecessors, draws correct conclusions regarding the basic private signals of the predecessors – as long as this is possible in the actual situation –, and then makes a rational decision while correctly using Bayes´ Rule.

With hypotheses 3 to 6 the rational behavior of the experimentees is examined. By inspecting various facts the preference of the experimentees for rational decisions and their strict orientation at Bayes´ Rule is tested.

H3: As the experimentees act rational and are oriented at Bayes´ Rule they will have no difficulty to sketch the correct way to the solution.

As only two alternative answers are available in the experiment, flukes are a hazard. A person who does not understand the task at all and therefore is not able to resolve it still has an accidental success rate of 50%. With the help of the required way to the solution systematic hits can be differentiated from flukes. This way the results that were found by exploring hypotheses 1 and 2 can be covered.

H4: As the experimentees act rational and are oriented at Bayes´ Rule the order in which the tasks are presented has no influence on the results.

As several decision making situations have to be managed it is possible without problems to present these tasks in different order. Hypotheses 4 is interesting because studies in Behavioral Finance have shown that the order in which pieces of information are presented can have quite an influence on the uptake and processing of the information. When this occurs it is interpreted as an indication that rational behavior has its limits.

H5: As the experimentees act rational and are oriented at Bayes´ Rule there are no varying success rates of the different decision making situations.

The experimentees are subject to three decision making situations. In two of the three decision making situations simple plausibility considerations based on Bayes´ Rule, or a broad calculation of probabilities, are sufficient to find the correct solution. As all experimentees have a good education in probability calculation it can be assumed that they can also manage these tasks easily. Should the three tasks show different success rates this does not indicate an unlimited rational behavior.

H6: Should some experimentees prove unable to cope with the decision making situations but still aspire to make a rational decision, the lifting of the communication ban will make the desoriented experimentees ask the well oriented experimentees to explain the correct way to the solution so that they are able to finally make the right decisions.

When the experimentees generally tend to make rational decisions they will seek information on the correct solution if possible. Should they not do this although there is the possibility to do so, this indicates a preference for a different decision making behavior.

The seventh hypothesis directly relates to the data interpretation of Huck and Oechssler. They have the view that "Bayesian" Informational Cascades do not occur because the subjects put an excessive value to their own private signal. Huck and Oechssler do not deny that there can be sequences of decisions which look like "Bayesian" Informational Cascades. But they conclude that the agents are not oriented at the private signals of the predecessors, and do not rationally use Bayes´ Rule. Huck and Oechssler suppose that most agents rather rely on their own private signal. In cases when the uncovering of the predecessors´ private signals and the rational orientation at Bayes´ Rule lead to the same decisions as the excessive orientation at the respective own private signal situations emerge which merely have the appearance of "Bayesian" Informational Cascades. Hypothesis 7 is focused on the examination of this proposition.

H7: There is a bias towards an excessive consideration of the respective own private signal.

Hypothesis 8, finally, shall examine if the differing results of Anderson and Holt on the one hand, and Huck and Oechssler on the other hand can be explained by distorting circumstances within their respective test populations. This can be examined by carrying out the census in several study parts, which will reveal if there are major result variations.

H8: There are such significant differences of the results from study part to study part that the review of single study parts can lead to varying judgements of the decision making behavior.

To verify the hypotheses 227 experimentees have to manage a total of 681 decision making situations. The experimentees take part in six study parts with a number of 55, 50, 46, 37, 24 and 15 persons. All experimentees are students at the Wolfsburg University of Applied Sciences and study business administration. 113 are undergraduate students, 99 graduate students, and 15 experimentees have already graduated in engineering and are doing post-graduate studies which correspond to an MBA. None of the persons has any experience with experimental business research, and all persons have a thorough education in the field of calculus of probability. This is part of the requirements of the *Abitur* and therefore prerequisite to attend a university. Furthermore probability calculation is part of the mathematics lecture of the first semester. All experimentees had attended these lectures before they participated at this experiment. Therefore it can be assumed that all persons principally master Bayes´ Rule.

There is no payment for the participation at this experiment. Those experimentees who correctly solve all tasks receive 15 bonus points for a later exam.[4] Those persons who do not solve any task correctly receive no bonus points for the exam. The incentive for the correct solution of the tasks is strong, as 15 bonus points mean an improvement of a whole grade (for example from 2.0 [good] to 1.0 [excellent]).[5] Later interviews revealed that this incentive corresponds to a bonus of ca. € 70,-.[6] When a student takes part in this experiment and can not make one correct solution he even suffers a loss due to the opportunity costs of the participation (the average duration of a census is ca. 100 minutes).

For five of the six study parts the spatial set-up of the experiment allows no communication among the persons, and supervisors strictly prevent the students from observing each other. Each experimentee has to solve the three tasks on his own. Only for the last of the six study parts these conditions are lifted. The 15 experimentees receive the three tasks, which they have to solve within 36 hours, and then hand them back to the master of ceremonies. Communication among the experimentees is expressedly allowed. Also they can use text books and ask experts. Only for this last study part there is a time limit (36 hours maximum). The participants of the first five study parts have no time limit. Each of the three tasks is handed out separately. After one task is finished the survey sheet is collected and the next task is handed out to the students. Although there is no time limit the survey of the first five study parts takes only between 86 and 108 minutes. The average duration of the first five study parts is 98 minutes.

Each experimentee has to solve three tasks. The use of a pocket calculator is allowed. The three tasks are designed as follows:[7] The students receive information about the character of the decision making situation. They have to decide between two alternative actions A and B. A has an a priori probability of 0.49 and B of 0.51. They are informed which private signal (a or b) they have, how good the reliability of their private signal (q) is, and how good the reliabil-

[4] For the effect of such incentives see Selten, Abbink, Buchta, and Sadrieh (1998), p. 22.

[5] It must be noted that there is a strong demand for the Business School at Wolfsburg University of Applied Sciences. In the past years only every tenth applicant could be accepted on average. The students who study business at Wolfsburg therefore belong to the best 10% of their school year and are usually very achievement-oriented. The possibility to improve the grades by participating at the experiment is thus seen as a strong incentive. This was not the least reason why 227 students followed the call to participate, although there was no payment.

[6] Other students were asked how much 15 bonus points for a later exam were worth to them, were they able to buy the 15 bonus points. The 42 students asked named numbers between 25,- and 200,- Euros. The average was 72,45 Euros.

[7] See Appendix A for the text of the tasks.

ity of their predecessors´ private signal is (p). Finally they get to know which decisions their predecessors made. They are also told that all predecessors have exactly one private signal and have made rational decisions. Then they have to decide between action *A* or *B*. A reward is promised for the case that they make the "right" decision. The right decision is the one which is the most probable after consideration of the own private signal, the actions of the predecessors and their implicit private signals, the reliability of the private signals, and the a priori probability.

Table 1: The three decision tasks

	Previous decisions	p	Signal	q	Rational action
Task 1	*B*	0.80	*a*	0.80	*B*
Task 2	*ABB*	0.65	*a*	0.65	*B*
Task 3	*AA*	0.60	*b*	0.65	*A*

It is relatively easy to answer the first two tasks. Task 1: the only predecessor chose *B*, thus the conclusion is that his private signal was *b*. The experimentee receives the private signal *a*. The two private signals neutralize each other, so the decision must be based on the a priori probability. Therefore action *B* is the right one.

Task 2: the first predecessor chose *A*, from which follows that his private signal is *a*. The second predecessor chose *B*, which hints as his private signal *b*. Also the third predecessor has obviously received signal *b*, because had he received *a*, *A* would have been the rational decision (two *a*s would have exceeded *b* with a reliability of the signals of 0.65, even when the a priori probability speaks for *B*). Now the student receives signal *a*. He must note that the private signals of his predecessors and his own private signal exactly neutralize each other (two *a*s and two *b*s). Therefore the experimentee has to orient himself anew at the a priori probability, which speaks for action *B*.

Only in Task 3 it is necessary to calculate the more probable of the two alternative actions:

$$prob(\alpha|aab) = \frac{prob(aab|\alpha)\,prob(\alpha)}{prob(aab|\alpha)\,prob(\alpha) + prob(aab|\beta)\,prob(\beta)}$$

$$= \frac{(0.6)^2(0.35)(0.49)}{(0.6)^2(0.35)(0.49)+(0.4)^2(0.65)(0.51)} = 0.5379 > \frac{1}{2}$$

The decision for alternative *A* is the rational one, because it is more probable (> 0.5) that this is the correct one.

These three decision making situations have the clear advantage that they allow a distinct differentiation if the subjects act according the estimation of Anderson and Holt, or according Huck and Oechssler´s interpretation (see Table 2). The students either choose a rational decision in the sense of "Bayesian" Informational Cascades, or they trust their own private signal. This clear distinction, which for the first time allows a clear discrimination between the two stated explanation patterns, is an important progress towards the studies of Anderson and Holt, and Huck and Oechssler. Both analyses to a large amount present decision making situations in which the strict orientation at the own private signal leads to the same decision as an inference of the private signals of the predecessors and, based on this, a rational use of Bayes´ Rule. Yet only experiments which allow the discrimination between the two explanatory approaches lead to an epistemological progress.

Table 2: Clear distinction between the two explanatory patterns

	Solution to be expected after Anderson and Holt	Solution to be expected after Huck and Oechssler
Task 1	*B*	*A*
Task 2	*B*	*A*
Task 3	*A*	*B*

In each of the six study parts the experimentees are divided into three groups. These three groups vary regarding the order in which the three tasks have to be solved. For each first group the order is: Task 1, Task 2, Task 3. For each second group the order is Task 3, Task 1, Task 2. The order for the third groups is Task 2, Task 3, Task 1. If the behavior of the subjects is rational the order in which the tasks have to be solved can have no influence on the result.

II. Results

Table 3 summarizes the results of the six study parts. "R" (for "Right") marks those decisions which can be called correct in the sense of a rational decision under deduction of the private signals of the predecessors and the correct use of Bayes´ Rule. Thus “R” marks all those decisions which confirm the approach of Anderson and Holt. “W” (for “Wrong”) marks those decision which do not meet rationale but rather follow the own private signal. Thus “W” highlights all those decisions which confirm Huck and Oechssler´s approach.

In all the experimentees had to manage 681 decision making situations (see Table 3). Only 248 of them were answered correctly in the rational sense, which means only 36%. 433 decisions were wrong, so in 64% of all decisions the experimentees either failed to make conclusions from their predecessors´ decisions on their private signals, or/and did not correctly use Bayes´ Rule, or/and based their decisions on completely different aspects. Thus it must be stated that both Hypothesis 1 and 2 have to be discarded.

Table 3: Summary of the results of the whole study

		Group							
		1		2		3		∑	
Run	1	R	W	R	W	R	W	R	W
		32	46	22	52	28	47	82	145
		Task 1		Task 3		Task 2		36%	64%
	2	R	W	R	W	R	W	R	W
		35	43	33	41	11	64	79	148
		Task 2		Task 1		Task 3		35%	65%
	3	R	W	R	W	R	W	R	W
		27	51	33	41	27	48	87	140
		Task 3		Task 2		Task 1		38%	62%
	∑	R	W	R	W	R	W	**R**	**W**
		94	140	88	134	66	159	**248**	**433**
		40%	60%	40%	60%	29%	71%	**36%**	**64%**

R = Right (in the sense of a rational decision with correct use of Bayes’ Rule); W = Wrong (the decision follows the private signal).

What further aggravates the situation is that from the 248 right decisions only a minority comes along with a correct reason for this decision, so that also Hypothesis 3 must be definitely rejected. Table 4 summarized the given ways to the solutions of the correct decisions. It becomes obvious that less than a quarter of the right decisions are based on the right rationale. For about 40% of the right decisions either faulty, nonsensical, or no ways were given. About every tenth person stated to have only guessed. About a quarter of the correct decisions are based on simplifying thumb rules: around 10% of the experimentees are oriented at the a priori probability, and 15% just decide as the majority of the predecessors did.

Therefore the present results in no way support the estimation that “Bayesian“ Informational Cascades can occur in reality. Only about 36% of the decisions are made according to the postulate of “Bayesian“ Informational Cascades. Of these 36% about three quarters of the decisions are made for the wrong reasons and are therefore only accidentally correct. Regarding the whole population this means: Not even every tenth makes his right decision based on the correct reasons.

Table 4: Given ways to the solution for the correct answers

Given way to the solution	Number	Percentage
Right way (inferring the private signals of the predecessors and correct use of Bayes’ Rule)	58	23,4%
Faulty use of Bayes’ Rule / nonsensical or non-comprehensible ways	88	35,5%
No way to find the solution stated	12	4,8%
Guessed	26	10,5%
Decision according to the majority decision of the predecessors	38	15,3%
Decision according to the a priori probability	26	10,5%

A review of the three groups which had to solve the tasks in varying order shows significantly varying success rates (see Table 3). While the results of group 1 (order: Task 1, Task 2, Task 3) and group 2 (order: Task 3, Task 1, Task 2) are almost exactly alike (success rate 40%), group 3 (order: Task 2, Task 3, Task 1) achieved only a success rate of 29%. Such considerable variations of the success rate, which alone result from varying task orders, are no indication of rational decision making behavior of the subjects. Therefore also Hypothesis 4 has to be rejected.

The three tasks have no corresponding success rates. As can be seen in Table 5 Task 3 is solved in only 26% of all cases, while Task 1 and 2 are solved correctly in more than 40%. This clear difference of the success rates does not indicate that the experimentees are willing and able to appropriately apply Bayes´ Rule on concrete decision making situations in possible Informational Cascades, although they principally manage the necessary procedures of probability calculation. Therefore Hypothesis 5 has to be rejected, too.

Table 5: Different success rates of the three Tasks

	Task 1		Task 2		Task 3	
Group	R	W	R	W	R	W
1	32	46	35	43	27	51
2	33	41	33	41	22	52
3	27	48	28	47	11	64
$\sum$	92 41%	135 59%	96 42%	131 58%	60 26%	167 74%

In the sixth and last study part with 15 students - who already have an engineering degree and are presently completing post-graduate business administration studies comparable to the MBA - the prohibition to communication is lifted. The students receive the three tasks and have to hand in the solutions 36 hours later to the MC. It is explicitly allowed to interchange, and the consultation of textbooks or expert opinions is not forbidden. When some of the participants are not intellectually up to the task but still strive for the best possible rational decision it can be expected that they use the time to gather information and to make the correct decisions. As can be seen from Table 13 in Appendix B the success rates are surprisingly alike to those of the whole study: 38% of all tasks were answered correctly, and for 62% of all tasks wrong answers were given. Thus, also Hypothesis 6 must be clearly rejected. Obviously the decisions are based on different decision making preferences than the “Bayesian“ Informational Cascades suggest. The majority of the experimentees seem not to look for rational, best possible decisions by applying Bayes´ Rule.

Let us assume that the experimentees have not thought through the tasks at all, but made their vote haphazardly for one of the two alternative actions. In this case about 50% of the answers would have had to be correct. The fact that only 36% of all solutions were correct (see Table 3) indicates that there must be a systematic defect regarding the decision making progress. So Hypothesis 7 comes into view: as 64% of all decisions correspond to the respective own private signals, and although this could lead in no case to the right decision (and thus to a reward), it must be presumed that a big part of the decision making was excessively influenced by the own private signals. Hypothesis 7 can therefore not be discarded. The present study results do not contradict the explanatory approach from Huck and Oechssler.

To conclude a comparison of the results of the six study parts follows to examine if the strongly deviating results of Anderson and Holt, and, on the other hand, of Huck and Oechssler can be possibly explained by a high variance of the results of each study part. Table 6 summarizes the results of the six study parts, and Appendix B gives the detailed results of the six study parts.

Table 6: The results of the six study parts

Study part	I	II	III	IV	V	VI
Number of correct answers	57	60	51	35	28	17
Number of false answers	108	90	87	76	44	28
Percentage of correct answers	35%	40%	38%	32%	39%	38%
Percentage of false answers	65%	60%	62%	68%	61%	62%

Study part I: 55 undergraduate students; study part II: 50 graduate students; study part III: 46 undergraduate students; study part IV: 37 graduate students; study part V: 24 undergraduate and graduate students; study part VI: 15 post-graduate students (corresponds MBA).

A certain amount of variations is obvious. The percentage of correct answers varies between 32% in study part IV and 40% in study part II. But as no study part provides a majority of correct solutions there can hardly be differing findings from a review of the single study parts. Therefore Hypothesis 8 must be rejected. There is no indication that the contradiction of Anderson and Holt´s, and Huck and Oechssler´s results respectively, can be explained by accidental, biasing peculiarities of the experimentee populations.

III. Examination Results and Conclusion

Between May 31 and July 02 2005 an experimental study was carried out at Wolfsburg University for the empirical examination of the theoretical approach of "Bayesian" Informational Cascades based on Banerjee (1992) and Bikhchandani, Hirshleifer, and Welch (1992). In six study parts 227 experimentees were confronted with three decision making situations each. The decision making situations required from the experimentees to draw conclusions from the visible decisions from their predecessors regarding their private signals, to acknowledge their own private signal, to consider the a priori probability and the reliability of the private signals, and to include these pieces of information into a correct use of Bayes´ Rule.

Former experimental results from Anderson and Holt (1997) gave reason to expect that at least a majority of the participants would be able to correctly solve the tasks. Experimental results from Huck and Oechssler (2000), on the other hand, indicated that the experimentees would excessively stress their own private signal. To clearly differentiate these two behavior patterns the experiment was designed in a way that the decisions allowed no interferences between correct rational decision making and an orientation at the own private signal.

Of the total number of 681 decisions only 248 (36%) were made in the sense of a rational decision. Of these 248 decisions only 58 were made for the right reasons. For the other 190 correct decisions it became obvious that the experimentees had either decided upon simplifying (irrational) thumb rules, had only guessed, or were not able to sketch a comprehensible way to the solution. Similarly, the participants made their decisions in 433 decision making situations (64%) contrary to the rational solution and in advantage of the private signal.

Further results indicate that the experimentees are only exceptionally willing to calculate the probabilities and then to make a rational decision:

- The order in which the tasks are presented influences the results.
- The three decision making situations are managed to a considerable varying degree.
- The success rates are not increased by the lifting of the communication ban and the possibility to refer to text books and expert opinions.

The urge to decide following simplifying thumb rules is obviously very strong – at least for this kind of decision making situations.

This study absolutely confirms the results from Huck and Oechssler. At the same time it severely questions Anderson and Holt´s results. Here the disadvantage of Anderson and Holt´s procedure becomes obvious, who required their experimentees to make decisions but who still made no efforts to determine on which thinking the decisions are based.

Only a small part (<10%) of the experimentees acts rational, considers all probabilities and correctly uses Bayes´ Rule. The major part of the participants is oriented at totally different decision making heuristics such as:

- Sole orientation at the own private signal.
- Sole orientation at the a priori probability.
- Sole orientation at the majority of the predecessors.
- Orientation at the accordance of the private signal, the a priori probability, and the predecessors´ majority (to varying degrees).
- Trust in good luck to guess the correct decision alternative.

If a number of experimentees has to make decisions before the background of one private signal and the observation of the decisions of the predecessors undoubtedly decision sequences emerge which look like “Bayesian“ Informational Cascades. What is actually behind it is normally nothing else than accidental, hardly rational but highly irrational (thumb rule) decisions of the experimentees. Only a minority of those who make the correct decision does this because they are determined to bring about a rational, best possible decision.

Table 7: Restaurant-example of Banerjee

Subject	1	2	3	4	5	6	7
Private Signal	*b*	*a*	*a*	*a*	*a*	*a*	*a*
Decision	*B*	*B*	*B*	*B*	*B*	*B*	*B*

With an a priori probability for *B* = 0.51 and for *A* = 0.49.

When a laboratory experiment leads to a situation like the one given in Table 7 one may not simply infer the existence of a “Bayesian“ Informational Cascade. Maybe subjects 2 and 3 decide merely upon the a priori probability, subjects 4 and 5 only according to the majority of their predecessors, and subjects 6 and 7 possibly only guess and hope to luck out and make an advantageous decision. What then looks like a sequence of rational decisions derived from observing the actions of the predecessors, by drawing conclusions to their private signals and correctly using Bayes´ Rule is in reality nothing more than an accumulation of decisions which are based on various irrational thumb rules, and which therefore only happen to be in accordance with each other. This, therefore, is not a “Bayesian“ Informational Cascade but merely a *ostensible* “Bayesian“ Informational Cascade.

Thus it can be pointedly concluded: The one thirsty in the desert believes to see an oasis on the horizon. In fact he is only the victim of an optical illusion arising from hot rising shimmering air. Similar to this are the results from Anderson and Holt. They believe to see “Bayesian“ Informational Cascades where in fact there are probably none; presumably they are deceived by a Fata Morgana.

A “Bayesian“ Informational Cascade can not be differentiated from an accidental, inconsequential rational behavior agreement by merely taking into account the decisions of the experimentees. In addition to examining the decisions of the participants it must be determined how and on which basis the experimentees make their decisions.

Should we for a longer time observe strong correspondences of the forecasts of financial analysts we now can not apply “Bayesian“ Informational Cascades as an explanatory pattern any more. This explanatory pattern also seemed so comfortable because it assumed that the financial analysts were rationally acting and honestly seeking the best possible decisions. Instead we will have to consider anew the explanatory approach of Reputational Herding if we do not want to content ourselves with the finding of accidentally corresponding behavior.

The experimental results of, for example, Cote and Sanders (1997), or the innovative evaluation of real forecast data of Spiwoks, Bizer, and Hein (2005) already indicate that the approach of Reputational Herding can explain the herd behavior of financial analysts much more convincing than the theory of “Bayesian” Informational Cascades.

Appendix A: Text of the Tasks

Task 1:

You must decide between alternative actions *A* and *B*. When you make the right decision you will get 5 bonus points for the exam.

To begin with action *A* is right in 49% of all cases, and action *B* is right in 51% of all cases.

Before you have to make your decision you will receive a hint (either “*a*“ or “*b*“) at the right action. This hint tells you in 80 out of 100 cases the correct action. This means: should you receive the hint “*a*”, in 80 out of 100 cases action *A* is the right one.

Another person before you was confronted with this decision making situation. You can see the decision your predecessor made, but not the hint this person received. You know that the reliability of the hint of the person before you was also 80%. This means: should this person for example receive hint “*a*“, in 80 out of 100 cases action *A* is correct. All participants receive exactly one hint. The hints are independent of each other. The person who has already made his decision has made a rational decision.

You are the second person to decide. The person before you had chose action *B*.

You receive hint “*a*“.

Which action should you now chose? *A* ☐ *B* ☐

Please briefly explain upon which rationale you made your decision, or which way you went to resolve this problem! These explanations have **no** influence on the granting of bonus points for the exam! Therefore you should give an open and honest answer here!

Task 2:

You must decide between alternative actions *A* and *B*. When you make the right decision you will get 5 bonus points for the exam.

To begin with action *A* is right in 49% of all cases, and action *B* is right in 51% of all cases.

Before you have to make your decision you will receive a hint (either “*a*“ or “*b*“) at the right action. This hint tells you in 65 out of 100 cases the correct action. This means: should you receive the hint “*a*”, in 65 out of 100 cases action *A* is the right one.

Other persons before you were confronted with this decision making situation. Person 1 had to make his decision first, than person 2, and so forth. Each person could see the decision their predecessors made, but not the hints these persons received. You know that the reliability of the hints of the persons before you was also 65%. This means: should one of these persons for example receive hint “*b*“, in 65 out of 100 cases action *B* is correct. All participants receive exactly one hint. The hints are independent of each other. All persons who already made their decision made a rational decision.

You are the 4th person to decide. The three predecessors decided thus: *A B B*

You receive hint “*a*“.

Which action should you now chose? *A* ☐ *B* ☐

Please briefly explain upon which rationale you made your decision, or which way, if at all, you went to resolve this problem! These explanations have **no** influence on the granting of bonus points for the exam! Therefore you should give an open and honest answer here!

Task 3:

You must decide between alternative actions *A* and *B*. When you make the right decision you will get 5 bonus points for the exam.

To begin with action *A* is right in 49% of all cases, and action *B* is right in 51% of all cases.

Before you have to make your decision you will receive a hint (either "*a*" or "*b*") at the right action. This hint tells you in 65 out of 100 cases the correct action. This means: should you receive the hint "*b*", in 65 out of 100 cases action *B* is the right one.

Other persons before you were confronted with this decision making situation. Person 1 had to make his decision first, than person 2, and so forth. Each person could see the decision their predecessors made, but not the hints these persons received. You know that the reliability of the hints of the persons before you was only 60%. This means: should one of these persons for example receive hint "*b*", in only 60 out of 100 cases action *B* is correct. All participants receive exactly one hint. The hints are independent of each other. All persons who already made their decision made a rational decision.

You are the 3rd person to decide. The two predecessors decided thus: *A* *A*

You receive hint "*b*".

Which action should you now chose? *A* ☐ *B* ☐

Please briefly explain upon which rationale you made your decision, or which way, if at all, you went to resolve this problem! These explanations have **no** influence on the granting of bonus points for the exam! Therefore you should give an open and honest answer here!

Appendix B: Detailed results of the six parts of the studies

Table 8: Study part I: 55 undergraduate students

		Group							
		1		2		3		∑	
Run	1	R	W	R	W	R	W	R	W
		6	13	5	13	5	13	16	39
		Task 1		Task 3		Task 2		29%	71%
	2	R	W	R	W	R	W	R	W
		10	9	7	11	0	18	17	38
		Task 2		Task 1		Task 3		31%	69%
	3	R	W	R	W	R	W	R	W
		7	12	10	8	7	11	24	31
		Task 3		Task 2		Task 1		44%	56%
	∑	R	W	R	W	R	W	R	W
		23	34	22	32	12	42	57	108
		40%	60%	41%	59%	22%	78%	35%	65%

R = Right (in the sense of a rational decision making by correctly applying Bayes' Rule); W = Wrong (that means that the decision follows the private signal).

Table 9: Study part II: 50 graduate students

		Group							
		1		2		3		∑	
Run	1	R	W	R	W	R	W	R	W
		10	6	3	14	8	9	21	29
		Task 1		Task 3		Task 2		42%	58%
	2	R	W	R	W	R	W	R	W
		9	7	6	11	5	12	20	30
		Task 2		Task 1		Task 3		40%	60%
	3	R	W	R	W	R	W	R	W
		8	8	6	11	5	12	19	31
		Task 3		Task 2		Task 1		38%	62%
	∑	R	W	R	W	R	W	R	W
		27	21	15	36	18	33	60	90
		56%	44%	29%	71%	35%	65%	40%	60%

R = Right (in the sense of a rational decision making by correctly applying Bayes' Rule); W = Wrong (that means that the decision follows the private signal).

Table 10: Study part III: 46 undergraduate students

		Group							
		1		2		3		∑	
Run	1	R	W	R	W	R	W	R	W
		6	10	7	8	4	11	17	29
		Task 1		Task 3		Task 2		37%	63%
	2	R	W	R	W	R	W	R	W
		7	9	7	8	2	13	16	30
		Task 2		Task 1		Task 3		35%	65%
	3	R	W	R	W	R	W	R	W
		4	12	6	9	8	7	18	28
		Task 3		Task 2		Task 1		39%	61%
	∑	R	W	R	W	R	W	R	W
		17	31	20	25	14	31	51	87
		35%	65%	44%	56%	31%	69%	38%	62%

R = Right (in the sense of a rational decision making by correctly applying Bayes' Rule); W = Wrong (that means that the decision follows the private signal).

Table 11: Study part IV: 37 graduate students

		Group							
		1		2		3		∑	
Run	1	R	W	R	W	R	W	R	W
		3	9	3	9	6	7	12	25
		Task 1		Task 3		Task 2		32%	68%
	2	R	W	R	W	R	W	R	W
		4	8	7	5	1	12	12	25
		Task 2		Task 1		Task 3		32%	68%
	3	R	W	R	W	R	W	R	W
		3	9	5	7	3	10	11	26
		Task 3		Task 2		Task 1		30%	70%
	∑	R	W	R	W	R	W	R	W
		10	26	15	21	10	29	35	76
		28%	72%	42%	58%	26%	74%	32%	68%

R = Right (in the sense of a rational decision making by correctly applying Bayes' Rule); W = Wrong (that means that the decision follows the private signal).

Table 12: Study part V: 24 undergraduate and graduate students

		Group							
		1		2		3		∑	
Run	1	R	W	R	W	R	W	R	W
		5	5	3	4	3	4	11	13
		Task 1		Task 3		Task 2		46%	54%
	2	R	W	R	W	R	W	R	W
		3	7	4	3	2	5	9	15
		Task 2		Task 1		Task 3		37%	63%
	3	R	W	R	W	R	W	R	W
		2	8	4	3	2	5	8	16
		Task 3		Task 2		Task 1		33%	67%
	∑	R	W	R	W	R	W	R	W
		10	20	11	10	7	14	28	44
		33%	67%	52%	48%	33%	67%	39%	61%

R = Right (in the sense of a rational decision making by correctly applying Bayes' Rule); W = Wrong (that means that the decision follows the private signal).

Table 13: Study part VI: 15 post-graduate students (corresponds to MBA) with no order of the tasks, with the possibility to communicate among the experimentees, and handing in after 36 hours maximum to work on it.

		Group							
		1		2		3		∑	
Run	1	R	W	R	W	R	W	R	W
		2	3	1	4	2	3	5	10
		Task 1		Task 3		Task 2		33%	67%
	2	R	W	R	W	R	W	R	W
		2	3	2	3	1	4	5	10
		Task 2		Task 1		Task 3		33%	67%
	3	R	W	R	W	R	W	R	W
		3	2	2	3	2	3	7	8
		Task 3		Task 2		Task 1		47%	53%
	∑	R	W	R	W	R	W	R	W
		7	8	5	10	5	10	17	28
		47%	53%	33%	67%	33%	67%	38%	62%

R = Right (in the sense of a rational decision making by correctly applying Bayes' Rule); W = Wrong (that means that the decision follows the private signal).

REFERENCES

Anderson, Lisa R. and Charles A. Holt. "Information Cascades in the Laboratory", *The American Economic Review*, 1997, *87* (5), pp. 847-862.

Arnott, Robert D. "What Risk Matters?", *Financial Analysts Journal*, 2003, *59*(3), pp. 6-8.

Banerjee, Abhijit V. „A Simple Model of Herd Behavior", *The Quarterly Journal of Economics*, 1992, *107* (3), pp. 797-817.

Bewley, Ronald and Denzil G. Fiebig. "On the Herding Instinct of Interest Rate Forecasters", *Empirical Economics*, 2002, *27*(3), pp. 403-426.

Bikhchandani, Sushil, David Hishleifer, and Ivo Welch. "A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades", *Journal of Political Economy*, 1992, *100* (5), pp. 992-1026.

Bogachan, Celen and Shachar Kariv. "Distinguishing Information Cascades from Herd Behavior in the Laboratory", *The American Economic Review*, 2004, *94*(3), pp. 484-498.

Cooper, Rick A., Theodore E. Day and Craig M. Lewis. "Following the leader: a study of individual analysts' earnings forecasts", *Journal of Financial Economics*, 2001, *61*(3), pp. 383-416.

Cote, Jane M. and Debra L. Sanders. "Herding Behavior: Explanations and Implications", *Behavioral Research in Accounting*, 1997, *9* (1), pp. 20-45.

Graham, John R. "Herding among Investment Newsletters: Theory and Evidence", *The Journal of Finance*, 1999, *54*(1), pp. 237-268.

Hong, Harrison, Jeffrey D. Kubik and Amit Solomon. "Security Analysts' Career Concerns and Herding of Earnings Forecasts", *RAND Journal of Economics*, 2000, *31*(1), pp. 121-144.

Huck, Steffen and Jörg Oechssler. „Informational cascades in the laboratory: Do they occur for the right reasons?", *Journal of Economic Psychology*, 2000, *21* (6), pp. 661-671.

Hung, Angela A. and Charles R. Plott. "Information Cascades: Replication and an Extension to Majority Rule and Conformity-Rewarding Institutions", *The American Economic Review*, 2001, *91* (5), pp. 1508-1520.

Keynes, John Maynard. "The General Theory of Employment, Interest, and Money", London 1936.

Olsen, Robert A. "Implications of Herding Behavior for Earnings Estimation, Risk Assessment, and Stock Returns", *Financial Analysts Journal*, July/August 1996, *52*(4), pp. 37-41.

Selten, Reinhard, Klaus Abbink, Joachim Buchta, and Abdolkarim Sadrieh. „How to play (3 x 3)-games. A strategy method experiment", *Games and Economic Behavior*, 2003, *45*(1), pp. 19-37.

Sgroi, Daniel. "The Right Choice at the Right Time: A Herding Experiment in Endogenous Time", *Experimental Economics*, 2003, *6* (2), pp. 159-180.

Spiwoks, Markus. "External Triggered Herding bei Rentenmarkt-Analysten", *Financial Markets and Portfolio Management*, 2004, *18*(1), pp. 58-83.

Spiwoks, Markus, Kilian Bizer, and Oliver Hein. "Anchoring Near the Lighthouse: Bond Market Analysts' Behavior Co-ordination by External Signal", Wolfsburg University of Applied Sciences Working Papers, No. 05-02, 2005.

Trueman, Brett. "Analyst Forecasts and Herding Behavior", *The Review of Financial Studies*, 1994, *7*(1), pp. 97-124.

Welch, Ivo. "Herding among Security Analysts", *Journal of Financial Economics*, 2000, *58*(3), pp. 369-396.