Strategic Delay and Rational Imitation in the Laboratory*

Anthony Ziegelmeyer, Kene Boun My,
Jean-Christophe Vergnaud, and Marc Willinger†

Preliminary draft. Comments are welcome.

Abstract

This paper investigates market failures due to strategic delays. We test experimentally a discrete model of dynamic investment, where two privately informed agents have an option to invest at the time of their choice in the presence of waiting costs. The equilibrium outcome of our experimental game is characterized by efficient imitation but complete revelation of information is time consuming. In accordance with the equilibrium solution, subjects better informed take investment decision before subjects who are less informed and subjects' decisions exhibit rational imitation. Still, subjects do not play exactly in accordance with the equilibrium sequence and we interpret their deviations from equilibrium play as an attempt to internalize the information externalities.

Keywords: Information Externalities, Social Learning, Strategic Delay, Experiments

JEL Classification: C91, D82

1 Introduction

In economic situations where decisions are based on private signals and have a common value component, individuals may rely on whatever information they have obtained via observation of others' actions. This process of *observational learning* can lead individuals to the failure to exploit their own information in a socially optimal way. Indeed, early models dealing with observational learning, also called social learning, and pure information externalities with exogenous timing of decisions have shown that, because they rationally process information, selfish individuals ignore their own information, after observing a finite number of other decisions, and imitate the "herd" (see Banerjee, 1992, Bikhchandani, Hirshleifer, and Welch, 1992, and Welch, 1992). Herd behavior has been proposed as an explanation of a variety of economic phenomena such as investments breakdown in crisis and failures of optimal technological shifts, as well as of widely observed social phenomena such as manias, social customs, and panics. Once the timing of decisions is endogenized, individuals might strategically delay their decisions in order to benefit from the positive information externalities generated by their predecessors' actions. Under the reasonable assumption that delay is costly, we encounter a new form of market failure namely that all the information initially possessed by individuals will be revealed asymptotically, but so slowly that economic welfare is much less than the

*Not everyone who commented on this work can be mentioned here, but the authors would particularly like to thank Frédéric Koessler and Bradley Ruffle. Of course, only the authors can be held responsible for the statements made herein. This paper is based on Chapter 9 of the first author dissertation.

†Ziegelmeyer (corresponding author): Max Planck Institute of Economics, Strategic Interaction Group, Jena, Germany (email: ziegelmeyer@econ.mpg.de). Boun My: BETA, Université Louis Pasteur, Strasbourg, France (email: bounmy@cournot.u-strasbg.fr). Vergnaud: EUREQua, Université Paris I, Paris, France (email: vergnaud@univ-paris1.fr). Willinger: LAMETA, Université Montpellier 1, Montpellier, France (email: willinger@lameta.univ-montp1.fr).

first best. As emphasized by Gale (1996), the most important lesson taught by social learning models is that information externalities result in serious failures to achieve a desirable social outcome. Whether the outcome is delay or incomplete revelation of information, the important ingredient is the free rider problem and the failure to internalize an information externality.

With the emergence of behavioral economics, however, economists have come to question whether human individuals tend to actually ignore costs imposed on others when reaching economic decisions. Experimental studies, with few exceptions, find evidence against theories based on selfish motives, and, despite the strong predictions generated by classical theory in externality settings, social scientists often question the truths provided by it.[1] Individuals who also care about others' payoff partially internalize negative externalities when they interact with other individuals. As a consequence, the interaction of rational individuals with social preferences leads to a more desirable social outcome than the one resulting from the interaction of rational selfish individuals in a social learning environment. Despite the theoretical interest of social learning models and their ability to explain a wide range of issues, it seems therefore worth assessing the usefulness of the rational and selfish view of herding. In the present paper, we provide evidence on the validity of strategic delays due to information externalities by testing experimentally two parametric versions of an endogenous-time herding game which combines irreversible investment, private information, and learning from others.

In the pioneering works on rational herding, the sequence of decisions is arbitrarily chosen, and social suboptima result with agents herding into an action and therefore never revealing their informative signals for later agents to use.[2] In subsequent models on rational herding agents can try to rectify the difference between their private information and the observed actions of others by waiting. These models focus therefore on strategic delays caused by information externalities. Pioneer contributions to this endogenous-time herding literature include among others Chamley and Gale (1994), Gul and Lundholm (1995), and Gale (1996) (Chamley, 2004 is the state of the art in formal modeling of rational herding and it provides substantive understanding of how the above mentioned models work).

Chamley and Gale (1994) consider a discrete-time model where a random number of agents have an opportunity to invest or not to invest with the option to invest latter. They suppose moreover that the true investment return is an increasing function of the number of possible investment opportunities, and that each agent's waiting cost is given by a common discount factor. By focusing on symmetric perfect Bayesian equilibria in which agents apply behavioral strategies, Chamley and Gale show that information aggregation is inefficient in this setting. Indeed, situations where all agents immediately invest and the game ends, and situations where no agent invest and no information is revealed at all occur with positive probability in equilibrium.

In contrast to Chamley and Gale (1994), time is assumed to be continuous in Gul and Lundholm (1995). In this model, two agents are asked to assess the future value of a project. Agents' utility functions capture the trade-off between the accuracy of a prediction and how early the prediction is made. Each agent has a private signal which helps him to forecast the sum of the signals, i.e., the value of the project. At equilibrium, agents' forecasts tend to cluster and they predict at almost the same date. In contrast with what is observed in Chamley and Gale's (1994) model, this clustering of the agents' choices is informationally efficient.[3] It remains that the sum of agents' expected utility is higher under exogenous timing than under endogenous timing, although the latter is informationally the most efficient.

[1] Gintis, Bowles, Boyd, and Fehr (2005) is a recent synthesis of research in different disciplines which argues that cooperation stems not from the stereotypical selfish agent acting out of disguised self-interest but from the presence of "strong reciprocators" in a social group.

[2] Lee (1993) and Smith and Sorensen (2000) have respectively shown that the two key assumptions for herding are the discreteness of the set of actions and the boundedness of the private signals.

[3] What drives Gul and Lundholm's (1995) result is the dimension of the action space. In the Chamley and Gale framework, the decision of an agent is binary: to invest or not to invest (i.e., to wait). In the Gul and Lundholm framework, the agents' action space is a continuum. Hence, when an agent acts in this latter, he reveals both his signal and his belief about the others' signal.

This last feature of the equilibrium in Gul and Lundholm's (1995) model illustrates a general result; when agents are involved in endogenous timing of decisions and delays are costly, there is a war of attrition effect that reduces welfare. As the rational herding literature made clear, informational externalities result in serious failures to achieve a desirable social outcome. Sources of market failures can either be too much delay or incomplete revelation of information.

This article investigates market failures due to strategic delays in an experimental endogenous-time herding game, called the *waiting game*. The basic story of the waiting game is as follows. Each of two agents can invest in one of two types of projects where the investment decision is irreversible and publicly observable. One of the projects is profitable and the other is unprofitable for both agents, but no one knows for sure which of these states of nature is the case. Each agent initially draws a conditionally independent piece of information about the state of nature and agents might have different information precision. Agents decide not just which project to choose but when to undertake the project, and there is a cost for delaying the project choice. The equilibrium of our two experimental games possesses the interesting feature that social learning is efficient, i.e., investment decisions reveal completely the private information. However, information might be fully revealed only after a long delay which entails a loss of social welfare. In other words, strategic delays due to information externalities produce suboptima results.

The main goal of the experiment is to test for the empirical relevance of strategic delays caused by information externalities particularly since it is the only source of market failure in the game considered. Indeed, previous experimental studies dealing with social learning and pure information externalities considered situations in which rational herding could be on the wrong action (see Anderson and Holt (1997) and Sgroi (2003) for the exogenous and endogenous case, respectively). On the contrary, the equilibrium outcome of our experimental games is characterized by efficient imitation but complete revelation of information is time consuming. The problem facing a subject is thus to optimally balance is desire to observe the actions of others, infer useful information, against the cost of delaying investment inasmuch as by waiting he imposes a negative externality on the other subject. At a more basic level, as with most experiments, the central notion is (Bayesian) rationality. The waiting game is a relevant interactive decision situation to measure the degree of subjects' strategic sophistication as it is dominance solvable. More importantly, the rational herding literature demonstrates that despite the rationality of individual behavior, the process of social learning is inefficient or fails completely. In fact, it is often because of that rationality that information externalities result in serious failures to achieve a desirable social outcome which hints at social benefits of boundedly rational behavior by individuals. At a more basic level, we experimentally investigate whether people respond appropriately to private signals and publicly observed actions.

The paper is organized as follows. In Section 2 we introduce the waiting game, we characterize its unique perfect Bayesian Nash equilibrium and we derive three testable hypotheses. Section 3 presents the experimental design. In Section 4 we describe the results of our experimental study and we compare them with the equilibrium predictions. Section 5 concludes the paper.

2 Theory and Research Hypotheses

2.1 The Waiting Game

The waiting game is a non-cooperative two-person game where both players can delay their investment opportunity in the presence of waiting costs. Investment returns are uncertain, actions are observable, and both players are endowed with a private signal correlated with the investment return. Any preplay communication between players is ruled out in this game.[4]

[4]As our model is void of any competition effects, the reader might ask: "Why can't the players just exchange their private information directly?" First, there are economic situations in which communication is anything but 'cheap talk'. Second, even if one takes the possibility of cheap talk seriously, it is not clear that this will alter the conclusions of the analysis. Indeed, in a closely related dynamic investment model with information externalities, Gossner and

Formally, we consider two risk-neutral players who can decide not just which investment option to choose, but in which period they invest. Time is discrete, and the periods are indexed by $t \in \{1, \ldots, T\}$. In the first period, each player $i \in \{1, 2\}$ chooses an action $a_i^1 \in A = \{O^{(+)}, O^{(-)}, W\}$, where action $O^{(+)}$ stands for investing in option $O^{(+)}$, action $O^{(-)}$ stands for investing in option $O^{(-)}$, and action W stands for "waiting". In the following periods, $T \geq t \geq 2$, each player i chooses an action $a_i^t \in A^t(a_i^{t-1})$, where

$$A^t(a_i^{t-1}) = \begin{cases} A & \text{if } a_i^{t-1} = W, \\ \emptyset & \text{otherwise.} \end{cases}$$

Thus, if a player invests in any given period, he has no other decision to make in subsequent periods. Each player's actions are publicly observed. Because $O^{(+)}$ and $O^{(-)}$ are irreversible actions, we call them terminal actions.

Each player i is endowed, before the start of the game, with a *private information*, i.e., not observable by the other player, which is correlated with a payoff relevant variable. Let m_i denote player i's private information. The m_i's are independently and uniformly distributed in a discrete set of possible signals $\mathbf{M} = \{-m, -m+1, \ldots, -1, 0, 1, \ldots, m-1, m\}$, where m is a strictly positive integer.

We assume that the terminal actions $O^{(+)}$ and $O^{(-)}$ are negatively correlated in the following sense. Investment option $O^{(+)}$'s undiscounted net return is equal to R if $m_1 + m_2 > 0$ and $-R$ if $m_1 + m_2 < 0$ whereas investment option $O^{(-)}$'s undiscounted net return is equal to R if $m_1 + m_2 < 0$ and $-R$ if $m_1 + m_2 > 0$, where R is a strictly positive real number. If $m_1 + m_2 = 0$ then both investment options reward zero. Waiting has a positive opportunity cost c, which is a strictly positive real number that we assume to be constant for each period.[5] In summary, if player i invests in option $O^{(+)}$ (respectively option $O^{(-)}$) and this invesment takes place in period t, player i's payoff is given by $R - (t-1)c$ if $m_1 + m_2 > 0$ (respectively if $m_1 + m_2 < 0$), 0 if $m_1 + m_2 = 0$, and $-(R - (t-1)c)$ if $m_1 + m_2 < 0$ (respectively if $m_1 + m_2 > 0$). If player i never invests then he gets nothing. For practical purposes, we assume that $R - (T-1)c \geq 0$ which implies that $T \leq (R+c)/c$.

The *outcome* of the waiting game in period t is the vector of actions taken by both players, where $a_i^t = \emptyset$ if $a_i^{t-1} \in \{\emptyset, O^{(+)}, O^{(-)}\}$. The *history* of the game in period t, which we denote by h^t, is a sequence of outcomes up to period t, i.e., $h^t = \big((a_1^1, a_2^1), \ldots, (a_1^t, a_2^t)\big)$ and $h^0 = \emptyset$. Let H^t denote the set of all possible histories up to period t. Player i's pure strategy s_i is represented by a sequence $\{s_i^t\}_{T \geq t \geq 1}$ where

$$\begin{aligned} s_i^t : H^{t-1} \times \mathbf{M} &\rightarrow A^t(a_i^{t-1}) \\ (h^{t-1}, m_i) &\mapsto s_i^t(h^{t-1}, m_i), \end{aligned}$$

describes the "pure strategy of player i at period t". A profile of pure strategies is denoted by $s = (s_1, s_2)$. Mixed strategies are defined the usual way.

2.2 The Equilibrium

Before characterizing players' optimal behavior in the waiting game, let us formally define the *threshold strategy.*

Definition. *Player $i \in \{1, 2\}$ follows the threshold strategy if he chooses his actions according to the map*

Melissas (2004) have shown that there always exists an equilibrium in which no credible information is transmitted through words. Moreover, for projects with a low expected net value, the babbling equilibrium is the only one.

[5] Ideally, the opportunity cost of waiting should be modeled as a common discount factor $0 < \delta < 1$. Linear costs are however easier to implement in the laboratory.

- $s_i^1(\emptyset, m_i) = \begin{cases} O^{(+)} & \text{if } m_i > \theta^1 \\ O^{(-)} & \text{if } m_i < -\theta^1 \\ W & \text{if } -\theta^1 \leq m_i \leq \theta^1, \end{cases}$

- *for all* $T \geq t \geq 2$, $s_i^t(h^{t-1}, m_i) = \begin{cases} O^{(+)} & \text{if } m_i > \theta^t \text{ or } s_{-i}^{t-1} = O^{(+)} \\ O^{(-)} & \text{if } m_i < -\theta^t \text{ or } s_{-i}^{t-1} = O^{(-)} \\ W & \text{if } -\theta^t \leq m_i \leq \theta^t \text{ and } s_{-i}^{t-1} = W, \end{cases}$

where, for each period $T \geq t \geq 1$, θ^t *is a positive real number such that* $\theta^t > \theta^{t+1}$.

The threshold strategy possesses the three following features. First, players with more extreme signals choose to move early. This is a reasonable feature as a player's expected payoff depends only on his own action and as high signal absolute values give a more accurate prediction of the actual return to investment.[6] Second, as actions reflect information, waiting is often more valuable than taking a terminal action in the first period, and, of course, the value of waiting becomes zero as soon as one of the two players has taken a terminal action. In other words, if a player has not yet taken a terminal action at the beginning of period $T \geq t \geq 2$ and the other player has taken a terminal action in the previous period, then imitation takes place in period t whatever the private information of the player who waited longer.[7] Third, if both players adopt the threshold strategy, imitation is efficient, i.e., players can potentially make errors only if they invest simultaneously.

It turns out that the threshold strategy characterizes optimal play in the waiting game as stated in the following proposition.

Proposition. *The threshold strategy is the unique rationalizable strategy in the waiting game. Accordingly, the waiting game has a unique perfect Bayesian Nash equilibrium in which each player adopts the threshold strategy.*

Proof. See Appendix 1.

As the threshold strategy is the unique rationalizable strategy, the strategy profile according to which both players adopt the threshold strategy is the unique outcome of the process of successive elimination of strictly dominated strategies in the waiting game. Therefore, optimal behavior in the waiting game does not require that players' beliefs are consistently aligned, i.e., that each player anticipates that the other will do what this other player indeed plans to do, but is justified by rationality alone (Bernheim, 1984 and Pearce, 1984 independently developed the notion of rationalizability). We now compute the threshold values θ^t, for all $T \geq t \geq 1$, as they are sufficient to characterize each player's optimal behavior in the waiting game.

2.2.1 Threshold value in period 1

Let m^1 be the smallest signal value leading to terminal action $O^{(+)}$ in period 1. By symmetry, $-m^1$ is the largest signal value leading to terminal action $O^{(-)}$ in period 1. In other words, if $m_i \in \{m^1, \dots, m\}$, player i invests in option $O^{(+)}$ in period 1, if $m_i \in \{-m, \dots, -m^1\}$, player i invests in option $O^{(-)}$ in period 1, and otherwise player i waits. By definition, m^1 is also the smallest signal value for which the expected value of choosing action $O^{(+)}$ in period 1 is strictly larger than the expected value of waiting. If player i holds signal value m^1, his expected value of choosing action $O^{(+)}$ in period 1 is given by $2\,m^1\,R/(2\,m+1)$. Besides, the expected value of waiting until period 2 is given by $2\,m\,(R-c)/(2m+1)$. Although player i's potential reward is reduced by the

[6] In other words, high signal absolute values are more informative, i.e., the magnitude of the signal indicates its quality.

[7] If private signals were observable, each player's optimal decision would be to invest in option $O^{(+)}$ in the first period if $m_1 + m_2 > 0$, to invest in option $O^{(-)}$ in the first period if $m_1 + m_2 < 0$, and in case $m_1 + m_2 = 0$ any action (mixture of actions) would be optimal. Thus, the *observable signals* scenario corresponds to the first-best solution.

cost of waiting, he is almost sure to get a strictly positive payoff (except in the case where the sum of the signals is equal to zero). Indeed, player i will decide $O^{(+)}$ in period 2 if player $-i$ has chosen $O^{(+)}$ or waited in period 1, which reveals that $m_{-i} \in \{-m^1+1, \dots, m\}$. Similarly, player i will choose $O^{(-)}$ in period 2 if player $-i$ has chosen $O^{(-)}$ in period 1, which reveals that $m_{-i} \in \{-m, \dots, -m^1\}$. Thus, whatever the terminal action chosen by player $-i$ in period 1, player i imitates in period 2. To sum up, player i, who holds signal value m^1, invests in option $O^{(+)}$ in period 1 if and only if

$$m^1 > \frac{m\,(R-c)}{R}. \tag{1}$$

According to inequality (1), all signal values strictly larger than $\theta^1 = m(R-c)/R$ will lead to terminal action $O^{(+)}$ in period 1. Similarly, all signal values strictly smaller than $-\theta^1$ will lead to terminal action $O^{(-)}$ in period 1. Since $c > 0$, inequality (1) shows that the extreme signal values m and $-m$ always lead to a terminal action in period 1.

2.2.2 Threshold value in period $n \geq 2$

If both players choose a terminal action in period 1, the waiting game is over. If one of the two players chooses a terminal action in period 1, the other player imitates his choice in period 2, and the waiting game ends in period 2. Indeed, suppose that player 1 waits in period 1 and observes that player 2 invests in option $O^{(+)}$ in period 1. Player 1 then infers that player 2 has a larger signal in absolute value than his own private signal (since $m_2 > \theta^1$), and by observing terminal action $O^{(+)}$ player 1 is sure that the sum of the signals is strictly positive. The same reasoning applies if player 1 observes player 2 investing in option $O^{(-)}$. The remaining case consists in both players waiting in period 1. In such a case, both private signals belongs to the set $\{-m^1+1, \dots, m^1-1\}$. We now identify the positive signal values that lead player i to invest in option $O^{(+)}$ in period 2 if both players have waited in period 1.

Let m^2 be the lowest signal value for which player i chooses $O^{(+)}$ in period 2. In other words, if his signal value belongs to $\{m^2, \dots, m^1-1\}$, player i chooses $O^{(+)}$ in period 2. He prefers to take terminal action $O^{(+)}$ in period 2 if the expected value of that action is strictly larger than the expected value of waiting until period 3. The expected value of choosing $O^{(+)}$ in period 2, with signal value m^2 is given by $2\,m^2\,(R-c)/(2\,m^1-1)$. Besides, the expected value of waiting until period 3 is given by $(2\,m^1-2)\,(R-2c)/(2\,m^1-1)$. So, player i, when endowed with private signal m^2, invests in option $O^{(+)}$ in period 2 if and only if

$$m^2 > \theta^2 = \frac{(m^1-1)\,(R-2c)}{R-c}. \tag{2}$$

Similarly, if player i's signal value is strictly smaller than $-\theta^2$ he plans to take terminal action $O^{(-)}$ in period 2.

More generally, the following recurrence relation allows one to compute the threshold value for each period $T \geq t \geq 2$:

$$\theta^t = \frac{[\theta^{t-1}](R-tc)}{R-(t-1)c},$$

where $\theta^1 = m(R-c)/R$, and $[k]$ is the integer part of k.

2.3 Research Hypotheses

From now on, whenever terminal decisions are not taken simultaneously in the waiting game, the player who takes his terminal decision first is called the *leader* and the player who takes his terminal decision second is called the *follower*. Summarizing the theoretical predictions of the waiting game, we formulate the following testable hypotheses:

Ordering Hypothesis: The *leader* has a strictly better quality signal than the *follower*.

Imitation Hypothesis: The *follower* chooses one period after the *leader* and takes the same terminal action whatever his private information.

Equilibrium Hypothesis: The sequence of choices is consistent with the equilibrium sequence.

Of course, the equilibrium hypothesis implies the two other hypotheses.

3 Experimental design

In this section, we first introduce the two parametric versions of the waiting game that we implemented in the laboratory. The two versions of the game differ only according to the cost of waiting which is our main treatment variable. We refer to our two experimental conditions as to the *high cost treatment* and the *low cost treatment*. Both parametric versions of the waiting game lead to identical equilibrium play. Second, we present the practical procedures of the two reference treatments. Third, we introduce the two additional experimental conditions that were realized in order to check for the robustness of the results with respect to methodological choices. Both additional treatments are based on the parametric version of the waiting game with a high waiting cost. The first control treatment is identical to the high cost treatment except for the matching rule of the subjects and the second control treatment only differs from the first control treatment as far as the payoff scheme is concerned.

3.1 The two reference treatments

In our experiment, we set R equal to 100 and m equal to 4. Thus, the discrete set of possible signals is given by $\{-4, -3, -2, -1, 0, 1, 2, 3, 4\}$.[8] In the high cost treatment (or simply Treatment 1) the opportunity cost of waiting, c, is set equal to 20. In the low cost treatment (or simply Treatment 2) the opportunity cost of waiting is set equal to 10. We set the number of periods of the parametric waiting game to 6 and 11, respectively for the high cost and the low cost treatment. Indeed, if $c = 20$, the expected gain (or loss) is null in period 6. Similarly, if $c = 10$, the expected gain (or loss) is null in period 11. Note that in the last period of the game each subject has to choose a terminal action and that he is aware that such a forced choice would have no impact on his earnings. According to the threshold strategy, the predicted decision periods, in the case where the other player has signal value 0, are given in Table 1. For positive (negative) signal values the leader should choose $O^{(+)}$ $\left(O^{(-)}\right)$ in the appropriate period. Note that, for both values of c, the threshold strategy predicts exactly the same sequence. This particular sequence of decisions leads to a complete identification of signals, since each player can infer the signal value of the player who is leader, i.e., the player who decided to take a terminal action first, by observing the period in which he invests. We note this strategy of perfect identification **4/3/2/1**. By choosing a relatively low cost of waiting, even in the high cost treatment, we want to avoid an equilibrium strategy which predicts to behave in the same manner with two different signal absolute values. By doing so, equilibrium predictions are easy to distinguish from subjects' behavior if any difference is observed.

As the theoretical predictions are independent of the cost of waiting, another possible parametric choice would have been to set the number of periods equal to 6 in the low cost treatment. But in such a case we would not have been able to distinguish, between both reference treatments, the behavior of subjects who got signal value 0 and who observed the other player waiting. Therefore we decided to set a higher number of periods for the low cost treatment in order to be able to observe different behaviors with an uninformative signal. Indeed, in the low cost treatment, a subject who

[8] Though this set of possible signals is not very large, we think that it is large enough to get rich data.

Table 1: Leader's optimal decision period.

Signal in absolute value is equal to	Observed sequence of actions	Optimal decision period	Thresholds in treatment Low cost	High cost
4	$\{\emptyset\}$	1	$\theta^1 = 3.60$	$\theta^1 = 3.20$
3	$\{W\}$	2	$\theta^2 = 2.66$	$\theta^2 = 2.25$
2	$\{W, W\}$	3	$\theta^3 = 1.75$	$\theta^3 = 1.33$
1	$\{W, W, W\}$	4	$\theta^4 = 0.86$	$\theta^4 = 0.50$

got signal value 0 can only choose one of the two terminal actions without care before period 11 if he is sure that the other subject has signal value 0 too.

3.2 Practical procedures

The experiment was run on a computer network using 32 inexperienced subjects at the BETA laboratory of experimental economics (LEES) at the University of Strasbourg. The subjects were recruited by phone from a pool of 400 students. Two sessions were organized, one with 7 groups of two subjects and the other one with 9 groups of two subjects. The first session corresponds to the *high cost treatment* (Treatment 1) and the second session corresponds to the *low cost treatment* (Treatment 2). Subjects were instructed that each of them would be matched with another subject for the whole duration of the experiment. Instructions were read aloud,[9] followed by a small questionnaire and two trial periods which were not counted in the subjects' scores. The experiment was divided into 20 rounds. In order to avoid losses for the subjects, they started the session with an endowment equal to the maximal loss possible over the 20 rounds. At the beginning of each round, the random drawing of the signal value was simulated on the screen by a wheel of fortune on which the 9 signal values appeared. The wheel stopped randomly on one of the possible values after a few seconds. After observing their signal value, subjects were asked to make their first period decision among the three possibilities: invest in option $O^{(+)}$, invest in option $O^{(-)}$, and $Wait$. In each period each subject's computer screen displayed the number of the period, the decision taken by the other player in the previous periods, and the remaining opportunity gain or loss. If the other subject had already taken a terminal action in one of the previous periods, the terminal action taken and the corresponding period were displayed. For example, if subject A chose to invest in option $O^{(+)}$ in period 1 in the high cost treatment, and subject B waited at least until period 3, subject B's screen displayed the following information in period 3: "Subject A has chosen to invest in option $O^{(+)}$ in period 1" and "The third period's opportunity gain or loss is equal to 60 Experimental Currency Units". Subjects were paid according to their relative performance with respect to the average performance of the whole group of subjects in a session. Let X_i be the total number of Experimental Currency Units (ECU) earned by subject i during the experiment. ECU were converted into French francs (FF) at the end of the session at the rate of $100\, X_i/\overline{X}$, where $\overline{X}$ is the average payoff of the subject sample over all rounds. The duration of an experimental session was about one hour and the average earning was equal to 100 FF per subject.[10]

3.3 Additional treatments

We organized two additional sessions with 32 inexperienced subjects. Both were based on the same parametric version of the waiting game than the high cost treatment, i.e., $m = 4$, $R = 100$ and

[9]The instructions are available from the authors upon request.

[10]The conversion rate between the euro and the French franc has been set at 6.55957 FF per euro.

$c = 20$. They differed with respect to the practical procedures. The first control treatment (or simply Treatment 3), which involved 16 subjects, has the same practical procedures than Treatment 1 except for the matching rule of the subjects. In Treatment 3, subjects were rematched with a different anonymous partner after each round. By comparing subjects' behavior in Treatment 1 with subjects' behavior in Treatment 3, we can report on the impact of reputational effects in the waiting game.[11] The second control treatment (or simply Treatment 4), which also involved 16 subjects, has the same practical procedures than Treatment 3 except for the payoff scheme: the accumulated points of a subject were converted at a conversion rate of 3 FF for 100 ECU.[12] The second control treatment was implemented in order to check if the payoff scheme used in the reference treatments has not induced specific behaviors by the subjects. Indeed, notice that though players' payoffs are independent in the waiting game, subjects' payoffs were not independent over the whole session in any of the reference treatments.

4 Results

We organize our experimental results according to our three research hypotheses.

4.1 Ordering Hypothesis

The ordering prediction states that the leader is strictly better informed than the follower. Actually, players who hold equal quality signals should act simultaneously and a player who is strictly better informed should not act after a player who is less informed. With the parameters used in our experiment, the ordering prediction even implies that the player who is strictly better informed takes a terminal action strictly before the other player. Table 2 summarizes the data for our two reference treatments.

Table 2: Predictive success of the ordering hypothesis in the two reference treatments.

	Simultaneous investments		Correct ordering		Incorrect ordering	
	Low cost	High cost	Low cost	High cost	Low cost	High cost
Identical signals	0.39	0.54	—	—	—	—
(in absolute value)	[0, 0.80]	[0, 0.83]				
Different signals	0.17	0.22	0.77	0.71	0.06	0.07
(in absolute value)	[0, 0.44]	[0.13, 0.39]	[0.44, 1]	[0.50, 0.86]	[0, 0.13]	[0, 0.13]

In Treatment 1 ($c = 20$), 19 % (26/140) of the rounds involve subjects with the same signal in absolute value.[13] In such cases, the simultaneity hypothesis is accepted only in 54 % (14/26) of the cases (the lowest and the highest percentages observed over all the groups are given in square brackets). When subjects have different signals in absolute value, they tend to choose more frequently in the predicted ordered sequence. Indeed, the ordering prediction is satisfied in 71 % (81/114) in such cases. Overall the compatibility rate for the ordering prediction, in the high cost treatment, is 68 % (95/140).

[11] Even by being rematched with a different partner after each round, a subject can nevertheless try to convince the whole group to behave in a specific manner. Strictly speaking, reputational effects do not completely disappear. Still, recent experimental evidence suggests that the random matching procedure is sufficient to prevent the development of a cooperative norm in the controlled conditions of the laboratory (Duffy and Ochs, 2005).

[12] The average earning was equal to 96 FF per subject in this case.

[13] Note that from a theoretical point of view, the probability that both players get the same signal in absolute value is equal to $\frac{17}{81} \simeq 21\%$.

In Treatment 2 ($c = 10$), the simultaneity hypothesis for equal quality signals is accepted only in 39 % (15/38) of the cases. This percentage is lower than in the high cost treatment but by applying a two-tailed Mann-Whitney U test, we can accept the null hypothesis of no difference at the 5 percent level.[14] On the other hand, the data for the low cost treatment are even more in accordance with the ordering prediction when the two subjects have different quality signals, since the prediction is satisfied in 77 % (110/142) of the cases. Nevertheless the difference with the high cost treatment is not significant (two-sided Mann-Whitney U test at the 5 percent level). Overall the compatibility rate for the ordering prediction, in the low cost treatment, is 69 % (125/180). Applying a two-tailed Mann-Whitney U test, we conclude that there is no significant difference between this compatibility rate and the high cost treatment's compatibility rate at the 5 percent level.

Table 5 and Table 6 in Appendix 5 summarize the data concerning the ordering prediction for the two control treatments. Overall the compatibility rate for the ordering prediction is 63 % and 61 % for Treatments 3 and 4 respectively. These rates are lower than in Treatment 1 because in Treatments 3 and 4 there are fewer correct orderings. This is probably due to the fact that mutual consistency is more difficult to achieve with changing partners than with a fixed partner.

4.2 Imitation Hypothesis

The imitation prediction states that the player who acts second takes the same terminal action than the player who acts first, and decides immediately after him. By immediate imitation we mean imitation in the period immediately following the leader's decision period. We first comment on the experimental results of our two reference treatments.

The average observed imitation rate in the high cost treatment is equal to 98 %. Applying a one-sided χ^2 test, we can accept the null hypothesis of no difference between the average imitation rate and the equilibrium prediction (imitation rate of 100 %) at the 5 percent level. Similarly, the average observed imitation rate in the low cost treatment, equal to 96 %, is not significantly different from 100 % at the 5 percent level. However, imitation was delayed in a few cases, so that the average rates of immediate imitation are a little lower, 97 % and 91 % for the high cost and the low cost treatment respectively. Nevertheless, both rates of immediate imitation are not significantly different from the equilibrium prediction ($p = 0.97$ and $p = 0.18$ for the high cost and the low cost treatment respectively). Furthermore, imitation rates and immediate imitation rates are relatively stable over rounds (see Figure 1 and Figure 2 below), although the immediate imitation rate seems to be more stable in the high cost treatment than in the low cost treatment. We interpret this stability as reflecting confidence of the subjects. In almost all rounds, imitation was considered as a better decision than taking the opposite terminal action. This conclusion seems to be strengthened by the observation that imitators were not discouraged when they experienced a loss in the previous round. In a few cases a subject who experienced a loss as imitator was again in the position of imitator in the next period. In all these cases (3 cases in the high cost treatment and 10 cases in the low cost treatment) we observed imitation after a loss.

We observed a few cases for which the subject who acted second did not imitate the subject who acted first, even after a longer delay. Note that if a subject imitates with a delay he faces an extra cost of waiting although he is certain that he will not observe any further information. Under the assumption of expected value maximisation, subjects who do not imitate immediately either act irrationally or doubt the rationality of the leader. If a follower doubts the rationality of the leader, risk aversion might justify delayed imitation as such a strategy clearly reduces the variance of the payoffs. A subject who chooses a different terminal action than the subject who acts first, does not use the information revealed by the observed choice. We observed only 8 rounds over 320 in which the ordering prediction was satisfied but the imitation prediction was not. In 3 of these cases the subject who acted second took a terminal action immediately after the subject who acted first, but

[14] Note that in the low cost treatment, 21 % (38/180) of the rounds involved subjects with the same signal in absolute value.

Figure 1: Imitation rate (○) and immediate imitation rate (♦) in Treatment 1.

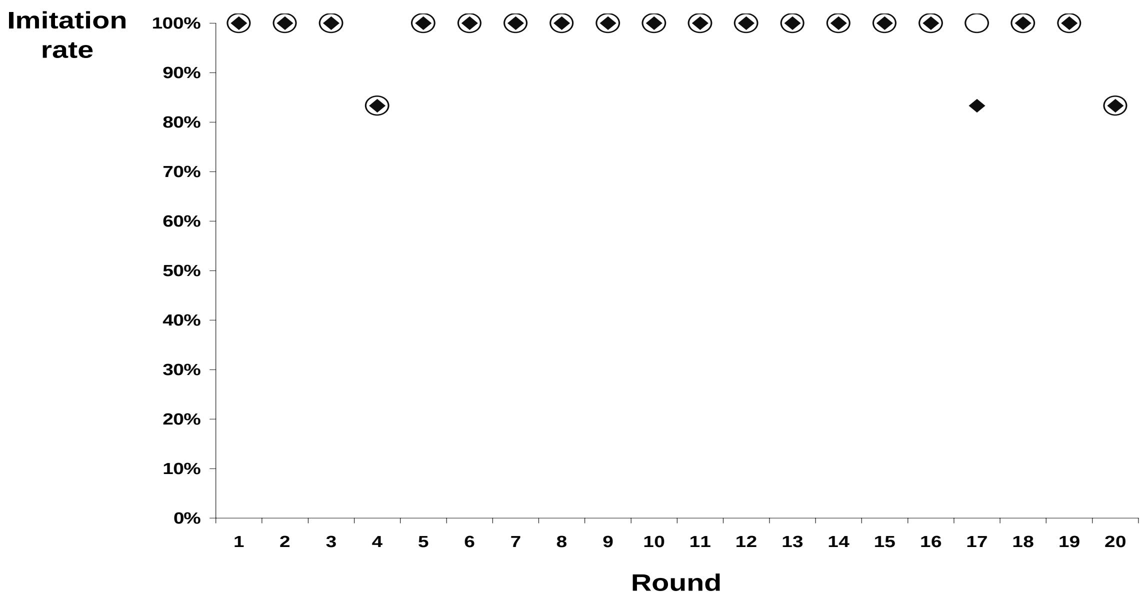
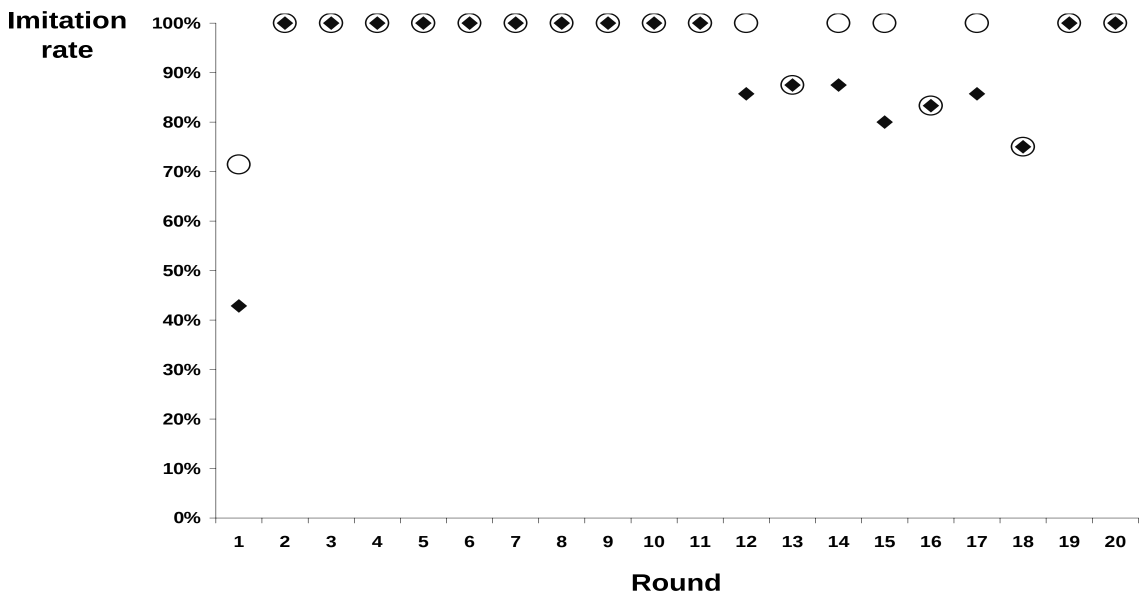


Figure 2: Imitation rate (○) and immediate imitation rate (♦) in Treatment 2.



followed his private signal. The other 5 cases are a combination between opposite terminal actions and excessive delay, in three of which the subject who acted second followed his private signal.

Figure 5 and Figure 6 in Appendix 5 show the temporal paths of the immediate imitation rate and the imitation rate for Treatments 3 and 4. The average observed imitation rates are equal to 94 % and 96 % for Treatment 3 and 4 respectively. The average observed immediate imitation rates are equal to 91 % and 93 % for Treatment 3 and 4 respectively. The two rates of imitation are slightly lower in Treatments 3 and 4, compared to Treatment 1.

4.3 Equilibrium Hypothesis

We turn now to the equilibrium prediction, according to which "the sequence of choices is consistent with the equilibrium sequence". The purpose of this section is precisely to try to measure the adequacy between the observed and the predicted sequence of choices. We gathered 280 and 360 individual decisions, respectively for the high cost treatment and the low cost treatment.

Leaders' behavior

We first report on the decisions of the subjects who happened to be leaders in the choices sequence. More precisely, we consider only the decisions of the leader when decisions are ordered, and the decisions of both players when decisions were taken simultaneously, leaving the followers' decisions out. Figure 3 and Figure 4 give representations of the data and provide comparisons with the theoretical prediction, respectively for the high cost treatment and the low cost treatment. The horizontal axis measures the signal value, and the vertical axis indicates the period at which the terminal action was taken by the leader. A point in the diagram relates the observed decision period with the signal value of the leader. Since most combinations are observed several times, their frequency is represented by the size of the points in the diagram. Hence, spheres represent the observed choices and the equilibrium strategy is represented by the bold circles. Remind that if the leader adopts the equilibrium strategy, he chooses a terminal action in period 1 if his signal is 4 or (-4), in period 2 if his signal is 3 or (-3), in period 3 if his signal is 2 or (-2) and in period 4 if his signal is 1 or (-1).

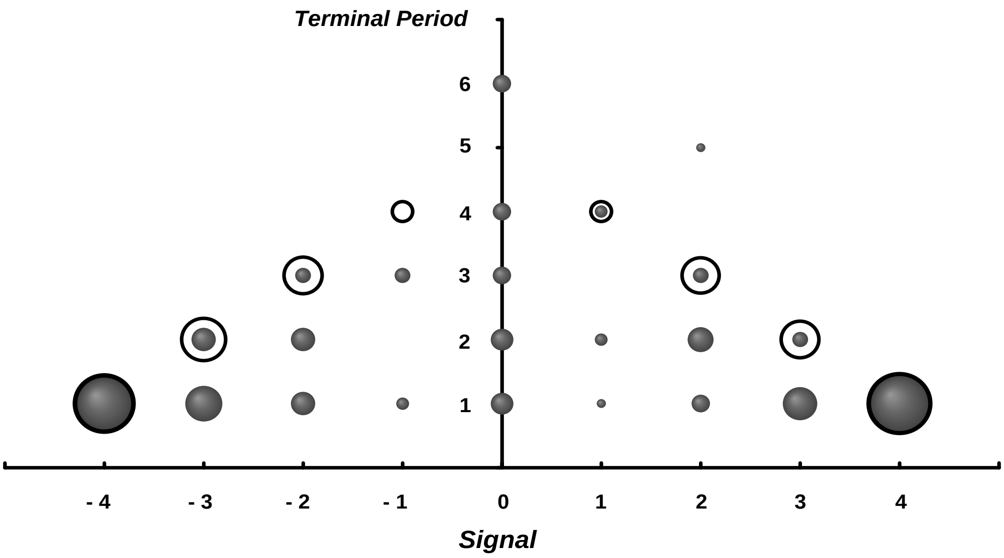


Figure 3: Leaders' terminal decision period related to the signal value for the high cost treatment (179 observations).

With respect to the equilibrium strategy, points below the "theoretical circles" can be interpreted as exhibiting *impatience*, and points above the theoretical circles as exhibiting *excessive delay*. Obviously, in our two reference treatments, most of the data fall on or below the theoretical circles and very few above. In particular, we observe that leaders holding signal value 3 or (-3) often choose a terminal action in period 1 instead of period 2 as predicted. More precisely, for the high cost treatment, respectively 72 % and 82 % of the leaders' terminal decisions are taken in period 1 for signal value equal to (-3) and 3. For the low cost treatment, 79 % and 82 % of the leaders' terminal decision period is 1, respectively for signal value equal to (-3) and 3. Moreover, a number of observations fall

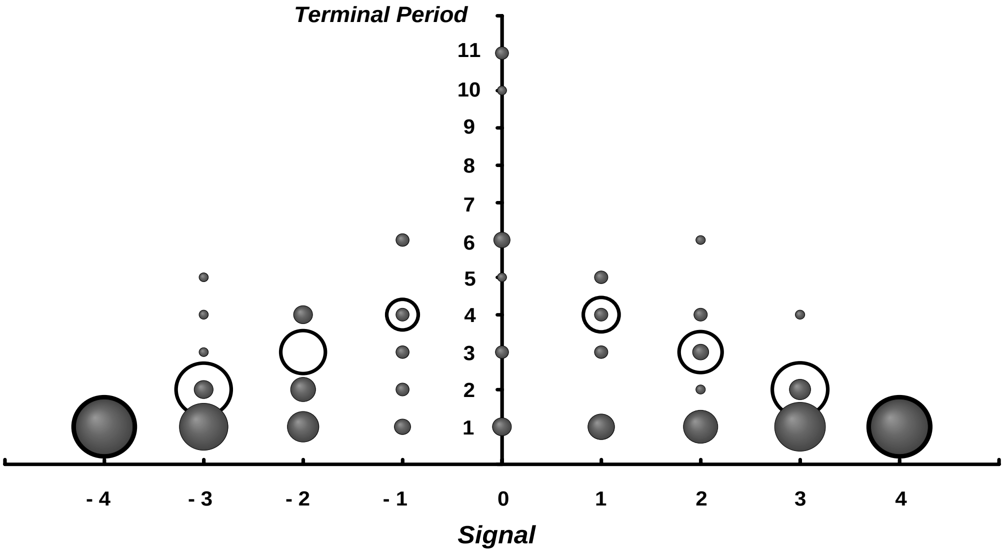


Figure 4: Leaders' terminal decision period related to the signal value for the low cost treatment (219 observations).

on the theoretical circles, and therefore fully agree with the theoretical prediction. For signal values equal to 4 in absolute value, all observations agree with the theoretical prediction.

For Treatments 1 and 2, applying two-tailed Kolmogorov-Smirnov (KS) tests, we cannot reject the null hypothesis that subjects holding signal 4 and 3 in absolute value take a terminal action in period 1 at the 5 percent significance level.[15] For signal values 2, 1 (in absolute value) and 0 there is no clear pattern, neither for the high cost treatment nor for the low cost treatment. More precisely, for these signal values and for both levels of cost, we cannot reject the null hypothesis that the distribution of induced choices is uniform over 2 or more periods at the 5 percent significance level (two-tailed KS tests). Moreover, the sign of the signal matters for the signal of magnitude 1, since the distribution over the set of periods differs according to sign. For the high cost treatment there is a uniform distribution over the periods 1, 2 and 4, for signal +1 (two-tailed KS test, 5% significance level) and over the periods 1 and 3 for signal -1 (two-tailed KS test, 5% significance level). For the low cost treatment, the distribution is over the periods 1, 3, 4 and 5 for +1 and 1, 2, 3, 4 and 6 for -1 ((two-tailed KS tests, 5% significance level). Similar observations can be made for signal values 2 and -2. We conclude from this analysis that absolute signal values 3 and 4 lead to a terminal action in period 1, whereas the other signal values do not lead to a terminal action in a specific period. A comparison between the low cost and the high cost treatment reveals that there is no significant difference in the chosen decision period, for all signal values except zero (one-tailed KS two-samples tests, 5% significance level except for signal value zero, 10% significance level). For the signal 0, the distributions of terminal actions are over a larger number of periods in the low cost treatment than in the high cost treatment, which is roughly in accordance with the equilibrium prediction.

Figure 7 and Figure 8 in Appendix 5 show the leaders' terminal decision period related to the signal value, respectively for Treatment 3 and 4. We gathered 320 individual decisions for both Treatment 3 and Treatment 4. No significant differences in the distributions of the leaders choices between the high cost treatment and Treatment 3 were observed (one-tailed KS two-samples tests, 5% significance level). Similarly, no significant differences in the distributions of the leaders choices

[15]Similarly to the χ^2 test, the Kolmogorov-Smirnov one-sample test is a goodness-of-fit test. It compares the null hypothesis that there is no difference between the observed cumulative frequency distribution and a theoretical cumulative frequency distribution, with an alternative hypothesis that there is a difference. The theoretical distribution with which our observed distributions for signal absolute values equal to 3 and 4 are compared concentrates all his mass frequency in period 1.

between the high cost treatment and Treatment 4 were observed (one-tailed KS two-samples tests, 5% significance level). Hence, *neither the matching rule nor the payoff scheme seems to have any influence on the leaders' behavior in the waiting game.*

Though, with respect to the equilibrium strategy, leaders' behavior exhibit impatience, potential leaders' behavior exhibit excessive delay. A player is a potential leader in period n, if n is his optimal decision period and if up to period n he has observed a sequence of "W". Therefore, a player who holds signal 4 in absolute value is a potential leader in period 1, a player who holds signal 3 in absolute value is a potential leader in period 2 if he observed the other waited too, and so on. Note that by this definition a subject can be in a position of potential leader even if he is the least informed, in case there is excess waiting by the other subject. Over all treatments, we observe only 26 cases for which a subject who is in a position of potential leader does not take a terminal action in the predicted period. In 11 of these cases the subjects have the same signal quality and are both in the position of potential leader, but one of them acts as an imitator, in some cases with excessive delay. The lack of simultaneity in these cases may be a coordination failure. Except for two cases where there is more than one period delay, cases of matching signal quality exhibit only a single period of delay. 13 cases correspond to situations where the subject with the highest signal quality waits too much periods, so that the other player becomes a leader. Finally, in 2 cases the least informed subject becomes also potential leader because of excess waiting by the better informed subject. It is striking that in 6 of the cases with equal signal quality, both subjects have extreme signals and therefore should have decided upon a terminal action in period 1. Overall we observe that potential leaders fail to act in the predicted way when they hold rather signal values below or equal 2 in absolute value (15 cases).

Predictive success of the equilibrium

In this section we examine the predictive abilities of selected strategies compared to the threshold strategy (also called strategy of perfect identification and shortly noted 4/3/2/1).[16] In this respect, we compute a measure of predictive success for 57 strategies that could possibly account for the observed behavior of our subjects in the high cost treatment.[17] Similarly, we compute a measure of predictive success for 64 strategies that could possibly account for the observed behavior of our subjects in the low cost treatment. Since the ordering and the imitation predictions are clearly well satisfied by our experimental data, all the strategies that we select as possible candidates for organizing the data include ordering and imitation. I.e., a higher-informative signal does not lead to take a terminal decision later than a less informative signal, and the observation of a terminal decision leads to adopting the same terminal action in the next period.[18] In the following lines we first explain how we apply the measure of predictive success to our data, then we justify our selection of strategies, and finally we report on the predictive success of the selected strategies (as we use the same selection process in both treatments, we only justify our choices for the high cost treatment).

To evaluate the predictive abilities of selected strategies we apply Selten and Krischker's (1983) measure of predictive success, which trades off the predictive parsimony of a theory against its descriptive power (see also Selten (1991)). The measure of predictive success (S) is the difference between the *hit rate* h and the *area* a ($S = h - a$), where the *hit rate* is the relative frequency of correct predictions and the *area* is the relative size of the predicted subset compared to the set of all possible outcomes. Roughly speaking, an impatient strategy, i.e., a strategy which induces all decisions to be in the first periods, has a low area rate.

Almost all of the strategies we have selected are based on two basic reference strategies that we call "*grouping strategy*" and "*delaying strategy*". A *grouping strategy* does not decompose perfectly the signal space. Instead, several signals lead to a terminal action in the same period. For example,

[16] Absolute symbols are omitted in this section.

[17] Qualitatively, we got similar results for Treatments 3 and 4.

[18] Of course, imitation only occurs if a terminal action has not already been taken and the round is not over.

43/2/1 means that signal values 4 and 3 lead to a terminal action in period 1, signal value 2 leads to a terminal action in period 2 and signal value 1 leads to a terminal action in period 3. 4321 is the extreme case of a grouping strategy that consists in following only one's own information, i.e., investing in option $O^{(+)}$ if the signal value is positive and investing in option $O^{(-)}$ if the signal value is negative. On the contrary, a *delaying strategy* implies more delay than predicted by the equilibrium strategy 4/3/2/1 that lasts at most four periods. Since apparently our subjects seemed to be impatient, the major part of the strategies considered have only a one period delay with respect to the equilibrium strategy. Notice however that delay may be present even if subjects are apparently impatient. For example, a subject who holds signal value 2, and who should take terminal action $O^{(+)}$ in period 3 according to the equilibrium strategy, may do so with another strategy. He may for example adopt strategy 43/-/21, meaning that he groups signal values 4 and 3 in period 1, waits in period 2 if his signal value is less than 3 and takes a terminal action in period 3 if he has a signal value equal to 1 or 2 (and similarly for negative values). This strategy has the same prediction than the equilibrium strategy for signal value 2, although the player his generally more impatient. We consider a set of 7 grouping strategies, $G = \{43/2/1,\ 432/1,\ 4321,\ 4/3/21,\ 4/321,\ 43/21,\ 4/32/1\}$, and a set of 4 delaying strategies having a one period additional delay $D1 = \{\text{-}/4/3/2/1,\ 4/\text{-}/3/2/1,\ 4/3/\text{-}/2/1,\ 4/3/2/\text{-}/1\}$. The other strategies we consider are constructed by combining a grouping strategy and a delaying strategy. We call them "*hybrid strategies*". The set of *hybrid strategies* is constructed step by step. We first take each grouping strategy in the set G, and we combine it with a one period-delay. For each grouping strategy we obtain therefore two or three hybrid strategies. Then we take the best ranked hybrid strategies with a one period-delay and we derive hybrid strategies with two periods-delay. Again, we take the best ranked hybrid strategies with two periods-delay and we derive hybrid strategies with three periods-delay. Finally, we also consider the following hybrid strategy with four periods-delay: 43/-/-/-/-/21.

We test also a "naïve" strategy which consists in being always a follower, i.e., always imitating. To sum up, the 57 strategies that we test are: 7 grouping strategies, 4 one period-delaying strategies, 6 two periods-delaying strategies, 38 hybrid strategies, the optimal threshold strategy and the follower strategy.

In order to rank the different strategies we compute an average measure of predictive success in the following way. First, we compute for each subject individually a measure of predictive success for each of the selected strategies. This is obtained by computing the average hit rate over the 20 periods and the average area rate conditional on the observed signals, and taking the difference. The selected strategies are then ranked, for each subject individually, according to this measure of predictive success. We aggregate over the sample of subjects this measure of predictive success to rank the selected strategies over our pool of subjects. Table 3 and Table 4 show the ranking, according to the measure of predictive success, of part of the tested strategies respectively for the high and low cost treatment (the complete ranking is given in Appendix 3). Recall that all selected strategies include ordering and imitation. Hence, in many rounds, two "close" strategies will make the same prediction. In this respect, we report the percentage of decrease for the measure of predictive success when moving from one ranked strategy to the one ranked below. More than the value of the measure of predictive success itself one should rely on this percentage to distinguish between strategies which perform well.

Strategies which do particularly well in both treatments group signal values 4 and 3.[19] Indeed, all the selected strategies which group high-informative signals outperform to a large extent the equilibrium strategy which ranks 21 and 31 respectively in the high and the low cost treatment. Thus, when endowed with high-informative but not extreme signals, subjects' decisions exhibit impatience and they are not influenced by the cost of the delay. However, by considering the four best strategies in each reference treatment, signal value 2 induces terminal decision in period 2 for the high cost treatment whereas it induces terminal decision only in period 4 for the low cost treatment. This

[19] We already pointed out in our preliminary analysis that subjects often take a terminal action in period 1 when their signal value is 3 (see Figure 3 and Figure 4).

Strategy	Measure of Predictive Success (S)	Rank	Percentage of decrease	Cumulative percentage of decrease
43/2/-/-/-/1	0.553630218	1		
43/2/-/-/1	0.553630218	2	0.00%	
43/2/-/1	0.553453851	3	0.03%	0.03%
43/2/1	0.552572016	4	0.16%	0.19%
43/-/2/-/-/1	0.548074662	5	0.81%	1.01%
43/-/2/-/1	0.548074662	6	0.00%	1.01%
43/-/2/1	0.547898295	7	0.03%	1.04%
43/-/21	0.547016461	8	0.16%	1.20%
43/-/-/-/2/1	0.535435038	9	2.12%	3.32%
43/-/-/-/21	0.535435038	10	0.00%	3.32%
43/-/-/-/-/21	0.531863610	11	0.67%	3.98%
43/-/-/2/1	0.531716637	12	0.03%	4.01%
43/-/-/2/-/1	0.531716637	13	0.00%	4.01%
43/-/-/21	0.531540270	14	0.03%	4.04%
4/32/-/-/-/1	0.530614345	15	0.17%	4.22%
4/32/-/-/1	0.530614345	16	0.00%	4.22%
4/32/-/1	0.530437978	17	0.03%	4.25%
4/32/1	0.529556143	18	0.17%	4.42%
4/3/2/-/1	0.525058789	19	0.85%	5.27%
4/3/2/-/-/1	0.525058789	20	0.00%	5.27%
4/3/2/1	0.524882422	21	0.03%	5.30%
4/3/21	0.524000588	22	0.17%	5.47%
43/21	0.522545561	23	0.28%	5.75%
4/3/-/-/21	0.512419165	24	1.94%	7.68%
4/3/-/-/2/1	0.512419165	25	0.00%	7.68%
4/3/-/-/-/21	0.508847737	26	0.70%	8.38%
4/3/-/2/1	0.508700764	27	0.03%	8.41%
4/3/-/2/-/1	0.508700764	28	0.00%	8.41%
4/3/-/21	0.508524397	29	0.03%	8.44%
4/321	0.499529688	30	1.77%	10.21%

Table 3: Measure of predictive success for the 30 first ranked selected strategies in the high cost treatment.

shift in observed behavior between our two reference treatments, although it is in contradiction with the equilibrium prediction, is intuitive: the less costly is the waiting option, the more waiting should be observed. Finally, signal value 1 induces terminal action as a leader in an undetermined period (between period 4 and 6 and between period 3 and 6 respectively for the low and the high cost treatment).

4.4 Efficiency

Though the threshold strategy is based on a sophisticated reasoning, it sounds "natural" as possibly being derived from a simple heuristic. It is quite obvious for most people to decide $O^{(+)}$ in period 1

Strategy	Measure of Predictive Success (S)	Rank	Percentage of decrease	Cumulative percentage of decrease
43/-/-/2/-/1	0.541401021	1		
43/-/-/2/1	0.541340055	2	0.01%	
43/-/-/21	0.540997119	3	0.06%	0.07%
43/-/-/2/-/-/1	0.535855630	4	0.95%	1.02%
43/-/-/-/-/21	0.533410620	5	0.46%	1.48%
43/-/-/-/2/1	0.530587121	6	0.53%	2.01%
43/-/-/-/21	0.530526154	7	0.01%	2.02%
43/-/2/-/1	0.528651440	8	0.35%	2.38%
43/-/2/1	0.528308505	9	0.06%	2.44%
43/-/-/-/-/2/1	0.527865230	10	0.08%	2.52%
43/-/-/-/2/-/1	0.525041726	11	0.53%	3.06%
43/-/21	0.524296159	12	0.14%	3.20%
43/-/2/-/-/-/1	0.523167010	13	0.22%	3.42%
43/-/2/-/-/1	0.523156851	14	0.00%	3.42%
43/2/-/-/1	0.522375720	15	0.15%	3.57%
43/2/-/1	0.522032784	16	0.07%	3.63%
43/2/1	0.518020439	17	0.77%	4.40%
43/2/-/-/-/-/1	0.516891290	18	0.22%	4.62%
43/2/-/-/-/1	0.516881131	19	0.00%	4.62%
43/21	0.486641838	20	5.85%	10.47%
4/3/-/2/1	0.477142524	21	1.95%	12.42%
4/3/-/21	0.476799588	22	0.07%	12.50%
4/3/-/2/-/1	0.471647935	23	1.08%	13.58%
4/-/-/32/1	0.468054732	24	0.76%	14.34%
4/-/-/321	0.467711797	25	0.07%	14.41%
4/3/-/-/21	0.466328623	26	0.30%	14.71%
4/3/-/-/2/1	0.466092379	27	0.05%	14.76%
4/3/2/-/-/1	0.464514876	28	0.34%	15.10%
4/3/2/-/1	0.464453909	29	0.01%	15.11%
4/-/3/2/1	0.464179561	30	0.06%	15.17%
4/3/2/1	0.464110974	31	0.01%	15.18%

Table 4: Measure of predictive success for the 31 first ranked selected strategies in the low cost treatment.

if their signal value is 4 (almost 100% of the subjects' decisions were in agreement with the threshold strategy when endowed with the highest signal in absolute value). Similarly, it is also quite obvious in period 4, if no investment has been observed, when endowed with signal value 1 to decide $O^{(+)}$. Indeed, the potential loss is small and the other subject certainly has a very low signal value too. Finally, having decided for the extreme signal values, it may seem natural to affect signal value 3 to period 2 and signal value 2 to period 3. If the threshold strategy is so "natural" why is it not able to predict the individual decisions made by subjects all throughout the game?

In fact, if the subjects' concern was efficiency (which we think was definitely the case) it is not surprising that their decisions were not totally in agreement with the theoretical predictions.

The process of information revelation is highly time consuming in the waiting game and it leads to large costs of delay. We interpret the subjects' deviations from the equilibrium play as an attempt to internalize the information externality. Two arguments can be put forward. First, over both treatments, the observed efficiency is shortly below the theoretical one (less than 5% difference and not significant at the 5 percent level by applying a χ^2 test). Second, and more importantly, if two players adopt the grouping strategy 43/2/1 then they get higher payoffs than theoretical ones (about 20% above). As the grouping strategy 43/2/1 was higher ranked in terms of predictive success in both treatments than the threshold strategy, our conclusion is: subjects' decisions exhibited impatience because it was efficient to do so.

5 Conclusion

In this paper, we present experimental results on a two-person game where both privately informed agents can delay their investment opportunity in the presence of waiting costs. The unique perfect Bayesian Nash equilibrium of the game is characterized by complete revelation of information which implies efficient imitation. These two traits of the equilibrium, called ordering and imitation hypothesis, are tested through the implementation of treatments with different costs of delay. We build a treatment with a high opportunity cost of waiting and an another treatment with a low opportunity cost of waiting. However, whatever the cost level considered, equilibrium strategies are the same in both parametric versions of the game. Overall, the compatibility rates for the two traits of the equilibrium are quite high. A bit more than two third of the subjects' decisions are in accordance with the ordering hypothesis in each treatment whereas almost all subjects' decisions exhibit rational imitation. Nevertheless, subjects' decisions only match loosely the equilibrium sequence. "Impatience" is observed when subjects are endowed with extreme signals (absolute signal values equal to 3) and subjects' decisions are also influenced by the cost of delay. We interpret the subjects' deviations from equilibrium play as an attempt to internalize the information externalities in order to reach a more desirable social outcome.

References

Anderson, L., and C. Holt (1997): "Information Cascades in the Laboratory," *American Economic Review*, 87, 847–862.

Banerjee, A. (1992): "A Simple Model of Herd Behavior," *Quarterly Journal of Economics*, 107, 797–818.

Bernheim, D. (1984): "Rationalizable Strategic Behavior," *Econometrica*, 52, 1007–1028.

Bikhchandani, S., D. Hirshleifer, and I. Welch (1992): "A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades," *Journal of Political Economy*, 100, 992–1026.

Chamley, C. (2004): *Rational Herds: Economic Models of Social Learning*. Cambridge University Press.

Chamley, C., and D. Gale (1994): "Information Revelation and Strategic Delay in a Model of Investment," *Econometrica*, 62, 1065–1085.

Duffy, J., and J. Ochs (2005): "Cooperative Behavior and the Frequency of Social Interaction," mimeo, Department of Economics, University of Pittsburgh.

Gale, D. (1996): "What Have we Learned from Social Learning?," *European Economic Review*, 40, 617–628.

Gintis, H., S. Bowles, R. Boyd, and E. Fehr (2005): *Moral Sentiments and Material Interests: The Foundations of Cooperation in Economic Life*. MIT Press, Cambridge.

Gossner, O., and N. Melissas (2004): "Informational Cascades Elicit Private Information," *International Economic Review*, forthcoming.

Gul, F., and R. Lundholm (1995): "Endogenous Timing and the Clustering of Agents' Decisions," *Journal of Political Economy*, 103, 1039–1066.

Lee, I. H. (1993): "On the Convergence of Informational Cascades," *Journal of Economic Theory*, 61, 396–411.

Pearce, D. (1984): "Rationalizable Strategic Behavior and the Problem of Perfection," *Econometrica*, 52, 1029–1050.

Selten, R. (1991): "Properties of a Measure of Predictive Success," *Mathematical Social Sciences*, 21, 153–167.

Selten, R., and S. Krischker (1983): "Comparison of Two Theories for Characteristic Function Experiments," in: R. Tietz, ed., *Aspiration Levels in Bargaining and Economic Decision Making* (Springer Verlag, Berlin and Heidelberg) 259-264.

Sgroi, D. (2003): "The Right Choice at the Right Time: a Herding Experiment in Endogenous Time," *Experimental Economics*, 6, 159–180.

Smith, L., and P. Sorensen (2000): "Pathological Outcomes of Observational Learning," *Econometrica*, 68, 371–398.

Welch, I. (1992): "Sequential Sales, Learning and Cascades," *The Journal of Finance*, 47, 695–732.

Appendix 1: Proof of Proposition 1

We denote by S_i (respectively Σ_i) player i's set of pure (respectively mixed) strategies and an element of Σ_i by σ_i, where $i \in \{1, 2\}$. In the following we first show that the only profile of mixed strategies which has the best response property (see definition below) is such that each player adopts the threshold strategy with probability one. Since the set of rationalizable strategies has the best response property it implies that the threshold strategy is the only rationalizable strategy. Finally, as pure strategies part of a Nash equilibrium are rationalizable, the perfect Bayesian Nash equilibrium we have identified is unique.

Let Δ_i denote a subset of player i's set of mixed strategies, i.e., $\Delta_i \subseteq \Sigma_i$, where $i \in \{1, 2\}$.

Definition. (Δ_1, Δ_2) *has the best response property if* $\forall i \in \{1, 2\}$, $\sigma^i \in \Delta_i$ *implies* $\exists\, \sigma_{-i} \in \Delta_{-i}$ *such that* σ_i *is a best response to* σ_{-i}.

From now on, we assume that (Δ_1, Δ_2) has the best response property. For $i \in \{1, 2\}$, we denote by

$$\Delta_i^p = \{s_i \in S_i \text{ such that } \exists\, \sigma_i \in \Delta_i \text{ which gives a strictly positive probability to } s_i\}$$

player i's set of pure strategies present in Δ_i. The following lemma states that if a player chooses a terminal action in the first period, the chosen investment option should reflect his private signal.

Lemma 1. *If* $s_i^1(\emptyset, m_i) \neq W$ *then a necessary condition for* $s_i \in S_i$ *to be a best response is that* $s_i^1(\emptyset, m_i) = O^{(+)}$ *if* $m_i \geq 0$ *and* $s_i^1(\emptyset, m_i) = O^{(-)}$ *if* $m_i < 0$.

Proof. For a given private signal $m_i \in \mathbf{M}$, $i \in \{1, 2\}$, the difference between player i's expected payoff if he invests in option $O^{(+)}$ in the first period and player i's expected payoff if he invests in option $O^{(-)}$ in the first period is given by $2\,R\,(\Pr(m_1 + m_2 > 0 \mid m_i) - \Pr(m_1 + m_2 < 0 \mid m_i))$. □

Lemma 2. *A necessary condition for $s^i \in S^i$ to be a best response is that $s^i_1(m_i, \emptyset) = s^e_1(m_i, \emptyset)$ for any m_i such that $m_1 \leq \mid m_i \mid \leq m$.*

Proof. For player i, endowed with signal m_i, the expected value of following his private signal in the first period is equal to $\frac{2|m_i|\, R}{2m+1}$. If he waits, he will get information. At best, he can make a perfect choice in period 2 and get an expected value equal to $\frac{2m\,(R-c)}{2m+1}$. The definition of m_1 is such that if $\mid m_i \mid \geq m_1$ then $\frac{2|m_i|\, R}{2m+1} > \frac{2m\,(R-c)}{2m+1}$. □

This condition states that for extreme signals, whatever the strategy of the other player, the information is not worthwhile.

Now we examine the cases where $\mid m_i \mid < m_1$. In this respect, we establish that a necessary condition for a strategy s^i "more impatient" than s^e to be a best response is that it exists a strategy in X^{-i} which is "more impatient" than s^e for even a weaker signal.

Lemma 3. *If $\exists\, m_i \in \mathbf{M}$ such that $\mid m_i \mid < m_1$ and $s^i_1(m_i, \emptyset) \neq W$, a necessary condition for s^i to be in X^i_p is that $\exists\, \sigma^{-i} \in X^{-i}$ and $m_{-i} \in \mathbf{M}$ such that $m_i\, m_{-i} < 0$, $\mid m_{-i} \mid < \mid m_i \mid$ and $\sigma^{-i}(m_{-i}, \emptyset) \neq W$ occurs with a strict positive probability.*

Proof. The proof is by contradiction. Suppose that $\forall\, \sigma^{-i} \in X^{-i}$, $\forall\, m_{-i}$ such that $m_{-i}\, \beta_i < 0$ and $\mid m_{-i} \mid < \mid \beta_i \mid$, we have $\sigma^{-i}(m_{-i}, \emptyset) = W$ with probability 1. For simplicity of notation, let us assume that $\beta_i \geq 0$. Besides, consider s^{i*} such that $s^{i*}(\beta', .) = s^i(\beta', .)$ for $\beta' \neq m_i$ and $s^{i*}(m_i, \emptyset) = W$, $s^{i*}(m_i, T) = T$, $s^{i*}(m_i, \overline{T}) = \overline{T}$, $s^{i*}(m_i, W) = T$. When endowed with signal m_i, player i's expected value by relying on strategy s^i is equal to $\frac{2m_i}{2m+1}R$. We now show that when endowed with signal m_i, player i's expected value by relying on strategy s^{i*} is larger than $\frac{2m_i}{2m+1}R$ whatever the strategy $\sigma^{-i} in X^{-i}$. From Lemmas 1 and 2 and according to our assumption *ad absurdum*,

- if $-m_i < m_{-i} \leq m$, $\sigma^{-i}(m_{-i}, \emptyset) \neq \overline{T}$ with probability 1 and in this case, $s^{i*}(m_{-i}, h_1) = T$ is a correct choice which yields $R - c$,
- if $-m_i = m_{-i}$, s^{i*} yields 0,
- if $-m_1 < m_{-i} < -m_i$, $\sigma^{-i}(m_{-i}, \emptyset) \neq T$ with probability 1 and $s^{i*}(m_{-i}, h_1)$ can be an incorrect choice,
- if $-m \leq m_{-i} \leq -m_1$, $\sigma^{-i}(m_{-i}, \emptyset) = \overline{T}$ with probability one and $s^{i*}(m_{-i}, h_1) = \overline{T}$ is a correct choice which yields $R - c$.

Hence, at worst, when endowed with signal m_i and by relying on strategy s^{i*}, player i's expected value is equal to $(\Pr(-m_i < m_{-i} \leq m) + \Pr(-m \leq m_{-i} \leq -m_1) - \Pr(-m_1 < m_{-i} < -m_i))(R - c)$ $= \dfrac{2m_i + 2(m - m_1) + 2}{2m + 1}(R - c)$. Consider the two linear functions $f(m_i) = \dfrac{2m_i\, R}{2m + 1}$ and $f^*(m_i) = \dfrac{2m_i + 2(m - m_1) + 2}{2m + 1}(R - c)$. As $f^*(0) \geq f(0)$ and by definition of m_1 $f^*(m_1 - 1) \geq f(m_1 - 1)$, for all $0 \leq m_i \leq m_1$ we can establish that $f^*(m_i) \geq f(m_i)$. In conclusion, we were able to show up a strategy s^{i*} which is a better response than s^i whatever the strategy $\sigma^{-i} \in X^{-i}$, a contradiction. □

Lemma 4. $\forall\, s^i \in X^i_p, \forall\, m_i, s^i(m_i, \emptyset) = s^e(m_i, \emptyset)$.

Proof. From Lemma 3, if s^i is such that $\exists\, m_i$ such that $\mid m_i \mid < m_1$ and $s^i(m_i, \emptyset) \neq W$ then for s^i to be in X^i_p it must exists s^{-i} in X^{-i}_p and $\mid \beta' \mid < \mid m_i \mid$ such that $s^i(\beta', \emptyset) \neq W$. But for s^{-i} to be in X^{-i}_p it must exists $s^{i'}$ in X^i_p and $\mid \beta'' \mid < \mid m_i \mid$, such that $s^i(\beta'', \emptyset) \neq W$. Since the number of signals is finite, an infinite regression is impossible. □

Lemma 5. $\forall s^i \in X_p^i$, $\forall m_i$, $s^i(m_i, T) = s^e(m_i, T) = T$ *and* $s^i(m_i, \overline{T}) = s^e(m_i, \overline{T}) = \overline{T}$.

Proof. We need only consider the case where $| m_i |< m_1$ and $s^i(m_i, \emptyset) = W$. Since the observation of $O^{(+)}$ (respectively $O^{(-)}$) reveals that $m_{-i} \geq m_1$ (respectively $m_{-i} \leq -m_1$), $s^i(m_i, T) = T$ (respectively $s^i(m_i, \overline{T}) = \overline{T}$) are dominant choices. □

The proof goes on by examining the case where $| m_i |< m_1$, $s^i(m_i, \emptyset) = W$ and $h_1 = W$. This implies that $(m_i, m_{-i}) \in \{-m_1 + 1, , \ldots, , m_1 - 1\}^2$. In other words, in period 2, the situation is similar to the situation just described in period 1 except with a new set of signals and a first level of outcome now equals to $R - c$. Hence, we can immediately see from Lemma 1 to Lemma 5 that: $\forall s^i \in X_p^i$, $\forall m_i$, $s^i(m_i, h_1) = s^e(m_i, h_1)$, $s^i(m_i, \{W, T\}) = s^e(m_i, \{W, T\}) = T$ and $s^i(m_i, \{W, \overline{T}\}) = s^e(m_i, \{W, \overline{T}\}) = \overline{T}$. The same reasoning applies for the rest of the periods.

Appendix 2: Descriptive Statistics for the Additional Treatments

	Simultaneous terminal choices	Correct ordering	Incorrect ordering
Identical signals (in absolute value)	0.53	—	—
Different signals (in absolute value)	0.27	0.66	0.07

Table 5: Compatibility of observed choice sequences with the ordering prediction in Treatment 3.

	Simultaneous terminal choices	Correct ordering	Incorrect ordering
Identical signals (in absolute value)	0.40	—	—
Different signals (in absolute value)	0.20	0.67	0.13

Table 6: Compatibility of observed choice sequences with the ordering prediction in Treatment 4.

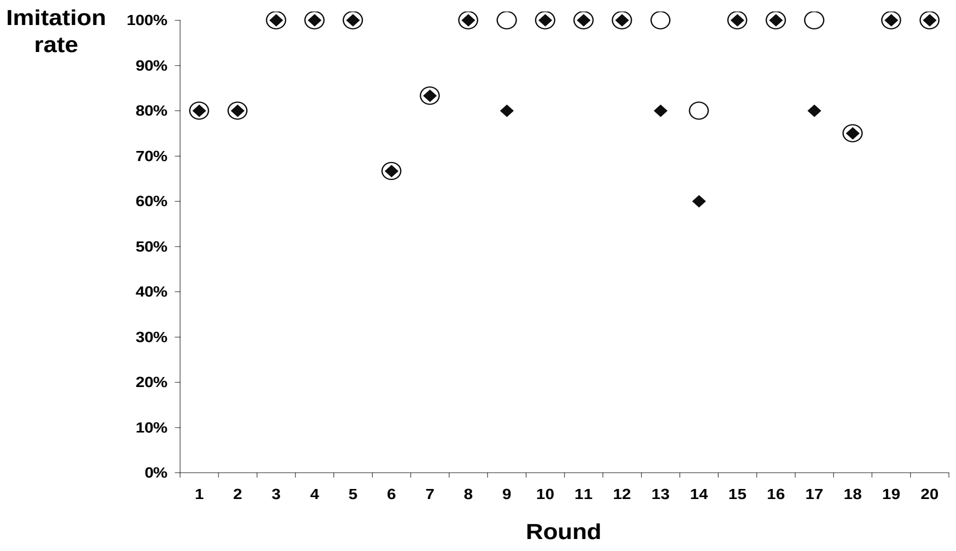


Figure 5: Imitation rate (○) and immediate imitation rate (♦) in Treatment 3.

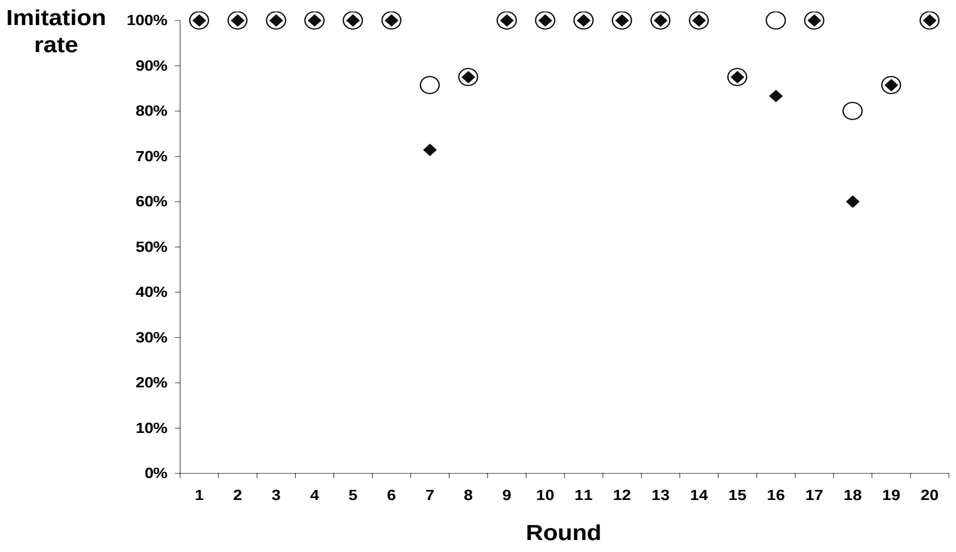


Figure 6: Imitation rate (○) and immediate imitation rate (♦) in Treatment 4.

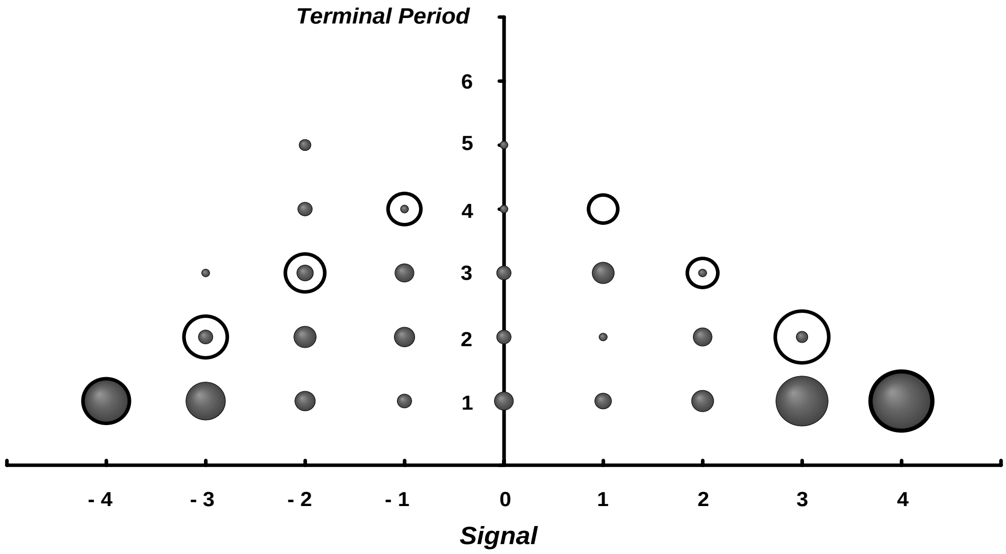


Figure 7: Leaders' terminal decision period related to the signal value for Treatment 3 (212 observations).

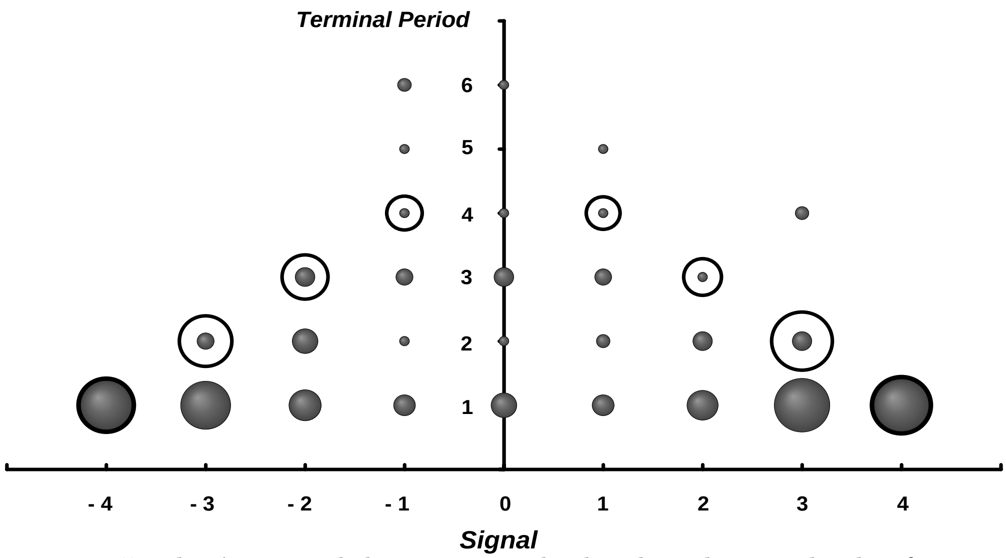


Figure 8: Leaders' terminal decision period related to the signal value for Treatment 4 (199 observations).

Appendix 3: Measure of Predictive Success in the High and Low Cost Treatment

Strategy	Measure of Predictive Success	Rank	Percentage of decrease	Cumulative percentage of decrease	Number of periods
43/2/-/-/-/1	0.553630218	1			6
43/2/-/-/1	0.553630218	2	0.00%		5
43/2/-/1	0.553453851	3	0.03%	0.03%	4
43/2/1	0.552572016	4	0.16%	0.19%	3
43/-/2/-/-/1	0.548074662	5	0.81%	1.01%	6
43/-/2/-/1	0.548074662	6	0.00%	1.01%	5
43/-/2/1	0.547898295	7	0.03%	1.04%	4
43/-/21	0.547016461	8	0.16%	1.20%	3
43/-/-/-/2/1	0.535435038	9	2.12%	3.32%	6
43/-/-/-/21	0.535435038	10	0.00%	3.32%	5
43/-/-/-/-/21	0.531863610	11	0.67%	3.98%	6
43/-/-/2/1	0.531716637	12	0.03%	4.01%	5
43/-/-/2/-/1	0.531716637	13	0.00%	4.01%	6
43/-/-/21	0.531540270	14	0.03%	4.04%	4
4/32/-/-/-/1	0.530614345	15	0.17%	4.22%	6
4/32/-/-/1	0.530614345	16	0.00%	4.22%	5
4/32/-/1	0.530437978	17	0.03%	4.25%	4
4/32/1	0.529556143	18	0.17%	4.42%	3
4/3/2/-/1	0.525058789	19	0.85%	5.27%	5
4/3/2/-/-/1	0.525058789	20	0.00%	5.27%	6
4/3/2/1	0.524882422	21	0.03%	5.30%	4
4/3/21	0.524000588	22	0.17%	5.47%	3
43/21	0.522545561	23	0.28%	5.75%	2
4/3/-/-/21	0.512419165	24	1.94%	7.68%	5
4/3/-/-/2/1	0.512419165	25	0.00%	7.68%	6
4/3/-/-/-/21	0.508847737	26	0.70%	8.38%	6
4/3/-/2/1	0.508700764	27	0.03%	8.41%	5
4/3/-/2/-/1	0.508700764	28	0.00%	8.41%	6
4/3/-/21	0.508524397	29	0.03%	8.44%	4
4/321	0.499529688	30	1.77%	10.21%	2
4/-/32/-/1	0.495429159	31	0.82%	11.03%	5
4/-/32/1	0.495252792	32	0.04%	11.07%	4
4/-/321	0.494370958	33	0.18%	11.25%	3
4/-/-/3/21	0.483318636	34	2.24%	13.48%	5
4/-/-/3/2/1	0.483201058	35	0.02%	13.51%	6
4/-/3/-/21	0.482789536	36	0.09%	13.59%	5
4/-/3/-/2/1	0.482319224	37	0.10%	13.69%	6
4/-/-/32/1	0.479600235	38	0.56%	14.25%	5
4/-/-/321	0.479512052	39	0.02%	14.27%	4
4/-/3/2/1	0.479071135	40	0.09%	14.36%	5
4/-/3/2/-/1	0.479071135	41	0.00%	14.36%	6
4/-/3/21	0.478894768	42	0.04%	14.40%	4
432/-/-/1	0.434009406	43	9.37%	23.77%	4
432/-/1	0.433127572	44	0.20%	23.98%	3
432/1	0.403101117	45	6.93%	30.91%	2
-/432/-/1	0.339168136	46	15.86%	46.77%	4
-/432/1	0.338286302	47	0.26%	47.03%	3
-/43/2/1	0.333612581	48	1.38%	48.41%	4
-/43/21	0.332730747	49	0.26%	48.68%	3
4321	0.317386831	50	4.61%	53.29%	1
-/-/432/1	0.316416814	51	0.31%	53.59%	4
-/4321	0.308259847	52	2.58%	56.17%	2
-/4/32/1	0.303982951	53	1.39%	57.56%	4
-/4/321	0.303101117	54	0.29%	57.85%	3
Follower	0.300705467	55	0.79%	58.64%	
-/4/3/2/1	0.287801293	56	4.29%	62.93%	5
-/4/3/21	0.287624927	57	0.06%	62.99%	4

Table 7: Ranking and measure of predictive success for the selected strategies in the high cost treatment.

Strategy	Measure of Predictive Success	Rank	Percentage of decrease	Cumulative percentage of decrease	Number of periods
43/-/-/2/-/1	0.541401021	1			6
43/-/-/2/1	0.541340055	2	0.01%		5
43/-/-/21	0.540997119	3	0.06%	0.07%	4
43/-/-/2/-/-/1	0.535855630	4	0.95%	1.02%	7
43/-/-/-/-/21	0.533410620	5	0.46%	1.48%	6
43/-/-/-/2/1	0.530587121	6	0.53%	2.01%	6
43/-/-/-/21	0.530526154	7	0.01%	2.02%	5
43/-/2/-/1	0.528651440	8	0.35%	2.38%	5
43/-/2/1	0.528308505	9	0.06%	2.44%	4
43/-/-/-/-/2/1	0.527865230	10	0.08%	2.52%	7
43/-/-/-/2/-/1	0.525041726	11	0.53%	3.06%	7
43/-/21	0.524296159	12	0.14%	3.20%	3
43/-/2/-/-/-/1	0.523167010	13	0.22%	3.42%	7
43/-/2/-/-/1	0.523156851	14	0.00%	3.42%	6
43/2/-/-/1	0.522375720	15	0.15%	3.57%	5
43/2/-/1	0.522032784	16	0.07%	3.63%	4
43/2/1	0.518020439	17	0.77%	4.40%	3
43/2/-/-/-/-/1	0.516891290	18	0.22%	4.62%	7
43/2/-/-/-/1	0.516881131	19	0.00%	4.62%	6
43/21	0.486641838	20	5.85%	10.47%	2
4/3/-/2/1	0.477142524	21	1.95%	12.42%	5
4/3/-/21	0.476799588	22	0.07%	12.50%	4
4/3/-/2/-/1	0.471647935	23	1.08%	13.58%	6
4/-/-/32/1	0.468054732	24	0.76%	14.34%	5
4/-/-/321	0.467711797	25	0.07%	14.41%	4
4/3/-/-/21	0.466328623	26	0.30%	14.71%	5
4/3/-/-/2/1	0.466092379	27	0.05%	14.76%	6
4/3/2/-/-/1	0.464514876	28	0.34%	15.10%	6
4/3/2/-/1	0.464453909	29	0.01%	15.11%	5
4/-/3/2/1	0.464179561	30	0.06%	15.17%	5
4/3/2/1	0.464110974	31	0.01%	15.18%	4
4/-/3/21	0.463836625	32	0.06%	15.24%	4
4/3/21	0.460098628	33	0.81%	16.05%	3
4/-/3/2/-/1	0.458684972	34	0.31%	16.36%	6
4/32/-/-/1	0.458178189	35	0.11%	16.47%	5
4/32/-/1	0.457835254	36	0.07%	16.54%	4
4/-/-/3/2/1	0.457301798	37	0.12%	16.66%	6
4/-/-/3/21	0.457240832	38	0.01%	16.67%	5
4/32/1	0.453822908	39	0.75%	17.42%	3
4/-/3/-/21	0.453365661	40	0.10%	17.52%	5
4/-/-/-/32/1	0.451837692	41	0.34%	17.86%	6
4/-/-/-/321	0.451776726	42	0.01%	17.87%	5
4/-/32/-/1	0.451490946	43	0.06%	17.93%	5
4/-/32/1	0.451148011	44	0.08%	18.01%	4
4/-/3/-/2/1	0.447871071	45	0.73%	18.74%	6
4/-/321	0.447135665	46	0.16%	18.90%	3
432/-/-/1	0.443020439	47	0.92%	19.82%	4
432/-/1	0.439008093	48	0.91%	20.73%	3
4/321	0.422444307	49	3.77%	24.50%	2
432/1	0.407629492	50	3.51%	28.01%	2
-/4/3/2/1	0.315414129	51	22.62%	50.63%	5
-/43/2/1	0.315345542	52	0.02%	50.65%	4
-/4/3/21	0.315071193	53	0.09%	50.74%	4
-/-/4/3/2/1	0.312651593	54	0.77%	51.50%	6
-/43/21	0.311333196	55	0.42%	51.93%	3
-/4/3/2/-/1	0.309919540	56	0.45%	52.38%	6
-/432/1	0.305057476	57	1.57%	53.95%	3
-/4/-/3/2/1	0.302980811	58	0.68%	54.63%	6
-/4/32/1	0.302382579	59	0.20%	54.83%	4
Follower	0.300146065	60	0.74%	55.57%	
-/4/3/-/2/1	0.299105639	61	0.35%	55.91%	6
-/4/321	0.298370233	62	0.25%	56.16%	3
4321	0.275222085	63	7.76%	63.92%	1
-/4321	0.273678875	64	0.56%	64.48%	2

Table 8: Ranking and measure of predictive success for the selected strategies in the low cost treatment.