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Ignorance is bliss: a game of regret*

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Abstract

Existing models of regret aversion assume that individuals can make an ex-post comparison between their choice and a foregone alternative. Yet in many situations such a comparison can be made only if someone else chose the alternative option. We develop a model where regret-averse agents must decide between the status quo and a new risky option that outperforms the status quo in expectation, and learn the outcome of the risky option, if unchosen, with a probability that depends on the choices of others. This turns what was previously a series of single-person decision problems into a coordination game. Most notably, regret can facilitate coordination on the status quo – an action that would not be observed if the agents were acting in isolation or had standard preferences. We experimentally test the model and find that regret-averse agents behave as predicted by our theory.

JEL codes: C72; C92; D81: D91.

Keywords: regret aversion; coordination games; information.

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1 Introduction

Economists model regret as the utility loss experienced from comparing a choice made - that turned out to be suboptimal - to a foregone alternative.[1] This implies that it is always possible for a decision maker to make an ex-post comparison between the choice and the foregone alternative. Yet in many situations, ranging from technology adoption (Ryan and Gross, 1943) to ordering food in a restaurant (Ariely and Levav, 2000), the decision maker can only make an ex-post comparison if someone else chose an alternative option.

In this paper, we introduce and experimentally test a model of regret aversion with this property. In our model, regret-averse individuals must decide between a risk-free status quo and a new and risky option (that will yield either more or less than the status quo, but outperforms the status quo in expectation). The key and novel feature is that they find out about the outcome of the risky option, if unchosen, with a probability that is a function of the choices of others. This simple assumption turns what was previously considered a series of single-person decision problems into a multi-player game where regret can facilitate coordination on an action that would not be observed if agents were acting in isolation or had standard preferences. In fact, if individuals were risk-neutral expected utility maximisers, they would choose the risky option. If individuals were regret averse and always able to compare their choice with the unchosen alternative, as assumed in existing regret-aversion models, they would all choose the risky option. However, when, as in our model, regret-averse individuals find out the outcome of alternative choices depending on the choices of others, there are two pure-strategy equilibria: one in which everybody chooses the status quo, and another in which everybody chooses the risky option. Coordinating on the status quo can be an equilibrium for regret-averse individuals because it insures them against anticipated regret, as none will ever find out whether the realization of the risky option was indeed better than the status quo.

To make things concrete, consider the example of technology adoption. Suppose that all the farmers in a population are currently using an existing technology, whose benefits are well known, and must decide between sticking with it or adopting a new technology. The new technology is risky, but its expected productivity is higher than

[1] See Sarver (2008) for an axiomatic treatment of regret preferences.

that of the existing technology. If the farmers are regret averse and learn the outcome of the new technology, if unchosen, with a probability that depends on the fraction of other farmers adopting it, then uniform non-adoption can be an equilibrium. The reason is that sticking with the old technology provides insurance against regret: it protects the farmer from ever learning whether the new technology was successful or not. Consequently, the new technology has to be significantly better in the case of regret aversion in order to ensure uniform adoption.

We test the predictions of a two-player variant of our model through a lab experiment. In the core part of the experiment, participants must decide between a sure amount of money and a lottery. If they do not choose the lottery, they will learn its outcome only if their partner chose the lottery. Hence, by choosing the lottery participants will experience regret if the lottery is unsuccessful, whereas by choosing the sure amount they will experience regret only if the lottery is successful *and* they learn about it. If they do not receive information, they can avoid regret.

Before playing the two-player regret game, we elicit the *smallest payoff such that each participant would choose the lottery* (henceforth referred to as *lottery threshold*) in two different scenarios. In the *information scenario* participants learn the outcome of the lottery even if they do not play it. In the *no information scenario* participants do not learn the outcome of the lottery unless they play it. The individual-specific lottery thresholds thus elicited serve two key purposes in our experiment. First, they allow us to classify participants into types. Participants who choose a higher lottery threshold in the no information scenario than in the information scenario are classified as regret averse, participants who choose the same lottery threshold in either scenario are classified as regret neutral and participants who choose a higher lottery threshold in the information scenario than in the no information scenario are classified as information lovers.[2] In our sample 22% of the participants are classified as regret averse, 50% as regret neutral and the remaining participants as information lovers.

Second, the lottery thresholds allow us to calibrate the lottery's payoffs in the core part of our experiment, so that each participant, despite potential heterogeneity in preferences,[3] faces the same decision problem. Namely, we want each participant to play

[2]The sure amount is *more* appealing to regret-averse individuals in the no information scenario than in the information scenario, as it allows them to remain ignorant and avoid regret. It is *less* appealing to information lovers, as it prevents them from receiving information.

[3]While our model assumes homogeneous (regret-averse) preferences, in the lab preferences are likely

the regret game when it has a dominant strategy and when it is a game of coordination.

When the regret game has a unique equilibrium in dominant strategies, players will choose it regardless of their beliefs on their partner's behaviour. Consistent with that, our data show that the vast majority of participants[4] choose the lottery when it is a dominant strategy, and the sure amount when it is a dominant strategy. When the regret game is a game of coordination, regret-averse players will choose what they believe their partner to choose and information-loving players will behave in the opposite way. The behaviour of regret-neutral players will not depend on their beliefs on the behaviour of others. In line with this theoretical prediction, the impact of beliefs on choice is significantly positive for regret-averse participants. However, the impact of beliefs on choice is significantly positive also for participants who are not regret averse. This suggests that participants, consistent with recent experimental evidence, exhibit conformist preferences (Charness et al., 2019; Charness et al., 2017).

We elicit the lottery thresholds also in a partner-dependent information scenario: a participant learns the lottery's outcome only if the lottery threshold chosen by his partner resulted in the lottery being the implemented option. In this threshold-based version of the game, regret-averse and information-loving players will choose the same lottery threshold as in the information scenario if they believe that their partner will play the lottery, and the same lottery threshold as in the no information scenario if they believe that their partner will not play the lottery. That is, they will choose a lottery threshold in between the thresholds chosen in the scenarios with and without information. This implies that the chosen threshold in the partner-dependent scenario will be higher (lower) than in the information scenario and lower (higher) than in the no information scenario for regret-averse (information-loving) players. Regret-neutral players will choose the same threshold in the three information scenarios. Our data strongly support these predictions.

Regret has so far been considered only in one-person decision problems, with the notable exception of Filiz-Ozbay and Ozbay (2007), who incorporate anticipated regret into the preferences of agents engaged in a sealed-bid auction. In their paper, a bidder's anticipated regret depends on the bids of others. However, unlike in our paper, their agents *always* find out the outcome of the foregone alternative. Hence, regret cannot

to be heterogeneous.

[4]66% of the regret-averse participants, 82% of the regret-neutral participants and 75% of the informating-loving participants.

be avoided. In our paper, instead, the outcome of the unchosen alternative is revealed *only if* someone else chose it. Hence, the experience of regret is uncertain, and it is such uncertainty that induces regret-averse agents to insure against regret. To the best of our knowledge, ours is the first model of regret aversion where an individual learns the outcome of an unchosen alternative depending on the choices of others, and thus where anticipated regret serves as a coordination device.

While the motivating example we employ is that of technology adoption, the model has potential applicability to any realm of human behaviour where herding behaviour is attributed to collective irrationality. Stock market bubbles are often attributed to individuals herding (Shiller, 2006), but regret could be the main driver here: letting go of a stock too early will be particularly painful if and when you find out how well it performed. When ordering food at a restaurant, regret aversion may compel an individual to order the same dish as his peers so as to avoid regret (Ariely and Levav, 2000), thereby limiting the amount of variety that a group experiences.[5]

The paper is structured as follows. Section 2 presents the model. Section 3 describes the experimental design and Section 4 presents the results. Section 5 concludes and discusses avenues for future research.

2 The model

2.1 Preferences

A risk-neutral decision maker chooses an option $a \in \{0, 1\}$, where 0 means choosing the risk-free status quo (e.g., sticking with an existing technology), and 1 means choosing a new and risky option (e.g., adopting a new technology).[6] In other words, the decision maker chooses between two lotteries, where, for simplicity, one lottery is degenerate. There are two states of the world, ω_1 and ω_2, that occur with probability p and $1-p$ respectively, where $p \in (0, 1)$. Choosing the risky option costs $c > 0$ and the risky option is successful only in state ω_1 wherein it brings benefit θ $(> c)$. If unsuccessful,

[5]If one's peers allow each other to taste their dishes, then you find out how good each dish was and may experience regret. It should be noted that if dishes are cardinally rankable, then loss aversion would have the same effect given that the disutility from ordering a worse dish than a peer, would exceed the utility gain from ordering an equally better dish than another peer.

[6]The assumption of risk-neutrality simplifies, but is not necessary for the analysis.

it yields a payoff normalised to 0 (i.e., the same payoff as the status quo).[7]

Suppose that, if the decision maker learns that his choice was *ex post* suboptimal, he experiences regret – a psychological penalty proportional to the payoff shortfall in the realised state. In existing models of regret aversion, the decision maker acts under the anticipation of experiencing future regret. This implies that he can always learn how the unchosen alternative performed. However, in real life that is not necessarily the case. In many situations the outcome of the unchosen alternative can be learnt only if someone else chose it. To capture this, in our setting the decision maker who sticks to the status quo may experience regret only if he learns whether the risky option was ultimately successful. Let $q \in [0,1]$ be the probability that an agent learns the outcome of the risky option *conditional on having stuck with the status quo*. The decision maker with regret-averse preferences has utility function $U^R(a, \omega, q)$ defined as

$$U^R(0, \omega, q) = \begin{cases} -qk(\theta - c), & \text{if } \omega = \omega_1 \\ 0, & \text{if } \omega = \omega_2 \end{cases} \tag{1}$$

and

$$U^R(1, \omega, q) = \begin{cases} \theta - c, & \text{if } \omega = \omega_1 \\ -c - kc, & \text{if } \omega = \omega_2 \end{cases} \tag{2}$$

where $k \geq 0$ is the coefficient of regret aversion.[8]

Standard preferences Standard preferences are obtained as a special case when $k = 0$, such that the decision maker does not experience regret (regret neutral). Equations (1) and (2) become

$$U^0(0, \omega, q) = \begin{cases} 0, & \text{if } \omega = \omega_1 \\ 0, & \text{if } \omega = \omega_2 \end{cases}$$

and

$$U^0(1, \omega, q) = \begin{cases} \theta - c, & \text{if } \omega = \omega_1 \\ -c, & \text{if } \omega = \omega_2 \end{cases}$$

[7]As further discussed later, the model can be extended to the case in which the decision maker chooses between two risky lotteries, provided that learning the outcome of the chosen lottery does not say anything about the outcome of the other.

[8]Our preference specification here is based on the axiomatic model of Sarver (2008). Following Sarver, the coefficient of regret aversion k is assumed to be state independent.

where $U^0(a, \omega, q)$ denotes the utility function of a decision maker with standard or regret-neutral preferences. Letting $\mathbb{E}_\omega$ denote the expectation operator, a regret-neutral decision maker will choose the risky option if the expected utility from doing so, $\mathbb{E}_\omega[U^0(1, \omega, q)]$, exceeds the expected utility of sticking with the status quo, $\mathbb{E}_\omega[U^0(0, \omega, q)]$. The decision maker follows a threshold rule specifying the choice of the risky option if and only if,

$$\theta \geq \theta^\star = \frac{c}{p}.$$

The threshold rule is independent of q.

Regret-averse preferences When $k > 0$, such that the decision maker is strictly regret averse, the decision maker follows a threshold rule specifying the choice of the risky option if and only if,

$$\theta \geq \theta^{\star\star}(q) = \frac{c}{p}\left(\frac{1 + k\big(1 - p(1-q)\big)}{1 + qk}\right) \tag{3}$$

The threshold rule varies with q. The expression in (3) nests two important cases. If $q = 1$ the decision maker will learn the outcome of the risky option no matter what. Here, there is no distortion to the threshold rule relative to standard preferences, in that,

$$\theta^{\star\star}(q)|_{q=1} = \theta^\star = \frac{c}{p} \tag{4}$$

If $q = 0$ the decision maker knows that he will definitely *not* find out about the outcome of the risky option unless he opts for it. Then (3) becomes,

$$\theta^{\star\star}(q)|_{q=0} = \frac{c}{p}\big(1 + k(1-p)\big) \tag{5}$$

When $k > 0$ and $p < 1$, (5) is a more demanding condition on θ than (4). That is, when a regret-averse decision maker will not find out about the realization of the risky option without choosing it, he requires a higher θ.

The reason for the difference between (4) and (5) is the difference in the power of the status quo as insurance against regret. When $q = 0$, the insurance against regret provided by the risk-free option is at its strongest. There is complete asymmetry in anticipated regret: if the decision maker chooses the risky option, he knows he will be able to make an ex post comparison and feel regret if the new option is not successful, whereas if he sticks to the status quo, he knows he will not be able to make an ex post comparison. Because of the powerful insurance against potential regret offered by the risk-free option, the outcome of the risky option in the event of a success must be high enough to tempt the decision maker away from the security of the risk-free option. Ignorance is bliss. On the other hand, when $q = 1$, the risk-free option offers no insurance against regret. The decision maker knows he will find out the outcome of the risky option whether he chooses it or not. The regret considerations are symmetric and cancel each other out, and the individual's condition is the same as if he were regret neutral.

Finally, suppose $q \in (0, 1)$. Here, $\theta^{\star\star}$ takes values in $\big(\theta^{\star\star}(q)|_{q=1}, \theta^{\star\star}(q)|_{q=0}\big)$ and decreases strictly in q, since for all $q \in (0, 1)$

$$\frac{d\theta^{**}(q)}{dq} = -\frac{c}{p}\frac{k(1+k)(1-p)}{(1+kq)^2} < 0, \tag{6}$$

Intuitively, the benefit that the risky option must yield in order to be chosen becomes lower as q increases due to the possibility of asymmetry in anticipated regret. As the likelihood of making an *ex-post* comparison in the case the risky option is not chosen reduces, the agent is increasingly - from an *ex-ante* perspective - insured against regret. And because of this insurance against potential regret, the threshold on the risky option's outcome must increase to tempt the agent away from the status quo. In other words, we have the following order on the thresholds, $\theta^\star = \theta^{\star\star}(q)|_{q=1} < \theta^{\star\star}(q)|_{q=0}$. For the derivation of the threshold rule (3) and the computation of the derivative (6), see Appendix A.

The model can be extended to the case in which players choose between two risky lotteries. All that is required for our result still to hold is that the outcome of the chosen lottery does not reveal anything about the outcome of the other lottery.

Preferences for information Since evidence shows that individuals are curious (for a review see Loewenstein, 1994) and have preferences for (non-instrumental) information (Falk and Zimmermann, 2016; Masatlioglu et al., 2017), we extend our model to account for that. Preferences for information are relevant in our setting as they can explain why an individual may regard the risky option as *more* appealing in the no information scenario – the opposite of what happens under regret-averse preferences.

A decision maker with preferences for information or information lover gets an additional benefit m when he learns the outcome of the risky option, regardless of what such outcome is. A regret-averse information-loving decision maker has utility function $U^{RI}(a, \omega, q)$ defined as

$$U^{RI}(0, \omega, q) = \begin{cases} -qk(\theta - c) + qm, & \text{if } \omega = \omega_1 \\ qm, & \text{if } \omega = \omega_2 \end{cases} \tag{7}$$

and

$$U^{RI}(1, \omega, q) = \begin{cases} \theta - c + m, & \text{if } \omega = \omega_1 \\ -c - kc + m, & \text{if } \omega = \omega_2 \end{cases} \tag{8}$$

This decision maker follows a threshold rule specifying the choice of the risky option if and only if

$$\theta \geq \tilde{\theta}^{**}(q) = \frac{c}{p}\left(\frac{1 + k\big(1 - p(1-q)\big)}{1 + qk}\right) - \frac{m(1-q)}{p(1+qk)} \tag{9}$$

Note that this is the same as (3), but has an additional and negative term. The threshold rules in the information scenario and no information scenario are:

$$\tilde{\theta}^{**}(q)|_{q=1} = \theta^{\star} = \frac{c}{p}$$

$$\tilde{\theta}^{**}(q)|_{q=0} = \frac{c}{p}\big(1 + k(1-p)\big) - \frac{m}{p}$$

The threshold rule in the information scenario is the same as (4). The threshold rule in the no information scenario is lower than (5). Note that $\tilde{\theta}^{**}(q)|_{q=0} < \tilde{\theta}^{**}(q)|_{q=1}$ if $m > ck(1-p)$. This means that, if the willingness to be informed is sufficiently high relative to the willingness to avoid regret, a decision maker will require a *lower* θ in the no information scenario than in the information scenario. The intuition is the following. An information lover will be more likely to choose the risky option when he would not learn its outcome unless he chose it himself.

For $q \in (0, 1)$,

$$\frac{d\tilde{\theta}^{**}(q)}{dq} = -\frac{c}{p}\frac{k(1+k)(1-p)}{(1+kq)^2} + \frac{m}{p}\frac{(1+k)}{(1+qk)^2}. \tag{10}$$

Equation (10) is positive if $m > ck(1-p)$ and negative (as in (6)) otherwise.

Intuitively, when preferences for information are sufficiently strong to dominate regret aversion, the prize that the risky option must yield to be chosen increases with the probability of being informed: as the probability of learning the outcome of the risky option decreases, the decision maker is more likely to choose the risky option himself - as he gains an additional benefit from such knowledge. When the willingness to avoid regret dominates the willingness to be informed, the opposite occurs: as the probability of learning the outcome of the risky option decreases, the decision maker becomes less likely to choose it, as the status quo can protect him against potential regret. For the derivation of the threshold rule (9) and derivative (10), see Appendix A.

The threshold rule for a regret-neutral information-loving decision maker is obtained as a special case when $k = 0$. This decision maker follows a threshold rule specifying the choice of the risky option if and only if

$$\theta \geq \tilde{\theta}^*(q) = \frac{c - m(1-q)}{p}$$

Then,

$$\tilde{\theta}^*(q)|_{q=1} = \theta^\star = \frac{c}{p}$$

$$\tilde{\theta}^*(q)|_{q=0} = \frac{c}{p} - \frac{m}{p}$$

In the no information scenario, a regret-neutral decision maker with preferences for information requires a *lower* return on the risky option, i.e., regards the risky option as *more* appealing than in the information scenario. The threshold rule $\tilde{\theta}^*(q)$ increases with q, for all $q \in (0, 1)$.

In the next subsection, we extend the setting to one with multiple regret-averse agents, but suppose that q is endogenously determined by the choices of others. More precisely, we assume that q is increasing in the number of other agents who choose the risky option. This turns a series of single-person decision problems into a multi-player game.

2.2 The regret game

2.2.1 The set up

We now imagine that there are multiple decision makers with preferences as defined in (1) and (2). The strategic setting is a symmetric N-player simultaneous-move game given by the $2N$-tuple, $G = (A_1, \ldots, A_N, U_1^R, \ldots, U_N^R)$, where each agent, i, chooses an action a_i from the set $A_i = \{0, 1\}$, and has utility function $U_i^R : \mathbf{A} \times \{\omega_1, \omega_2\} \to \mathbb{R}$, where $\mathbf{A} := \prod_{j \in \mathcal{N}} A_j$, with typical element $\mathbf{a} = (a_1, \ldots, a_N)$ and $j = 1, ..., N$. From player i's perspective a pure action profile $\mathbf{a} \in \mathbf{A}$ can be viewed as $(a_i, \mathbf{a}_{-i})$, so that $(\hat{a}_i, \mathbf{a}_{-i})$ will refer to the profile $(a_1, \ldots, a_{i-1}, \hat{a}_i, a_{i+1}, \ldots, a_N)$, i.e., the action profile $\mathbf{a}$ with $\hat{a}_i$ replacing a_i.

For each state, the utility function of agent i is as defined in (1) and (2) save one difference: q_i depends on the actions of the other agents. More precisely we have that

$$U_i^R\big((0, \mathbf{a}_{-i}), \omega\big) = \begin{cases} -q_i(\mathbf{a})k(\theta - c), & \text{if } \omega = \omega_1 \\ 0, & \text{if } \omega = \omega_2 \end{cases} \tag{11}$$

and

$$U_i^R\big((1, \mathbf{a}_{-i}), \omega\big) = \begin{cases} \theta - c, & \text{if } \omega = \omega_1 \\ -c - kc, & \text{if } \omega = \omega_2 \end{cases} \tag{12}$$

where q_i is defined as

$$q_i(\mathbf{a}) := \frac{\sum_{j \neq i} a_j}{N - 1} \tag{13}$$

The intuition behind the assumption that q_i is increasing in the fraction of agents adopting the risky option is the following. When sticking with the status quo, regret-averse agents will not actively seek information about the risky option. However, the more other agents who choose the risky option, the harder it will be not to learn about its performance. Consider our motivating example of a farmer who chooses not to adopt the new technology. Because he is regret averse, he does not wish to find out how well the technology performed ex post, and thus does not go in search of this information. But the more farmers adopt the new technology, the more people will talk about it, the more the news will report it and the harder it will be for the farmer to avoid the information.

While it seems implausible that the function q_i would be decreasing in the fraction of other agents who choose the risky option, the assumption that the function q_i is linearly increasing from 0 to 1 is made solely for reasons of tractability. For example, letting x denote the fraction of other agents who have chosen the risky option, and abusing notation by writing q as a function of x, one could easily imagine a convex likelihood function, $q(x) = x^2$, or concave likelihood function, $q(x) = \sqrt{x}$. In the former case, the likelihood of finding out when few people choose the risky option is small. The marginal effect of an increase in the proportion of individuals choosing the risky option on q is increasing. This captures a band-wagon effect: the more individuals who choose the risky option, the higher the marginal effect of each of them. The latter case is the opposite. Alternatively, one might consider a step-function where an agent is guaranteed to learn about the risky option's performance once enough others adopt it, $q(x) = 1_{\{x \geq d\}}$, where $1_{\{\}}$ denotes the indicator function and d is the cut-off. For example, one can think that the news may report on a new technology via public radio once it becomes sufficiently popular, and that investors cannot escape the news. Finally, one might imagine that there is always some chance that an agent who chooses the status quo will learn about the risky option, so that $q(x) = \alpha + \beta x$, where $\alpha > 0, \beta \geq 0$ and $\alpha + \beta \leq 1$.

2.3 Results

2.3.1 Equilibria

There are three classes of the regret game, depending upon the parameters. When $\theta < c/p$, it is a dominant choice for each player to stick to the status quo. Thus, the only equilibrium is for each player to choose the status quo. Similarly, when $\theta > \frac{c}{p}(1 + k(1-p))$, the only equilibrium is for each player to choose the risky option. For values of θ in the interval between these two thresholds however, the game is one of coordination, with two equilibria: all players play the risk-free option, and all players play the risky option. This brings us to our main result on the pure-strategy Nash Equilibria.[9]

Theorem 1. *With N regret-averse players, the set of pure-strategy Nash Equilibria is:*

1. $\{(0, \dots, 0)\}$, *when* $\theta < \frac{c}{p}$,

[9]There is also a totally mixed strategy equilibrium but we ignore it as it is very unstable.

2. $\{(1,\ldots,1)\}$*, when* $\theta > \frac{c}{p}(1+k(1-p))$*,*

3. $\{(0,\ldots,0),(1,\ldots,1)\}$*, when* $\theta \in [\frac{c}{p}, \frac{c}{p}(1+k(1-p))]$*.*

Proof. See Appendix A. □

That the only pure-strategy equilibria are symmetric is easily seen by imagining a two-player variant of the game. In a two-player variant of the game, the intuition behind part 3 of Theorem 1 is straightforward: players want to imitate each other. The reason is that the potential benefit of the risky option is not high enough to induce its choice in the case that the other player does not choose it. Similarly, if the other player is choosing the risky option, a player must insure himself against future regret given that he will learn the outcome of the risky option with certainty. For $\theta \in [\frac{c}{p}, \frac{c}{p}(1+k(1-p))]$, the risky option is attractive to the regret-neutral agent, but unattractive to the regret-averse agent, as long as he knows that by sticking to the status quo he can avoid learning the risky option's outcome. An equilibrium in which neither player chooses the risky option and thus neither player learns its outcome, is supported. But if one player chooses the risky option, then the safe option loses its status as a regret-haven: the risky option suddenly appears more attractive to the non-adopting player than the safe option. And so an equilibrium in which both players adopt the risky option is supported. In summary, the setting is a game of pure coordination.

The key feature here is that when a player chooses the risky option, his decision imposes a negative externality on a player who chooses the status quo: it eliminates the regret-haven status of the safe option enjoyed by the player who sticks to the status quo.

Preferences for information As discussed in Section 2.1, when the willingness to be informed dominates the willingness to avoid regret ($m \geq ck(1-p)$), a decision maker will require a lower θ in the no information scenario than in the information scenario. That is, he will be more likely to choose the risky option when he would not learn about its outcome unless he chose the risky option himself. When players hold such preferences, the pure-strategy Nash Equilibria of the game involve anticoordination with their partners, as stated by the following Corollary.

Corollary. *In equilibrium, in a two-player variant of the game, a regret-neutral player* *with $m > 0$ and a regret-averse player with $m \geq ck(1-p)$ will choose the risky option if they believe their partner to choose the sure option and the sure option otherwise.*

The intuition is the following. If an information loving player believes his opponent to choose the safe option, he will choose the risky option, as that is the only way to learn the lottery's outcome. If he believes his opponent to choose the risky option, he will choose the safe option, as he will learn the outcome of the risky option anyways.

2.3.2 Welfare and equilibrium selection

It is interesting to compare the (common) expected utility levels at each equilibrium. When all choose the status quo, from (11) it is clear that each agent has expected utility of 0. When all choose the risky option, (12) implies that each agent has expected utility $p\theta - c - (1-p)kc$. Comparing these two, we get that uniform choice of the risky option is the pareto dominant equilibrium if and only if $\theta \geq \theta^{\star\star}(q)|_{q=0} = \frac{c}{p}\big(1 + k(1-p)\big)$. But this is precisely the productivity threshold at which individuals would always choose the risky option in any case. Thus, for values of θ where there are two equilibria, coordinating on the status-quo is Pareto-dominant and always preferred ex-ante.

In symmetric large-population binary-action games, existing equilibrium selection techniques - be they evolutionary like *stochastic stability* (Kandori et al., 1993; Young, 1993) or higher-order belief-based like *global games* (Carlsson and Damme, 1993; Morris and Shin, 2003) - favour the equilibrium that is most difficult to destabilise. For this reason, it is important to compute the threshold on q, which we denote by $q^\star$, at which action 1 becomes optimal. Simple algebra yields

$$q^\star(\theta, p, c, k) := \frac{1}{k(\theta - c)}\big(\theta^{\star\star}(q)|_{q=0} - \theta\big) \tag{14}$$

When $q^\star \leq 1/2$, the equilibrium where all players choose the risky option is selected, and when $q^\star > 1/2$, the equilibrium where all players choose the safe option is selected.

3 Experimental Design

3.1 Overview

We conducted a lab experiment to test the predictions of a two-player variant of the regret game. In the core part of the experiment (decision 6 and its repetitions), participants must decide between a sure amount of money and playing a lottery. There is an informational asymmetry. The sure amount of money is known regardless of the decision made, whereas if participants choose the status quo, they learn the outcome of the new lottery only if their partner chooses it. This implies that if participants choose the lottery, they will experience regret if the lottery turns out to be unsuccessful, whereas if they choose the status quo, they will experience regret only if the lottery was successful and they learn about it. If they do not learn the lottery's outcome, they will avoid regret.

Before playing the two-player regret game in the core part of the experiment, we elicit the *smallest lottery prize such that each participant would choose the lottery* (henceforth, *lottery threshold*) in two scenarios. In the *information scenario* participants learn the outcome of the lottery even if they do not play it (decision 1), whereas in the *no information scenario* participants do not learn the outcome of the lottery unless they play it (decision 2). That is, in the language of our model decisions 1 and 2 are designed to elicit the thresholds with and without information. These lottery thresholds serve two key purposes in our experiment. First, they allow us to classify participants into types, described in detail in the following subsection. Second, they allow us to choose payoffs in the core part of the experiment, so that, despite potential heterogeneity in thresholds, participants face similar choices. Namely, we want each participant to play the regret game when it has a unique equilibrium in dominant strategies and when it is a game of coordination.

We elicit the lottery thresholds also in a third, partner-dependent information scenario: a participant learns the lottery's outcome only if the lottery threshold chosen by his partner resulted in the lottery being the implemented option. This constitutes a threshold-based version of the regret game.

We used a within-subject design. For all the strategic decisions, (incentivised) first order beliefs were elicited in order to measure participants' attempt to coordinate with their partner. All sessions were run in May 2017 in the experimental laboratory at the University of Bonn. The experiment was programmed and conducted with the software z-Tree (Fishbacher, 2007). A total of 144 subjects participated in the experiment, 56% of whom were female, and most of whom were students.

3.2 Calibrating the lottery thresholds

In the first part of the experiment, i.e. decisions 1, 2 and 3, participants were faced with a sure amount (€5 with certainty) and a risky lottery (€x with 50% probability and €0 with 50% probability). Using a variant of the BDM method (Becker et al., 1964), we elicited their *lottery thresholds*: each participant was asked to state the smallest lottery prize x for which they preferred playing the lottery than receiving the sure amount.[10] They could choose any number from the list $\{5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15\}$. After they had submitted their choice, the computer picked a random number from the same list, independently drawn for each participant. All the numbers were equally likely. If the number picked by the computer was *smaller* than the number x chosen by the participant, the sure amount was the implemented option, i.e. the participant received €5. If the number picked by the computer was *equal or larger than* the number x chosen by the participant, the lottery was the implemented option, i.e. the participant received the number picked by the computer in € with 50% probability and €0 otherwise.[11]

The above setting was identical in decisions 1, 2 and 3. The difference was given by the information provided to the participants who did not play the lottery. The number x was labelled x_1, x_2 and x_3 in decisions 1, 2 and 3 respectively.

Decision 1 *Information ($q = 1$).* Participants were told that, if their choice x_1 resulted in the sure amount being the implemented option, the computer would nevertheless inform them about the lottery's outcome.

Decision 2 *No information ($q = 0$).* Participants were told that, if they chose a number x_2 such that the sure amount was the implemented option, they would not be informed about the lottery's outcome.

[10] Throughout the experiment, we used neutral language. The sure option and the lottery were referred to as "option on the left" and "option on the right" respectively.

[11] Whether the lottery was successful or not was perfectly correlated across participants, but the lottery could potentially yield different prizes to different participants in case of success.

Classification into types Participants who chose a *higher* lottery threshold in the no information scenario (decision 2) than in the information scenario (decision 1), i.e. $x_2 > x_1$, are classified as *regret-averse types*. The sure amount was more appealing to them in the no information scenario than in the information scenario, as it allowed them to remain ignorant about the outcome of the unchosen option and thus avoid regret. As discussed, for these participants the desire to avoid regret dominates the desire to be informed, i.e., $m < ck(1-p)$.

Participants who chose the same lottery threshold in either information scenario, i.e., $x_2 = x_1$, are classified as *regret-neutral types*. The sure option was equally appealing to them regardless of whether it allowed them to avoid information.

Participants who chose a *lower* lottery threshold in the no information scenario (decision 2) than in the information scenario (decision 1), i.e. $x_2 < x_1$ are classified as *information-loving types* or *curious types*. The sure amount was less appealing to them in the no information scenario, as they could not learn the lottery's outcome unless they chose it. For these participants, the preference for information dominates regret aversion, i.e. $m \geq ck(1-p)$.

Decision 3 *Partner-dependent information*. Participants were told that, if their choice x_3 resulted in the sure amount being the implemented option, they would be informed about the lottery's outcome only if their partner played the lottery. Two scenarios were possible: (i) if their partner played the lottery, participants were in the same situation as in decision 1: they learnt the lottery's outcome, (ii) if their partner did not play the lottery, they were in the same situation as in decision 2: they did not learn the lottery's outcome.

As further discussed in Subsection 3.5, in this threshold-based version of the game, regret-averse and information-loving participants should choose the same lottery threshold as in decision 1 if they expect to learn the lottery's outcome and the same lottery threshold as in decision 2 if they expect not to learn the lottery's outcome. Participants classified as regret-neutral should choose the same lottery threshold in all three information scenarios, regardless of their beliefs.

Matching Before reaching decision 3, participants were informed that, before each of the following four decisions, they would be randomly assigned to another participant, each time a new one, whose identity would always remain anonymous. As we used matching groups of size 4 to increase the number of independent observations, each participant was also told that there were 3 potential participants that could be randomly assigned to him.

Feedback After each of the first three decisions, participants learnt the number randomly picked by the computer, and thus whether the implemented option was the lottery or the sure amount. In the latter case, the information provided varied across decisions as described above.

3.3 Regret game

In the second part of the experiment (decision 4 onwards), participants played the regret game described in Section 2. They had to decide between the sure amount (earning €5 with certainty) and a lottery (earning "an amount" in € with 50% probability and €0 with 50% probability). Unlike the previous part of the experiment, the lottery's outcome in case of success was given: it was calibrated using the lottery thresholds elicited in decisions 1 and 2. If participants chose the sure amount, they learnt the lottery's outcome only if their partner chose the lottery. This setting is identical in all the decisions in the second part of the experiment. The distinctive feature was given by the amount the lottery yielded if successful, as described in what follows.

Decision 4 The lottery's payoff in case of success was *smaller* than the amount chosen in decision 1, namely $x_1 - 2$. This allowed us to test the prediction of the regret game when choosing the sure amount is the unique equilibrium in dominant strategies, i.e. when $\theta < \frac{c}{p}$.

Decision 5 The lottery's payoff in case of success was *bigger* than the amount chosen in decision 2, namely $x_2 + 2$. This allowed us to test the prediction of the regret game when choosing the lottery is the unique equilibrium, i.e. when $\theta > \frac{c}{p}(1 + k(1 - p))$.

Decision 6 The lottery's payoff in case of success was *in between* the lottery threshold chosen in decision 1 and the lottery threshold in decision 2, namely $\frac{x_1+x_2}{2}$. This allowed us to study behaviour when the game has two pure-strategy Nash Equilibria. Decision

6, being the most interesting case of the regret game and thus the core part of the experiment, was repeated another 19 times (decisions 7 to 25). Throughout these decisions, participants kept the same partner as in decision 6, and were informed about it.

3.4 Post-experimental questions and payment

After decision 25, the participants were asked some final, non-incentivised questions. We measured the Regret Scale (Schwartz et al., 2002), the Big-Five personality traits (Gosling et al., 2003) and demographic characteristics.

At the end of the experiment, each participant received: (i) a show-up fee of €4, (ii) the payment for one randomly chosen decision out of the 25 decisions made, (iii) the payment for one randomly chosen belief out of the 23 beliefs elicited, but only if they correctly guessed their partner's choice. On average, a participant earned €11.50 in the experiment.

3.5 Testable predictions

In decision 3, the threshold-based variant of the regret game, regret-neutral participants should choose the same lottery threshold as in decision 1 and in decision 2, independently of their beliefs. In contrast, regret-averse and information-loving participants should choose the same lottery threshold as in decision 1 if they believe that their partner will play the lottery (i.e., if they expect to learn the lottery's outcome) and the same lottery as in decision 2 if they believe that their partner will not play the lottery (i.e., if they expect not to learn the lottery's outcome). That is, they should choose a lottery threshold in between the thresholds chosen in the scenarios with and without information. As $x_2 > x_1$ for regret-averse types and $x_2 < x_1$ for information-loving types, for regret-averse (information-loving) participants x_3 will exceed (fall short of) x_1 and fall short of (exceed) x_2. For regret-neutral participants x_3 will equal x_1 and x_2. This yields our first testable prediction.

Prediction 1. *The partner-dependent lottery threshold x_3 will exceed (fall short of) the lottery threshold x_1 and fall short of (exceed) the lottery threshold x_2 for regret-averse (information-loving) participants. The lottery thresholds x_1, x_2 and x_3 will be the same for regret-neutral participants.*

Decision 4 tests Theorem 1 part 1, i.e. it explores behaviour in the regret game when choosing the sure amount is the unique equilibrium in dominant strategies. Similarly, decision 5 tests Theorem 1 part 2, i.e. it explores behaviour in the regret game when choosing the lottery is the unique equilibrium. This yields our second testable prediction.

Prediction 2. *Regret-averse and regret-neutral participants will choose the sure amount in decision 4 and the risky option in decision 5.*[12]

Decision 6 and its repetitions test Theorem 1 part 3, i.e. they explore behaviour in the regret game when it is a game of coordination with two pure strategy Nash Equilibria. A regret-averse type will choose the lottery if he believes that his partner will choose the lottery, and the sure amount otherwise. An information-loving type will choose the sure amount if he believes that his partner will choose the lottery, and the lottery otherwise. A regret-neutral type will be indifferent. This implies that beliefs will have an opposite effect for regret-averse participants and curious participants, and no effect for regret-neutral participants.

Prediction 3. *When the regret game is a game of coordination (decision 6 and its repetitions), believing that the partner will choose the lottery increases (decreases) a regret-averse (information-loving) participant's probability of choosing the lottery, and does not affect a regret-neutral participant's probability of choosing the lottery.*

4 Experimental results

4.1 Types

In our sample, 22% of the participants chose $x_2 > x_1$ and are classified as *regret-averse types* ($k > 0$). The sure amount was more appealing to them when it allowed them to avoid information and thus potential regret. Half the participants chose $x_2 = x_1$ and are classified as *regret-neutral types* ($k = 0$). The remaining participants chose $x_2 < x_1$ and are classified as *information-loving types*. The sure amount is less appealing to them in the no information scenario, as they will not learn the lottery's outcome unless

[12]For information-loving types the game has a dominant strategy in decisions 4 and 5 only when $x_1 - x_2 \leq 2$. f $x_1 - x_2 > 2$ the game has no dominant strategy – behaviour depends on beliefs.

they choose it.[13] Figure 1 shows the distribution of the coefficient of regret aversion k across our sample.

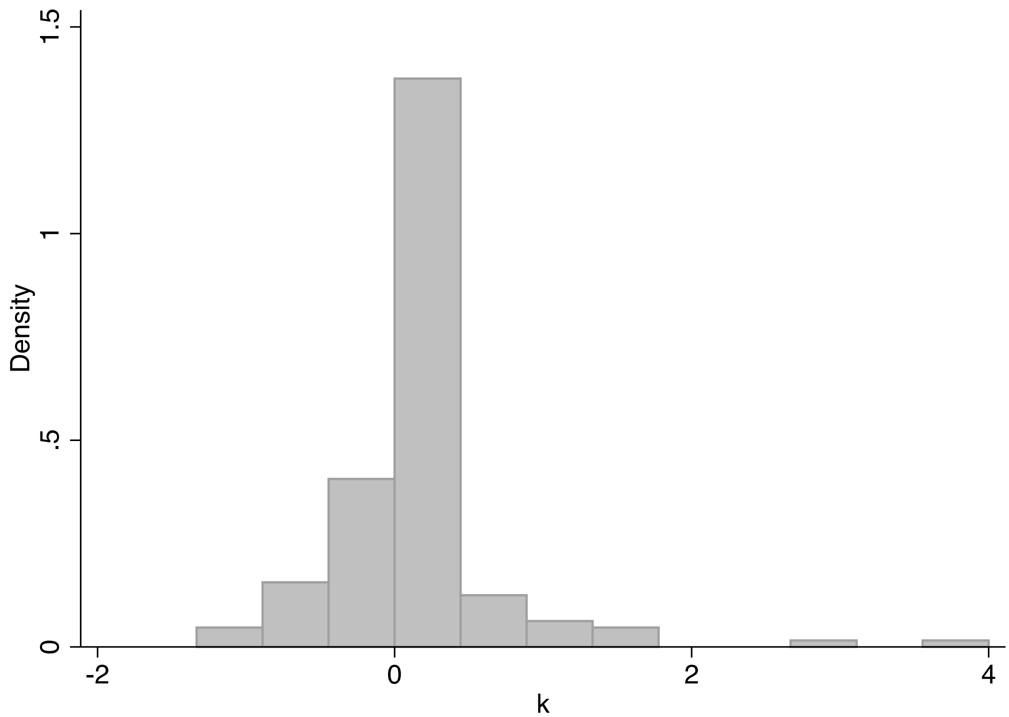

Figure 1: Distribution of k.

4.2 Threshold-based regret game

Table 1 presents the amounts chosen in decision 1, decision 2 and decision 3 – overall and broken down by type. It can be observed that, consistent with Prediction 1, for regret-neutral participants the mean amount chosen in decision 3 does not significantly differ from the mean amount chosen in decision 1 and the mean amount chosen in decision 2. For regret-averse participants (with no or weak preferences for information), mean x_3 is higher than mean x_1 and lower than mean x_2. For information-loving participants, the opposite happens: mean x_3 is lower than mean x_1 and higher than mean x_2.

To check whether these differences are statistically significant, we run the Wilcoxon

[13] As discussed, individuals will choose $x_2 < x_1$ if they are regret neutral and have preferences for information ($m > 0$), and if they are regret averse and have preferences for information that dominate their regret aversion ($m \geq ck(1-p)$).

Table 1: Mean amount chosen in D1-D3 by type

	regret averse	**regret neutral**	**information loving**	**all**
x_1	9.15	11.53	12.33	11.22
	(2.40)	(2.04)	(1.98)	(2.39)
x_2	12	11.10	9.77	11.16
	(2.56)	(2.70)	(2.34)	(2.40)
x_3	11.25	11.64	11.10	11.41
	(2.59)	(2.30)	(2.70)	(2.47)
$x_1 - x_3$	-2.1***	-0.11	1.23**	-0.19
$x_2 - x_3$	0.75*	-0.54	-1.33*	-0.25
N	32	73	39	144

Standard deviation in parentheses.
The Wilcoxon test tests $H_0 : x_1 - x_3 = 0$ and $H_0 : x_2 - x_3 = 0$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
"Information loving" includes regret neutral with $m > 0$ and regret averse with $m \geq c[1 + k(1 - p)]$.

equality test on matched data. The null hypotheses $H_0 : x_1 - x_3 = 0$ and $H_0 : x_2 - x_3 = 0$ are rejected for regret-averse participants and information-loving participants, and not rejected for regret-neutral participants. Our data support Prediction 1.

Result 1. *The partner-dependent lottery threshold x_3 is significantly higher (lower) than the lottery threshold x_1 and significantly lower (higher) than the lottery threshold x_2 for regret-averse (information-loving) participants. It is not significantly different from x_1 and x_2 for regret-neutral participants.*

Prediction 1 implies that the partner-dependent lottery threshold x_3 chosen by a regret-averse participant will be highly correlated with his first order belief about the amount chosen by his partner. This correlation should be higher than for non regret-averse participant. This is due to the fact that, as discussed, regret aversion induces a desire to coordinate. Let ρ denote the correlation between a participant's x_3 and the lottery threshold he believes his partner to choose in decision 3. We find that the correlation for regret-averse participants, ρ_{RA}, equals 0.77, the one for regret-neutral participants, ρ_{RN}, equals 0.45, and that for non regret-averse participants (i.e. regret-neutral and information-loving participants), $\rho_{\neg RA}$, equals 0.47. The test for equality of correlation coefficients rejects the null hypotheses $H_0 : \rho_{RA} = \rho_{RN}$ and $H_0 : \rho_{RA} = \rho_{\neg RA}$. In particular, ρ_{RA} is significantly higher than ρ_{RN} ($p = 0.01$), and ρ_{RA} is significantly higher than $\rho_{\neg RA}$ ($p = 0.01$).

Table 2: Fraction of agents choosing the lottery in D4 and D5 by type

	regret averse	**regret neutral**	**information loving**	
			$x_1 - x_2 \leq 2$	$x_1 - x_2 > 2$
Decision 4	6%	18%	29%	60%
Decision 5	66%	82%	75%	60%

4.3 Regret game

When the regret game has a unique equilibrium in dominant strategies, the large majority of participants should choose it, regardless of their type and beliefs. Table 2 shows the percentages of participants choosing the lottery in decision 4 and decision 5 by type. In line with Prediction 2, most regret-averse and regret-neutral participants chose the sure amount in decision 4 and the lottery in decision 5. Moreover, in line with Prediction 2, most information-loving participants chose the sure amount in decision 4 and the lottery in decision 5 when $x_1 - x_2 \leq 2$, i.e. when the sure amount was the unique equilibrium in decision 4 and the lottery was the unique equilibrium in decision 5. When the game had no dominant strategy, i.e. when $x_1 - x_2 > 2$, the percentages of informating-loving participants choosing the sure amount in decision 4 and the lottery in decision 5 were remarkably lower. Our results support Prediction 2.

Result 2. *When the unique equilibrium of the regret game is to choose the sure amount, most participants choose the sure amount, regardless of their type. When the unique equilibrium of the regret game is to choose the lottery, most participants choose the lottery, regardless of their type.*

When the regret game is a game of coordination, regret-averse types should choose what they believe their partner will choose, whereas information-loving types should choose what they believe their partner will not choose. Regret-neutral types will be indifferent. This implies that a participant's belief on the behaviour of his partner should have an opposite effect for regret-averse participants and for information-loving participants, and no effect for regret-neutral participants. In particular, believing that the partner will choose the lottery should increase the probability of choosing lottery for regret-averse participants and decrease it for information-loving participants.

We reshape our dataset so that each individual is observed as many times as the repetitions of decision 6, and use the dataset as a panel. Using a logit model, we estimate the marginal effect of beliefs on choice by type.[14]

A description of our control variables follows. The variable *belief* equals 1 if the individual believes that his partner is choosing the lottery in the current round and 0 if he believes that his partner is choosing the sure amount. The variables *beliefs*regret averse*, *beliefs*information loving* and *beliefs*regret neutral* equal *belief* if the agent is regret averse, information lover and regret neutral respectively. The variable *past regret* captures regret generated by previous decisions, and equals 1 (i) if an individual has not chosen the lottery in the previous round, while his partner has, and the lottery has been successful, or (ii) if an individual has chosen the lottery in the previous round and the lottery was not successful. It equals 0 otherwise.[15] In column (1), labelled *Baseline*, we control for *beliefs*regret averse*, *beliefs*information loving* and *beliefs*regret neutral*. In column (2), labelled *Baseline + past regret*, we additionally control for *past regret*. In column (3), labelled *Controls*, we additionally control for demographics (female dummy, student dummy and age), and in column (4), labelled *Controls + Big 5* we additionally control for the Big-Five personality traits.

Consistently with Prediction 3, believing that their partner will choose the lottery significantly increases regret-averse participants' likelihood of choosing the lottery. However, the same holds for regret-neutral participants and information-loving participants - although for regret-neutral participants the magnitude of the coefficients is smaller than for regret-averse participants. This significantly positive relationship between own behaviour and beliefs about others is consistent with recent experimental evidence and suggests that participants exhibit conformist preferences (Charness et al., 2019; Charness et al., 2017) – sufficiently strong to dominate their desire to be informed. In particular, the correlation between behaviour and first-order beliefs can be explained by social conformity, i.e. the desire to adjust to the behaviour of others, or by a consensus effect, i.e. believing that others will do the same as us.

Result 3. *Believing that their partner will choose the lottery significantly increases participants' probability to choose the lottery, for every type.*

[14]We cluster the standard errors at the matching groups-levels. We also repeat all our regressions using a logit model with random effects. Our results do not change.

[15]Note that, while both (i) and (ii) can be interpreted as regret driven by past, unsuccessful decisions, their nature can potentially differ. While (i) captures peer-induced regret, as well as personal loss, (ii) only captures loss. Given that, we also repeat our regressions splitting *past regret* into two dummies respectively corresponding to cases (i) and (ii). Our results do not change.

Among the participants who choose what they believe their partner to choose, i.e. who try to coordinate, 64% choose the lottery and 36% choose the sure amount. Regret-averse participants try to coordinate on the sure amount more often than the other participants, thus supporting the key insight of our model: regret can facilitate coordination on the sure amount. Finally, having experienced regret in the past, being female and being a student significantly increase the probability of choosing the lottery.

Table 3: Impact of beliefs on choice by type

Dep. var.: choice	Baseline	Baseline + past regret	Controls	Controls + Big 5
belief*regret averse	0.175***	0.167***	0.166***	0.166***
	(0.032)	(0.033)	(0.033)	(0.033)
belief*information loving	0.148***	0.137***	0.137***	0.139***
	(0.027)	(0.029)	(0.028)	(0.028)
belief*regret neutral	0.186***	0.172***	0.167***	0.170***
	(0.027)	(0.028)	(0.027)	(0.027)
N	2880	2736	2736	2736

Marginal effects from logit regression. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Standard errors in parentheses, clustered at matching group-level.

5 Discussion

An individual can only experience regret if she learns about an unchosen alternative. In many situations, ranging from technology adoption to ordering food in a restaurant, learning about the unchosen alternative is possible only if someone else chose it. In this paper, we have developed a model of regret aversion where the probability of learning about the alternative depends on the behaviour of others. This implies that individuals who act under the anticipation of future regret are partaking in a multi-player game and not each in their own one-person decision problem. When choosing between a risk-free status quo and a new and risky option that outperforms the status quo in expectation, individuals holding standard preferences would choose the risky option, whereas regret-averse individuals may coordinate on the status quo. The status quo becomes an equilibrium outcome because it provides individuals with insurance against anticipated regret. In the example of technology adoption, a new technology that is unequivocally beneficial for expected utility-maximisers may be shunned if individuals are regret averse, as uniform non-adoption of the new technology insures them against anticipated regret. In fact, evidence shows that new technologies take time to diffuse, even in developed nations. An example is the diffusion of hybrid corn in Iowa in the 1940s (Ryan and Gross, 1943). Ryan and Gross found that most farmers only adopted the new technology based on the experiences of neighbours in their community, despite the fact that many of them had learned about the superiority of the new technology from salesmen.

We have tested the predictions of a two-player variant of our regret game through a laboratory experiment. We classified participants into types based on their decisions in a threshold-based variant of the regret game. Then, in the core part of the experiment, we asked participants to choose between a sure amount of money and a lottery. If they did not choose the lottery, they learnt its outcome only if their partner chose the lottery. Our experimental data show that, as predicted by our model, regret-averse participants tried to coordinate with their partner. Believing that their partner chose the lottery significantly increased their likelihood of choosing the lottery. However, non regret-averse participants tried to coordinate with their partners too. This suggests that participants hold (also) conformist preferences, which is consistent with recent experimental evidence (Charness et al., 2019; Charness et al., 2017).

Potential extensions of the model abound. The following three variants would yield equilibria where some fraction of the players would opt for the risky option, while the remainder would not. The first would be similar to the bank run model of Diamond and Dybvig (1983), in that some subset of the population have standard preferences, while the remainder are regret-averse. The second would be to split the population into two groups that have different likelihoods of finding out about the alternative, or that are able to reap different benefits from it, like in the Language Game of (Neary, 2012). The last variant would be to imagine that the agents are connected through a network typology, where some agents are better connected than others, and thus the likelihood of finding out about the risky option becomes individual-specific. This has been shown to matter for technology adoption. For example, Banerjee et al. (2013) show that the centrality of agents that participate first in a technology adoption programme affects the subsequent diffusion of adoption by less connected agents.

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Appendix

A Proofs

Threshold rules

A regret-averse information-loving decision maker will choose the risky option if and only if

$$p(\theta - c + m) + (1-p)(-c - kc + m) \geq -pqk(\theta - c) + pqm + (1-p)qm$$

Rearranging yields the threshold rule (9):

$$p\theta - c - kc + m + pkc \geq -pqk\theta + pqkc + qm$$

$$\theta \geq \frac{c[1 + k(1 - p(1-q)] - m(1-q)}{p(1+qk)} = \tilde{\theta}^{**}(q)$$

For $m = 0$, the threshold rule (3) is obtained.

For $q \in (0, 1)$, the derivative of (9) with respect to q is:

$$\frac{d\tilde{\theta}^{**}(q)}{dq} = \frac{ckp(p + pqk) - (c + ck - ckp + ckpq)pk}{p^2(1+kq)^2} - \frac{-m(p + pqk) - pk(m - mq)}{p^2(1+qk)^2}$$

Rearranging yields (10):

$$\begin{aligned}\frac{d\tilde{\theta}^{**}(q)}{dq} &= \frac{ckp^2 - cpk - ck^2p + ck^2p^2}{p^2(1+kq)^2} - \frac{-mp - pkm}{p^2(1+qk)^2} \\ &= -\frac{c}{p}\frac{k(1+k)(1-p)}{(1+kq)^2} + \frac{m}{p}\frac{(1+k)}{(1+qk)^2}\end{aligned}$$

For $m = 0$, (6) is obtained. $\frac{d\tilde{\theta}^{**}(q)}{dq} > 0$ if and only if

$$\frac{m}{p}\frac{(1+k)}{(1+qk)^2} > \frac{c}{p}\frac{k(1+k)(1-p)}{(1+qk)^2}$$

$$m > ck(1-p)$$

Proof of Theorem 1

Cases 1 and 2 have already been shown and are trivial as for such outcome levels, the strategic situation boils to a dominant strategy game with each player having the same decision problem. Consider Case 3. It is easy to see that both symmetric profiles are Nash Equilibria over this range. To see why these are the *only* Nash Equilibria, consider the value of q_i at which the agent is indifferent between the safe option and the risky option. That is, define $q^\star$ such that

$$p\theta - c - (1-p)kc = -pq^*k(\theta - c)$$

If $q_i < q^\star$ then the best-response for player i is to choose $a_i = 0$, while if $q_i > q^\star$ then his best-response is $a_i = 1$. In the case that $q_i = q_i^*$, both actions are best-responses. Symmetric behaviour is always an equilibrium so we need only consider action profiles where behaviour is not symmetric. So, consider a profile, $\mathbf{a}$, such that $a_j = 0$ and $a_k = 1$ for some $j, k \in \mathcal{N}$. If $\mathbf{a}$ is a NE then it must be that $q_j \leq q^\star \leq q_k$. However, by the way in which we defined the probability function in (13), it must also be the case that $q_j = q_k + \frac{1}{n-1} > q_k$, which is a contradiction.

B Experimental instructions

Instructions

Welcome to the study.

Please note that you may not talk to the other participants at any time during the entire study. Should this happen, we will be forced to terminate the study.

Please read these instructions carefully.

In this study, you will make 25 decisions.

At the end of the study, you will be paid in cash for ONE of these 25 decisions, picked at random by the computer.

Each decision is equally likely to be picked. So you should regard each decision as if it was the relevant one.

In addition, we will ask you 23 additional questions.

At the end of the study, ONE of the additional questions will be randomly picked and paid on the base of your answer.

Each question is equally likely to be picked. So you should answer each question, as if it were the relevant one.

In addition, you will receive €4 for your participation in the study.

Instructions about the first part of the study

Please read these instructions carefully.
In the first part of the study, we will give you two options.

Left	Right
€x with 50% probability and €0 with 50% probability	€5 with certainty

First, you must specify the smallest number x, such that you would prefer option "Left" to option "Right". You can choose any number in the list (5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15).
After you have submitted your decision, the computer will randomly pick a number from the list (5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15).
All numbers have the same probability of being picked.
If the number picked by the computer is smaller than the number x you chose, then Right will be the selected option. This means that you will get €5.
If the number picked by the computer is equal to or bigger than the number x you chose, then Left will be the selected option. This means that you will get the number of € picked by the computer with 50% probability and 0 with 50% probability.
If you have any questions, please raise your hand and we will come to you.

Decision 1 (on screen only)

You have two options.

Left	Right
€x with 50% probability and €0 with 50% probability	€5 with certainty

First, you must specify the **smallest** number x, such that you would prefer option "Left" to option "Right". You can choose any number in the list (5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15).
After you have submitted your decision, the computer will randomly pick a number from the list (5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15).
All numbers have the same probability of being picked.
If the number picked by the computer is smaller than the number x you chose, then Right will be the selected option. This means that you will get €5.
If the number picked by the computer is equal to or bigger than the number x you chose, then Left will be the selected option. This means that you will get the number of € picked by the computer with 50% probability and 0 with 50% probability.

Important information

After you have submitted your decision, the computer **will let you know** the outcome of option "Left" even if you have chosen a number x such that option "Right" is selected.
This means that, if "Right" is the selected option, you will learn nevertheless how much you would have earned, had "Left" been the selected option.

Decision 2 (on screen only)

You face the same decision as before.

Left	**Right**
€x with 50% probability and €0 with 50% probability	€5 with certainty

First, you must specify the **smallest** number x, such that you would prefer option “Left” to option “Right”. You can choose any number in the list (5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15).
After you have submitted your decision, the computer will randomly pick a number from the list (5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15).
All numbers have the same probability of being picked.
If the number picked by the computer is smaller than the number x you chose, then Right will be the selected option. This means that you will get €5.
If the number picked by the computer is equal to or bigger than the number x you chose, then Left will be the selected option. This means that you will get the number of € picked by the computer with 50% probability and 0 with 50% probability.

The only difference is the following. After you have submitted your decision, the computer **will NOT let you know** the outcome of option “Left” if you have chosen a number x such that option “Right” is selected.
This means that, if “Right” is the selected option, you will NOT learn how much you would have earned, had “Left” been the selected option.

Instructions about decisions 3, 4, 5 and 6

Please read these instructions carefully.
Before each of the next four decisions, you will be randomly assigned to another participant.
In this lab, there are 3 potential participants who can be randomly assigned to you.
At no time will you find out the identity of the other participant.
If you have any questions, please raise your hand and we will come to you.

Decision 3 (on screen only)

You are randomly paired with another participant. Each of you faces the same decision as before.
First, you must specify the **smallest** number x, such that you would prefer option “Left” to option “Right”. You can choose any number in the list (5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15).
After you have submitted your decision, the computer will randomly pick a number from the list (5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15).
All numbers have the same probability of being picked.
If the number picked by the computer is smaller than the number x you chose, then Right will be the selected option. This means that you will get €5.

If the number picked by the computer is equal to or bigger than the number x you chose, then Left will be the selected option. This means that you will get the number of € picked by the computer with 50% probability and 0 with 50% probability.

The only difference is the following. If you have chosen a number x such that option “Left” is selected, you always know the outcome of option “Left”.
If you have chosen a number x such that option “Right” is selected, the computer **will inform you about the outcome of option “Left” only if “Left” is the selected option for your partner**. This means that, if “Left” is the selected option for your partner, you will learn nevertheless (as in Decision 1) how much you would have earned, had “Left” been the selected option. If “Right” is the selected option for your partner, you will NOT learn (as in Decision 2) how much you would have earned, had “Left” been the selected option.

Instructions about the second part of the study

Please read these instructions carefully.
In the second part of the study, we will give you two options.

Left	**Right**
€“a number” with 50% probability and €0 with 50% probability	€5 with certainty

Unlike in the previous part of the study, we will now give you a number.
So instead of choosing a number, you will choose either Left or Right.
If you have chosen option “Left”, you will always know the outcome of option “Left”.
If you have chosen option “Right”, the computer will inform you about the outcome of option “Right” only if your partner has chosen “Right”.
This means that if you have selected option “Right” and your partner option “Left”, you still learn (as in decision 1) how much you would have earned if you had chosen option “Left”. If you and your partner have chosen “Right”, you will NOT learn (as in decision 2) how much you would have earned if you had chosen “Left”.
If you have any questions, please raise your hand and we will come to you.

Decision 4 (on screen only)

You are now paired with another participant. This participant could be either the same as before or a different one.

Left	**Right**
€x *chosen in D1-2* with 50% probability and €0 with 50% probability	€5 with certainty

If you have chosen option “Left”, you will always know the outcome of option “Left”.
If you have chosen option “Right”, the computer will inform you about the outcome of option “Left” only if your partner has chosen option “Left”.

This means that if you have chosen option “Right” and your partner option “Left”, you will learn nevertheless (as in Decision 1) how much you would have earned, had you chosen option “Left”. If both you and your partner have chosen option “Right”, you will NOT learn (as in Decision 2) how much you would have earned, had you chosen option “Left”.

Decision 5 and decision 6 are exactly the same as decision 4, but the outcome of the lottery in case of success is, respectively, the x chosen in decision 2 plus 2, and the sum of the x chosen in decision 1 and the x chosen in decision 2, divided by 2.

Instructions about the third part of the study

Please read these instructions carefully.
In the third part of the study, you will repeat decision 6 for other nineteen times.
In these additional nineteen decisions, you will still be paired with the same partner.
If you have chosen option “Left”, you will always know the outcome of option “Left”.
If you have chosen option “Right”, the computer will inform you about the outcome of option “Right” only if your partner has chosen “Right”.
This means that if you have selected option “Right” and your partner option “Left”, you still learn (as in decision 1) how much you would have earned if you had chosen option “Left”. If you and your partner have chosen “Right”, you will NOT learn (as in decision 2) how much you would have earned if you had chosen “Left”.
If you have any questions, please raise your hand and we will come to you.