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Topic:
Regret for inaction in decision-making under uncertainty

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Chapter 1. Introduction.

For a considerable amount of time economists preferred to focus only on purely rational, economical aspect of human behavior in attempt to predict, describe and interpret the choices people prefer. This way of research and modelling showed sufficient ability of explaining the real behavior, but still a significant amount of observed cases could barely be explained by models of this kind. The most important and widely used example of such model is the Expected Utility Theory, which was formulated by J. von Neumann and O. Morgenstern in 1947. The model was based on four axioms that explained "rational" behavior, but later studies uncovered that these axioms are not always consistent with empirical observations. That was quite logical, considering the fact that people are not like robots, they are highly emotional living creatures and their decisions tend not to be based solely on material outcomes.

The first model to intentionally and completely deviate from the Expected Utility Theory was the one called "Prospect Theory" presented in 1979 by D. Kahneman and A. Tversky. This theory made a sufficient impact on further development of such models, even though it had suffered from sufficient theoretical issues. That was the time when the first theory of regret came forward.

The regret as a factor determining human choices came to economics from psychology, where it was studied long before entering the economic sphere. In 1982 G. Loomes and R. Sugden presented a revolutionary new theory: the Regret theory.

One may be curious, why exactly regret, why not disappointment or any other human-like emotion like anger or guilt? The answer can barely be that straightforward. Nevertheless, regret has been supported by multiple studies to be both most ratioanalizable and most influential emotional feeling.

Regret is a widely known feeling, and everyone who was ever not satisfied with the conducted choice is familiar with this emotion. Susan B. Shimanoff (1984) claimed regret to be the second most frequent emotion felt. Regret can be interpreted as a feeling of self-blame for not making the best possible decision. Being a part of decision-making process under uncertainty, regret can be technically divided into two important but distinctive fields: regret over an action and regret over inaction. It's an interesting fact that in Italian these types of regret even are named differently: "il rimorso" for action regret and "il rimpianto" for inaction regret.

The division of that kind is simple as the nature of understanding and applicability of these types of regret is not the same. Most existing theories in economic literature concentrated on regret over an action, explaining the preference between several actions. Although psychological literature moved

much further, considering regret as a whole concept of human perception of reality. All aforementioned indirectly makes us approach the main topic of the following paper: the significance of regret for inaction and it's inherency from the analysis of human decision making.

For the reason that both types of regret have a biasing effect on preferred decisions both of these types should be included in the analysis. There has already been conducted a great amount of experiments in order to understand, which type of the regret prevails. However, these researches seem to lead to opposite results.

Some researches, like that of Kahneman and Tversky (1982), seemed to result in action taking the first ruling role. The others, like ones of Gilovich & Medvec (1995) and of Zeelenberg et al. (2002), focused on prevailing inaction effect. For now, we can not state for certain, which type of regret has a higher power to affect the decision. Although, it can surely be seen that the regret for inaction is as much important as regret for action, therefore we will construct a model that will be able to incorporate both types of regret as an indivisible phenomenon.

Chapter 2. Literature review.

The concept of regret as a factor that influences human behavior has been explored in psychological literature for a very long time. For instance, in Nicomachean Ethics Aristotle already discussed the notion of regret and it's impact on human choices. However, in economical literature regret appeared for the first time as a part of normative theory not so long ago - until then it was assumed to be a part of behavioral features that cannot be claimed rational. Later on regret was accepted as rational emotion because of the tendency to improve decision-making (S. Bourgeois-Gironde, 2010).

First theoretical models existed before introduction of regret. We will focus on one of such theories, probably the most popular and successful - The Expected Utility Theory (EUT). This model possesses a high explanative power being intuitively simple, that was the reason for popularity. Even today, a great amount of simple models of economic analysis base on it. The theory was shaped and introduced by J. von Neumann & O. Morgenstern in 1947; it explained the motives of choice of a decision-maker under uncertainty, whose preferences satisfied a set of defined axioms of rational behavior. Despite having high explanative power at first, later researches and experiments showed that actual human tend to violate formulated axioms (H. Lindman, 1971; S. Lichtenstein & P. Slovic, 1971; D. Grether & C. Plott, 1979; M. Allais & O. Hagen, 1979; P. Schoemaker, 1982).

In order to explain the observed behavior, in 1979 D. Kahneman and A. Tversky proposed a theory, which they called "Prospect theory". The theory came out as a logical explanation of the experimental results that proved the violation of EUT assumptions. For example, the issue with preferences transitivity assumption (A. Tversky, 1969). Prospect theory made one important step forward: it assumed the dependence of one prospect on the other. This dependence revealed in a way that a forgone better prospect negatively influenced the result of the one taken. Unfortunately, the theory was very difficult to implement as it had some theoretical downsides.

In 1982 a new theory by G. Loomes and R. Sugden was released. The Regret theory, as authors named it, explained preference reversals, the empirical evidence for the failure of an assumption of transitivity to fulfill in reality. Some of the most significant features of the model were simplicity of application, lucidity, ability to successfully explain the violations of EUT (Allais paradox (Allais, 1953), transitivity and equivalence axioms). The theory introduced regret as a decrease in 'choiceless' utility obtained by an individual under certain occurred state of the world and chosen action. The model turned out to be much less complicated than it's predecessor for that reason gaining wide popularity. Many further researches on regret took this model as base. The named theory came

almost at the same time with another model proposed by Bell (1982), who considered regret as an additional characteristic of consequences. However, we preferred to stress out the model by LS as it is closely related to our own new developed model.

The main idea of the traditional approach to regret is that people are assumed to be regret-averse and tend to minimize the experienced regret (M. Zeelenberg & R. Pieters, 2006b).

However, in contrast to empirical literature, where both types of regret were issued, tested and explored, in normative theories only regret for action has been counted so far. As our theory supported by model attempts to capture and express the effects of regret for inaction, we should clarify the empirical support for importance inaction regret.

Most of existing studies focused on determining which regret effect prevails: for action or for inaction. For instance, Spranca, M., Minsk, E., & Baron, J. (1991) found out that harm being the result of omission is preferred to that of commission. The authors conducted six distinct experiments by placing people in hypothetical situations. The respondents were asked to evaluate the "normality" of offered options and then determine the choice.

Baron (1992) found that omission bias tends to vary in different situations: it is much stronger in an imaginary situation of shooting one man to save a couple of others than in a vaccination case.

Kahneman & Tversky (1982) found out that the subsequent regret of actions tend to outweigh that of inactions. Kahneman & Miller (1986) concluded that inaction tends to be more normal than actions because it is easier to be imagined than outcomes of untaken action. Having chosen action, people can easily picture the result that they could have achieved in case of inaction. However, in the reverse situation imagining what might have happened is not that easy and straightforward: if we refuse to act, we don't really know what could have happened had we chosen differently.

J. Baron & I. Ritov (2003) reviewed existing literature on omission and commission biases and explored the possible factors for both types of regret. Authors came to the conclusion of high impact of personal characteristics on the biases: they observed both types of biases depending on individual differences. Later in the examples to our model we will show how biases might depend on personal characteristics.

A lot of theories concerned on the so called anticipated regret and it's effects on decisions. Those studies are very important to mention as they had indirectly proposed the method to introduce the inaction regret into our new model of regret.

Sarver (2008) found the relation between anticipated regret and the desire to reduce the amount of available choices. Menus of lotteries were taken as the basis for preferences. Author developed a model and came to conclusion that agents could shift to a smaller number of menus and that shift would not distort the choice.

Research made by Zeelenberg (1999) on Dutch postcode lotteries brought about interesting results on regret: anticipated regret can facilitate both risk-averse and risk-seeking decisions. The researcher also showed that people tend to take actions in order to minimize or fully get rid of the post-decisional regret. That was the main goal of experiments where participants were given some information after decision (to these participants the regret was made salient). Those participants acted differently from the ones who did not learn the possible alternatives (that could have realized if different action was taken) and thus did not experience regret.

Filiz-Ozbay, E. & Ozbay, E.Y. (2007) found that auction's participants bid more aggressively knowing they will be given information on the winning bid in contrast to information on, for example, second highest bid. This is a very interesting point, which will be captured in out theory as well - the manipulation with received information.

Ritov (1996) found that anticipated regret fuels risk-seeking choices. She examined how bidders behaved during auctions and came to important result: the allowance of offers to be open shows to become one of the main influential factors that determine the outcome of negotiations.

Our theory combines the discovered influence of anticipated regret on taking decisions with an assumption of taking information as one of drivers for experiencing regret. To sum up all the mentioned material, we would like to stress out that researches on biases of action/inaction regret came to totally different conclusions: some situations proved the first to be positive, others showed the second to prevail. Nevertheless, the introduction of information into the model can help to explain such contradictive results both from normative and intuitive sides. Information as a variable function might also be useful to explain the change in anticipation of regret and thus the deviation from previously chosen option (option with no information present). And that leads us to the main chapter of our work.

Chapter 3. The complete theory of regret.

Including the concept of regret into a model of rational human behavior made a revolutionary step. The theory that had already been widely discussed and explored in psychological literature, finally found it's application in economics only in 1980s. However, the step was incomplete, as in previously proposed models only the regret for action had been captured. We will show with a simple example the importance of including the regret for inaction in the model of rational choice.

Consider a situation: you are offered a lottery ticket. The price of ticket is not that high, but you know that the probability of winning the prize of one million so low that, technically, you are indifferent between buying and not buying the ticket. You know that in case you refuse to purchase, you'll never know was that exact ticket the winning one or not. So you decide to stick to your money and go.

But what if the seller intentionally shows you the number of the ticket? You start reconsidering the situation once again. And now there is a small chance that this exact number wins and you didn't take the chance to buy it. This negative feeling even with such a low probability forces you to change your mind and buy the ticket.

So what exactly was the driver for the decision shift? The intuitive answer would be: inaction regret.

This hypothetical case is not unique. As regret for action shifts our decision in favor of inaction, the same way regret for inaction shifts in in the opposite direction. As empirical studies prove, the power of these shifts may vary according to situation, but one thing stays unchanged: the regret for inaction has to be captured in line with action regret. And that is what our model attempts to accomplish.

3.1 The new model.

Framework:

- Two-player simultaneous game.
- The two players: man (M) and nature.
- There are N possible alternative states of nature (assume they are finite, for simplicity).
- Nature chooses the state, M chooses action.
- M receives exogenous information that makes ex-post conception of the game different to ex-ante one.

Denote $S = \{s_1, s_2, \dots, s_n\}$ a space containing all states. The space S is associated with the set of probabilities P over the states, s.t. $p_j = P(s_j)$ (each state s_j has a probability of occurrence equal to p_j). M doesn't know which state is true (which has occurred).

M has to choose one of K available moves (actions and inaction) $a_i \in A$ (let's denote inaction as a_0). M's preferences can be described with a utility function of the form

$$U\colon A \times S \to \mathbb{R}.$$

Every action specifies a utility-consequence for every state: $U_{ij} = U(a_i, s_j)$[1]. Move a_0 is defined as inaction, which means it brings about U_0, initial utility, in every possible state. These utilities can be treated, for example, as utilities over monetary outcomes of actions or incorporate also other factors defining the state of personal well-being. In their model, Loomes, G. and Sugden, R. (1982) similarly defined such utilities as "choiceless utility", or the "utility that the individual would derive from the consequence if he experienced it without haven chosen it"[2].

The choice, available to M, can be represented as follows:

Table 1

Move	s_1	s_2	⋯	s_N
a_0	$\boldsymbol{U_0}$	$\boldsymbol{U_0}$	$\boldsymbol{U_0}$	$\boldsymbol{U_0}$
a_1	$\boldsymbol{U(a_1, s_1)}$	$\boldsymbol{U(a_1, s_2)}$	⋯	$\boldsymbol{U(a_1, s_N)}$
.	.	.		.
.	.	.		.
.	.	.		.
a_K	$\boldsymbol{U(a_K, s_1)}$	$\boldsymbol{U(a_K, s_2)}$	⋯	$\boldsymbol{U(a_K, s_N)}$

In order to make the game easier to understand intuitively, we will present it in three moments.

[1] We assume these utilities do depend solely on chosen action and realized state (approach similar to that in EUT).

[2] Loomes, G. and Sugden, R. (1982). 'Regret theory: an alternative theory of rational choice under uncertainty', ECONOMIC JOURNAL, vol. 92(368), pp. 805–24.

First moment: M analyses all available information (objective and subjective) and chooses action that maximizes his expected extended utility.

Second moment: player and nature make their moves.

Third moment: M observes the outcomes and can either suffer from regret or not.

Assumptions:

- Each action-state combination leads to 'choiceless' utility outcome for the player that he can perfectly determine
- M does not know which state of the world realizes. But after the game is played he receives exogenous information (information that can not de deduced from the game) that the realized state is from the subset $S' \subset S$.[3] This information can be modelled with an 'exclusion' function of the form

  $$Ec: A \times S \to 2^S.$$

  Function $Ec(a_i, s_q)$ defines for the player the subset of all possible states that could have happened (information received after the game).
- When M obtains information, he readjusts the probability distribution over the possible outcomes (suppose, he can surely say which state(s) hadn't been realized).

  New probability distribution over the states P' is assigned (only in his consideration) such that $p'_j = P'(s_j).\ \forall q\ \ If\ s_q \notin S' then\ p'_q = 0$. Other probabilities of states are assigned proportionally to those p_j that were before.
- The difference of achieved 'choiceless' utility from any other better alternative that could have been obtained had he chosen another action (given information received) induces the feeling of regret.
- Once regret is determined, the new 'extended' utilities are obtained for every action and state by subtracting regret (loss in utility as a result of decision) from initial 'choiceless' utility.
- The player is able to analyze 'extended' utilities over all available actions to make a choice of move that maximizes expected 'extended' utility.

[3] For simplicity, we will assume he can completely exclude some states from considering after the game is played

We will impose some logical restrictions on the regret function f:

- $f\ is\ continuous\ and\ twice\ differentiable\ on\ R$
- $f\ is\ strictly\ increasing\ (so\ that\ f'(x) > 0)$. This assumption is derived from the simple fact that the more we 'lost' as a consequence of wrong decision, the regret we feel.
- $f\ is\ convex (so\ that\ f''(x) > 0)$. This assumption is not as straightforward as the preceding one, nevertheless it's also intuitive:
- $f(0) = 0$. There is no regret for zero expected difference between the best option we could have achieved and what we actually got (i.e. our choice was optimal).

We will also impose some restrictions on the information function to make it applicable into the model:

- If some state $s_q$realizes, then for every possible action a_i, the information received (as a subset S') must include s_q:

$$If\ s_q\ is\ true\ then\ for\ \forall a_i\ \Rightarrow s_q \in S'$$

- For every pair of action-state exogenous information function specifies subset S' so that this subset contains all states that could have happened. But at the end of the game M receives 'choiceless' utility (payoff) and he can receive endogenous information on possible states. The exclusion function incorporates both endogenous and exogenous information

$$\forall\ a_i\ \ \Delta U(a_i,*) \rightarrow S'_{endogenous}(a_i);$$

$$Ec(a_i, s_j) = S' = S'_{endogenous}(a_i, s_j) \cap S'_{exogenous}(a_i, s_j)$$

It's quite natural to assume regret depending on the difference between the achieved outcome and the outcome that could have been achieved if our move was different.

Some state realizes, but M can't exactly tell which one.

We will define regret as a function[4] of a form

[4] In their Regret theory, Loomes and Sugden considered rejoice as an opposite side of regret. We intentionally do not include the same thing for a set of reasons:

1. We are examining the phenomenon of regret for inaction. In order to be able to analyze it solely, we had to exclude the influence of other disturbing factors (like rejoice, being the factor that decreases regret)
2. Connolly & Butler (2002), found out that regret and rejoicing may not come as completely opposite, so the relationship is not that trivial as LS supposed in their model

$$R\colon (a_i, s_t) \in A \to f\Big(\max_{c\in[1..K]}\big[E\big(U(a_c, s_t)\big|Ec(a_i, s_t)\big)\big] - U(a_i, s_t)\Big).$$

And expected regret over an action a_i:

$$E\big(R(a_i,*)\big) = \sum_{\forall s_t \in S} p'_t * f\left(\max_{c\in[1..K]}\big[E\big(U(a_c, s_t)\big|Ec(a_i, s_t)\big)\big] - U(a_i, s_t)\right).$$

M does not necessarily know the realized state ex-post, but when analyzing the game ex-ante, he is able to determine the consequences of each 'action-state of the world' pair and these consequences can provide information after the game is played. With this obtained information, the game changes as new probabilities over states are achieved. This 'new' game has same move-space A. Having this 'new' game under consideration, M might have picked a different move. And in this abstract situation he does, he is going to regret the wrong choice.

M will make decision ex-ante considering his feelings ex-post. The decision rule will be as follows:

$$a_c \succcurlyeq a_d \Leftrightarrow E\big(U(a_c,*) - R(a_c)\big) \geq E\big(U(a_d,*) - R(a_d)\big).$$

That is, M will prefer move a_c to move a_d only if the expected 'extended' utility he would achieve after move a_c exceeds that of move a_d.

We suggest that maximizing the expected 'extended' utility is consistent with rational human behavior. First of all, this is because the mentioned assumption can be confirmed by empirical studies (M. Zeelenberg & R. Pieters, 2006b).Obviously, there exist a great variety of other important factors that influence human decisions (like love, guilt, responsibility, anger), but those are beyond the frames of our research and can be explored in further experiments and theories.

3.2 The new model and the examples.

Existing literature on choice under uncertainty focused on preference between actions, leaving the aspect of inaction aside. Inaction could not be possibly considered due to an assumption of perfectly knowing the state after the game. Indeed, the played could learn the state through payoffs in case of action, however, assuming he could learn the state choosing inaction is too much for an assumption. Although, he might have received this information exogenously. And that is what needs to be specified to introduce inaction in our model. The information 'fuels' both types of regret under uncertainty as it leads to reconsidering initial game with new probabilities over the states. The information can affect regret for action or for inaction or both. That is why we should consider both types of regret - because we cannot say for sure which kind of regret prevails. It may occur the regret for inaction to become higher than regret for action due to received information. And that would exactly be the case, where individual will change his initial choice, switching to action.

In the following examples, we wanted to show that our model successfully represents the effect of inaction regret.

Consider a following game scenario:

Table 2

Move	s_1	s_2	s_3	s_4
a_0	1	1	1	1
a_1	4	0	0	0

Suppose, all states carry the same probability of ¼.

The game is as follows: if state s_1 happens, you will derive utility of 4 if you choose to act. But if some other state realizes, you'll loose everything. If you decide not to act you're left with what you had before - the utility of 1. Those utilities are stated as payoffs or 'choiceless' utilities (they're achiever irrespectively of choice as was explained in our model before).

If we value the game from the point of view of expected utility, you should be indifferent between playing and not playing:

$$EU(a_0) = \frac{1}{4} * 1 + \frac{1}{4} * 1 + \frac{1}{4} * 1 + \frac{1}{4} * 1 = \mathbf{1}.$$

$$EU(a_1) = \frac{1}{4} * 4 + \frac{1}{4} * 0 + \frac{1}{4} * 0 + \frac{1}{4} * 0 = \mathbf{1}.$$

We defined regret in a natural way - as a decrease in utility due to feeling of self-blame. The main problem with regret for inaction would be the assumption of perfectly knowing the state of the world that occurred. In reality, if we refuse to participate in action, we usually get no information of the true state (as the payoffs are equal for all states). This is in contrast to taking action - where we certainly learn the true state and can make conclusions on experienced regret.

We will consider two critical cases for inaction regret: perfectly knowing the state after the game (receiving it exogenously) and not knowing it at all (no new information received).

Case 1. Perfectly knowing the state

This case can be thought of as a situation where the exclusion function $Ec(a_i, s_j)$ excludes all the states except for the true one. In reality, this information can be obtained if, for example, in the casino we do not make the bet, but stay to watch the outcome.

If the player is able to determine the realized state (he receives information on exact state), he knows for sure the best outcome that could have been achieved at each state of the world. The total expected regret over inaction would be:

$$R(a_0) = \frac{1}{4} * f(3) + \frac{1}{4} * f(0) + \frac{1}{4} * f(0) + \frac{1}{4} * f(0) = \frac{f(3)}{4}.$$

The regret for action can be similarly determined:

$$R(a_1) = \frac{1}{4} * f(0) + \frac{1}{4} * f(1) + \frac{1}{4} * f(1) + \frac{1}{4} * f(1) = \frac{3}{4} f(1).$$

Bearing in mind the assumption of convexity, we can see that regret for inaction prevails:

$$R(a_0) > R(a_1).$$

As $f(3) > 3 * f(1)$ (the necessary condition for convexity).

Having equal expected 'choiceless' utility both for action and inaction, the individual would choose to act as this option would yield a higher *extended* utility.

Case 2. Not knowing the state.

This time, choosing inaction results in not knowing the true state. The only opportunity would be to compare the payoff ('choiceless' utility) with the expected payoff we could have achieved over an action. Having no clue of realized state, we experience zero regret for inaction whatever state realizes.

$$R(a_0) = \frac{1}{4} * f(0) + \frac{1}{4} * f(0) + \frac{1}{4} * f(0) + \frac{1}{4} * f(0) = 0.$$

As for action, we perfectly learn the state through payoffs, therefore we're able to determine regret for action as in Case1:

$$R(a_1) = \frac{1}{4} * f(0) + \frac{1}{4} * f(1) + \frac{1}{4} * f(1) + \frac{1}{4} * f(1) = \frac{3}{4} f(1).$$

$$R(a_1) > R(a_0).$$

Having equal expected 'choiceless' utility both for action and inaction, this time the individual would choose not to act as this option would yield a higher *extended* utility.

From these two cases we can derive two important theoretical issues that have been observed by researchers and explained by our model:

- the importance of considering inaction regret while explaining or predicting decision-making behavior;
- the effect of obtained information of preferred choice.

However, information the player receives may not be that trivial. We will show a more complex case of such information.

3.3 The new model and a more complex information function.

Imagine a situation: you are walking down the street and see the man that has a randomization machine and 20 balls. 1 even and 4 odd are red, other 1 odd and 14 even are green. He offers you the bet that costs money you value as 10 (your utility over money you have). The balls are numbered. Suppose also that you have personal regret function so that

You pick up odd or even and if the machine chooses the ball with that kind of number, you win. The game is as follows: if you choose 'odd' and odd number wins, you feel utility of 40; if your number does not, you lose everything you had and have utility of 0.

The man does not tell you the kind of number that is chosen by the machine, you can only see the color. Assume he is not trying to hold you up, so that if you win, he tells you that. You like odd numbers and if you play, you choose 'odd' (you can't choose even). Let's show the game:

Table 3

Move	Odd (s_1)	Even (s_2)
a_0	**10**	**10**
a_1	**40**	**0**

Initially, the probabilities of odd state is 1/4 and bad state is 3/4.

If we value the game from the point of view of expected utility, you should be indifferent between playing and not playing:

$$EU(a_0) = \frac{1}{4} * 10 + \frac{3}{4} * 10 = \mathbf{10} = \frac{1}{4} * 40 + \frac{3}{4} * 0 = EU(a_1).$$

Would that be the case in our model?

Suppose, you analyze the bet and understand that in case you do not participate, but watch the outcome, you will find out the color of the chosen ball. And if it's red, you'll feel sad, because you understand that given information about color, you consider a 'new' game. So in that new game the winning by choosing odd is more probable than before. If in ex-ante case you were indifferent, then in this ex-post you could have chosen to play. All aforementioned may drive the regret for not participating to force you to play.

Let's see that.

The new information-adjusted game has $p_1' = \frac{4}{5}\ and\ p_2' = \frac{1}{5}$.

We can see how probabilities change in each case:

Table 4

	Odd (s_1)			Even (s_2)		
	RO	GO	Total	RE	GE	Total
No new information	4/20	1/20	1/4	1/20	14/20	3/4
Ball is red	4/5	0	4/5	1/5	0	1/5
Ball is green	0	1/15	1/15	0	14/15	14/15

According to our new regret model, the regret we feel if we do not participate, watch and obtain the information about red picked ball is:

$$\boldsymbol{R(a_0|ball\ is\ red)} = f\big(E(U(a_1)|ball\ is\ red) - U(a_0)\big) = f\left(\frac{4}{5} * 40 + \frac{3}{9} * 0 - 10\right) =$$
$$= f(22) > 0.$$

If we stay and obtain the information about green ball, the regret is:

$$\boldsymbol{R(a_0|ball\ is\ green)} = f\big(\ E(U(a_1)|ball\ is\ green) - U(a_0)\big) =$$
$$= f\left(\max(\frac{1}{15} * 40 + \frac{14}{15} * 0,\ 10) - 10\right) = f(0) = 0.$$

The total expected regret over inaction will be

$$E\big(R(a_0,*)\big) = \frac{5}{20} * f(22) + \frac{15}{20} * 0 > 0.$$

If we choose to play, we know the state for sure. If we win, we do not experience the regret

$$\boldsymbol{R(a_1|s_1)} = f\big(E(U(a_0)|s_1) - U(a_1)\big) = f(0) = 0.$$

On the contrary, if we lose, we have the sure regret

$$\boldsymbol{R(a_1|s_2)} = f\big(\, E(U(a_0)|s_2) - U(a_1)\big) = f(10 - 0) = f(10).$$

The total expected regret over action will be

$$R(a_1) = \frac{1}{4} * 0 + \frac{3}{4} * f(10) = \frac{3}{4} f(10)$$

The decision will be as follows:

$$a_c \succcurlyeq a_d \Leftrightarrow E\big(U(a_c) - R(a_c)\big) \geq E\big(U(a_d) - R(a_d)\big).$$

For a_0:

$$E\big(U(a_0)\big) - R(a_0) = 10 - \frac{1}{4} f(22)$$

For a_1:

$$E\big(U(a_1) - R(a_1)\big) = E\big(U(a_1)\big) - E\big(R(a_1)\big) = 10 - \frac{3}{4} f(10)$$

As extended expected utilities defined over action and inaction, depend on specification of the regret function, for individuals who have regret functions satisfying $f(22) > 3 * f(10)$, the preferred choice would be reversed if new information on color will be uncovered.

Thus, some of people with mentioned characteristics will prefer to participate in gamble, even though it's riskier than refusing to play. Our model uncovers a very interesting fact from real life: people can be forced to prefer action just by manipulating the information they receive. The information doesn't have to be true (for example), to make impact on choices - it's enough for the person just to believe in this information. However, that would be the grounds for a more complicated model and further development of the issue.

Chapter 4. Discussion and applications.

Choice is something people conduct every day, good choices make them better-off, bad choices do the opposite. In fact, uncovering the drivers for decisions may provide huge opportunities: the ability to manipulate how people react to deals. For instance, that would be very useful for marketing research (or the questions like "how to make to consumer buy the product").

Regret undoubtedly is one of such drivers, so it can be exploited to achieve the desired outcomes. Strictly speaking, that is exactly what postcode lotteries' advertisements like `Don't you have any tickets? Then your neighbors will win everything. So make sure that you buy some now!' (Zeelenberg, 1999) aim for - to make the consumer buy the ticket. What do advertisers exploit? The answer would be - the information. That is exactly what we have studied and captured in our model - the effect of available information on preferred choice.

Apart from the marketing area, regret has a considerable impact on healthcare services. The person who gets aware of the possible result of not taking the medical examination might switch to the choice of taking one (because the regret he will feel afterwards if he gets sick is so huge that even with low probability and high cost of examination it is able to change the decision).

Regret is not always used to manipulate in a 'bad' egoistic (like in consumers situation) way. Any one of us can remember the terrible images on the cigarette packs and photos of car crashes with drivers texting messages. Those advertisements aim at stimulating the feeling of regret that individuals might feel as a result of wrong choice to make them more likely to conduct the rights decision.

Our model has a few crucial positive features: it's intuitively easy to understand, it can be easily implemented as the restrictions imposed on functions are natural. We have taken the simplest version of information function, however it can be completely different and affect not only states of the world. Our aims were to show the possible reason for existing phenomenon of regret for inaction and to determine possible grounds for change in decisions when practically no real factor changed. We considered information to be the best possible explanation for mentioned empirical facts.

As any other model proposed to explain the existing occurrences, our is build upon a few assumptions that can be eliminated in later studies to make the predictions of the model more accurate: the restriction on the regret function of convexity, the absence of rejoice, the information function bringing about the set of probable states.

Our model reveals one very interesting phenomena - the power of information to change people's decisions not changing anything real. And that could be applied almost in every human-related sphere.

Chapter 5. Conclusion.

The main goals for this work was to demonstrate the existence of inaction effect in decision making process and to propose the new theory that would be able to accommodate both two existing effects of action and inaction. These two concepts constitute a single entity to be processed in human mind deciding upon options in uncertainty. We showed on the basis of existing literature that the effect of omission regret can even outweigh the effect of commission one which means that it has to be taken in account considering the decision-making procedure (otherwise the results might become misleading). To accomplish this phenomenon of inaction regret we proposed a new model that could explain risk-seeking decisions that are not justified by expected utility gained. We also have proved the significance of this modification, suggested the scope for potential application and mentioned several opportunities for further research and development.

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