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Take it or leave it: experimental evidence on the effect of time-limited offers on consumer behaviour

by Robert Sugden*
Mengjie Wang*
Daniel John Zizzo**

*School of Economics, CCP and CBESS, University of East Anglia
**Behavioural and Experimental Northeast Cluster and Newcastle University Business School

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In our experimental tasks, subjects choose among several offers in which one might be time-limited. We vary the time pressure level, the offer value and the occurrence timing of time-limited offers. We control the amount of feedback information that subjects get in various treatments and also subjects' degree of risk aversion. The experimental results show a strong tendency for subjects to choose time-limited offers. Feedback information has a significant impact on subjects' decisions. Subjects' decision quality shows no improvement with experience. Time-limited offers cause significant consumer welfare losses.

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C91, D03, D12, D18.

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Centre for Behavioural and Experimental Social Science
University of East Anglia
Norwich Research Park
Norwich NR4 7TJ
United Kingdom
www.uea.ac.uk/cbess

Take it or leave it: experimental evidence on the effect of time-limited offers on consumer behaviour*

Robert Sugden[1], Mengjie Wang[1], and Daniel John Zizzo[2]

[1]Centre for Behavioural and Experimental Social Science, Centre for Competition Policy, and School of Economics, University of East Anglia, Norwich NR4 7TJ, UK

[2]Behavioural and Experimental Northeast Cluster and Newcastle University Business School, Newcastle University, 5 Barrack Road, Newcastle upon Tyne NE1 4SE, UK

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*Corresponding author: Mengjie Wang (m.wang3@uea.ac.uk).
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1 Introduction

Time-limited offers are one of the most frequently applied pricing practices. A consumer survey launched by the OFT reports that almost 80 per cent of consumers has been exposed to time-limited offers within 12 months, one in six adverts in the reviewed newspaper contained a time-limited offer, and around two-thirds of the respondents who experienced time-limited pricing went on to purchase the offer (OFT, 2010b). This raises the question of whether, for given offers, the presence of a time limit makes consumers more likely to accept them. If this is the case, then it is important to understand the mechanisms by which time-limited offers influence consumers' behaviour and whether these offers can harm consumers by restricting their time for making rational decisions. Moreover, time-limited offers can reduce competition in the market by making it difficult for consumers to compare prices. In the context of regulation, it is important to know whether and how firms benefit from making time-limited offers, and if time-limited offers are anti-competitive. This article reports an experiment designed to throw some light on these questions.

Time-limited offers can influence consumer behaviour through three possible mechanisms. The first mechanism is pressure. There are two different kinds of pressure. One is the pressure of having to make a decision in a few seconds, rather than being able to think about it more carefully. The literature suggests that people will respond to time pressure by using various heuristics adaptively to maintain accuracy of the decision with less effort (Payne *et al.*, 1988). Under time pressure of this kind, people are found more likely to rely on the 'affect heuristic' to make judgements between risk and benefit (Finucane *et al.*, 2000). Payne *et al.* (1988) found in their experiment that under severe time pressure, subjects focused more on a subset of the information and changed their information processing strategies. Ben Zur and Breznitz (1981) asked subjects to choose between pairs of gambles under different levels of time pressure. They found that subjects tended to spend more time observing negative aspects under high time pressure, whereas they preferred observing positive dimensions when they were given sufficient time. Hence, subjects' choices became less risky under high time pressure.

The other kind of time pressure is 'information pressure', i.e. forcing the customer to make an accept/reject decision on the basis of limited information, rather than a full search. This kind of time-limited offer converts choice under certainty (finding the lowest price) into choice under uncertainty, and makes the uncertainty very salient. Armstrong and Zhou (2011) analysed sellers' incentives to use exploding offers or buy-now discounts to discriminate against customers who wish to investigated all rival offers [1]. They developed a sequential search model with

[1] An exploding offer is that a seller refuses to sell to a customer unless she buys immediately. A firm offering a buy-now discount tells the potential customer that she will pay a higher price if she decides to purchase at a later date. Both exploding offers and buy-now discounts encourage a potential customer to make a quick purchase decision without investigating other deals in the market (Armstrong and Zhou, 2011).

horizontally differentiated products with the assumption that firms are able to discriminate between customers visiting for the first time and returning visitors. The results show that both exploding offers and buy-now discounts may reduce the matching quality between consumers and products, and may also raise market prices. Huck and Wallace (OFT, 2010a) conducted an experiment to examine the impact of time-limited offers which use search costs to restrict consumers from observing the prices of other shops. No learning is found at all under time-limited offers, which means that subjects have difficulty to adjust their search strategies and improve their performance over time. Subjects also suffered big welfare losses.

Time-limited offers can generate both time pressure and information pressure by restricting consumers' available time and information to make decisions. The interaction between time pressure and information pressure might enhance the salience of the uncertainty of the decision task and activate heuristics which favour certainties. Therefore, this mechanism may induce a bias in consumer choice in favour of time-limited offers. So far, there has been surprisingly limited experimental study investigating the influence of both time pressure and information pressure on consumer behaviour. Compared to the experiment reported in Huck and Wallace (OFT, 2010a), our experiment considers both time constraints and information constraints of time-limited offers. Hence, the design of our experiment can provide valuable evidence of how time-limited offers affect consumer judgement and decision making through the mechanism of time pressure.

The second possible working mechanism of time-limited offers is feedback-conditional regret [2]. Regret theory proposes that people not only experience regret when the outcome of foregone options would have been better and rejoice when the outcome of the rejected option would have been worse, but can also anticipate these emotional consequences and take them into account when making decisions (Bell, 1982; Loomes and Sugden, 1982). Thus, when making decisions, people seek to minimize their future regret. A series of experimental studies has indicated that when people make choices under uncertainty, anticipated regret may promote risk avoiding tendencies (Simonson, 1992; Richard *et al.*, 1996). Recent research shows that outcome feedback on foregone acts has a profound influence on anticipated regret aversion and subsequent decision making. When the feedback on the foregone act is absent, there is no way for anticipated regret aversion to influence decision making (Zeelenberg, 1999). People also have the tendency to choose the action which can prevent them from getting positive feedback on the rejected option (Zeelenberg *et al.*, 1996).

[2] An important assumptions in regret theory is that people experience regret and rejoicing only by comparing 'what is' and 'what might have been'. Hence, a decision maker who can make the necessary comparison has the need to anticipate future regret only if there is explicit information on unchosen options (Zeelenberg, 1999). To accommodate the influence of outcome feedback on anticipated regret-aversion and rejoice-seeking in risky choice, Humphrey (2004) modified the original version of regret theory (Loomes and Sugden, 1982). The modified theory is called feedback-conditional regret

Feedback-conditional regret implies that by choosing a time-limited offer, people can avoid receiving feedback on unobserved offers which might cause them to regret their choices. Therefore, it is plausible that, through this mechanism, time-limited offers may bias consumers' decisions towards accepting those offers. To our knowledge, this is the first study taking into account the influence of feedback-conditional regret when analysing time-limited offers.

Risk aversion is the third possible mechanism by which time-limited offers may influence consumer decision making. Prospect theory tells us that people tend to be risk averse in the domain of sure gains and risk seeking in the domain of sure losses. Losses are also weighed more heavily than gains. There is a lot of evidence showing that people are willing to pay a premium to avoid risks of loss and to obtain sure gains (e.g. Kahneman and Tversky, 1979; Cicchetti and Dubin, 1994). Moreover, a growing literature reports that subjects show very high degrees of risk aversion when facing small-stakes gambles (e.g. Rabin, 2000; Cox and Sadiraj, 2006).

As information pressure converts consumers' choice under certainty into choice under uncertainty, a time-limited offer forces the consumer to make choices between a sure option (choosing the time-limited offer) and an uncertain option (rejecting the time-limited offer and waiting for the other offers). Also, the gains and losses that the consumers face are relatively small. Therefore, it is reasonable to believe that time-limited offers may able to exploit consumers' risk aversion.

Our experiments are designed to test the influence of time-limited offers on consumer behaviour by simulating this real-world problem of the consumer. In the experiment, the subjects need to choose one offer among several offers, one of which may or may not be time-limited. By changing the available time of time-limited offers, we are able to compare subjects' behaviour under different levels of time pressure. By varying the feedback information that subjects get between treatments, the experiment allows us to test whether a desire to avoid feedback-conditional regret motivates consumers to choose time-limited offers. It also provides a new setting to investigate the impact of feedback about consumers' previous choices on their later purchasing decision on whether to choose a time-limited offer or not. In addition, we also control for risk aversion.

Our results show that on aggregate, when time pressure is not extreme, consumers do choose time-limited offers more frequently than otherwise equivalent offers that are not time-limited. Both time pressure and information pressure can explain the high rate at which time-limited offers are chosen. Subjects' degree of risk aversion varies under different time pressure levels. Regret plays an important part in learning and causes subjects to choose more time-limited offers. Subjects' decision quality shows no improvement with experience. Hence, time-limited offers generate persistent consumer welfare losses. Our experimental results suggest that firms will be tempted to exploit consumers' bounded rationality by using time-limited offers. They may also use time-limited offers to prevent consumers from searching for the company with the lowest offer, thus reducing competition in the market.

The rest of the paper is organized as follows. Section 2 introduces the design and procedures of the experiment. Section 3 presents the hypotheses. A simple rational choice model is set up in Section 4 that explains how a rational decision maker would behave in our experimental setting. The results are reported in Section 5. Section 6 discusses the results and section 7 gives the conclusions.

2 Experimental design

2.1 Experimental procedures

The experiment contained two parts, part 1 with the Card task and part 2 with the Lottery task. At the beginning of each part, participants received a copy of the instructions for that part. Additionally, the experimenter read aloud the instructions. After this, participants had to complete a computerised questionnaire with the purpose of testing their understanding of the basic rules and tasks involved. If they made any mistake, the computer would show them the right answer and the related part of the instruction. They were also allowed to ask the experimenter for clarification. The formal experiment started after participants completed the questionnaire.

In part 1 of each session, each participant was required to complete 30 Card tasks (see Section 2.2 for details). In each task, participants were endowed with 10 *EP (Experimental Point)* as their initial budget and told that they had to buy one good out of 6 offer prices; their earnings from the task would be equal to the endowment minus the price of the chosen offer. None of the offer prices would be higher than the endowment. Thus, participants had an incentive to choose the offer with the lowest price.

Part 2 of each session contained 15 lottery tasks. Each lottery task required the participant to choose between a certain lottery and a risky lottery. By choosing Lottery 1, the certain lottery, the participant would get the amount of EP for sure. In contrast to Lottery 1, Lottery 2 had five possible outcomes with equal probability (20%). The participant had to choose one lottery in each task.

In order to incentivize the tasks, at the end of each session, the computer randomly selected two of the 30 Card tasks and one of the 15 Lottery tasks for real. Each participant's EP earnings from part 1 was the sum of their earnings in these two Card tasks. Their EP earnings from part 2 depended on their choice in the selected Lottery task and on which of the five outcomes was selected at random by the computer. If they chose Lottery 1, they earned the outcome of Lottery 1; if they chose Lottery 2, they earned the randomly selected outcome. The EP earnings of the two parts made up their final EP earnings from the session. Finally, they were paid at the exchange rate of £1 for every 2.5 EP.

2.2 Experimental design

Treatments

To allow us to investigate the impact of the feedback on decisions. Therefore, two feedback conditions were applied in the experiment, *NF (No feedback) treatment* and *RF (Regret feedback) Treatment*. Each session of the experiment was randomly assigned to one of these two treatments.

In the NF treatment, participants were not given any feedback other than the price of the chosen offer and the outcome of the chosen lottery. In the RF treatment, they were always provided with information about all the offer prices and the outcomes of both lotteries after they made the decision. Details about how these two treatments work will be given later. The experimental instructions can be found in Appendix A.

Part 1: Card task

The Card task was designed to investigate whether the time limits can affect consumers' decision on which offer to choose and whether their choices depend on the feedback they receive.

In each task, the participant has the chance to see 6 offer prices presented on 6 separate cards, 5 blue and 1 red. The offer price on each blue card was in the range from 0.00 to 10.00 EP; the offer price on the red card was in the range from 0.00 to 4.00 EP. All the prices were generated by the computer, and each price in the range was equally likely. During the task, these cards were turned over one by one to uncover the offer prices. The time interval between cards being turned over was fixed within each task, but might vary between tasks. Once a blue card was turned over, it would stay turned over. Therefore, offers on the blue cards were available to the participant throughout the task.

We manipulated the time pressure condition by using two different type of red cards, *standard red card* and *TL (time-limited) red card*. The offer on a standard red card was available throughout the task once the card was turn over, in the same way that a blue card offer was. However, the offer on a TL red card was available only for a certain number of seconds after it was turned over. When this time was out, the card was turned back and the offer could no longer be chose. Therefore, the participant had to decide whether to take the offer within these seconds. No more offers appeared until the TL red card was turned back. The level of time pressure was varied by differing the available time of the time-limited red card which was also the time interval between cards being turned over. The available time of the TL red cards was either 4 seconds (High time pressure) or 12 seconds (Low time pressure). Once the TL red card was turned over, there was a message below the card which told subjects the available time and a countdown clock reminding the subjects how many seconds were left before the TL red card would turn back.

The standard red cards were designed for two main control purposes. We set the offer prices on the TL red cards and standard red cards so that averaging over all tasks, the expected values of accepting and rejecting a TL offer were equal. To give the time-limited offer a sufficiently high expected value, we had to make the distribution of the offer prices on red cards better than that on blue cards. Hence, we used the standard red cards to control for the possibility that subjects chose the red card just because it was a special offer. Also, the mixture of tasks with standard red cards and TL red card would make the feeling of surprise of getting TL offers more salient.

In each session, 15 tasks with standard red cards and 15 tasks with TL red cards were randomly assigned to these 30 card tasks. Throughout these 15 tasks with TL red cards, 4 seconds TL red cards and 12 seconds TL red cards were almost evenly distributed [3]. The type of the red card could be discovered only when the red card in the task was turned over. In addition, the position of the red card was randomized, so that it could be the first, second, or third card in the task. This also increased the surprise element of getting TL offers.

In each task, subjects were allowed to pick any offer they liked at any time, apart from the offers on the TL red cards which could only be chosen within the time constraint. There was no cost to turning over the cards. Subjects could not move on to part 2 of the experiment until everyone had finished the 30 card tasks in part 1. So, subjects had nothing to gain by picking offers quickly. They were also told the distributions of offer prices on blue and red cards, and that there would always be 5 blue cards and one red card. Thus, they had all the information necessary for making rational decisions.

NF (No feedback) treatment. After each task, the offer price chosen by the participant was shown on the screen. This was the end of the task. If the participant chose an offer before all the cards were turned over, she could not get any information about the offer on the remaining cards.

RF (Regret feedback) treatment. After each task, if the participant chose an offer before all the cards were turned over, the remaining cards were then turned over to show her the offers on these cards along with the offer price she had actually chosen. In this way, we provided the

[3] As there were 15 tasks with TL reds, some subjects got seven 4 seconds TL red cards and eight 12 seconds TL red cards and the others got eight 4 seconds TL red cards and seven 12 seconds TL red cards.

participant with the chance to compare the offer she chose and the offer she could have chosen.

Part 2: Lottery task

In order to investigate the relationship between participants' choice under time pressure with their risk attitude, we need to have information about participants' risk attitudes. For that purpose we employed our lottery choice tasks.

The novel part of our lottery task is that we created an equivalent decision problem for each task the participant faced in the Card task, but in a different format. Each Card task with a TL red card had a corresponding lottery task. In each lottery task, the outcome of the certain lottery (Lottery 1) was designed to be the same as the payoff that the participant could get from choosing the TL red card. The expected value of the five outcomes of the risky lottery (Lottery 2) was approximately equal to the expected payoff that the participant could get from rejecting the time-limited red card in the matched Card task. These two values were designed to be as close as possible subject to certain constraints (e.g. rounding). The five outcomes of Lottery 2 also approximated the distribution of the payoff that participant could get from choosing the best remaining blue card.

NF (No feedback) treatment. If the participant chose Lottery 1 in the task selected for payment, her EP earning in part 2 would be the outcome of Lottery 1. If the chosen lottery was Lottery 2, then the computer would determine the outcome of that lottery by picking one of the five outcomes in that lottery at random.

RF (Regret feedback) treatment. The computer would first determine the outcome of Lottery 2 in that task. The result would then be shown to the participant no matter which lottery she chose in that task. If the participant chose Lottery 1 in that task, her EP earnings in this part would be the outcome of Lottery 1; the result of Lottery 2 would not affect her earnings. If the chosen lottery was Lottery 2 in that task, her EP earning would be the outcome already picked by the computer.

3 Hypotheses

Our experimental design allows us to investigate the effect of time-limited offers in different dimensions. In particular, we are interested in testing the following hypotheses. Hypotheses which consider subjects' chosen rate of time-limited offers and decision quality take expected utility theory with the assumption of risk neutrality as the baseline. Lottery tasks are used to control for subjects' risk attitudes.

Hypothesis 1: In aggregate, offers are more likely to be chosen if they are time-limited. The frequency with which subject choose time-limited offers is higher than the rational choice benchmark.

Hypothesis 1 implies that, when all offers are taken together, the probability that subjects choose time-limited offers is higher than the probability that they choose standard (red card) offers. We selected the parameters of the card tasks so that, in aggregate for a fully rational and risk-neural participant, the probability of choosing the TL offer and the probability of choosing the standard offer were both equal to 0.5. Because of the three working mechanism of time-limited offers, time-limited offers might exploit risk aversion which favours these offers. Therefore, it is reasonable to predict that subjects' chosen rate of time-limited offers may higher than it would be if they were both fully rational and risk neutral.

Hypothesis 2a: Subjects are more risk averse under time pressure than without time pressure.

Hypothesis 2b: Subjects are more risk averse under high time pressure than under low time pressure.

Hypotheses 2a and 2b provide tests of whether there is an interaction between time pressure and information pressure. Based on the analyses in section 1, we know that time-limited offers convert choice under certainty to choice under uncertainty. The interaction between time pressure and information pressure may enhance the salience of decision uncertainty and so exploit subjects' risk aversion by activating heuristics favouring certainties.

Hypothesis 3: Subjects are more likely to choose time-limited offers in the NF treatment than in the RF treatment.

In the NF treatment, subjects can always learn the payoff of picking the time-limited offer, but can learn the payoff of choosing the best remaining offer only if they reject the time-limited offer. Subjects may run the risk of regret from comparing outcomes if they reject the time-limited offer, but not if they choose the time-limited offer. As the NF treatment removes the regret associated with accepting the TL offer while keeping the regret associated with rejecting it, this allows an unambiguous prediction that feedback-conditional regret may cause people to choose the time-limited offers more often in the NF treatment.

Compared to the NF treatment, subjects in the RF treatment can get more feedback information about their accepted offer. They can learn whether the time-limited offer they accepted is the best among all the offers or worse than offers come after. Because one will always learn whether the non-chosen option would have resulted in a better outcome, possible regret is associated with both taking the time-limited offer and rejecting the time-limited offer. Therefore, the implications of regret theory for the RF treatment depend on the details of the task and on specific assumptions about the non-linearity of regret.

Hypothesis 4: When feedback information on previous choices is provided, subjects are more likely to choose the time-limited offer if in a previous decision they rejected a time-limited offer which ex post proved to be a good buy. Conversely, subjects are more likely to reject the time-limited offer if in a previous decision they accepted a time-limited offer which ex post proved to be a bad buy.

When consumers are given feedback information on their previous decisions, both anticipated regret and experienced regret can be evoked by the feedback of the chosen and unchosen offers. In both treatments, if they rejected a time-limited offer which ex post proved to be a good buy, they might feel regret. It might drive them to try to avoid making similar 'mistakes' of rejecting good time-limited offers, which would increase the probability that they chose time-limited offers from then on. They might also feel rejoicing if they rejected a bad time-limited offer. In the RF treatment, if they accepted a time-limited offer which ex post proved to be a bad buy, they might feel regret about picking this offer and choose less time-limited offers in later tasks. They might feel rejoicing if they accepted a good time-limited offer. Therefore, it is plausible that the feedback on consumers' previous choices will influence their subsequent decision making.

Hypothesis 5: The quality of subjects' decisions improves with experience.

As subjects gain more experience of dealing with time-limited offers over time, they are able to get a better intuitive understanding of the distribution of the prices and the features of the time-limited offers. They might become more experienced in calculating the cut off value for choosing the time-limited offers. By adjusting their expectation and decision strategies, subjects may be able to make better decisions.

4 Rational choice model

This section describes what a fully rational and risk neutral subject who knew the experimental environment would do in our card tasks setting. It serves as a rational benchmark which helps us to choose the parameters in the card task so that, for a risk neutral expected utility maximizer, the probability of choosing a red card is the same whether the card is time-limited or not, which makes our tests more powerful. The distributions of outcomes in the lottery task is matched to the distributions in the corresponding card tasks.

In order to make the model clearer and simpler, we assume that subjects have a linear utility function. It is normalised so that 0 is the utility of a payoff of 0 EP (i.e. paying the whole of the endowment) and 1 is the utility of 10 EP (i.e. paying a price of 0). More details on the model are provided in Appendix B.

As there are two types of red card in the Card task, the rational decision strategies are not the same between tasks with different types of red cards. First, we focus on how a fully rational risk neutral decision maker should behave in the task with a time-limited red card. If a subject chooses the time-limited offer, the task ends and the price of the time-limited offer is what she will pay. If a subject rejects a time-limited offer, she can pick any offer among the blue cards. If the subject knows the distribution of offers on the blue cards and how many of these cards remain to be turned over, she can calculate the utility she would receive from choosing the time-limited offer and the ex ante expected utility she would receive from choosing the best blue card offer. She can then precisely work out an optimal 'reservation price' for choosing the time-limited offer.

Let us consider a situation where a subject turns over a time-limited red card with offer value r, when m blue cards have already been turned over, the offer on the best of these cards is b, and there are n blue cards still left to be turned over. In this case, the subject's expected gain from choosing the time-limited red card is r, and her expected gain from rejecting the offer on the time-limited red card and choosing the best blue card offer is $\frac{n+b^{n+1}}{n+1}$. Hence, the optimal decision rule for a fully rational risk neutral individual is:

$$\begin{cases} \text{if } r > \frac{n+b^{n+1}}{n+1} & \textit{accept} \\ \text{if } r = \frac{n+b^{n+1}}{n+1} & \textit{indifference} \\ \text{if } r < \frac{n+b^{n+1}}{n+1} & \textit{reject} \end{cases}$$

Based on this optimal decision rule, the probability that a fully rational risk neutral agent chooses the time-limited offer is:

$$\Pr(\text{red card chosen}) = \begin{cases} [r(n+1)-n]^{\frac{m}{(n+1)}} & \text{If } m \geq 1 \text{ and } r \geq n/(n+1), \\ 1 & \text{If } m = 0 \text{ and } r \geq n/(n+1), \\ 0 & \text{If } r < n/(n+1). \end{cases} \tag{1}$$

Next, we move on to the tasks with standard red cards. In the task with a standard red card, the rational decision strategy is trivial, i.e. wait to the end of the task and choose the lowest price. Therefore, in a task with $m+n$ blue cards and one standard red card, the probability that a rational agent chooses the offer on the standard red card is:

$$\Pr(\text{red card chosen}) = r^{(m+n)} \tag{2}$$

Comparing formulas (1) and (2), we then know the difference between the probability that a rational agent chooses a time-limited offer and a standard offer under the same circumstance. When $r < n/(n+1)$, the optimal decision rule implies that a rational individual would never choose the red card with a time-limited offer, but with probability $r^{(m+n)}$ she would choose the red card with standard offer. When $m = 0$ and $r \geq n/(n+1)$, a rational individual would choose the time-limited offer for sure, but with the probability of $r^{(m+n)}$ she would still choose the standard red card with the same offer value. When $m \geq 1$ and $r \geq n/(n+1)$, the probability that a rational agent chooses a time-limited red card is always higher than the probability that she chooses a standard red card. This means that the probability that a rational agent chooses a time-limited offer is always higher than the probability that she chooses a standard offer if the offer value is higher than the expected value of the best of the remaining offers. Instead, a rational agent would always reject the time-limited offer with the offer value less than the expected value of the best of the remaining offers, but a standard red card with the same offer value could still be chosen with a positive probability.

The above analysis assumes risk neutrality. A risk averse individual would be more likely to choose the time-limited red card if the offer on the card was better than the best blue card so far, as the time-limited offer is a certain option and rejecting the offer is an uncertain option. Therefore, compared to the probability that a risk neutral agent chooses the time-limited offers as predicted by the rational decision model, a risk averse agent would be more likely to choose a time-limited offer when the offer is better than the best blue card so far. As noted earlier, our experiment controls for subjects' risk attitude by using the lottery tasks.

5 Results

The experiment was conducted in 14 sessions at the Centre for Behavioural and Experimental Social Science (CBESS) Laboratory at the University of East Anglia during the Summer of 2014. The experiment was programmed and conducted with the experimental software z-Tree (Fischbacher, 2007). Participants were recruited via email and the CBESS online recruitment system (Bock *et al.*, 2012). Altogether 209 participants (101 male and 108 female) participated in our experiment, 105 in the no feedback treatment and 104 in the regret feedback treatment. Most of the participants were students from a wide range of schools and with an age range from 18 to 55. The experiment lasted about 50 minutes. Average earnings were £10.43 per person. The lowest earning was £6.31, the highest was £11.82.

There are two sorts of decision mistakes that may occur in the Card task. The first is that subjects choose an offer on the red card which is not the best offer so far in the task. The second sort of decision mistake is missing the best offer in the task with standard red card because of not waiting until the end of the task. These mistakes could result from subjects' misunderstanding of the task or from impatience. Before we analyse the results of the experiment, we need to check that these two sorts of decision mistake could not influence the validity of our results.

Table 1 checks the first sort of decision mistake by red card types and treatments. In tasks with a red card which was not the best card among the cards that had been turned over so far, on average only 1.32 % of the choices per subject were the first sort of decision mistake, 1.98%

in the NF treatment and 0.65 % in the RF treatment. In addition, in 75.92% of the tasks with standard rad cards, subjects waited until the very end of the tasks. Overall, these results prove subjects' good understanding and patience with respect to the task.

Table 1: Decision mistake rate

	Standard	Time-limited	Total
	%	%	%
NF	1.52	2.39	1.98
RF	0.20	1.29	0.65
Overall	0.88	1.84	1.32

> **Result 1**: In aggregate, time-limited offers are more likely to be chosen than standard offers. Moreover, the chosen rate of time-limited offers is higher under low time pressure than under high time pressure. Subjects also suffered significant welfare losses in the tasks with time-limited offers.

Based on the rational choice model, the experiment was designed so that in aggregate, the chosen rate of standard and time-limited offers should both be equal to 0.5 if subjects are risk neutral expected utility maximizers. Because of the randomization in the experimental design, it turned out that for fully rational risk neutral subjects, the chosen rate of the standard offers would be 49.05% and the chosen rate of the time-limited offers would be 49.76%.

The rates at which subjects chose standard and time-limited offers in the NF and RF treatments are reported in Table 2. These rates are calculated by excluding data from tasks in which the offer on the red card was dominated by the offer on the best blue card so far. The average choice rate for time-limited red cards (55.26%) is higher than that for standard red cards (51.77%), and is statistically significant at the $p< 0.05$ level[4] using a Wilcoxon Signed-Rank test. This evidence supports Hypothesis 1. However, it also shows that the difference mainly comes from the RF treatment. In the NF treatment, the choice rate for time-limited red cards is higher than that for standard red cards by less than 2 percentage points. In the RF treatment, this difference goes up to around 5 percentage points and is significant ($p < 0.05$ in a Wilcoxon Signed-Rank test). This finding is contrary to Hypothesis 3 which predicts that the choice rate for time-limited offers would be higher in the NF treatment than in the RF treatment.

Table 3 reports the average choice rates for time-limited offers under different time pressure levels. These average choice rates are significantly higher under low time pressure than under high time pressure ($p < 0.001$ in a Wilcoxon Signed-Rank test). From Table 3, we can see that

[4]Throughout the paper, all the reported bivariate tests are two-sided. All tests are at the level of individual subjects (using individual-level averages when needed to control for non-independence of observations by the same subjects).

Table 2: The choice rates for the two types of red card by treatment

	Standard	Time-limited	
	%	%	*p-value*
NF	51.62	53.23	0.371
RF	51.87	56.71	0.018
Overall	51.74	54.96	0.021

subjects chose significantly more time-limited offers than the standard offers under low time pressure. Under high time pressure, the choice rate for time-limited offers is quite close to that for standard offers. These features are observed in both treatments. This result explains why we did not find a significant difference in Table 2 between the choice rates for time-limited and standard offers in the NF treatment.

Table 3: The choice rates for time-limited offers by time pressure levels

	high time pressure (4s)	low time pressure (12s)	
	%	%	*p-value*
NF	48.27	58.44	0.001
RF	51.28	62.17	0.001
Overall	49.77	60.30	0.001

Table 4 reports the average values of subjects' accepted offers and the standard deviations for tasks with different red card types for both treatments. According to our rational benchmark, the mean value of the chosen offers in the tasks with time-limited red cards should be higher than in the tasks with standard red cards in both treatments. This implies that information pressure would make the subjects worse off even if they were fully rational and risk neutral and were allowed to make decisions without time constraints. Our result shows that overall, the difference between the average values of subjects' chosen offers in the tasks with time-limited red cards and in the tasks with standard red cards is highly significant in a Wilcoxon Signed-Rank test ($p < 0.001$). This finding indicates that subjects suffered significant welfare losses in the tasks with time-limited offers, compared to the payoffs they got in the tasks with standard offers. No significant difference in mean values of accepted offers shows between the NF treatment and the RF treatment.

Table 4: Average value of chosen offers by treatments

	Standard		Time-limited	
	Mean	Std. dev	Mean	Std. dev
Actual choices				
NF	1.204	0.369	1.507	0.395
RF	1.176	0.283	1.513	0.377
Overall	1.190	0.330	1.510	0.385
Rational benchmark				
NF	1.100	0.245	1.383	0.332
RF	1.124	0.242	1.373	0.318
Overall	1.112	0.243	1.378	0.324

Result 2: In aggregate, subjects showed risk averse in the tasks with time-limited offers under low time pressure, while being risk seeking under high time pressure.

By comparing subjects' risk attitudes as shown in the lottery tasks and in the card tasks, we can investigate how the time pressure influences their decisions and how this relates to their risk attitude.

To calculate subjects' risk attitude, we need to make some assumptions. First, we assume that all individuals have the same Constant Relative Risk Aversion (CRRA) utility function:

$$\begin{aligned} U(x) &= \frac{x^{1-r}}{1-r}, \quad r \neq 1 \\ &= \ln(x), \quad r = 1 \end{aligned} \tag{3}$$

The parameter r is the coefficient of relative risk aversion. The higher is r, the more risk averse the subject. Negative r indicates risk-seeking. Second, we assume that individuals maximise expected utility. Third, when an individual computes the Expected Utility difference, they make a computational error e, where $e \sim N(0, \sigma^2)$.

We estimated subjects' utility function from their choices in the lottery tasks and their choices in the card tasks using structural maximum likelihood methods. Our previous finding suggests that subjects behave differently under high time pressure and low time pressure in the card tasks. Therefore, we estimated the utility function separately for these two situations. The estimation results are shown in Table 5.

Table 5: Subjects' risk attitude

	Lottery tasks	Card tasks	
		(4s)	(12s)
$\hat{r}$	0.443	-0.629	1.363
$\hat{\sigma}$	0.282	3.605	0.052

The results indicate that when subjects face the time-limited offers under low time pressure, the degree of risk aversion that they show in their choices is much greater than when this same task is presented without time pressure. When subjects face the card tasks having only 4 seconds, the negative $\hat{r}$ shown in Table 5 suggests they become risk-loving. We also can see from the results that under high time pressure, the estimated computational error term $\hat{\sigma}$ is much higher than under low time pressure. This indicates that subjects' choices are quite unstable under high time pressure, but very stable under low time pressure.

> **Result 3**: In aggregate, subjects' decisions are biased in favour of choosing time-limited offers, especially under low time pressure.

There are generally two types of decision biases subjects can make in this experiment: the bias toward choosing the offers on the red cards and the bias toward rejecting the offers on the red cards. The bias toward choosing the offers on the red cards occurs when a consumer chooses an offer on the red card which should not be chosen by a fully rational risk neutral consumer. On the other hand, the bias toward rejecting the offers on the red cards occurs when a consumer rejects an offer on the red card which should be chosen according to the rational prediction.

Table 6 summaries the subjects' average decision bias rate by the types of bias [5]. In Panel 6a, We observe significantly more decision biases toward choosing time-limited offers than decision biases toward rejecting time-limited offers in the NF treatment (e.g., p=0.018 in a Wilcoxon Signed-Rank test) and the RF treatment (e.g., p<0.001 in a Wilcoxon Signed-Rank test). It means that subjects are more likely to be biased in favour of choosing the time-limited offers.

Panel 6b reports subjects' average choosing bias rate and rejecting bias rate under low time pressure and under high time pressure. On average, subjects' choosing bias rate is 14.17% in the tasks with time-limited offers which are available for 12 seconds, which is significantly higher than subjects' rejecting bias rate (5.40%) at p<0.001 level in a Wilcoxon Signed-Rank test. In the tasks with time-limited offers which are available for 4 seconds, no significant difference between choosing bias rate and rejecting bias rate is found in the NF treatment (e.g., p=0.352 in a Wilcoxon Signed-Rank test) and the difference is only marginally significant in

[5] In these 30 tasks, 15 of them are with standard red cards and 15 of them with time-limited red cards. The calculation of this table takes into account only the tasks with red cards having offer values which are the best among these offers that have already been seen.

the RF treatment (e.g., p=0.098 in a Wilcoxon Signed-Rank test) . As the time pressure level increases from low to high, the choosing bias rate decreases and the rejecting bias rate increases. This explains the results we find in Table 3 that subjects choose less time-limited offers under high time pressure than under low time pressure.

Table 6: Summary of the decision bias

(a) The decision bias rate by treatment

	NF	RF	Overall
Choosing bias	11.14%	13.52%	12.33%
Rejecting bias	7.84%	6.30%	7.07%
Difference	3.30%**	7.22%†	5.26%†

(b) The decision bias rate by time pressure levels

	Low	High
Choosing bias	14.17%	10.57%
Rejecting bias	5.40%	8.61%
Difference	8.77%†	1.96%*

Notes: $*$ 10% level, $**$ 5% level, and † 0.1 % level

Figure 1 displays the kernel density estimation of these two types of decision bias. It tells the relationship between decision bias and the offer value on the red cards. The curve representing 'rejecting bias' peaks around the point 1.3. The 'choosing bias', on the other hand, is more frequently shown between value 1.7 and 3. The results indicates that two main findings. First, offer prices around the average offer value are the most confusing prices to the consumer relative to other offer values. Second, they indicate that subjects are more likely to make a choosing bias when the offer prices on the red cards are above average but not too good, while they are more vulnerable to rejecting bias when the offer prices are below average but not too bad.

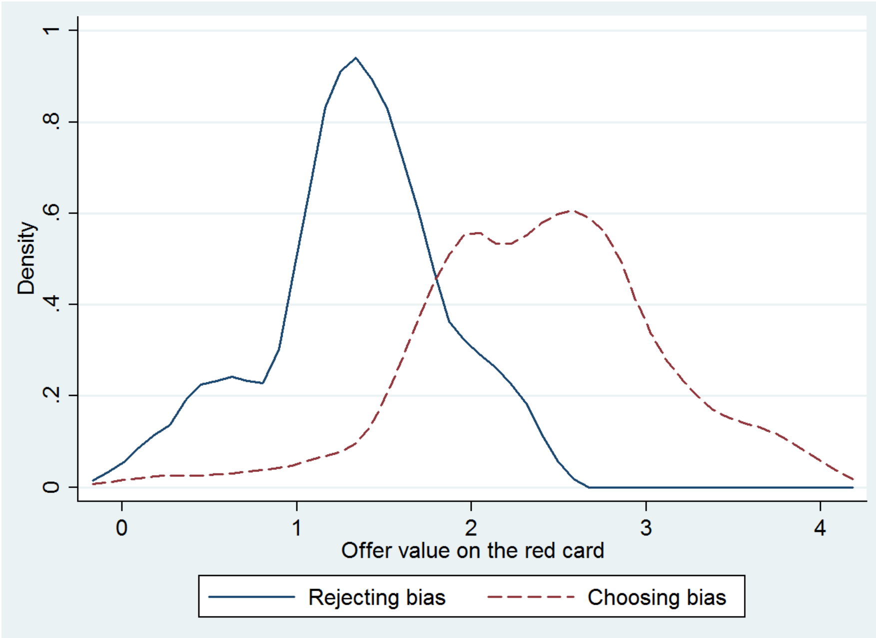

Figure 1: Density of subjects' decision bias over time-limited offer value

> **Result 4**: On average, subjects suffer persistent welfare loss. There is no evidence to support the hypothesis that subjects' decision bias rates decrease as experience in dealing with time-limited offers increases.

Figure 2 compares the mean values of subjects' chosen offers between tasks with standard red cards and tasks with time-limited red cards over the 30 periods of the experiment. The solid lowess smooth line shows the mean values of subjects' chosen offers in the tasks with standard red cards. The dashed lowess smooth line shows the mean values of subjects' chosen offers in the tasks with time-limited red cards.

Several important preliminary findings can be obtained from Figure 2. First of all, the mean values of subjects' chosen offers in the tasks with time-limited offers are significantly higher than the mean values of subjects' chosen offers in the tasks with standard red cards over all 30 periods. Second, the distances between the mean values of subjects' chosen offers in these two type of card tasks does not vanish overtime and even gets larger after 20 periods. In addition, no significant difference between the mean values of the chosen offers under low time pressure and the mean values of the chosen offers under high time pressure over the 30 periods is found. These findings confirm the results shown in Table 4 that subjects were overall worse off in the tasks with time-limited offers than in the tasks with standard red cards. Decisions did not get better as subjects gained more experience of dealing with the time-limited offers.

Figure 2: Mean values of the chosen offers over time

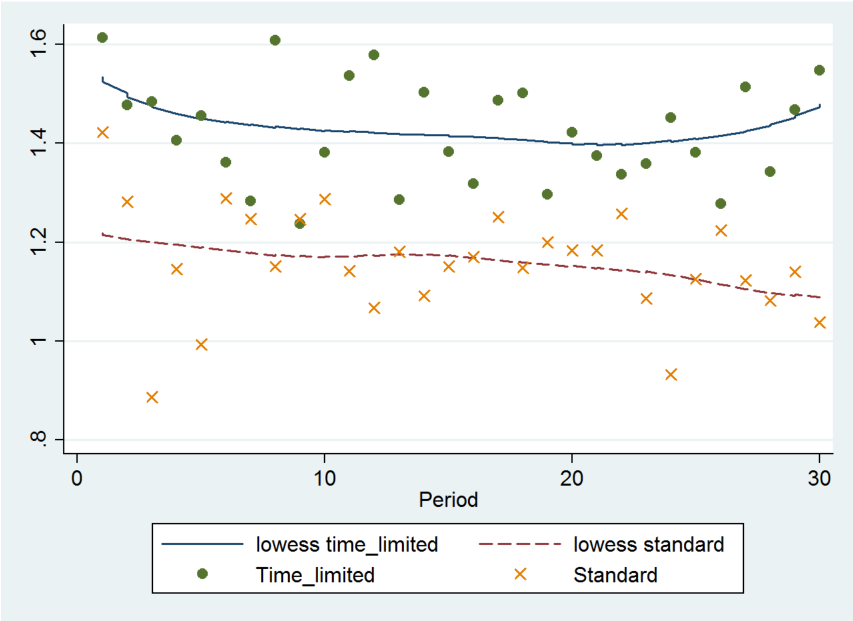

Table 7 helps us to get some further ideas on how subjects' decisions change with their experience. In Panel 7a, we calculate the subjects' total payment for chosen offers in the first, second, and third 10 periods both in the tasks with only standard offers and in the tasks with only time-limited offers. Subjects' welfare loss is defined as the difference between subjects' payment in the tasks with standard offers and in the tasks with time-limited offers. It can be seen that on average this difference is stable among the three sets of periods, which indicates that subjects did not get better over time as they gained more experience of dealing with these offers. We then examine the differences in welfare loss among these three sets of periods using Wilcoxon Signed-Rank tests. The result in Panel 7b shows that the changes in subjects' welfare loss over time are not significant. This evidence supports the finding in Panel 7a that subjects suffer persistent welfare loss.

Table 7: Summary of subjects' welfare loss overtime

(a) Welfare loss across first, second, and third sets of the experimental periods

	First	Second	Third
Time-limited	7.104	7.329	6.916
Standard	6.031	5.674	5.687
Welfare loss	1.073†	1.430†	1.417†

(b) Welfare loss: Wilcoxon Signed-Rank test p-value matrix

	First	Second	Third
First		0.502	0.447
Second			0.934
Third			

Notes: In panel (a), † 0.1% level.

Turning to decision bias, Panel 8a in Table 8 shows averages choosing bias, rejecting bias and total decision bias in the first, second, and third 10 periods. No decrease in subjects' choosing bias rate or rejecting bias rate is found overtime. Compared to the first 10 periods, subjects' choosing bias rate even increased in the second and third 10 periods. The results shown in Panel 8b also suggest that there is no significant decrease in subjects' decision bias rate over these 30 periods. Therefore, no evidence is found to support Hypothesis 5 that subjects' decision quality improves overtime.

Table 8: Summary of subjects' decision bias overtime

(a) Decision bias across first, second, and third parts of the experimental periods

	First	Second	Third
Choosing bias	11.74%	12.23%	13.97%
Rejecting bias	7.55%	6.73%	8.91%
Total bias	19.29%	18.96%	22.88%

(b) Total decision bias : Wilcoxon Signed-Rank test p-value matrix

	First	Second	Third
First		0.906	0.186
Second			0.476
Third			

Result 5: The regret of missing a good time-limited offer in the previous period increases the subjects' red card choice probability, while the feeling of regret on choosing a bad time-limited offer has the opposite effect. However, subjects put more weight on the regret from making bad decisions than on the rejoicing from making good decisions.

In order to further explore the determinants of the choice of the time-limited offers, especially the effect of feedback information on subjects' decisions, we regress subjects' decisions on whether to choose the red card or not on a set of variables. We employ three Logit models that assume subject-level random effects for the error term. These models include not only variables that affect the expected utility difference between accepting and rejecting the red card, but also variables meant to capture how subjects' decisions evolve over time based on their previous choices. We estimated one model for the overall data (model (1)) and two separate models for the NF and RF treatment data (model (2) and (3)). We take account only of tasks with time-limited red cards and where the offers on the red cards are better than the offer on the best previous blue card.

In model (1), *Treatment* is a dummy equal to 1 if subjects are in the RF treatment sessions. *Period* represents the time period. *Offer value* represents the offer value on the red card. *Available time* is a dummy equal to 1 when the time-limited offer is available for 12 seconds. *Position* controls for the position of the red card, equal to 1, 2, or 3 depending on whether it is the first, second, or the third card respectively. *Lag MG* is the percentage of subjects' missed good time-limited offers in previous periods. *Lag MB* is the percentage of subjects' missed bad time-limited offers [6]in previous periods. Table 9 shows the results of these three regression models, including the coefficients and the marginal effects.

In model (1) for the aggregate data, there is strong evidence that the position of the red card positively affects subjects' decisions about whether to choose the offer on it. For a given offer value, a time-limited offer is more likely to be chosen if it comes later. This finding is in line with the rational choice benchmark. The available time shows a strong positive effect on the red card chosen. This is consistent with our previous findings that subjects choose more time-limited offers under low time pressure than high time pressure. The coefficient of variable *Lag MG* is significant and positive, while the coefficient of variable *Lag MB* is negative but not significant. In line with our Hypothesis 4, subjects are more likely to choose a time-limited offer if in previous decisions they have rejected some good time-limited offers. Rejecting bad time-limited offers in the previous decision seems to reduce the probability that subjects choose time-limited offer, but this effect is not significant. This suggests that the influence of regret of missing a good time-limited offer is much greater than rejoicing of rejecting a bad time-limited offer. The results of model (2), which is for the NF treatment are in line with model (1).

As in the RF treatment, subjects are always provided with information about all the offers, so they can learn from the feedback about whether the offer they have chosen is the best offer among all the offers, especially among the offers they have not seen before they made the decision. Therefore, we include *Lag CG* and *Lag CB* in model (3). *Lag CG* is the percentage of good time-limited offers that subjects have chosen in the previous periods. *Lag CG* is the percentage of bad time-limited offers that subjects have chosen in the previous periods. The results of model (3) show that the coefficient of *Lag CB* is strongly negative. This confirms that the higher the proportion of bad time-limited red cards they have chosen in the previous rounds, the less likely that they decide to choose one afterwards. It is interesting to see that only the coefficients of *Lag MG* and *Lag CB* are statistically significant. This indicates that subjects put more decision weight on the regret of missing a good time-limited offer and choosing a bad time-limited offer than on the rejoicing of making good decisions in the past.

[6] Good time-limited offers are these where the time-limited offer is the best one among all the offers received so far. Bad time-limited offer are these where the time-limited offer is worse than the offers received afterwards

Table 9: Estimation for time limited offer

	(1) Overall		(2) NF		(3) RF	
	β / SE	ME	β / SE	ME	β / SE	ME
Treatment	0.292	0.070	–	–	–	–
	(0.183)	(0.044)	–	–	–	–
Offer value	−2.122†	−0.512†	−2.405†	−0.593†	−1.983†	−0.464†
	(0.090)	(0.022)	(0.149)	(0.037)	(0.117)	(0.028)
Position	0.383†	0.092†	0.426†	0.105†	0.364†	0.085†
	(0.077)	(0.019)	(0.114)	(0.028)	(0.109)	(0.025)
Available time	0.080†	0.019†	0.071***	0.017***	0.092†	0.022†
	(0.016)	(0.004)	(0.024)	(0.006)	(0.022)	(0.005)
Lag MG	2.044†	0.493†	2.721†	0.670†	1.582†	0.371†
	(0.284)	(0.068)	(0.456)	(0.112)	(0.373)	(0.087)
Lag MB	−0.055	−0.013	−0.149	−0.037	0.010	0.002
	(0.228)	(0.055)	(0.355)	(0.087)	(0.307)	(0.072)
Lag CB	–	–	–	–	−1.103***	−0.258***
	–	–	–	–	(0.382)	(0.089)
Lag CG	–	–	–	–	0.293	0.069
	–	–	–	–	(0.349)	(0.082)
Period	0.002	0.000	0.003	0.001	0.004	0.001
	(0.009)	(0.002)	(0.013)	(0.003)	(0.013)	(0.003)
Constant	2.326†	–	2.741†	–	2.573†	–
	(0.295)	–	(0.442)	–	(0.419)	–
lnsig2u	−0.058	–	0.428	–	−0.523	–
	(0.211)	–	(0.264)	–	(0.365)	–
Observations	2475		1257		1218	
LR chi2	566.399		268.400		292.549	
Prob > chi2	0.000		0.000		0.000	
Baseline predicted probability	0.184		0.037		0.345	

$*$ 10% level, $**$ 5% level, $***$ 1% level, † 0.1 % level. Cluster-robust standard errors in parentheses. **Notes**: The dependent variable in these three models is a dummy equal to 1 if the subject chose the time-limited offer and 0 if the subject rejected the time-limited offer in the task. We used panel data to estimate all these models. The data used to estimate model 2 contains 2571 observations from 105 subjects. The data used to estimate model 3 contains 2546 observations from 104 subjects. For each model, the left column contains coefficients, and the right column report marginal effects. Results for all three models are based on random effects logit estimations in which subject-specific random effects are controlled.

6 Discussion

This paper differs from previous studies of time-limited offers (e.g. OFT, 2010a; Armstrong and Zhou, 2011) by proposing the testing three possible working mechanism of time-limited offers. A rational decision model is derived to identify how a risk-neutral expected utility maximizing subject would make choices in our experimental setting. Our lottery tasks allowed us to identify the role of risk attitudes.

Our key finding is that in aggregate, subjects chose more time-limited offers than standard offers. In addition, subjects' payoffs were significantly lower in the tasks with time-limited offer than in the tasks without.

Placing a time limit on an offer has two effects. One effect is that it forces a consumer to make a decision about that offer without knowing the values of all the other offers. Because this 'information pressure' limits the information that the consumer can use to make a rational decision, time-limited offers can be expected to make consumers worse off no matter how rational they are.

The second effect is that time-limited offers put consumers under time pressure. In our experiment, we varied the available time of the time-limited offer to test the influence of different levels of time pressure on subjects' choices. Ben Zur and Breznitz (1981) found that subjects spent more time observing negative aspects under high time pressure, which caused them become more risk averse. As noted above, time-limited offers also cause information pressure which converts choice under certainty into choice under uncertainty and makes the uncertainty very salient. Putting consumers under time pressure might add to this effect of information pressure by activating decision heuristics which favour certainties. Our results showed that under low time pressure, subjects did become more risk averse. Subjects' degree of risk aversion was higher than in their lottery choices. Their decisions were biased in favour of choosing the time-limited offer which provided them with certainty and a sure payoff. However, putting the subjects under extreme time pressure did not make this effect stronger. Instead, subjects' choices became risk loving and less unstable; the degree of bias towards accepting time-limited offers reduced. It may because that under high time pressure, subjects might see choosing the time-limited offer as a sure payment out of their endowment, so they became risk loving in order to avoid sure loss, especially when the time-limited offer was not particularly good.

Can feedback-conditional regret influence subjects' decision on whether to choose the time-limited offer? Our experimental design allowed us to investigate the influence of feedback conditional regret on subjects' decisions. In the NF treatment, subjects always learned the payoff of picking the time-limited offer, but not the payoff that they could get by choosing the best remaining offer unless they rejected the time-limited offer. Evidence shows that people have the tendency to choose the action which can prevent them from getting feedback on the rejected option (e.g. Zeelenberg *et al.*, 1996; Ritov, 1996). So, it is plausible that subjects in the NF treatment would prefer choosing the time-limited offer to avoid getting positive feedback on how much more they could get by rejecting the time-limited offer. However, our results showed that in the RF treatment, subjects chose slightly more time-limited offers than they did in the NF treatment under both high time pressure and low time pressure. This is evidence against the regret feedback hypothesis. One possible explanation for this result is that in the NF treatment, subjects wanted to receive feedback on the other offers. Although feedback conditional regret indicates that people are reluctant to choose the option which might yield regret, there is still evidence showing that people desired to receive feedback on foregone options (Zeelenberg *et al.*, 1996). Van Dijk and Zeelenberg (2007) demonstrate that when people make decision under uncertainty, their curiosity about the uncertain situations may overcome regret aversion. In addition, subjects in our experiment were asked to make repeated decisions. Subjects might believe that getting the feedback information on forgone offers may help them to get a better sense of the distribution of the offer prices and, therefore they could make better decision overtime.

Did subjects learn to make better decisions overtime? In both treatments, the continual turning over of cards allowed subjects to observe realisations of the random processes that determined offer prices. Subjects also received either partial feedback information or full feedback information on their decisions. Therefore, one might have expected the quality of subjects' decisions to increase as they became more experienced in dealing with time-limited offers. However, our results indicated that their decision biases did not decrease over time. Although no evidence was found to support the feedback-conditional regret hypothesis, the results of the regression models indicate that regret played an important part in learning. Subjects were influenced by the regret of missing good time-limited offers and choosing bad good ones. Also, the rejoicing of choosing good time-limited offers and rejecting bad ones affected subjects' decisions. Evidence indicated that subjects gave greater weight to anticipated regret than to anticipated rejoicing when making decisions (see also Beattie *et al.*, 1994; Larrick and Boles, 1995; Zeelenberg *et al.*, 1996). The anticipated regret of missing good time-limited offers was also given more weight than the anticipated regret of choosing bad good time-limited offers, which induced subjects to choose more time-limited offers afterwards. As a result, the welfare losses that subjects suffered in the task with time-limited offers were persistent.

The results of our experiment send a clear warning message to policy makers that we should be concerned about the use of time-limited offers by firms. Time-limited offers restrict consumers' opportunities to search for the lowest prices of products, and therefore are likely to cause significant welfare losses. Forcing consumers to make decisions with limited information under time pressure makes consumers vulnerable to errors induced by the use of decision heuristics which favour accepting time-limited offers. Firms which use time-limited offers may try to exploit consumers' risk aversion which also favours time-limited offers. Moreover, subjects' in our experiment failed to improve their decisions over time, even though they were provided with full feedback for learning. Hence, they suffered persistent welfare losses. It is reasonable to believe that consumers may make even worse decisions when they lack good feedback or have no opportunity to learn. In addition, because time-limited offers make consumers less likely to choose the lowest prices in the market, we expect them to reduce price competition. Thus the general practice of using such offers might lead to anti-competitive effects.

7 Conclusion

In this paper, we present an experimental study on the influence of time-limited offers on consumer behaviour. In our experiment, subjects chose among several offers in which one might be a time-limited offer. Our experimental design allowed us to check the three possible working mechanism of time-limited offers: time pressure, feedback conditional regret and risk aversion.

Overall, the evidence shows that in aggregate consumers are more likely to choose time-limited offers than standard offers. When consumers have limited time and information to make rational decision, they are biased in favour of choosing time-limited offers. This bias generates significant consumer welfare losses. Also, consumers cannot efficiently learn to make better decisions even though they are given full feedback on their previous decisions. Therefore, these welfare losses are persistent.

Time-limited offers restrict consumers' ability to search for the lowest price of a product and risk having anti-competitive effects. By forcing consumers to make decisions with limited information under time pressure, these offers are detrimental in making consumers vulnerable to errors induced by the use of decision heuristics. Policy makers should take these effects into account when assessing the use of time-limited offers by firms.

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Appendix A

The instructions below were used in the experiment.

Instructions

Welcome to today's experiment and thanks for coming. In this experiment, you will need to make a series of choices. You will receive your earnings from this experiment at the end.

I shall say more about what will be involved in the experiment soon. Before I do this, I need to set some ground rules, which you must all observe. There must be no talking during the experiment unless you want to ask a question. In this case, simply raise your hand and I will come to you. You must not attempt to look at what other people are doing.

Please keep to these simple rules, because anyone breaking them may be asked to leave the experiment without payment.

I will now describe the nature of the tasks within the experiment.

Tasks

This experiment contains two parts. In both parts, you can earn a certain number of experimental points depending on the decision you made. At the end of the experiment, these points may be converted to money earnings. Details will be given later. You will be paid the sum of your money earnings in these two parts.

Part 1

In Part 1, there are 30 tasks. In each task, you will be given 10 points as your initial budget, and your job is to buy a good with these points. You will have the chance to see 6 offer prices for this good. All these prices range from 0.00 to 10.00 points. Therefore, none of them will exceed your initial budget.

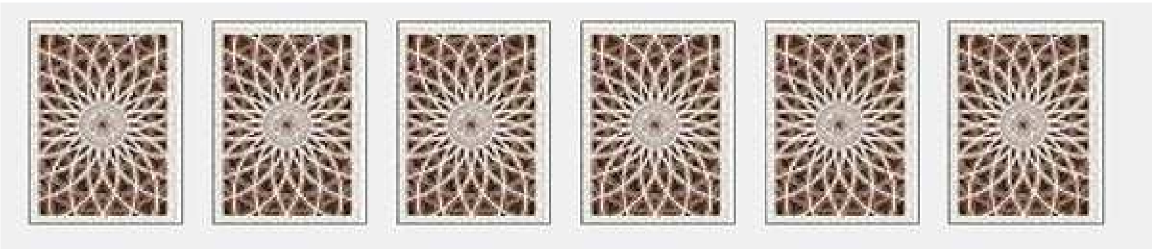
During the task, you need to choose one of these offer prices. The price of your chosen offer is what you will pay. Your point earnings will be equal to 10 points minus this price. Please remember that you cannot keep all these 10 points as your earnings, because you always have to choose one offer price in each task.

Now, I am going to describe the offer prices in detail.

In each task, these 6 offer prices will be presented on 6 separate cards, 5 blue and 1 red. The offer price on each blue card will be in the range from 0.00 to 10.00 points. The actual price for each blue card will be generated randomly by the computer. Each price in the range will be equally likely. The offer price on the red card will be in the range from 0.00 to 4.00 points.

The actual price will be generated randomly by the computer. Each price in the range will be equally likely.

At the beginning of each task you will only be able to see the backs of these 6 cards. You will not know which card is the red card. The picture below shows you how the screen will look.



As time goes on, cards will be turned over one by one in order from left to right. The time interval between cards being turned over will be fixed within each task, but may vary between tasks.

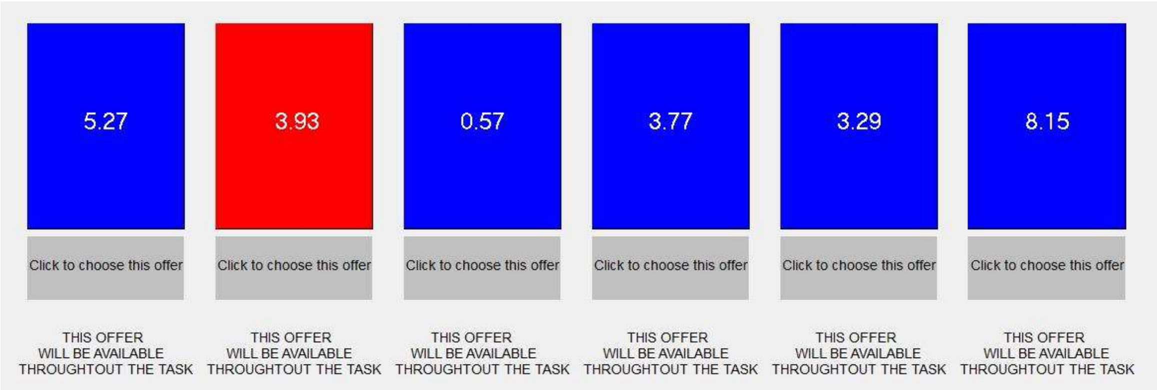
Once a blue card is turned over, it will stay turned over. This means that the offer on the card will stay available throughout the task.

There are two types of red card. One is called a standard red card. Once a standard red card is turned over, it will stay turned over, in the same way that a blue card does, and so the offer on the card will stay available throughout the task. The other type of red card is called a time-limited red card. The offer on a time-limited red card will be available only for a certain number of seconds. When this time is out, the card will be turned back. Once it is turned back, you cannot choose that offer any more.

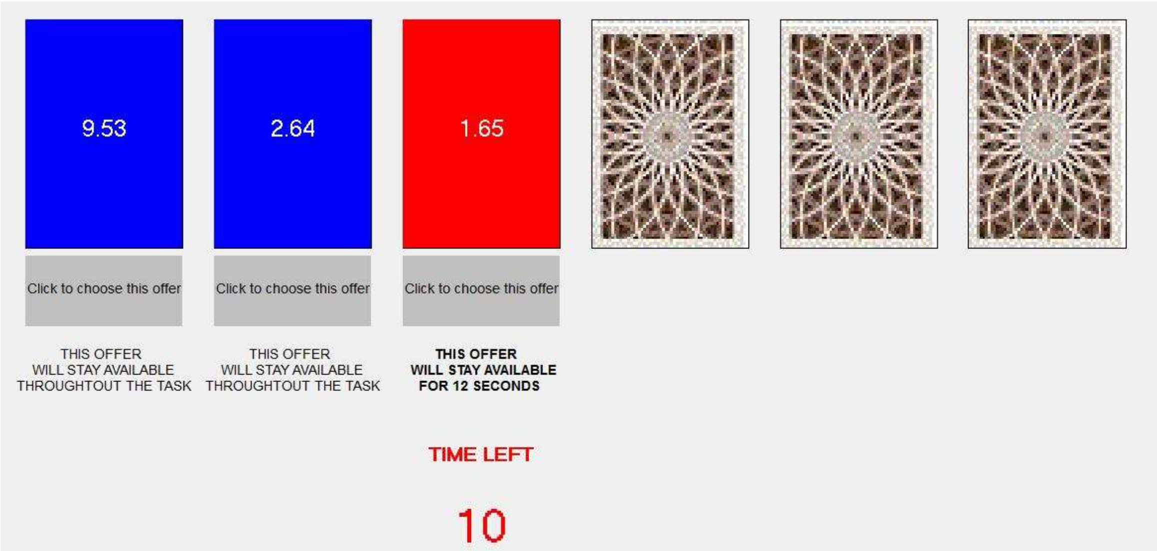
Until the red card is turned over, you will not know whether it is a standard red card or a time-limited red card. You will discover this only when the card is turned over. As shown in the example below, the message under the red card will tell you which type of card it is.

If the message below the red card says 'offer available throughout the task', this means that it is a standard red card. The picture below is an example of this type of red card and the corresponding message.

The picture below is an example of how the standard red card looks if you wait until the very end of the task before choosing an offer.



If the message under the red card says 'offer available for x seconds', this means that it is a time-limited red card and will be turned back after these x seconds. There will be a countdown clock below the message reminding you how many seconds are left before it will be turned back. The picture below is an example of this type of red card, the message, and the countdown clock.



The picture below shows how the time-limited red card looks after it is turned back, if you wait until the very end of the task before choosing an offer.

So if you meet a time-limited red card, you need to decide whether to choose the offer on the card before it is turned back.

[**For *NF (No feedback)* treatment**]

To choose an offer, you need to click the grey button with the words 'Click to choose this offer' on it below the card that you want to choose. If you accept an offer, the task ends. The offer price on the card you picked will then be shown on the screen. This is the final price you have chosen to pay for the good in the task. After you click the 'Next task' button below this price, the computer will move on to the next task.

[**For *RF (Regret feedback)* treatment**]

To choose an offer, you need to click the grey button with the words 'Click to choose this offer' on it below the card that you want to choose. If you accept an offer, the task ends. If you chose an offer before all the cards are turned over, the remaining cards will then be turned over to show you the offers on these cards. You will not be able to change your decision at this stage. The offer price on the card you picked will then be shown on the screen. This is the final price you have chosen to pay for the good in the task.

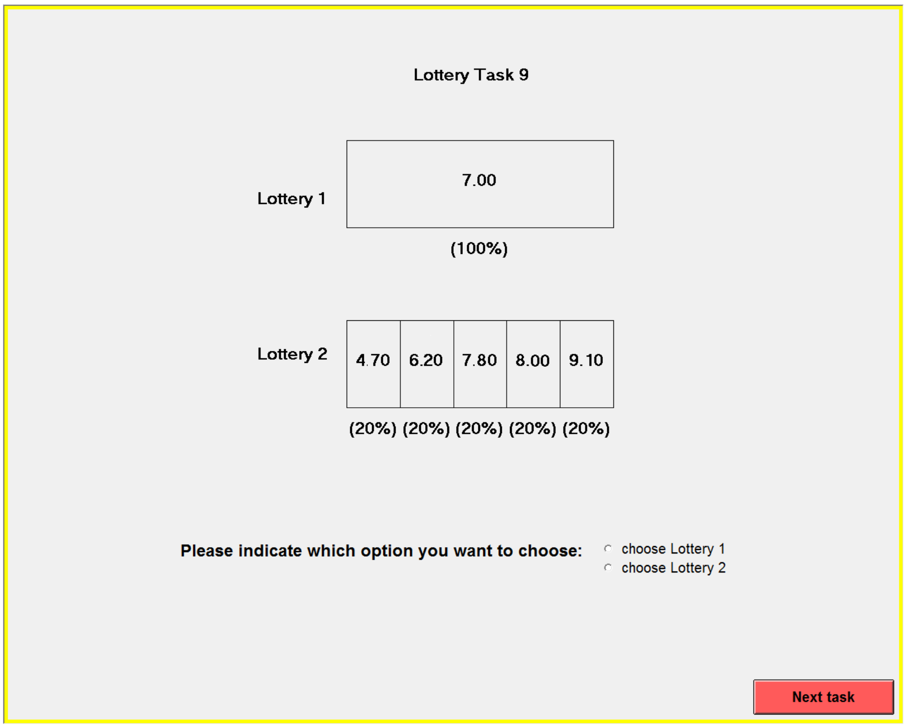
At the end of the experiment, two tasks will be picked at random from these 30 tasks by the computer. Your final point earnings in Part 1 will be the sum of the points you earned in these two selected tasks. Finally, your point earnings will be converted to money earnings at the exchange rate of £1 for every 2.5 experimental points. Please raise your hand if you have any questions. Before starting to take decisions, we ask you to answer some questions in the next several screens. The purpose of these questions is to check whether you have understood these instructions. Any mistake you may make in doing these questions will not affect your final money earnings. When you have finished Part 1, please remain seated. I will distribute the instruction for Part 2 after everyone has finished Part 1.

Part 2

In this part of the experiment, you will have the opportunity to earn an additional amount of experimental points according to the decisions you make.

There are 15 lottery tasks, each of which will require you to choose between two lotteries. At the end of the experiment, one of these lottery tasks will be picked by the computer at random and played out for real. Your point earnings in Part 2 will be determined by your decision in this lottery task.

For each lottery, the boxes beside the option label represent the possible outcomes. Points you can earn from each outcome are shown in the box. For each lottery and outcome, the number of chances out of 100 that you will get this outcome if you choose this lottery is shown at the bottom of the outcome box as a percentage. The picture below is an example of how these lottery tasks look.



In every lottery task, Lottery 1 has only one outcome, as in this example. So there is only one box beside the lottery label, and the percentage chance shown below the box is 100%. This means that, if you choose Lottery 1, you are certain to earn the number of points shown in the box.

In every lottery task, Lottery 2 has five outcomes, all of which are equally likely, as in this example. So there are five boxes beside the lottery label, and the percentage chance shown below each box is 20%. This means that if you choose Lottery 2, there are 20 chances out of 100 that you will earn the number of points shown in the first box, 20 chances out of 100 that you will earn the number of points shown in the second box, and so on.

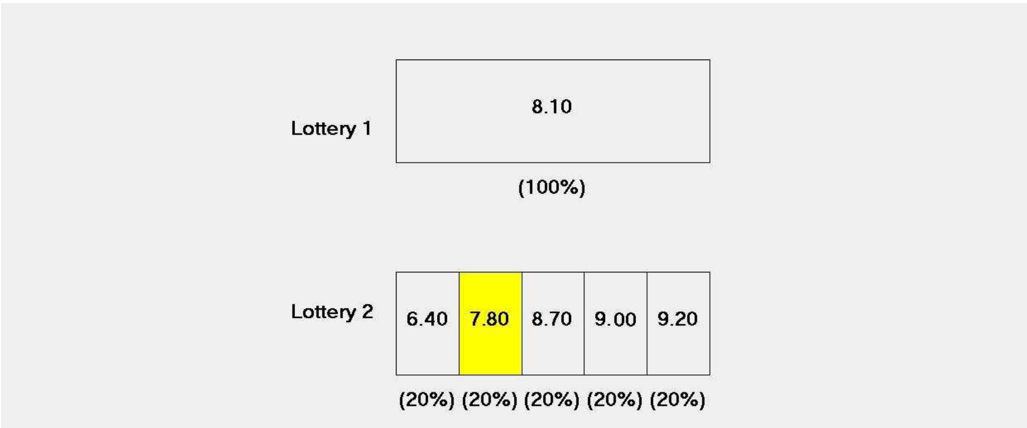
To choose a lottery, you need to click 'Choose Lottery 1' or 'Choose Lottery 2'. After you click the 'Next task' button at the bottom of the screen, the computer will move on to the next task.

[For *NF (No feedback)* treatment]

At the end of the experiment, one lottery task will be picked at random from these 15 tasks by the computer. If you chose Lottery 1, your point earnings will be the number of points shown in the box for Lottery 1, and this will be the end of Part 2 of the experiment. If you chose Lottery 2, the computer will then determine the outcome of that lottery by picking one of the five boxes in that lottery at random. The box that the computer has picked will be highlighted on the screen. Your point earnings will be the number of points shown in the highlighted box. The picture below is an example of how the outcome of Lottery 2 is shown.

[For *RF (Regret feedback)* treatment]

At the end of the experiment, one lottery task will be picked at random from these 15 tasks by the computer. The computer will then determine the outcome of Lottery 2 in that task by picking one of the five boxes in that lottery at random. The box that the computer has picked will be highlighted on the screen. You will always see which box the computer has picked, but this will affect your earnings only if you chose Lottery 2 in this task. If you chose Lottery 1, your point earnings will be the number of points shown in the box for Lottery 1. If you chose Lottery 2, your point earnings will be the number of points shown in the highlighted box. The picture below is an example of how the outcome of Lottery 2 is shown.



Finally, your point earnings will be converted to money earnings at the exchange rate of £1 for every 2.5 experimental points. These will be added to your earnings from Part 1.

Please raise your hand if you have any questions. Before starting to take decisions, we ask you to answer some questions in next several screens. The purpose of these questions is to check whether you have understood these instructions. Any failure you may make in doing these questions will not affect your final money earnings. When you have finished Part 2, please remain seated and wait patiently until you are paid.

Appendix B

Rational choice model

First, we focus on how a risk neutral rational decision maker should behave in the task with time-limited red card. In order to make the model more clear and simple, we assume that subjects have a linear utility function. It is normalised so that 0 is the utility of a payoff of 0 EP (i.e. paying the whole of the endowment) and 1 is the utility of 10 EP (i.e. paying a price of 0).

Let us first consider a case that an individual is in a situation without red card, m blue cards has been already turned over, and there are n cards left to be turned over which are all blue cards. The best blue card so far has offer value b. From these, we can know that the probability that the offer value on the best of n cards is smaller than b can be expressed as pr(value of best of n cards $\leq b) = b^n$. With probability b^n, the individual will end the game by choosing the card with value b. In this event, her expected gain from the game is b. With probability $1 - b^n$, the best of the n cards will be better than b, and she will end the game by choosing this card. In this event, her expected gain from the game is the expected value of the best of the n cards, conditional on this being worth more than b.

The cumulative distribution function of offer value on the best of n cards is $F(x) = x^n$. So the density function of offer value on the best of n cards is $f(x) = nx^{n-1}$. Therefore, the expected value of the best of the n cards, conditional on this being worth more than b, is: $\frac{\int_b^1 x \cdot f(x)\,\mathrm{d}x}{1-b^n}$, which equals to $\frac{n(1-b^{n+1})}{(n+1)(1-b^n)}$.

Then putting these components together, the individual's expected gain from the task can be represented by the following formula:

$$(b \cdot b^n) + \frac{n(1-b^{n+1})}{(n+1)(1-b^n)} = \frac{n+b^{n+1}}{n+1}$$

Now, consider an individual who turns over a time-limited red card with offer value r, when m blue cards have already been turned over, the offer on the best pf these cards is b, and there are n blue cards still to turn over. If she rejects the offer on the time-limited red card, the expected gain from the game is the outcome above, $\frac{n+b^{n+1}}{n+1}$. Hence, the optimal decision rule for a risk neutral individual is:

$$\begin{cases} \text{if } r > \frac{n+b^{n+1}}{n+1} & \textit{accept} \\ \text{if } r = \frac{n+b^{n+1}}{n+1} & \textit{indifference} \\ \text{if } r < \frac{n+b^{n+1}}{n+1} & \textit{reject} \end{cases}$$

Based on this optimal decision rule, the probability that a rational agent chooses the time-limited offer for given r, n and m, is:

$$\Pr(\text{red card chosen}) = \Pr(r \geq \frac{n + b^{n+1}}{n+1}) = \Pr(b \leq [r(n+1) - n]^{\frac{1}{(n+1)}}) \tag{4}$$

However, in the case when $r < \frac{n}{n+1}$, i.e. r <(expected value of the best of n blue cards), $\Pr(b \leq [r(n+1)-n]^{\frac{1}{(n+1)}}) = 0$, which means a rational agent will reject the TL offer irrespective of the value of b.

Now, suppose there have been m previous blue cards, and that b is the best of these. Then for any x:

$$\Pr(b \leq x) = x^m \tag{5}$$

(Note that this holds only for $0 < x < 1$; otherwise, $\Pr(b \leq x) = 0$ or 1).

Combine formula (4) with the generic formula (5), we can get the following probabilities that a rational agent chooses the time-limited offer conditional on the value and the position of the offer:

$$\Pr(\text{red card chosen}) = \begin{cases} [r(n+1) - n]^{\frac{m}{(n+1)}} & \text{If } m \geq 1 \text{ and } r \geq n/(n+1), \\ 1 & \text{If } m = 0 \text{ and } r \geq n/(n+1), \\ 0 & \text{If } r < n/(n+1). \end{cases} \tag{6}$$

Next, we move on to the tasks with standard red cards. In the task with a standard red card, the optimal decision rule that a rational individual should apply to get the best deal is to turn over all the cards and choose the card with the lowest offer value. Therefore, in a task with i blue cards and one standard red card, the probability of a rational individual choosing the standard red card with offer value r is r^i. To be consistent, we replace i with $m+n$ to represent the total number of blues cards in the task. Then, the probability that a rational agent chooses an offer on the standard red card is:

$$\Pr(\text{red card chosen}) = r^{(m+n)} \tag{7}$$

Comparing formula (6) and (7), we then know the difference between the probability that a rational agent chooses a time-limited offer and a standard offer under the same circumstance. When $r < n/(n+1)$, the optimal decision rule implies that a rational individual would never choose the red card with time-limited offer, but with probability $r^{(m+n)}$ she would choose the red card with standard offer. When $m = 0$ and $r \geq n/(n+1)$, a rational individual would choose the time-limited offer for sure, but with the probability of $r^{(m+n)}$ she would still choose the standard red card with the same offer value. When $m \geq 1$ and $r \geq n/(n+1)$, the probability that a rational agent chooses a time-limited red card is always higher than the probability that she chooses a standard red card as predicted by the rational decision model. This means that the probability that a rational agent chooses a time-limited offer is always higher than she chooses a standard offer if the offer value is higher than the expected value of the best of the remaining offers. Instead, a rational agent would always reject the time-limited offer with the offer value less than the expected value of the best of the remaining offers, but a standard red card with the same offer value could still be chosen with a positive probability.

This rational decision model tells us that the probability that a risk neutral rational agent chooses a time-limited offer depends mainly on the offer value (r) and the position of the offer (n). Thus, in the experiment, we carefully choose the range of r and the possible position of the time-limited offer, making sure that the probabilities that a risk neutral rational agent chooses a time-limited offer and an offer on the standard red card are nearly the same.