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Abstract: Sequential search is often costly and time-consuming. The time cost is usually unknown *ex ante* and its presence and duration must be inferred as the search progresses. We disentangle the effect of time cost on search behavior from people's (in)ability to perceive time delay between offers. We find that people are able to infer the existence of the time cost, but their inference is imperfect. We also compare the effect of time cost with the effect of monetary cost and find that the time cost reduces the amount of exerted search, but not as much as the monetary cost does. Discriminating between the effects is critical for increasing the empirical validity of search models and designing mechanisms capable of improving the quality of decisions, especially in unfamiliar or infrequently encountered situations.

Keywords: Sequential Search, Time Cost, Search Cost, Experiment

JEL Classification: C6, C91, D83

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1. INTRODUCTION

The opportunity cost is one of the most important concepts introduced by economics. Its fundamental component, the value of time, shapes incentives faced by economic agents and thus influences their behavior (Becker, 1965; Heckman, 2015). A prominent example where the value of time plays a crucial role and determines the extent of the underlying economic activity is sequential search. Everyday life sequential search processes of evaluating candidates in the hiring process, acquiring and reviewing job offers, or comparing prices are often costly and time-consuming and frequently involve time delays. Anecdotal evidence suggests that people often continue to search for a better deal even though the opportunity cost of their time far exceeds the expected increase in payoffs from the additional search.[1] Since time is a scarce and valuable resource (Goldszmidt et al., 2020), it is crucial to understand how the time search cost impacts search behavior and whether people undervalue time when searching for better alternatives.

Monetary search costs have been shown to shorten search in multiple contexts, but not much is known about the effect of time search costs. Search theory predicts that an increased search cost of any type will lead to shorter search (McCall, 1970; Yeo, 1998). Empirical literature provides evidence that, as the monetary search cost (henceforth, monetary cost) increases, people do indeed search less (e.g. Kerstholt, 1994; Zwick, Rapoport, Lo & Muthukrishnan, 2003). However, what if people must devote their time instead of money to searching for better alternatives? Search models typically do not stipulate how different types of costs influence the length of search activity.[2] Theoretically, a higher time cost should decrease search, just as a higher monetary cost would. However, apart from its different nature, the time cost is also specific in that it is usually *ex ante* unknown (and thus also less salient) and its presence and duration must be inferred after the search commences.

While there exists indicative evidence that people misallocate time (e.g. Bhui, 2019), not much is known about whether time and money constructs influence decisions in a similar way or whether their impact is fundamentally different. The existing (and still rather scant) economics and psychology literature provides mixed evidence. In certain environments the differences between time and monetary effects seem to be substantial, with monetary effects usually exacerbating the underlying behavioral tendency. For example, people are more likely to cheat when thinking about money than time (Gino & Mogilner, 2014), and are more risk averse (Okada & Hoch, 2004) and more susceptible to sunk-cost fallacy (Soman, 2001) when allocating money rather than time. They are also more likely to volunteer their time than to make monetary donations (Brown, Meer, & Williams, 2019; Lilley & Slonim, 2014). On the other hand, in situations where scarcity and poverty play a role (Mullainathan & Shafir, 2013; Giné, Townsend & Vickery, 2008; Strayer, Drews & Crouch, 2006) or in scenarios involving competition as in an all-pay auction (Breaban, Noussair & Popescu, 2020), the time and monetary effects appear to be similar.

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[1] Examples are plentiful, from lengthy internet search to save a few dollars on lower airfares, hotel deals, or consumption goods to attending house viewings and auctions for months on end, a situation common in large metropolitan areas with increasing real estate prices.

[2] McCall (1970) states that the length of search activity depends on the opportunity cost of time, which could be approximated by the perceived wage rate (Goldman & Johansson, 1978; Lippman & McCall, 1976), suggesting that time and monetary costs are theoretically equivalent.

Given these diverging results, the implications of time costs for sequential search are not obvious. Previous literature also suggests that people are inept at estimating time duration (Lorko, Servátka & Zhang, 2019 and 2020). Estimation inaccuracies persist even in repeated settings, suggesting skewed perception of time. In addition to the potential discrepancies between the effects of time and monetary costs, yet another question arises: Do people perceive time costs accurately?

To study whether people take time costs into account when deciding how long to search, we designed a laboratory experiment that allows us to control the decision-making environment and draw causal inference. The search task shares many features with the secretary problem.[3] It is framed as selling houses, in which the participants earn payoffs based on the offers they accept. The implemented experimental environment parallels everyday life where the search process of reviewing and rejecting offers is costly and time-consuming. For example, the seller might need to incur a monetary cost to verify the credit of each buyer. In a similar fashion, it takes time to obtain the credit scores and to evaluate the conditions of each offer.

In the experiment, each seller reviews one price offer to buy (henceforth offer) at a time and must decide whether to accept or reject it. The offers are drawn from an unknown distribution.[4] The decision cannot be recalled, meaning that, if an offer was rejected, the seller cannot change his mind and accept that offer later on. Within this setup, we introduce an unannounced time cost, represented by a time delay every time the participant rejects an offer and waits for a new one, and compare it to a situation where no search cost is present. The behavior in the former case could be influenced by the presence of the time cost and by the ability to perceive the time cost and incorporate it into the decision-making process. To separate the effect of time cost from the perception abilities, we introduce a treatment in which the time cost is announced before the search begins so that the participants do not need to infer it as they make their decisions. Finally, by means of a nested experimental design, we establish whether the announced time cost affects search to the same degree as the monetary cost. The monetary cost is known at the time when the decision to search is made and calibrated to reflect the opportunity cost of time of our participants.

The contribution of our study to the literature on sequential search is three-fold. First, we extend the empirical analysis of search behavior into the time domain. While time is implicitly present in some studies that vary the time horizon of search (e.g. by changing the number of available offers), to the best of our knowledge, no previous empirical study has explicitly considered the distinct effect of time cost in any sequential search setting despite the fact that the time cost is a prevalent factor in many everyday decisions. Second, unlike the monetary cost, which is sometimes known before the search commences (e.g. costs for obtaining credit scores), the time cost is usually unknown ex ante. Including an unannounced time delay in our design thus bridges the lab with the field and increases the external validity of the experiment by introducing a sequential search feature (an unknown cost that must be inferred) present outside

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[3] See Ferguson (1989) and Freeman (1983) for historical reviews on the secretary problem and its origin. In contrast to the classical secretary problem that assumes people derive utility only from the optimal (highest) offer, our experiment allows participants to earn money also from sub-optimal choices, instead of zero payoffs when anything other than the highest offer is accepted. This design feature parallels typical decisions in that a decision maker earns payoffs also from alternatives other than the optimal one, for example if he sells a house for the second-highest offer. For further discussions see Bearden et al. (2005, 2006) where participants receive a positive payoff that is rank-dependent and Angelovski and Güth (2019) who study search in a cardinal secretary problem.

[4] While a seller might have some knowledge about the real estate market in general, each house has its specificities; the aggregate price level may not convey enough information regarding buyers' values for a particular house.

the laboratory. Our third contribution stems from separating the effect of time cost per se from people's (in)ability to perceive time delay between subsequent offers and accounting for it in their search behavior. It is important to distinguish between these two effects as they have different implications for theoretical modeling of search behavior. Understanding the origins of search inefficiencies (e.g. continuing the search when the opportunity cost of time is higher than the potential increase in payoffs) will allow to design mechanisms capable of improving decision quality, especially in unfamiliar or infrequently encountered situations and when decision makers lack experience. Finally, making a distinction between the time cost and monetary cost is critical to obtaining empirical information that can guide the process of constructing search models with increased empirical validity.

The data confirm our hypotheses about the impact of monetary and time costs on search length. We find that participants reduce the amount of search in the presence of unannounced and announced time costs, but not as much as in the presence of monetary cost. We also observe less search with the announced time cost than with the unannounced time cost, implying that participants perceive the time cost imperfectly. The shorter search results in lower accepted offers and thus lower payoffs in the presence of monetary cost, but not in the presence of time costs. If we take the calibrated monetary value of time search cost into account, the time costs (both announced and unannounced) and the monetary cost reduce the profit in a similar way. Our findings imply that not only monetary costs but also time costs should be carefully considered when designing policy interventions aimed at reducing market frictions.[5] A similar argument also applies to improving customer's experience both in the public and private sector. Finally, our observation that people undervalue their time complements a recent empirical finding by Goldszmidt et al. (2020) that the U.S. Government undervalues time improvements and thus underinvests public resources in time-saving infrastructure, pointing out significant inefficiencies in both the public and private sector.

2. RELATIONSHIP TO THE LITERATURE

Numerous sequential search situations, in which immediate decisions must be made and cannot be revisited, display features of the secretary problem. In the classical secretary problem (Gardner, 1960), the decision maker is sequentially presented with a set of n candidates interviewed for a single position. There is no recall and the decision maker receives a positive payoff only if he selects the best candidate. Each presented candidate is either accepted on the spot or not. After acceptance, the search stops. According to the optimal decision rule of the classical version of the secretary problem, there are two steps to maximize the probability of finding the best candidate. The decision maker first reviews and consequently rejects 1/e (≈ 0.37 as n approaches infinity) of the candidates and then he accepts a candidate who is better than any of the previously rejected candidates; where n is the total number of candidates available in the pool and e is the Euler's number ≈ 2.718 (see Lindley, 1961 or Gilbert & Mosteller, 1966 for a detailed proof). Given that the first approximately 37% of candidates are always rejected, there is a 37% chance that the best candidate is among them and thus happens to be rejected. If this is the case, the decision maker who follows the optimal decision rule will

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[5] For example, unpaid blood donors are 10% more likely to donate again if the waiting time is reduced by 38% (Craig et al., 2016). Depending on the implementation costs to the blood collection agency, a relatively straightforward intervention can thus increase blood collection and simultaneously improve donors' experience, resulting in higher overall efficiency.

keep searching and accept the final candidate (because he could not find a better one), resulting in considerable search costs in terms of money and/or time.

Yeo (1998) theoretically sets up a version of the secretary problem in which he introduces a fixed per-candidate interview search cost with positive payoffs from selecting any of the k best candidates. The payoffs are increasing with the quality (and thus the rank) of the candidate. The objective is then to find the optimal decision rule and use it to evaluate the probabilities of success and the proportion of candidates interviewed (i.e. the search length). Yeo concludes that, as the search cost increases, it is optimal to decrease search activity. Under certain restrictive conditions, unlikely to occur in the field (e.g. a known distribution or an equal likelihood of all offers within a particular price range), it is possible to derive acceptable thresholds for search with costs (Christian & Griffith, 2016).

The notion of search cost in economic theory is general and refers to the opportunity cost of time which includes explicit costs (associated expenditures) as well as any implicit costs (the maximum benefit people could obtain by spending time on another activity). Search costs in the traditional models of commodity markets introduce frictions that can result in behavior that deviates from the competitive equilibrium (see the reviews by Diamond, 1995 and Stiglitz, 1989). Within the literature on markets with frictions, the most conceptually related study to ours is Bakos (1997). Akin to our research question regarding different search costs, Bakos presents a model that separates costs of searching over price and product characteristics in the context of an electronic marketplace. However, the nature of costs associated with finding a product of, say, better quality or lower price remains the same; what varies is only the amount. While our experimental approach also makes a distinction between different types of search costs, monetary and time costs differ fundamentally in their very nature and might therefore be perceived differently by the person who is searching.

Previous experimental research provides evidence that search costs can have a significant impact on search activity. Seale and Rapoport (1997) present an experiment that closely incorporates the main assumptions of the classical secretary problem in the design: a known number of candidates presented randomly one at a time, a positive payoff resulting only from selecting the overall best candidate, and no recall. Seale and Rapoport show that participants stop their search earlier than the optimal decision rule dictates. They also use a simulation to demonstrate that the observed search behavior better coincides with the search length predicted by the optimal decision rule when a 1% search cost is assumed. Seale and Rapoport thus speculate that the early stopping behavior can be explained by the presence of endogenous search cost, as the participants might want to finish the experiment in the shortest time possible. From this perspective, the time spent on observing and evaluating each candidate can be considered a search cost by the participants.

Early stopping behavior is also found in experiments that relax some of the assumptions of the secretary problem. For example, Seale and Rapoport (2000) implement an unknown candidate population; Bearden et al. (2005, 2006) allow for rank-dependent payoffs from offers; and Zwick et al. (2003) allow for the recall of previously rejected offers.[6] Using a 2x2 design, Zwick et al. examine the effects of monetary cost size and the size of candidate population. Their experimental task is framed as a search for new apartments; the participants earn a payoff of $10 if they find the overall best apartment; otherwise, they earn $0. In the treatment with no

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[6] For the remainder of the paper we use the word ‘offer’ to refer to the choices available to the participants to avoid confusion stemming from different experimental designs and framings.

search cost, participants stop searching too soon, providing further support for earlier Seal and Rapoport (1997) findings. In treatments with search cost, the participants end their search sooner than with no search cost. Related to the current study, Hsiao, Kemp and Servátka (2020) find that framing the secretary problem as selling houses increases the search length and increases payoffs. Hsiao et al.'s study, however, focuses on the impact of context on sequential search decisions and thus does not include any types of costs.

Job search is another prominent example of sequential decision-making. McCall (1970) provides an analogous prediction to Yeo (1998) regarding the effect of search cost on job search. In McCall's model, the job seeker knows the distribution of wage offers, the search is unlimited, and there is no recall. The job seeker receives one randomly selected wage offer at a time and decides whether to reject or accept it. Once the offer is accepted, the search ends and the job seeker receives a wage equal to the offer. The job seeker thus considers the current wage offer against the prospects of being unemployed and receiving his outside option (representing unemployment compensation, welfare payment, and/or leisure benefits) and facing the search cost again in the next round(s) to obtain a new draw from the wage distribution. McCall shows that a relatively high cost compared to the wage offer encourages the job seeker to limit search, holding everything else constant. In the extreme, it might even mean that the job seeker prefers to remain unemployed.

Job search models share several assumptions with the secretary problem, including the random presentation of job offers and no recall. Their other features, such as knowledge of the distribution of offers and an unbounded search horizon, do not coincide with the classical secretary problem. However, despite the difference in assumptions between the job search and secretary problems and the resulting difference in decision-making environments, laboratory experiments studying job search also find that participants stop searching too soon (e.g. Cox & Oaxaca, 1989, 2000). Cox and Oaxaca (2000) experimentally test the job search behavior with known and unknown wage distributions, allowing for recall. When the distributions are unknown, it is more challenging to find the optimal stopping point of job search, compared to the scenario where distributions are known. An offer that is *a priori* relatively high ("good news") can imply that it is highly probable that the search is from the favorable distribution, but at the same time it can look unattractive when it is a posteriori relatively low offer from the favorable distribution ("bad news"). Cox and Oaxaca find that people terminate their search early with the finding being robust to whether wages are drawn from known or unknown distributions. In daily life, seekers usually do not know the underlying distribution. The existence of search cost exacerbates the complexity of their decisions as it becomes less clear whether it is worth searching longer to get a higher payoff (i.e. whether the benefit from additional search will exceed the search cost).

In summary, that monetary cost shortens search is well documented in both theoretical and empirical literature. Sequential search, however, is often time-consuming and one might even argue that the time cost is unavoidable. The impact of time cost on search behavior has not been tested empirically and because of its different nature, one might wonder whether it is behaviorally equivalent to the effect of monetary cost. The main contribution of the current paper is therefore identifying how different search costs influence search behavior and, in the case of time cost, also distinguishing between whether the effect is driven by people having to infer the time cost from the experienced delay when waiting for the next offer and/or the time cost itself.

3. METHODS

3.1 EXPERIMENTAL DESIGN AND PROCEDURES

The experiment consists of 2 practice rounds and 10 cumulatively paid rounds. The decision-making task is framed as selling 10 houses; one house being sold in each round.[7] In each round, a participant reviews up to 20 offers for the given house, coming from an unknown distribution. The offers are presented one at a time and there is no recall. Once an offer appears on the screen, the participant decides whether to accept or reject the offer. If the participant has not accepted an offer prior to the final (20th) offer, he/she is forced to accept the final offer regardless of its value.

The same 10 sequences (rounds), generated prior to the experiment, were employed for each participant in all treatments (see Appendix B for details). Each sequence, including those in the practice rounds, was generated in Microsoft Excel by randomly sampling from a uniform distribution of the house prices (in thousands of NZD) in each of 10 different Christchurch suburbs according to the average of prices and their standard deviations. The price offers were presented in experimental currency units (ECUs). The participants were informed that they would be paid in cash based on their cumulative payoffs according to the exchange rate of 1000 ECUs = 1 NZD. The cumulative payoff is the sum of all 10 accepted offers minus the sum of search costs from the 10 rounds.

The experiment consists of four treatments implemented in an across-subject design. All subject groups are disjoint, and no subject participated in more than a single session. In the baseline no cost treatment (henceforth No Cost), the price offers are presented without any (time or monetary) search cost being imposed.[8] In the monetary search cost treatment (henceforth Monetary Cost), each participant has to pay 20 ECUs to obtain each new offer. The monetary cost is cumulative, i.e. the more offers the participant obtains, the higher the sum that he/she has to pay in total. For example, if the participant accepts the 20th offer for a house, the total monetary cost in this round is 20 x 20 ECUs = 400 ECUs.

Ex ante it is unclear whether the time cost operates in the same way as the monetary cost. To facilitate a comparison between the monetary cost and the time cost, we introduce two distinct time cost treatments. The Unannounced Time Cost treatment parallels everyday life where the time cost is usually unknown at the beginning of search. In this treatment, no information about time delay is provided and the instructions are identical to the No Cost treatment. In the Unannounced Time Cost treatment, the search behavior can therefore be influenced by the presence of the time cost and the ability to infer the time cost as it is being experienced while searching for another offer. We conjecture that this environment will dampen the shortening effect of time delay on search.

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[7] A description of a house, consisting of the floor area, the number of bedrooms, suburb and the year the house was built in, is presented at the beginning of the round, prior to any price offer. To enhance the link between the experiment and the outside-the-lab world, the house descriptions presented to participants were taken from houses sold in 12 different suburbs in Christchurch, New Zealand during October 2014. All information was obtained from the Quotable Value Limited database (qv.co.nz). The effect of context and additional context-relevant information is explored in a companion paper (Hsiao et al. 2020). We find that that framing a sequential search problem as selling houses leads to longer search and higher earnings than a context-free frame. Manipulating whether or not the framed decision-making scenario includes a description of the house, which would be naturally available in a real estate market, does not impact the search length or the total earnings.

[8] The data from the No Cost treatment are also reported in Hsiao et al., 2020 (House with Info treatment).

To identify the net effect of time cost, our design includes the Announced Time Cost treatment, in which participants are instructed that there is a 5-second time delay prior to presenting each offer. Announcing the presence and size of the time cost before the search begins means that the participants do not need to infer it as they make their decisions. The Announced Time Cost treatment is therefore directly comparable with the Monetary Cost treatment, the presence and size of which are also announced before the search commences.

The parameterization of costs implemented in the Monetary Cost treatment (20 ECUs) and both time cost treatments (a 5-second delay) was calibrated to facilitate their comparison. In general, the opportunity cost of time depends on the maximum payment rate a participant can earn. (We assume the participants had no other better paying alternative since they decided to attend the experiment). The experiment is parameterized to yield a maximum payment of $14, which is also used to calibrate the opportunity cost of time (this information was not revealed to participants). Using the implemented exchange rate ($1 =1000 ECUs), a 5-second delay experienced in both cost treatments thus equals approximately 2 cents ($14*5/3600 seconds) or 20 ECUs, i.e. an equivalent of the cost incurred by the participants in the Monetary Cost treatment.

In both time cost treatments, the time delay is implemented identically – each participant must wait five seconds before a new offer is displayed on the screen. Similar to the monetary cost, the time cost is also cumulative, meaning the more offers the participant searches through, the longer he/she has to wait in total. For example, if a participant accepts the 20th offer for a house, the total delay is 20 x 5 seconds = 100 seconds. Therefore, the 5-seconds time delay can cumulatively yield a significant waiting time.[9] This was indeed the case as the Unannounced Time Cost treatment session in the present experiment lasted on average 15 minutes longer (approximately one hour and 10 minutes) than the No Cost treatment session (55 minutes). The Announced Time Cost treatment session lasted on average one hour. The Monetary Cost treatment session lasted 45 minutes. (Note that the actual time duration is also a function of the observed search length, our dependent variable.)

An important feature of the experimental protocol was that in all treatments the participants received their earnings after everyone completed the experiment, keeping the procedures constant across treatments. Our conservative design therefore detects the lower bound of the effect of time cost on search behavior. If the participants were able to leave the experiment early, the effect of the time cost would likely be more pronounced. However, having participants depart at their own pace is easily observable by others, introducing a potential confound in behavior. For example, an early departure might be interpreted by other participants as a signal that a short search is a "better" strategy, resulting in a loss of control over the data generating process. The implemented design controls for such eventuality.[10] One might also think that having more time when waiting for a new offer (and thus also cumulatively) in both time cost treatments could yield better decisions.[11] To address this potential concern, we opted to not impose a time limit on participants' decisions in any of the

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[9] In a pilot session, we trialed a 10-second delay. During the session that lasted three hours, many participants dropped out. Subsequently, we recalibrated the Unannounced and Announced Time Cost treatments to a 5-second delay. No participant dropped out of the experiment in either treatment under the new parameterization.

[10] The interaction of the amount of search with the opportunity cost of time is an interesting question in its own right and could be explored, for example by allowing the participants to leave the lab as in Knowles and Servátka (2015) or introducing a parallel task, e.g. watching videos (Kamei & Markussen, 2019) or browsing the internet. We leave this exploration for future research.

[11] For an example of how time pressure can affect decisions see Kocher, Pahlke and Trautmann (2013).

treatments; i.e. they could take as long as they needed to evaluate each offer that was presented to them.

A total of 188 undergraduate students from the University of Canterbury in Christchurch, New Zealand participated in the experiment; 48 in the No Cost treatment, 44 in the Monetary Cost treatment, 43 in the Unannounced Time Cost treatment, and 53 in the Announced Time Cost treatment. The participants were recruited using ORSEE (Greiner, 2015) and earned 12.20 New Zealand Dollars (NZD) on average. No specific information regarding experimental earnings was provided in the invitation email. The payoff protocol was single-blind, meaning that the experimenter was able to track participant decisions to their identity. The search task was implemented using z-Tree software (Fischbacher, 2007).

After arriving at the lab, the participants were randomly assigned to a cubicle and read the instructions (provided in Appendix A.1 – 3) at their own pace. Any questions were answered in private. Upon completion of the experiment, all participants were privately paid their earnings for the session.

4. HYPOTHESES AND BENCHMARK SIMULATIONS

What is the optimal decision rule for a payoff-maximizing risk-neutral decision maker in our implemented variation of the secretary problem? As the offers come from an unknown distribution, we conduct a simulation that allows us to evaluate the performance of different decision rules in our treatments and to derive a benchmark prediction for the impact of search cost on search behavior. Each simulation compares the payoffs resulting from 20 different decision rules, each of which prescribes how many offers to reject, followed by accepting the next highest offer (see Figure 1 for details). For example, the rule "Accept the next highest offer after seeing the first 2 offers" means that a participant always rejects the first two offers. He then keeps searching and does not stop until the encounters an offer that is higher than the first two offers he rejected (thus also higher than all offers he has observed up to that point). Each simulation iteration randomly draws a set of 20 random offers from each of 10 uniform distributions that we use to generate offers in the experiment, representing 10 houses in different suburbs. The simulation runs separately for each house. We provide more details on simulation procedures in Appendix C.

To compare the performance of decision rules across treatments we run the simulation using the search cost of 0 (representing the No Cost treatment) and 20 ECUs (representing all cost treatments). We compare the performance of all 20 possible decision rules with and without costs using the average payoff (in ECUs) they yield. The average payoff represents the average value earned from accepting an offer according to a given decision rule net of the cumulative search cost.

It is trivial to see that, due to the accumulation of search costs, every decision rule yields a higher payoff if there is no cost (0 ECU) than if the cost is 20 ECUs (see Figure 1). According to the simulation, the decision rule that prescribes to "Accept the next highest offer after seeing the first 4 offers" yields the highest payoff if there is no cost whereas with costs the optimal decision rule is to always "Accept the next highest offer after seeing the first offer". The simulation thus suggests that in this environment, it is optimal to stop the search sooner (i.e., accept an earlier offer) when the search is costly as compared to a situation when it is not. This is due to the cumulative nature of the search cost which, given this parameterization, causes the overall payoff to decrease if one searches for more than one offer.

Simulation result: In the presence of search cost it is optimal to search less than in a situation when there is no cost.

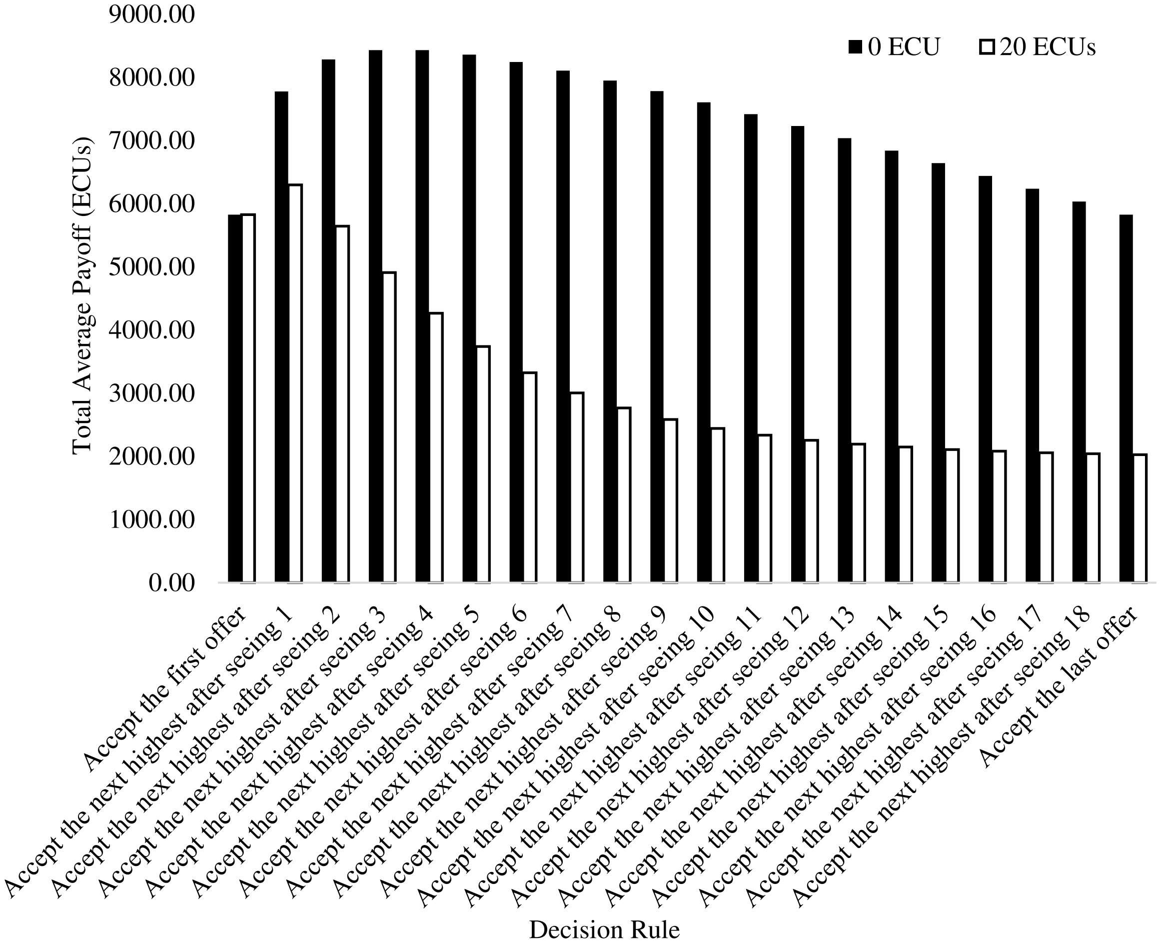

Figure 1. The total average payoff for all decision rules for the costs of 0 ECU and 20 ECUs

Based on the simulation results and in line with previous research, we conjecture that participants will search less in the presence of the monetary cost than when there is no search cost. Without the cost, the decision rule to "Accept the next highest offer after seeing the first 4 offers" yields the highest total payoff, achieved by stopping at Position 10. With the cost, the decision rule to "Accept the next highest offer after seeing the first offer" yields the highest total payoff, achieved by stopping at Position 6.

While we have calibrated the monetary cost to be nominally equivalent to the time cost, we formulate our behavioral hypotheses based on the previous literature suggesting that monetary costs tend to be more salient or at least equivalent to time costs. Although we anticipate the effect of the announced and unannounced time cost to be weaker than the effect of the monetary cost, we expect both time costs to influence the search length relative to the situation where there is no cost.

In line with the above argument regarding the saliency of costs, if both monetary and time costs are announced, we expect the monetary cost to have a stronger impact on the search length. This leads to a hypothesis that search will be shorter in the presence of the monetary cost than in the presence of the announced time cost. Further, we conjecture that the need to infer the presence of time delay associated with every new offer will diminish the effect of the time cost, leading to shorter search if the time cost is announced than when it is unannounced. The above conjectures thus yield the following testable hypothesis regarding the search length (as measured by the average stopping position).

Hypothesis (Average stopping position)**:** No Cost > Unannounced Time Cost > Announced Time Cost > Monetary Cost

5. RESULTS

5.1 Summary Statistics

Table 1 displays the summary statistics for the key variables measuring search behavior and its outcomes across treatments.[12] The *stopping position*, measured as the position in the sequence where a participant accepts an offer, represents the search length (the higher the stopping position, the longer the search.) The *average accepted offer* measures the economic outcome of search behavior but does not take the monetary cost into consideration. We thus also calculate the *total payoff* which subtracts the cumulative monetary search cost from the accepted offers. This variable is relevant for the Monetary Cost treatment but does not consider the incurred time cost in the time cost treatments. The time cost is included in calculating the *total profit* across all treatments, assuming the opportunity cost of time in the time cost treatments is equivalent to the calibrated monetary cost.

Table 1: Summary statistics

Variables	Treatment			
Mean (SD)	No Cost	Unannounced Time Cost	Announced Time Cost	Monetary Cost
Simulation benchmark				
Stopping position	10	(6, 10)	(6, 10)	6
Behavior				
Average stopping position	11.58 (2.77)	10.42 (2.15)	9.37 (2.77)	6.37 (3.5)
Average accepted offer	733.89 (58.07)	738.79 (43.63)	734.29 (41.34)	673.23 (89.92)
Total payoff	7338.85 (580.71)	7387.86 (436.28)	7342.95 (413.42)	5459.16 (777.59)
Total profit	7338.85 (580.71)	5303.67 (461.97)	5468.96 (466.56)	5459.16 (777.59)
N	48	43	53	44

Note: Standard errors are reported in parentheses.

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[12] For the summary statistics (i.e., the mean and standard deviation), we compute the average for each individual first and use each average as a single observation.

Table 2: Mann-Whitney rank-sum tests for pair-wise comparisons between treatments

	Comparisons				
Mann–Whitney U test (p values)	No Cost vs. Monetary Cost	No Cost vs. Announced Time Cost	No Cost vs. Unannounced Time Cost	Announced Time Cost vs. Unannounced Time Cost	Announced Time Cost vs. Monetary Cost
Average stopping position	<0.001	<0.001	0.011	0.039	<0.001
Average accepted offer	<0.001	0.656	0.824	0.477	<0.001
Total payoff	<0.001	0.656	0.824	0.477	<0.001
Total profit	<0.001	<0.001	<0.001	0.121	0.218

Note: All reported test are two-sided.

Table 2 presents the results of the two-sided Mann-Whitney rank-sum tests between treatments for the above described variables. The tests confirm our hypothesis that monetary cost decreases the search length. In the No Cost treatment, the average stopping position over 10 rounds is 11.58. The search length plunges to 6.37 when the search involves a monetary cost of 20 ECUs for every additional offer, with the difference being statistically significant. We find that time costs shorten the search length as well. The average stopping position is equal to 10.42 when the time cost is unannounced and 9.37 when the time cost is announced. The differences in search length between each of the time cost treatments and the No Cost treatment as well as between the two time cost treatments themselves are statistically significant. Participants also search significantly less in the presence of the monetary cost than in the presence of the time costs (announced and unannounced), with both differences being statistically significant. Taken together, the above results imply the time cost shortens search but not as much as the monetary cost does. The results also indicate that participants are able to infer the unannounced time cost, but the inference is imperfect.

Result 1 (Average stopping position): No Cost > Unannounced Time Cost > Announced Time Cost > Monetary Cost

We find that the reduced search length is associated with lower accepted offers in the Monetary Cost treatment, but not in the two time cost treatments. In the No Cost treatment, the average accepted offer is 733.89, which is not statistically different from 738.9 or 734.29 in the Unannounced and Announced Time Cost treatments, respectively. The average accepted offer in the Monetary Cost treatment is only 673.23, which is significantly lower than that the average accepted offer in all three other treatments.

Result 2 (Average accepted offer): No Cost = Unannounced Time Cost = Announced Time Cost > Monetary Cost

Next, we examine the total payoff, which is calculated as the sum of accepted offers in all 10 rounds minus the monetary costs (if incurred). The total payoff in the No Cost treatment is 7338.85, which is not statistically significantly different from 7387.86 and 7342.95 in the Unannounced Time Cost and Announced Time Cost treatments, respectively. Due to the lowest accepted offers and the incurred monetary costs, the total payoff of 5459.16 in the Monetary

Cost treatment is statistically significantly lower than the total payoff in all the other three treatments.

Result 3 (Total payoff): No Cost = Unannounced Time Cost = Announced Time Cost > Monetary Cost

One caveat of the total payoff is that it does not take into account the opportunity cost of time delay. Therefore, we generate the total profit statistic that subtracts the calibrated monetary value of the experienced cumulative time delay from the accepted offers. For example, if in the Announced and Unannounced Time Cost treatments the 19th offer of 500 ECUs is accepted, the profit for that round equals 500 ECUs – (19×20 ECUs) = 120 ECUs, as the participant has to wait for 19 x 5 seconds and the opportunity cost of each 5-second delay is 20 ECUs. (The total profit then sums the profits for all 10 rounds.) In the Monetary Cost treatment, if the 19th offer of 500 ECUs is accepted, the profit equals the payoff, i.e. 500 ECUs − (19 × 20 ECUs) = 120 ECUs. Thus, for the same offer in the same position, the Unannounced Time Cost, Announced Time Cost, and Monetary Cost treatments should yield the same profit. Based on our calibrated monetary value of the time cost, we find that the total profit yields 5303.67 in the Unannounced Time Cost treatment and 5468.96 in the Announced Time Cost treatment, both of which are statistically significantly lower than in the total profit the No Cost treatment. However, neither the differences between the Monetary Cost and the two time cost treatments nor the difference between the Announced and Unannounced Time Cost treatments themselves are statistically significant.

Result 4 (Total profit): No Cost > Unannounced Time Cost = Announced Time Cost = Monetary Cost

All presented results are also robust with respect to the rank of the accepted offer within the inspected offers as well as within all offers. The details are available upon request.

5.2 Regression analysis

We also conduct a regression analysis to verify the robustness of our results. We find that all non-parametric test results are confirmed**.** In the absence of time or monetary costs, participants search through 11.58 offers on average. Compared to the No Cost treatment, the search length decreases by 5.21 when a monetary cost is involved. Participants also shorten their search by 1.16 with the unannounced time cost and further 1.05 if the time cost is announced. The average accepted offer is 733.89 in the No Cost treatment and decreases by 69.65 in the Monetary Cost treatment, with the difference being statistically significant. The difference between the No Cost treatment and each of the two time cost treatments as well as between the two time costs themselves are also statistically insignificant. Because of the monetary cost of 20 ECUs in the Monetary Cost treatment, the total payoff decreases by 187.97, which is also statistically significant. If we take the equivalent monetary value of time cost into account, the total profit is reduced by 203.52 in the Time Cost treatment. The difference in the total profit between the Announced and Unannounced Time Cost treatments is only weakly significant.

Table 3: OLS regressions

Model	(1) Average stopping position	(2) Average price of accepted offers	(3) Total payoff	(4) Total profit
Time cost	-1.16**	4.90	49.01	-2035.18***
	(0.518)	(10.699)	(106.989)	(109.462)
Time cost is announced	-1.05**	-4.49	-44.94	165.29*
	(0.502)	(8.747)	(87.467)	(95.238)
Monetary Cost	-5.21***	-60.65***	-1879.69***	-1879.69***
	(0.662)	(15.930)	(144.051)	(144.051)
Constant	11.58***	733.89***	7338.85***	7338.85***
	(0.400)	(8.384)	(83.838)	(83.838)
N	188	188	188	188
Adjust R2	0.302	0.149	0.668	0.676

Note: Standard errors are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1%-level, respectively. Monetary cost =1 for Monetary Cost and =0 otherwise. Time cost =1 for Announced Time Cost and Unannounced Time Cost and =0 otherwise. Time cost is announced =1 for Announced Time Cost and =0 otherwise.

Experience and Learning

Does experience (learning over time) improve search behavior over time? Figure 2 displays participants' search behavior (stopping position, accepted offers, payoff, and profit) over time, separately for each treatment. The fluctuations in Figure 2 are driven mainly by the price distributions of different suburbs (i.e. each round). We thus add the price of the first offer in each round as a proxy for the distribution in the OLS regression with time trend variable (Table 4). We find that participants search more over time, and their search yields higher offers, payoffs, and profit, although the effect size is relatively small.

Note: NC = No Cost; UTC = Unannounced Time Cost; MC = Monetary Cost; ATC = Announced Time Cost.

Figure 2: Variables of Search behavior over time

Table 4: Regression analysis with the learning effect

Model	(1) Stopping position	(2) Price of accepted offers	(3) Payoff	(4) Profit
Time cost	-1.156**	4.901	4.901	-203.518***
	(0.514)	(10.627)	(10.627)	(10.872)
Time cost is announced	-1.051**	-4.494	-4.494	16.529*
	(0.499)	(8.688)	(8.688)	(9.460)
Monetary cost	-5.211***	-60.651***	-187.970***	-187.970***
	(0.658)	(15.823)	(14.308)	(14.308)
1st Offer	-0.009***	0.487***	0.514***	0.609***
	(0.001)	(0.016)	(0.016)	(0.019)
Round	0.167***	5.354***	4.160***	2.691***
	(0.038)	(0.725)	(0.802)	(1.018)
Constant	14.862***	483.087***	477.422***	442.239***
	(0.545)	(11.761)	(11.631)	(12.300)
N	1880	1880	1880	1880
Adjust R2	0.152	0.189	0.273	0.250

Note: Standard errors are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1%-level, respectively. Monetary cost =1 for Monetary Cost and =0 otherwise. Time cost =1 for Announced Time Cost and Unannounced Time Cost and =0 otherwise. Time cost is announced =1 for Announced Time Cost and =0 otherwise. Round is an interval variable, ranging from 1 to 10.

6. DISCUSSION

Life is full of examples where people sequentially search through available alternatives: looking for a new job, trying to hire an employee, or selling and buying various items. Reviewing new offers is often costly not only in monetary terms but also timewise. Anecdotal evidence suggests that people sometimes ignore or underappreciate the time they devote to search, resulting in suboptimal decisions, such as searching too long especially if the opportunity cost of their time is high.

In this paper, we investigate the effect of time and monetary costs in a search problem framed as selling houses. As the participants search from an unknown distribution, we conduct simulations to derive a prediction that a (monetary) search cost leads to shorter search. To empirically compare the effect of the monetary cost with the time cost effect, we calibrate the time delay experienced when waiting for a new offer to reflect the opportunity cost of our participants. The two types of costs also vary in another dimension. While the monetary cost is often known (or could easily be verified) before the search commences, the time cost rarely enters the decision-making process and becomes more salient only after experiencing it. Our experimental design therefore also separates the time cost effect from people's (in)ability to perceive time delay between subsequent offers. Being able to identify these two effects has implications for theoretical modeling of search behavior and providing practical recommendations.

Our experiment confirms the hypothesis that participants search less when time and monetary costs are involved; however, the monetary cost decreases search by more than the time cost. The finding suggests that the time cost is less salient than the monetary cost in search decisions. We also find that the announced time cost decreases search by more than the unannounced time cost, signifying that participants infer the time delay imperfectly. The shorter search observed in the presence of monetary cost results in a lower total payoff, which is not the case when with either the announced or unannounced time cost. However, if we consider the equivalent monetary value of time cost, both announced and unannounced time costs reduce the profit to the same degree as the monetary cost does. We find no statistically significant differences between announced and unannounced time costs in terms of the total profit.

There are at least three potential underlying causes for the difference between the observed amount of search in the presence of time and monetary costs. First, the perceived value of participants' time might not equal their actual opportunity cost of time (at least the way we calibrated and used it in the time cost treatments). Some previous research also reports that money and time are processed differently (Lee, Lee, Bertini, Zauberman & Ariely, 2015). Second, the implemented framing of selling houses might have interacted with the perception of time cost (and its monetary value as calculated in the Monetary Cost treatment). This second explanation is in line with the finding that different frames can elicit systematically different decisions (e.g. Tversky & Kahneman, 1981); in some cases, people make better decisions with framing than without (e.g. Hsiao, Kemp & Servátka, 2020). Housing is usually associated with positive images (e.g. comfort, security, childhood memories) and when something is being perceived more positively, it may also be perceived as more important and more worth doing (e.g. the halo effect in Nisbett & Wilson, 1977; Kahneman, 2011). Hence, people may be inclined to invest more time and therefore search longer than they would if only the monetary payoffs were considered as in a context-free experiment or in our simulation. Finally, similar to what the previous studies suggested (e.g., Okada & Hoch, 2004; Soman, 2001; Lilley & Slonim, 2014; Brown, Meer & Williams, 2019), people may be more willing to spend time rather than money due to the intrinsic difference and possibly also because money can stored or saved for future use, which is not possible with time.

Our research opens possibilities for future extensions and robustness checks. In many situations, recalling a previously rejected offer is possible. There exists evidence that people are willing to search longer when recall is allowed, both with and without monetary search cost (Zwick et al., 2003). It would therefore be useful to examine whether the effect of time cost on search behavior persists also after allowing for recall. In a similar fashion, the impact of time search cost can vary with the opportunity cost of time (Knowles & Servátka, 2015). Another interesting extension would separate the perception of time delay from incorporating the awareness about the time cost in the decision-making process. A study of this type calls for interdisciplinary approach, perhaps combining experiments with neuroscience methods. We leave these explorations for future research.

Our findings have important implications for improving the quality of decisions in unfamiliar or infrequently encountered situations, e.g. buying or selling houses. These sequential decisions can be associated with sizeable financial consequences and people often do not have the opportunity to "practice" before making the decision. Knowing that both time and monetary costs can contribute to sub-optimal decision-making, may help people take preventive measures (e.g. planning ahead on the number of searches one will conduct before making decisions), and thus mitigate the observed inefficiency.

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APPENDIX A

APPENDIX A.1

Instructions for the no cost and unannounced time cost treatments (the instructions were identical in both cases; the treatments differed only in the 5 second time delay imposed in the unannounced time cost treatment, which however was not announced in the instructions).

GENERAL INSTRUCTIONS

Overview

You are about to participate in a decision-making experiment. If you follow these instructions carefully you may earn a considerable amount of money which will be paid to you in cash at the end of the experiment. If you have a question at any time, please raise your hand and the experimenter will approach you and answer your question in private. We ask that you not to talk otherwise during the experiment. Also, please turn off your cellphone and do not use the computer for any other purpose than your participation in the experiment requires. If you break these rules, we will have to exclude you from the experiment and from all payments.

INSTRUCTIONS

You will participate in 10 scenarios, in which you will be selling houses. In each scenario, you will be asked to decide whether to accept or reject a price offer for a particular house. You will be given a brief description of the house that will be followed by a series of price offers. The price offers are randomly generated by the computer and available one at a time. Once a price offer is presented, you can either accept or reject it. If you accept the price offer, the house will be sold at the price you accepted. All sales are final. If you reject the price offer, the offer will disappear; you cannot go back to the previously rejected offer. In total there are 20 price offers available for each house; if you have not accepted an offer prior to the 20th offer, you will be *forced to accept* the 20th (i.e. the final) offer. *Therefore, make your decisions carefully.*

There is no time limit on how long the price offers will be available for, so take as long as you need to evaluate each offer.

Practice scenarios

There will be two practice scenarios. These practice scenarios are there to help you become familiar with the software. You will not be paid for the decisions you make in these two practice scenarios.

How payoffs are determined

The payoffs will be denoted in experimental currency units (ECUs).

1000 ECUs = 1 NZD

Your ECUs will be converted into NZD at this rate, and you will be paid in NZD when you leave the lab. The more ECUs you earn, the more NZD you earn.

Your payoffs are determined as follows:

Total ECUs you earn

=

Accepted price offer for House 1 + Accepted price offer for House 2 + ….+ Accepted price offer for House 10

Example: Suppose you accepted the price offer 450 for House 1, 260 for House 2, 380 for House 3,…, 658 for House 10. The total amount of ECUs you earn is 450+260+380+…. +658.

Do you have any questions?

You are now ready to begin the experiment. First, we will conduct two practice scenarios, with no money payoffs. Then, you will make decisions in 10 scenarios with money payoffs.

APPENDIX A.2

Instructions for the announced time cost treatment.

GENERAL INSTRUCTIONS

Overview

You are about to participate in a decision-making experiment. If you follow these instructions carefully you may earn a considerable amount of money which will be paid to you in cash at the end of the experiment. If you have a question at any time, please raise your hand and the experimenter will approach you and answer your question in private. We ask that you not to talk otherwise during the experiment. Also, please turn off your cellphone and do not use the computer for any other purpose than your participation in the experiment requires. If you break these rules, we will have to exclude you from the experiment and from all payments.

INSTRUCTIONS

You will participate in 10 scenarios, in which you will be selling houses. In each scenario, you will be asked to decide whether to accept or reject a price offer for a particular house. You will be given a brief description of the house that will be followed by a series of price offers. The price offers are randomly generated by the computer and available one at a time. There is a five second waiting time before presenting each offer. Once a price offer is presented, you can either accept or reject it. If you accept the price offer, the house will be sold at the price you accepted. All sales are final. If you reject the price offer, the offer will disappear; you cannot go back to the previously rejected offer. In total there are 20 price offers available for each house; if you have not accepted an offer prior to the 20th offer, you will be *forced to accept* the 20th (i.e. the final) offer. *Therefore, make your decisions carefully.*

There is no time limit on how long the price offers will be available for, so take as long as you need to evaluate each offer.

Practice scenarios

There will be two practice scenarios. These practice scenarios are there to help you become familiar with the software. You will not be paid for the decisions you make in these two practice scenarios.

How payoffs are determined

The payoffs will be denoted in experimental currency units (ECUs).

1000 ECUs = 1 NZD

Your ECUs will be converted into NZD at this rate, and you will be paid in NZD when you leave the lab. The more ECUs you earn, the more NZD you earn.

Your payoffs are determined as follows:

Total ECUs you earn
=
Accepted price offer for House 1 + Accepted price offer for House 2 + ….+ Accepted price offer for House 10

Example: Suppose you accepted the price offer 450 for House 1, 260 for House 2, 380 for House 3,…, 658 for House 10. The total amount of ECUs you earn is 450+260+380+…. +658.

Do you have any questions?

You are now ready to begin the experiment. First, we will conduct two practice scenarios, with no money payoffs. Then, you will make decisions in 10 scenarios with money payoffs.

APPENDIX A.3

Instruction for the monetary cost treatment.

GENERAL INSTRUCTIONS

Overview

You are about to participate in a decision-making experiment. If you follow these instructions carefully you may earn a considerable amount of money which will be paid to you in cash at the end of the experiment. If you have a question at any time, please raise your hand and the experimenter will approach you and answer your question in private. We ask that you not to talk otherwise during the experiment. Also, please turn off your cellphone and do not use the computer for any other purpose than your participation in the experiment requires. If you break these rules, we will have to exclude you from the experiment and from all payments.

INSTRUCTIONS

You will participate in 10 scenarios, in which you will be selling houses. In each scenario, you will be asked to decide whether to accept or reject a price offer for a particular house. You will be given a brief description of the house that will be followed by a series of price offers, denoted in experimental currency units (ECUs). The price offers are randomly generated by the computer and available one at a time. Once a price offer is presented, you can either accept or reject it. If you accept the price offer, the house will be sold at the price you accepted. All sales are final. If you reject the price offer, the offer will disappear; you cannot go back to the previously rejected offer. In total, there are 20 price offers available for each house; if you have not accepted an offer prior to the 20th offer, you will be *forced to accept* the 20th (i.e. the final) offer. For inspecting *each* price offer you will incur a cost of 20 ECUs. *Therefore, make your decisions carefully.*

There is no time limit on how long the price offers will be available for, so take as long as you need to evaluate each offer.

Practice scenarios

There will be two practice scenarios. These practice scenarios are there to help you become familiar with the software. You will not be paid for the decisions you make in these two practice scenarios.

How payoffs are determined

The payoffs will be denoted in experimental currency units (ECUs).

1000 ECUs = 1 NZD

Your ECUs will be converted into NZD at this rate, and you will be paid in NZD when you leave the lab. The more ECUs you earn, the more NZD you earn.

Your payoffs are determined as follows:

Total ECUs you earn
=
(Accepted price offer for House 1- 20 ECUs * the number of inspected offers for House 1) + (Accepted price offer for House 2 – 20 ECUs * the number of inspected offers for House 2) + …. + (Accepted price offer for House 10 – 20 ECUs * the number of inspected offers for House 10)

Example: Suppose you accepted the 3rd price offer for House 1 and the price offer has a value of 450, the 4th price offer for House 2 with a value of 260, the 1st offer for House 3 with a value of 500,….., the 5th price offer for House 10 with a value of 658. The total amount of ECUs you earn is (450 - 20*3) + (260 - 20*4) + (500 - 20*1) +…. + (658 - 20*5).

Do you have any questions?

You are now ready to begin the experiment. First, we will conduct two practice scenarios, with no money payoffs. Then, you will make decisions in 10 scenarios with money payoffs.

APPENDIX B

Table 5: The actual price offers sequences used in the experiment

Round **Offer**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	388	739	310	420	292	494	522	252	789	341
2	488	803	290	637	264	225	252	709	829	459
3	683	221	637	727	344	272	562	966	996	453
4	321	729	372	561	266	994	255	885	241	625
5	625	159	619	643	396	602	370	737	799	504
6	744	150	207	663	445	987	292	449	722	387
7	279	299	455	568	266	523	533	910	1088	250
8	848	818	400	636	241	683	237	250	876	308
9	276	585	251	422	370	1400	262	933	503	492
10	678	875	708	336	484	1574	343	491	650	455
11	408	130	452	414	264	1413	220	450	890	353
12	435	795	516	479	186	184	460	394	1264	588
13	679	481	420	332	578	1081	294	899	645	438
14	465	2	607	494	244	558	535	372	1740	408
15	393	525	410	546	189	273	297	505	1179	481
16	397	429	324	724	565	1182	452	608	250	467
17	588	62	214	411	271	305	284	827	840	418
18	358	459	480	267	235	661	436	712	272	273
19	644	748	463	357	350	785	581	838	449	554
20	495	374	617	733	373	89	197	541	105	553

Each sequence of offers, including those in the practice rounds, was generated in MS Excel by randomly sampling from an interval of the average house price (in thousands of NZD) in a different Christchurch suburb plus/minus the standard deviation for that suburb.[13] The house transactions took place in October 2014. The transaction information was obtained from the Quotable Value Ltd. database (qv.co.nz).

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[13] Randbetween (lowerlimit, upperlimit).

APPENDIX C

Simulations and Hypotheses

The simulations are run using Processing 3 (version 3.02) software.[14] A total of 20 decision rules containing all possible stopping positions (1 to 20) is evaluated.

Each simulation cycle generates a set of 20 random offers. Decision rule 0 is to accept the first offer regardless of the value; decision rule 1 means to reject the first offer and choose the next highest offer, decision rule 2 refers to reject the first two offers and choose the next highest offer and so on. Decision rule 19 is to accept the 20th/final offer regardless of the value. The simulation runs separately for each house.

The simulation yields the average payoffs in ECUs of each decision rule when there are 0 and 20 ECUs. The average payoff gives an indication of which decision rule is the optimal, i.e., yields the highest payoff, when all offers yield a positive payoff. The simulation results of the total average payoff show that in 0 ECU, the optimal decision rule is“Accept the next highest after seeing 4”, which is to reject the first four offers, then accept the next highest offer. The total payoff starts to decrease if one chooses a decision rule after this, resulting an optimal stopping position at the 10th offer. The optimal decision rule is to “Accept the next highest offer after seeing the first offer” when there is 20 ECUs, which yields the highest payoff than all the other decision rules tested.

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[14] Processing is free to download at https://processing.org/.