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Choosing to search: choice with a default option

Ian Chadd¹ , Emel Filiz-Ozbay²  and Erkut Yusuf Ozbay² 

¹Department of Economics, Rensselaer Polytechnic Institute, Troy, NY, USA

²Department of Economics, University of Maryland, College Park, MD, USA

Corresponding author: Emel Filiz-Ozbay; Email: efozbay@umd.edu

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Abstract

In the presence of a default option, the optimal search rule for an agent with a reference-dependent utility and a search cost predicts: (i) the default increases the reservation utility due to the *reference effect*, leading to a better choice, and (ii) those with higher reservation utility will *self-select* into search and are more likely to find a superior option. Our experiments document the presence of both effects. Those who reject the default are likely to find higher-ranked options in their active search, supporting the self-selection effect. Even when the self-selection channel is shut down, the reference effect remains.

Keywords: Choice architecture; Default option; endogenous choice; reference dependence

JEL Codes: C91; D83; D91

1. Introduction

Information acquisition is fundamental in making good decisions. Moreover, information acquisition is costly, in terms of time or cognition, such that in a broad class of economically relevant problems¹ an individual may not consider all available options (e.g., Gabaix et al., 2006; Caplin et al., 2011). Furthermore, in the presence of a *default* option, individuals have a tendency to stick with this default.² While sticking with the default option is an easy way of making a choice, still some individuals opt out of their defaults, exert effort to evaluate their non-default options, and make an *active choice*.³ Hence, in order to assess the merits of default options, it is crucial to investigate how the provision of default options influences active choice.

As an example consider a conference participant who attends meetings in an unfamiliar city and needs to decide what to eat for lunch. By incurring a cost, which may be imposed by the time or cognitive capacity allocated, she can search for other lunch options in the area. Suppose a sandwich is provided by the conference organizers and it is her default option. The presence of such a default option, firstly, may switch on “reference-dependence” concerns in her choice and she may evaluate the other available options with respect to this default if she chooses to search other restaurants actively.

¹For example, when choosing a retirement savings plan, one needs to read the plan details and create a portfolio. Moreover, individuals are conceivably heterogeneous in their costs, for example, in a retirement savings decision, evaluation requires financial literacy and evaluating alternatives is less costly for the financially literate individuals.

²E.g. retirement saving (Madrian & Shea, 2001), prescription drug insurance (Ericson, 2014), consumer product configuration (Levav et al., 2010).

³We follow the “active choice” terminology of Chetty et al. (2014) to distinguish between settling with a default option versus evaluating and choosing from the available set of other options. The latter behavior is called “active choice” throughout the paper.

Although standard models assume that individuals should evaluate alternatives independent of the default option, consuming alternatives better or worse than the reference may trigger a sense of gain or loss in the sense of Kahneman and Tversky (1979).⁴ Secondly, the offer of a default option may impact the “self-selection” motive: Only those whose expected net benefit of searching other options exceeds the value of the default will “self-select” into active search. This rational channel is present even under the standard model, and it operates similar to the entry decision in endogenous entry games such as auctions or tournaments where individuals with higher expectations from the game than the entry cost enter the game (e.g. Levin and Smith, 1994; Bajari and Hortaçsu, 2003; Boosey et al., 2020) or voting for game change for those whose expected payoff from the new game exceeds the status-quo game (Dal Bo et al., 2010). So, in the above example of lunch choice at a conference, according to the reference-dependence channel, the participant will feel a loss if she ends up with a lunch option inferior to the default sandwich option that she didn’t choose. Similarly, finding an option superior to the default may create an additional gain feeling. Hence, she may search more in order to avoid loss or to increase gain. According to the self-selection channel, only the participants who believe that they can find a superior lunch option than the sandwich will incur the search cost and look for an alternative restaurant in the area.

Distinguishing between these two channels is necessary in order to conduct optimal default design. If only the self-selection channel is present, a chosen default simply affects who takes part in active search; those who search both with and without a default are unaffected by this policy choice. In contrast, if the reference channel is also present, a default will alter how all decision makers conduct search, leading to consequences perhaps unintended by a policy maker unaware of this behavioral channel. Establishing the existence of these two channels can illuminate whether the objective function of a policy maker should include each of these channels in applied settings.

In this paper, we analyze a choice problem where the agent goes through as many options as she wants to evaluate and picks one from the set she has investigated. The agent is assumed to incur a search cost for evaluating alternatives and has a reference-dependent utility (gain/loss utility) in the presence of a default option. We conduct experiments to test the theoretical predictions regarding the reference and self-selection effects introduced by the default. In the experiments, our subjects select among options that are presented as sequences of symbols of # and %. The monetary value of an option is equal to the number of # symbols in the sequence.⁵ Note that in such a choice task, understanding the monetary value of an option requires effort and hence it corresponds to the costly search problem we study theoretically.

In our Baseline, subjects must choose from ten such options, incurring a cognitive cost to search among them. To study the effect of a default option we introduce an option that a subject can choose without incurring a search cost; this default option is never presented as a sequence of symbols to be interpreted. In this Endogenous Treatment, in each decision problem, subjects can take the default or reject it and choose to search, in which case they see ten displayed options as in the Baseline and cannot choose default anymore (see footnote 11 and the corresponding paragraph for justification of this assumption).

To identify the marginal impact of the reference and self-selection effects, we first note that both are present in the Endogenous Treatment: Low search cost subjects will reject the default and search while those who search will evaluate searched options relative to the default, regardless of their search

⁴Reference-dependence has been robustly shown in various contexts (for a detailed review see O’Donoghue and Sprenger, 2018). Furthermore, it has been shown that a reference-dependent model fits the data better than the standard model, e.g. job search (DellaVigna et al., 2017) and retirement age decision (Seibold, 2021). Reference dependent utilities are also applied various environments under uncertainty à la Köszegi and Rabin 2006 such as evaluation of experiences (Bushong and Gagnon-Bartsch, 2022; Gagnon-Bartsch and Bushong, 2022) and social comparisons (Langtry, 2022).

⁵In similar option choice experiments, Caplin et al. (2011) and Chadd et al. (2021) present the value of each option as a sequence of addition and subtraction operations. In order to avoid the possibility of cheating in an online platform, we use a different task.

cost. To isolate the two effects, we introduce a treatment where everyone knows about the default but subjects are sometimes forced to opt out of the default option.⁶ In this Exogenous Treatment, subjects are told about the existence of a default, but are assigned to either the default or search exogenously with equal probability. This is an advantage of collecting data in a controlled experiment.

Comparing the active choices when the default option is involuntarily opted out and “when there is no default option” identifies the impact of the reference-dependence channel; comparing the active choices in the presence of a default option when it is voluntarily and involuntarily opted out yields the additional impact of the self-selection channel. Thus, the difference between choices in our Baseline and Exogenous Treatment is attributable to the reference-dependence channel; the difference between choices in the Exogenous and Endogenous Treatments is attributable to the self-selection channel.

We build our testable hypotheses based on the theoretical predictions for the choice problems in each treatment. We investigate an optimal search model under reference-dependent utility via the gain/loss utility model where the value of the default option serves as the reference point. We use the functional form of Kőszegi and Rabin (2006) which is built on the prospect theory of Kahneman and Tversky (1979) that simplifies it by ruling out diminishing sensitivity and probability weighting. In the current model, a decision maker holds a belief in the distribution of option values and incurs a cost to learn the value of each alternative. So, at each point of the search, she evaluates whether the reference-dependent utility of continuing the search exceeds the cost of it. The optimal strategy is a cutoff rule characterized by a reservation utility: Stop searching once an option with a value higher than the reservation utility is found (result 1), otherwise keep searching.

Our theoretical comparative statics imply that the reservation utility is higher when there is a reference. In other words, more search is expected in the presence of a default option, and hence, the quality of active choices in the Exogenous Treatment will be better than in the Baseline Treatment. Additionally, an individual with a lower search cost has a higher reservation utility, implying that she searches more.⁷ Therefore, it is expected that only those whose costs are low would reject the default option and self-select into an active choice in the Endogenous Treatment, implying that the quality of active choices will be superior in this treatment.⁸

Our design allows us to address several problems present in the field data. Despite substantial research on default options in numerous environments, several obstacles in field data prevent the joint study of the impacts of the reference-dependence and self-selection channels on the quality of the active choice. First, due to subjective valuations of the alternatives in applications (such as insurance or retirement plan choices), it is not possible to determine the quality of active choices without making additional assumptions. To overcome this obstacle, we design experiments where the subjects' choice is on objectively valued options, hence any change in choice due to the presence of a default can be measured in terms of the change in the objective value of the chosen alternative.

Secondly, identifying the marginal contributions of reference and self-selection effects of default option might not be possible with field data. Note that, in those environments, when there is no default option, none of these effects are present, but when the default is offered and the individuals decide whether to opt out of the default option, both effects are activated.

We find evidence of both reference and self-selection effects. Subjects choose the best option most frequently in the Endogenous Treatment, where both effects are present, and least frequently in the Baseline. Moreover, even when failing to find the best option, subjects still choose higher-valued options in the Exogenous Treatment versus the Baseline (reference effect) and in the Endogenous

⁶This is similar to the exogenous versus voluntary game change implemented by Dal Bo et al. (2010) in a multi-player voting game to isolate and control for the selection effect. Selection has a more direct effect in our setting as we do not have the strategic interaction and belief formation aspects of Dal Bo et al. (2010) in our single-person decision problems.

⁷A similar result can be derived based on gain/loss parameters as well.

⁸This is consistent with the findings of Chetty et al. (2014) who show that more financially sophisticated individuals tend to opt out of the default contributions and actively choose their contributions to retirement savings.

Treatment versus the Exogenous Treatment (self-selection effect). Results are qualitatively similar if we instead look at monetary gains over random choice.

Our results have direct policy implications for choice architects. Providing some reference to consumers in the form of default option may overall lead to the choices of options with higher consumption value. The gain/loss motivation caused by a reference may incentivize any type of consumer to search more. Moreover, the availability of a default helps consumers with poor searching skills (or high searching costs) to settle for a choice with higher value without exerting search effort than what they expect to find if they have searched actively. Aside from these effects, the overall welfare effects of default are a more delicate issue due to the increased cost of longer search and gain/loss utilities. Eliciting those measures is beyond the scope of the current research.

The rest of the paper is organized as follows. [Section 2](#) explains the design of the experiments. [Section 3](#) provides a theoretical model of search with reference dependent utility and characterizes the optimal search rule. [Section 4](#) reports the data analysis of the experiments. [Section 5](#) concludes with a discussion of our findings and their implications. The proofs are in the Online Appendix. Experimental instructions with screenshots can be found in the Online Appendix.

2. Experimental design

The experiments were programmed in oTree (Chen et al., 2016) and the data was collected online via the Prolific platform in Fall 2020. Each subject participated in the experiment only once.

When a session started, a subject first approved an online consent form and received the instructions for the relevant treatment.⁹ Next, 20 decision problems appeared one by one. Each subject, across all treatments, saw the same set of decision problems, the order of which were randomized at the subject level. We used Experimental Currency Units (ECU) in the experiments with an exchange rate of 10 ECU=\$1. At the end of the experiment, subjects were paid for one randomly selected decision that they made. On average, subjects earned \$3.58, including the participation fee of \$1, for an average of approximately 15 minutes of participation.

A choice problem was presented as a choice list with 10 options in it. [Fig 1](#) shows an example of a choice problem. Each option was displayed as a sequence of 50 symbols constructed by % and #. The value of an option is the number of # symbols in the sequence. Therefore, the optimal choice would be to select the option with the highest number of # symbols. In order to make the decision more challenging, only the option that the subject's cursor is on is highlighted (it is Option 2 in [fig 1](#)). Hence, the subject needs to move the cursor around in order to evaluate each option.¹⁰ The subjects were given 120 seconds to make a selection and submit it by clicking a submission button on the screen. If they failed to submit an option within this time limit, they got a payoff of zero ECU for that problem.

In order to generate option values, for each decision problem we randomly drew 10 values from a normal distribution with a mean of 20 ECU and a standard deviation of 8 ECU. We repeated this process, redrawing from the same distribution, until each decision problem had (i) a unique option with maximal value and (ii) no options with value less than zero ECU. The subjects were informed about the value distribution function.

We have three treatments such that all of the treatments are identical in terms of the available 20 decision problems. They differ based on the existence of a default option and, in the case of default

⁹See the Online Appendix for screenshots of the instructions.

¹⁰Because the experiment was run online with less experimenter monitoring than is available in a lab experiment, a natural concern is that subjects might "cheat" somehow in order to maximize their earnings with little effort. In order to prevent an obvious form of cheating, options in each decision problem were presented using a picture (png file) rather than text. This way subjects could not simply copy and paste the decision problem to another piece of software (e.g. Microsoft Excel or Word) to count the # symbols for them.

Decision Problem: 1

Time left to complete this page: 1:06

Please select one of the following options.

If this problem is chosen for payment, you will be paid for the number of # displayed for the option you choose.

- Option 1: #####
- Option 2: #####
- Option 3: #####
- Option 4: #####
- Option 5: #####
- Option 6: #####
- Option 7: #####
- Option 8: #####
- Option 9: #####
- Option 10: #####

Next

Fig 1. An example decision screen

Notes: The above screenshot displays an example decision problem. Option sequences were partially hidden unless the cursor hovered over the option, as is the case for Option 2 in the above. The value of an option was the number of # symbols in the sequence. Option 2 was therefore worth 14 ECU (\$1.40) if it was chosen by a subject in a given decision problem. Subjects were not paid for the decision problem if they did not (i) select an option in the list (by clicking it) or (ii) click the Next button before the time allotted (highlighted at the top of the screen) ran out.

option, they differ by whether this option can be endogenously chosen by the subject or exogenously assigned to the subject.

Baseline Treatment: In this treatment, a subject sees all the options in a choice problem without any default or reference option. For each problem, she makes a choice from the presented list of options, submits her choice, and moves to the next problem. She responds to 20 choice problems in total. No default option is presented.

Endogenous Treatment: In this treatment, for each problem, a subject is first *offered* a default option of 14ECU. If she takes this offer, she moves on to the next problem without having to choose between the 10 options. If she rejects this offer, she sees the 10 options similar to the Baseline. This procedure repeats for each of the 20 decision problems presented in a session.

Exogenous Treatment: In this treatment, for each problem, a subject is first *presented* a default option of 14ECU. She is told that with 50% chance she will receive this amount for the current problem and with 50% chance she will see a choice problem with 10 options on the next screen. If the latter event occurs, she makes an active choice similar to the other two treatments. For each of the 20 decision

problems in the session, there is an independent randomization for getting the default option or making an active choice for that problem.

We chose 14 ECU as the value of the default option in the Exogenous and Endogenous treatments since it was lower than the mean so that we would have meaningful self-selection, but not so low that no subjects would ever choose the default option. Section 4 presents evidence that our choice of default option value was effective and in about 81.5% of the decision problems the default was rejected and about 60% of the subjects always rejected the default. The theory predicts a similar effect qualitatively for the introduction of default. Since we are interested in the existence of those effects, we leave the variation of default for future research, which may allow us to estimate the behavioral and cost parameters.

In our Endogenous Treatment, if a subject rejects a default and starts active search, the default is no longer available to her. Note that otherwise it is hard to deduce whether active search is conducted or not for a subject choosing the default since it can happen either because the subject did not like any other option or because she did not consider anything else. In such an environment, the underlying consideration model needs to be known in order to identify the likelihood of an active choice (Abaluck and Adams-Prassl, 2021). In an experiment, this complication may be trivially eliminated entirely by excluding the rejected default from the active search, so that the choice of default directly reveals that the active search is not performed.¹¹

We collected decisions from 70, 99, and 157 participants in the Baseline, Endogenous, and Exogenous Treatments, respectively. There are more subjects in the Endogenous Treatment than in the Baseline to have enough observations of active choice in the former. The number of subjects is the highest in the Exogenous Treatment because only half of all observations were of active choice by design. Additionally, we filter out inattentive subjects by excluding those who spent very little time (less than 15 seconds) on the initial instructions page. We also exclude subjects who failed to choose an available option within the allotted time in at least one decision problem where they had to make an active choice. These two exclusions of inattentive subjects led to dropping approximately 5% of our subjects across each treatment.¹² This results in 65, 92, and 147 attentive subjects in the Baseline, Endogenous, and Exogenous Treatments, respectively.¹³ This and other relevant treatment details are summarized in Table 1.

3. Model of optimal search with a default option

In order to form our hypotheses, we investigate an optimal search model allowing a reference-dependent utility. The proofs are in the Online Appendix.

In particular, we employ a reference-dependent utility function based on Kőszegi and Rabin (2006) that builds on the prospect theory model of Kahneman and Tversky (1979), and for simplicity assume away diminishing sensitivity and probability weighting: $u(x, r) = x - \beta(r - x)^+ + \gamma(x - r)^+$, where $x \in \mathbb{R}_+$ is the value of an option, $r \in \mathbb{R}_+$ is a reference, and $(y)^+ := \max\{y, 0\}$. Note that

¹¹The rejected default being removed from the set of available options in an active search is also relevant for some applications. For example, if the default has limited availability then when it is rejected by an agent, it will be taken by someone else, or the default option may be offered as a take-it-or-leave-it offer. There may also be legal reasons for unavailability of the default once rejected. For example, a college athlete needs to resign from her existing team in order to initiate an active search. Opting out of the default option may be costly as in Carroll et al. (2009), and if this cost is high enough, it may even nullify the benefit of the default option once it is rejected.

¹²We aimed to balance observations of active choice across treatments. In pilot sessions, about 95% of the subjects were attentive. Moreover, the pilots of the Endogenous Treatment had majority of the subjects self-selected to choose actively in all decision problems. Aiming for 60-70 attentive subjects in the Baseline, we recruited about 60% more subjects for the Endogenous and doubled the number for the Exogenous knowing that only half of the time in expectation they will be forced to choose actively.

¹³Our results are qualitatively similar if we include these inattentive subjects, as reported in the Online Appendix.

Table 1. Treatment summary

	Treatment		
	Baseline	Endogenous	Exogenous
Default option	✗	✓	✓
Selection	–	✓	✗
Channels	–	Reference Self-Selection	Reference
N	70	99	157
Attentive N	65	92	147

Notes: “Default Option”: indicates whether there was a 14 ECU default option presented to the subject. “Selection” indicates whether the subject could select the default option endogenously. “Attentive” indicates that the subject spent more than 15 seconds on the initial instructions page and never timed out.

in this specification, in addition to the consumption utility denoted by the first term, there is disutility from having an option with a value lower than the reference as well as additional gain when consumption exceeds the reference. The coefficients $\beta \geq \gamma \geq 0$ are the loss and gain parameters, respectively.

We treat the default option as the static reference when it is present. This is natural for our experiment where the decision is relatively quick and the default is not available once the active search starts; hence, a subject may compare the options that she finds out through search with respect to the forgone reference of the default. The literature specifies different references depending on the context. Della Vigna et al. (2017) takes the average income of previous rounds in a job search problem. Job search for an unemployed worker is a long process and previous income affects standards of living. Hence, a person may compare searched options with respect to those standards. Backward-looking references have also been used by Bowman et al. (1999) in the context of consumption and savings problems. Since the value of our default option is quite salient (prominently displayed to subjects in each problem) and because subjects are only paid for one decision problem, we do not model the reference as backward looking.¹⁴

In our setup, there are a number of alternatives and the value of each alternative is unknown to the decision maker, but she knows that the values are distributed i.i.d. by $F(x)$. The value of an alternative can be learned by incurring a cost. Let $c > 0$ denote the cognitive cost of searching one more option.¹⁵ We assume that c is less than the expected value of the option given F so that search might be meaningful at least for some situations, i.e. $E[x] > c$. The person may learn each option sequentially in any order she wants. The decision maker has the option of earning zero by not doing anything for the duration of the experiment: This is what we paid to subjects if they do not make any decision in 120 seconds. We define the decision problem in discrete time where in each period $t \in \{0, 1, \dots, T\}$, the decision maker decides whether to evaluate an option or not. At $t = 0$, not searching means taking the default in the Endogenous Treatment, and it means receiving zero in the other two treatments. When search is stopped in a given period, the decision maker selects the alternative with the highest reward among the ones of which she has learnt their values so far. T denotes the highest period at which the subject understands that she can evaluate exactly one more option.¹⁶ Hence, $T + 1$ is the period at which the person knows that her probability of finding an option that will impact her choice

¹⁴In section 4.1, we provide empirical support for a static reference approach.

¹⁵While the assumption of such a fixed search cost is standard, it is possible that in some applications the search cost may vary as decision makers face repeated search problems as in our experiment. Under this alternative assumption, choice optimality would be correlated with the decision round in the Baseline, for which we find no evidence (OLS $p > 0.10$ for all choice optimality measures as defined in section 4).

¹⁶In the experiment, each choice has ten options, hence $T \leq 10$.

is zero. So, she understands that she will not be able to evaluate a new option and if she does not make a selection now, her earnings will be zero at that time.¹⁷

We define a reservation utility, u^R , by modifying the Gittins-Weitzman index (Gittins, 1979; Weitzman, 1979) for $u(x, r)$. The reservation utility can be interpreted as a fictitious value that makes the subject indifferent between taking this value and evaluating one more option. The next result shows that optimal search is a cutoff strategy described by the reservation utility. A subject should keep searching as long as the best option in hand so far has a lower value than the reservation. We also show how the cost and gain/loss parameters, c , β , γ , and r affect the reservation utility with implications on the expected value of choice.

Result 1. For any $r, \beta, \gamma, c > 0$, there is a unique reservation utility, u^R , such that for any $t \in \{1, \dots, T\}$, it is uniquely optimal to select the highest value option that is found until $t - 1$ if this value is higher than u^R ; otherwise, search more. The reservation utility u^R increases with β and γ , weakly increases with r , and decreases with c .

First, note that the well-known cut-off structure of the optimal strategy in the standard dynamic search model without behavioral utilities (see e.g., Caplin et al., 2011) generalizes to the gain/loss utility model according to result 1.¹⁸ The proof of result 1 constructs the marginal utility of searching one more period given the best option in hand so far. In a given period t , for a subject whose best option so far is u_t , the marginal expected utility of evaluating one more option rather than stopping search is described as a function of u_t . The intersection of this function with the cost of searching one more option gives the optimal reservation utility. Fig 2 illustrates this constructed function when there is a reference, r , denoted by the solid curve, and when there is no reference, denoted by the dashed curve.

The solid function has a kink at the reference when the reference is introduced. This is because the forces causing the shift on the left and right of r are different. If the value of the best option in hand so far is already above the reference itself, the introduction of the reference will increase the marginal utility of search due to the additional motivation of the gain utility. If it is below the reference, the subject will feel the loss in the presence of a reference, so the marginal utility of search increases both to avoid that loss and to potentially gain some amount above the reference. Due to this asymmetry, we see a kink at r on the solid curve in fig 2.

The dashed curve was derived under the assumption that there is no gain/loss utility in the Baseline (i.e. $\gamma = \beta = 0$). Alternatively, subjects in the Baseline may have some unobservable reference (e.g. 0 or $E[x]$) and employ gain/loss utility. From result 1, the optimal reservation utility is a weakly increasing function of the reference. Hence, if the Baseline has a reference that is smaller than r , then the reservation utility in the Baseline will be weakly smaller than in Exogenous, directionally similar to our model predictions. If, instead, the Baseline has a higher reference than r , we predict that the reservation utility will be larger in the Baseline than in Exogenous, which is inconsistent with our findings. For ease of exposition and to avoid making predictions based on an unobservable reference, we assume there to be no gain/loss utility in the Baseline. This assumption is also consistent with there being no salient reference presented in the Baseline environment, so the subjects' gain/loss concerns may not be triggered.

¹⁷Note that the choice problem in the experiments presents all options without enforcing sequential search (similar to Caplin et al., 2011; Chadd et al., 2021.) Caplin et al. (2011) report strong support for the predictions of sequential optimal search for their standard choice case, similar to the choice problem we used. Building on their results, here we use an optimal search model.

¹⁸An alternative modeling approach might treat the total cost of search as a reference, which would predict dynamically evolving reference dependence. This would imply a history-dependent reservation utility, rather than a cut-off strategy. Given the strong evidence for cut-off strategies in the literature, we chose not to use search cost as a reference.

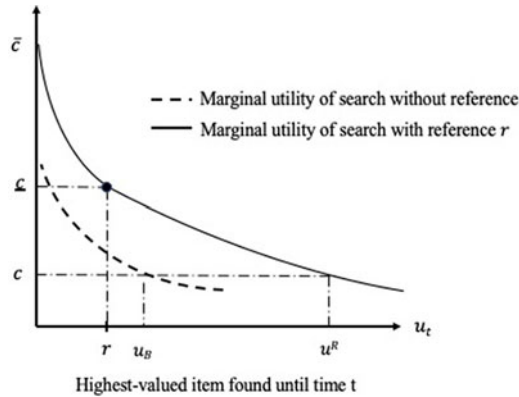


Fig 2. Marginal utility of searching given u_t and optimal reservation utility

Notes: This figure illustrates the marginal utility of searching one more period as a function of the highest-valued item found until time t , u_t . The dashed curve refers to the case with no reference (Baseline) and the solid curve refers to the case with reference r (Treatments.) Optimal reservation utility is found when the corresponding marginal utility equals the marginal cost of search, c ; given by u_B for the Baseline and u^R in the Treatments. $\underline{c}$ and $\bar{c}$ correspond to the cutoffs found in Result 2. $\underline{c}$ corresponds to a decision maker whose reservation utility is equal to r . $\bar{c}$ corresponds to a decision maker who would never search. All those with $c \in [\underline{c}, \bar{c}]$ choose the default in Endogenous, but search in Exogenous if assigned to active choice.

Fig 2 also provides an example of a subject with a cost parameter of c , and shows how the optimal reservation of such a subject shifts from u_B when there is no reference as in the Baseline to u^R when there is a reference as in the Exogenous Treatment. Note that for every cost level, the optimal reservation level will be higher in the Exogenous Treatment than the Baseline because the solid curve is higher than the dashed curve as fig 2 illustrates. So both those who search little or a lot without the reference will be motivated to search more with the reference since the shift occurs on the whole domain. This observation leads to corollary 1.

Corollary 1. *The reservation utility is higher when there is a reference and hence, more search leading to a choice of a higher value option is expected when the gain/loss utility is triggered by the reference.*

Corollary 1 implies that a subject is expected to search more in the Exogenous Treatment than the Baseline and to find a better ranked option. This implication is summarized in Hypothesis 1.

Hypothesis 1. (Reference Effect) *For any rank level, the probability of choosing a better ranked option is higher in the Exogenous Treatment than that in the Baseline.*

Recall that the value of not searching in the initial period of the Exogeneous and Endogenous Treatments are different. At period 0, while $u_0 = 0$ in the Exogenous Treatment, $u_0 = r$ in the Endogeneous Treatment. According to the optimal search strategy found in result 1, a subject whose u^R is below r should not start the initial search in the Endogeneous Treatment. Since the reservation utility decreases with cost, one can find a cutoff cost level to determine who will start searching in this treatment. As can be seen in fig 2, that cutoff is $\underline{c}$ that corresponds to $u^R = r$; only subjects with reservation utility higher than the default will choose to search in the Endogeneous Treatment. Additionally, note that a subject whose cost is $\bar{c}$ has reservation utility equal to 0, and so would not search when they could attain utility $r > 0$ by choosing the default. For a subject whose cost is in $(\underline{c}, \bar{c})$ the value of the default option will be above her reservation utility, and hence, she will take the default option rather than searching in the Endogeneous Treatment. However, such a subject would prefer

searching in the Exogenous Treatment. This causes those subjects with high costs to drop out from search in the Endogenous Treatment. The next result states this selection result.¹⁹

Result 2. For a given pair of gain/loss parameters, there is a range of cost, $(\underline{c}, \bar{c})$, such that a subject with $c \in (\underline{c}, \bar{c})$ would search in the Exogenous Treatment but not in the Endogenous Treatment.

For our experiment, result 2 implies that the expected reservation utility of the subjects who rejected the default will be higher in the Endogenous Treatment than the expected reservation utility of those who are forced to search in the Exogenous one. Those with a low reservation ($u^R < r$) will take the default in the Endogenous Treatment while they search in the Exogenous one. This will increase the average reservation utility of the active searchers in the Endogenous one. Since the higher expected reservation utility means more search in expectation in the Endogenous Treatment, finding a better-ranked option is more likely to happen in this treatment than the Exogenous one. This observation is stated in the next Corollary.

Corollary 2. *In a population with heterogeneous marginal costs, when there is a reference, the agents who self-select into active search have higher expected reservation utility than those who are forced to search. Hence, the choice of a higher-ranked option is more likely in the former case.*

Corollary 2 can be directly tested in our experiments as stated in hypothesis 2 below.

Hypothesis 2. (Self-selection Effect) *For any rank level, the probability of choosing a better-ranked option is higher in the Endogenous Treatment than in the Exogenous Treatment.*

4. Results

Throughout the analysis, we refer to the choice from the 10 presented options as “active choice”. Choosing the default in the Endogenous Treatment or receiving the default as the result of randomization in the Exogenous one are not considered active in this terminology. While the latter is clearly not an active choice, as the computer assigns the default to the subject, we apply this terminology to the Endogenous Treatment as well in order to distinguish between choosing after search and settling with the default without seeing any other option (see also Chetty et al., 2014).

We start our analysis with the entry decisions in the Endogenous Treatment. Table 2 presents descriptive statistics for the Active Choice Selection Rate, which we define as the percentage of decision problems (out of 20) where a subject chose to see their options and make a choice (i.e., they did not choose the default option).

Several trends emerge. Overall, subjects engage in “active choice” in roughly 81.5% of all decision problems. They are more likely to search actively in the earlier rounds by about 5 percentage points. At one extreme, out of 92 subjects, 4 *always* chose the default. At the other, 55 subjects (59.78%) chose actively for all 20 decision problems, always forgoing the default option. These subjects are our first evidence for the self-selection effect in line with the prediction of Result 2. We take this as evidence that the most meaningful comparison between our treatments restricts attention only to these subjects who rejected the default (i.e., chose actively) in all 20 decision problems *and* chose one of the available options in the active choice problem (i.e., did not time out). In this way we more closely mimic one-shot real-world (e.g., procurement auction) or laboratory (e.g., tournament) entry decisions that have been previously studied in the body of literature.

¹⁹ A similar selection result can be written in terms of the gain/loss parameters since these parameters are the two other sources of heterogeneity affecting the initial search decision in the model. Note also that the model assumes risk-neutrality for simplicity, so another selection result could be derived in terms of risk attitudes in an extension of the current work. As we mention in section 4, our results are inconsistent with an interpretation of selection exclusively based on risk attitudes.

Table 2. Entry decisions in endogenous treatment

	Mean	SD	Min	p25	Median	Max
Active choice selection rate	.815	.303	0	.7	1	1
N	92					

Notes: This table displays the Active Choice Selection Rate, defined as the percentage of decision problems where the subject made an active choice (i.e. did not choose the default), for the Endogenous Treatment. Note that 55 of 92 subjects (59.78%) always chose Active Choice and 4 of 92 subjects (4.35%) never chose Active Choice.

Table 3. Correct rate by treatment

		Baseline	Exogenous	Endogenous
Correct Rate	Mean	68.8%	71.6%	79.3%
	Std. Dev.	(46.4)	(45.1)	(40.6)
	Obs.	1300	1501	1100
	p-values	vs Baseline: 0.411		vs Exogenous: 0.002

Notes: p-values are calculated via logistic regression with subject-level clustering.

Furthermore, the high rate of Active Choice in this treatment indicates that the subjects found the decision problem moderately easy and hoped to find better options than the default in their active choices. As we mentioned in [section 2](#), we intentionally chose a relatively low value for the default option to have enough observations for endogenous entry, but we did not set it too low so as to have meaningful self-selection. [Table 2](#) shows that our design choices succeeded in these goals since neither (i) everyone always chose the *default option* nor (ii) everyone always chose *actively*.²⁰

[Table 3](#) reports the frequency with which subjects choose the highest-valued option (Correct Rate) in each treatment. There is evidence of a selection effect: The Correct Rate is highest in the Endogenous Treatment at 79.3%, nearly 8 percentage points higher than in the Exogenous Treatment. However, there is only weak evidence of reference dependence at this extensive margin: While the Correct Rate is higher in the Exogenous Treatment (71.6%) than in the Baseline (68.8%), this difference is not statistically significant. [Table 3](#) reports the Correct Rate aggregating all the rounds, as subjects are no more likely to choose the optimal option in earlier rounds than in later ones.

To look at the intensive margin of choice differences between treatments, we examine the discrete rank of the chosen option conditional on choosing sub-optimally (i.e., not choosing the highest-valued option). The distributions of the Rank of Chosen Option for the Baseline and Exogenous Treatments are reported in [fig 3](#). Since the only difference between Active Choice in the Baseline and the Exogenous Treatment is that, in the latter, a subject was aware of an exogenously foregone default option, any resultant change in choices between these two environments is attributable to this default option serving as a reference during Active Choice. We find that subjects are more likely to choose better-ranked (i.e., higher-valued) options in the Exogenous Treatment relative to the Baseline (One-Sided KS $p < 0.01$).²¹ This supports [Hypothesis 1](#).²²

To test if there is self-selection in addition to a reference effect, we perform the rank comparison for the Exogenous and Endogenous treatments in [fig 4](#). Recall that the only difference between the

²⁰Besides this, once in active choice, subjects choose options below the value of the default very rarely (0.3% in the Endogenous Treatment). This is similar in other treatments (2.2% in the Baseline; 1.4% in Exogenous). Though the magnitude of these treatment differences is statistically indistinguishable from zero (per logistic regression), the direction is consistent with the theory.

²¹Moreover, per the Barrett and Donald (2003) test of unidirectional dominance, the Rank distribution for Baseline First-Order Stochastically Dominates that for Exogenous ($p > 0.10$ for $H_0 : F_{Baseline} \leq F_{Exo}$ and $p < 0.01$ for $H_0 : F_{Exo} \leq F_{Baseline}$).

²²Our results are qualitatively similar when we test for treatment differences in the Rank of Chosen Option conditional on sub-optimal choice using ordered logistic regressions with subject-level clustering.

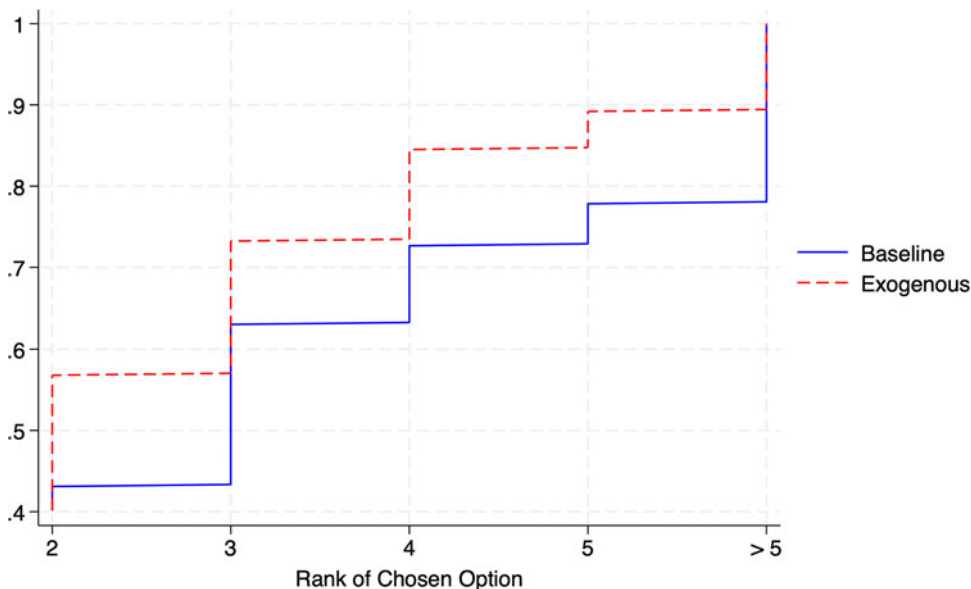


Fig 3. CDF of rank of chosen option: baseline vs exogenous treatment
Notes: Rank is lower for higher-valued options. Since it is rare for subjects to choose options worse than rank 5, we pool those observations into a single category. CDFs are presented conditional on sub-optimal choice (Rank > 1).

Exogenous and Endogenous treatments is that in the latter, subjects can freely choose the default option instead of it being exogenously assigned. The value of the default option serves as a reference in both. Therefore, any choice difference between these two treatments is attributable to selection. Note that for any ranking level, the CDF of the Endogenous Treatment is higher than that of the Exogenous one. This indicates that subjects are more likely to choose better ranked (i.e., higher valued) options in the Endogenous Treatment relative to the Exogenous Treatment (One-Sided KS $p < 0.01$).²³ This finding supports [Hypothesis 2](#).²⁴

In addition to investigating the effects of the default using the Rank of the chosen option, we alternatively consider monetary gains. “Gain” is defined as the percentage of available monetary gains that the subject attained above the mean option value within a given decision problem. Formally, in decision problem i , let v_i^* be the value of the optimal option, $\bar{v}_i$ be the mean value of the available options, and v_i be the value of the option that the subject chose. We then define Gain as follows:

$$\text{Gain}_i = \frac{v_i - \bar{v}_i}{v_i^* - \bar{v}_i}$$

[Fig 5](#) presents distributions of Gain across the Baseline, Endogenous, and Exogenous Treatments, conditional on sub-optimal choice, mirroring the above Rank analysis. These distributions tell a similar story to those for Rank in [fig 3](#) and [4](#). First, subjects experience more Gain in the Exogenous Treatment relative to the Baseline, indicative of a reference effect (One-Sided KS $p < 0.01$). Additionally, they experience more Gain in the Endogenous Treatment relative to the Exogenous one, consistent with the self-selection effect (One-Sided KS $p < 0.01$).²⁵

²³Moreover, per the Barrett and Donald (2003) test of unidirectional dominance, the Rank distribution for Exogenous First-Order Stochastically Dominates that for Endogenous ($p > 0.10$ for $H_0 : F_{Exo} \leq F_{Endo}$ and $p < 0.05$ for $H_0 : F_{Endo} \leq F_{Exo}$).

²⁴Results are qualitatively similar when we test for treatment differences in the Rank of Chosen Option, conditional on sub-optimal choice using ordered logistic regressions with subject-level clustering.

²⁵Results are qualitatively similar when we investigate treatment effects via OLS regression with subject-level clustering. Moreover, Barrett and Donald (2003) tests of FOSD are also significant for both Baseline versus Exogenous ($p > 0.10$ for

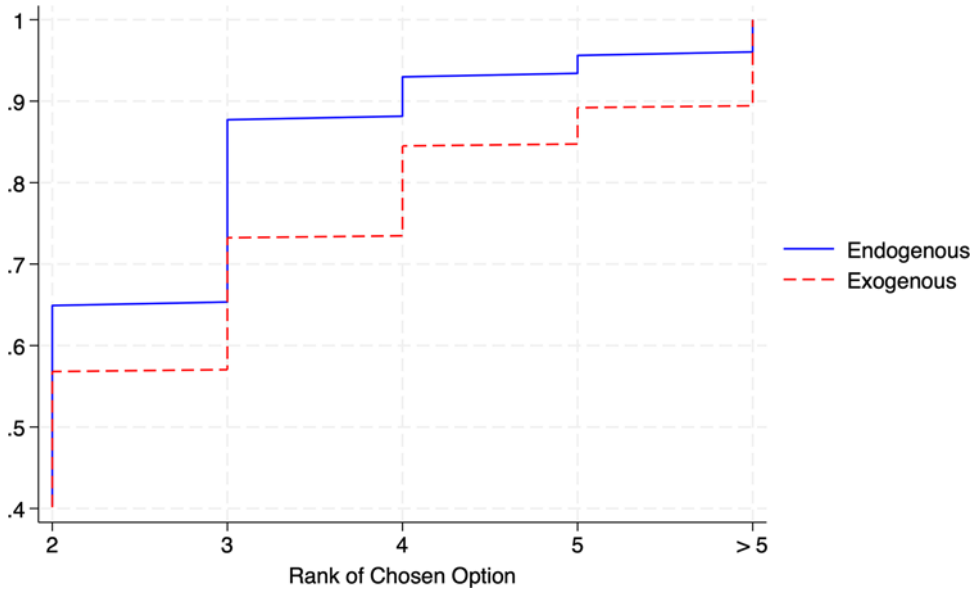


Fig 4. CDF of rank of chosen option: exogenous vs endogenous treatment

Notes: Rank is lower for higher-valued options. Since it is rare for subjects to choose options worse than rank 5, we pool those observations into a single category. CDFs are presented conditional on sub-optimal choice (Rank > 1).

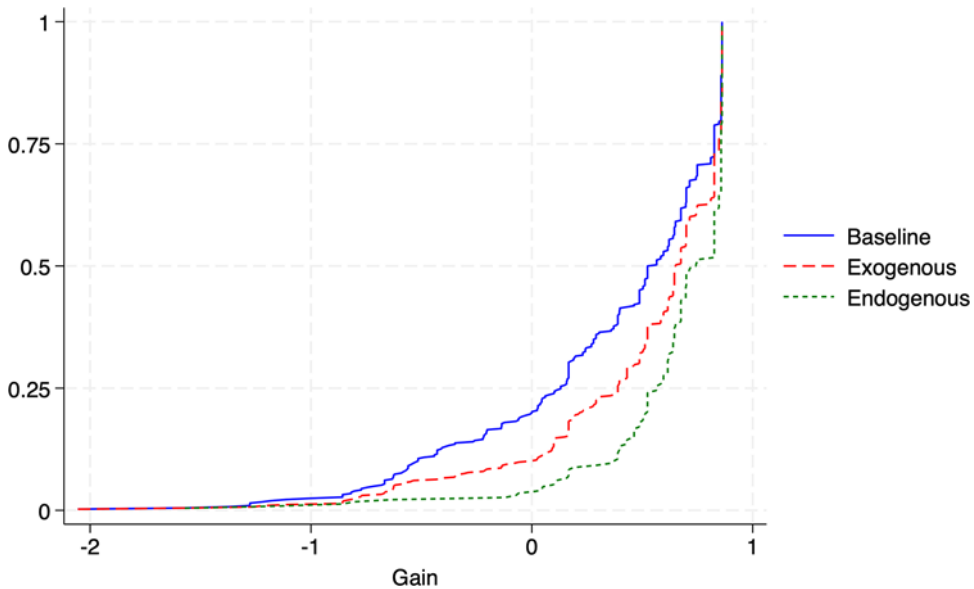


Fig 5. Gain distributions

Notes: Gain is calculated as the percentage of the available monetary gain above the mean option value captured by the choice of the subject, i.e. $\text{Gain}_i = \frac{v_i - \bar{v}}{v_i^* - \bar{v}}$ where v_i is the value of the chosen option, v_i^* is the value of the optimal option in the decision problem, and $\bar{v}$ is the mean option value in the decision problem. CDFs are presented conditional on sub-optimal choice (Gain < 1).

$H_0 : F_{\text{Exo}} \leq F_{\text{Baseline}}$ and $p < 0.10$ for $H_0 : F_{\text{Baseline}} \leq F_{\text{Exo}}$. and Exogenous versus Endogenous comparisons ($p > 0.10$ for $H_0 : F_{\text{Endo}} \leq F_{\text{Exo}}$ and $p < 0.01$ for $H_0 : F_{\text{Exo}} \leq F_{\text{Endo}}$) when we include all observations.

4.1. Complementary analysis and discussion

In this section, we explore complementary analysis that is not directly linked to the predictions derived in [section 3](#). These analyses provide additional support for the reference and selection effects, as well as for our modeling approach.

4.1.1. Decision times support the Selection story

As additional support to the results derived from choice data, we look at decision time data. Since subjects are forced to choose actively both in the Exogenous Treatment and the Baseline, searching skills are expected to be similar in these two cases. On the other hand, the reference presented in the Exogenous Treatment increases the reservation utility of the optimal search with respect to that in the Baseline according to result 1. Since the higher reservation would mean a longer search in expectation when we keep the skill level fixed, the average decision time in the Exogenous Treatment is predicted to be higher. We observe that the subjects indeed spend *more* time in the Exogenous Treatment relative to the Baseline (31.18 vs. 23.73 seconds, respectively; Mann-Whitney $p < 0.001$).

In the Endogenous Treatment, while the reference effect predicts more search (due to higher optimal reservation), the self-selection effect may increase or decrease the decision time. Since only the lower-cost subjects are self-selecting in this case, these subjects might also be faster in evaluating each option. On the other hand, self-selection also predicts higher reservation on average for these actively searching subjects, implying evaluation of more options in a given decision problem. So it may take these subjects longer to submit a final decision even if they are faster in the evaluation of each option. In the data, we see that the actively searching subjects in the Endogenous Treatment spend on average 26.60 seconds on a decision problem and this is significantly faster decision time than in the Exogenous Treatment (Mann-Whitney $p < 0.001$).²⁶ Thus, arguably, the lower-cost subjects are skillful and faster.²⁷

4.1.2. Is the reference “evolving?”

As mentioned in [section 3](#), we treat the default option as a static reference when it is present, in contrast to models that use backward-looking references (e.g., average income in previous rounds of job search DellaVigna et al. (2017)). Of course, despite this modeling assumption and the salience of the default option, it is possible that subjects evaluate options relative to an evolving reference. There are three primary references worth exploring here: the previously searched option within the decision problem, the best option previously searched within the decision problem, and the previously chosen option in a previous round.

Assume that either of the first two alternatives serves as a reference when evaluating the next option in the same problem. Then subjects in the Baseline would exhibit a reference effect; previously searched options serve as a reference even in the absence of a default option. In the absence of a mechanism for the default option to affect this reference, this would predict no difference between the Baseline and the Exogenous Treatment. Our results above show that subjects generally choose higher-valued options in the Exogenous Treatment versus the Baseline, indicating that the default option itself affects choice.

Alternatively, if the option chosen in a previous round serves as a reference (either alone or in a rolling average), we should see positive correlation between the value of the previously chosen option

²⁶Note also that subjects spending less time in Endogenous than in Exogenous, but making better decisions, is not consistent with an interpretation of selection exclusively based on risk attitudes. It is also inconsistent with an interpretation of the reference effect being stronger in Endogenous (e.g., since the default is offered deterministically rather than assigned with some probability) and with an interpretation of subjects being overall less engaged in Exogenous (e.g., since they have less agency over the choice of default).

²⁷Additionally, pooled across treatments, 99% of decision problems were solved in under 104 seconds. This varied, but not significantly, across treatments, with 99% of decision problems solved in under 102 seconds in the Baseline, 107 seconds in Exogenous, and 96 seconds in Endogenous. We take this as evidence that our time constraint was not binding for nearly all subjects.

and the option chosen in the current round. This effect should be strongest in the Baseline where this evolving reference does not compete for attention with the salient default option. Our data is inconsistent with this story: We find no effect of previous round chosen option value on (i) the value of the object chosen, (ii) the rank of the object chosen, (iii) the normalized monetary gain of the object chosen, and (iv) the likelihood of choosing the highest valued option in the current round.²⁸ In terms of modeling predictions, this approach would also predict less search in Exogenous relative to the Baseline because of the frequency of the relatively low default option assigned to subjects in the former. Again, our data is inconsistent with this prediction.

We take this as evidence that our choice of a static reference to generate predictions for this experiment is appropriate and consistent with the search patterns of our subjects.

4.1.3. *Treatment effects are not driven by learning*

Given that subjects make 20 decisions in each treatment, it is possible that subjects learn over time about features of the environment (e.g., where the default option sits in the option value distribution) pertinent to their search decisions. One may therefore be concerned about the extent to which our estimated treatment effects are merely reflective of different patterns of *learning* across treatments, not the reference and selection effects identified in the model.

First, we note that the information set regarding the (i) distribution and (ii) where the default sits in the option value distribution (in treatments with a default) are identical across treatments, so there is no reason ex-ante to believe that beliefs about the expected value of search should differ across treatments. We also note that the value of the default was relatively low (i) ex-ante in the distribution and (ii) ex-post in the realized option values. Across 20 decision problems, all had at least 60% of available options at or above the default; 80% were above the default in 12/20 of the decision problems. So learning where the default sat relative to other options to be searched would be relatively quick. Moreover, subjects were told of the nominal default option value in every period.

When we reinvestigate our treatment effects looking only at the latter 15 rounds, results are qualitatively similar to our main analysis.²⁹ Thus, even if we account for possible learning, we still see evidence of the selection and reference effects.

Another channel for learning might be through learning-by-doing. This would predict faster decisions in the Endogenous Treatment than the Exogenous one, as typically more decisions are made in the Endogenous Treatment. To check such a learning-by-doing argument, we look at how average time spent in decisions depends on active choice assignment rate in Exogenous and we find positive and significant correlation (OLS $p = 0.04$), indicating that subjects who make more decisions spend more time on average; the opposite of what learning-by-doing would predict.

5. Conclusion

In this paper we document that the presence of a default option can affect choice through two channels: self-selection and reference-dependence. Both effects lead to options with higher objective values being chosen more frequently by decision makers who actively search. While the former channel is strategic and expected to be presented by anyone with or without reference dependent utilities, the latter one is a psychological motive and can be explained by gain/loss utilities.

Our results suggest new ways in which default options can be powerful modulators of choice. Our theoretical analysis provides optimal search strategies of decision makers with reference dependent utilities in the presence of a default option or other references. A large and growing body of literature investigates the welfare effects of reference dependence and default options as well as optimal default design (e.g., Carroll et al., 2009; Bernheim et al., 2015; Bernheim and Gastell, 2020; Goldin and Reck, 2020; Choukhmane, 2021; Goldin and Reck, 2022; Reck and Seibold, 2022). Incorporating these

²⁸See Table 6 in the Online Appendix for supportive estimates from panel OLS and Logistic regressions.

²⁹Results are reported in the Online Appendix.

results into optimal default design problems should be a fruitful exercise both theoretically and empirically. Our findings suggest that choice architects should be mindful of the possibility of selection and reference dependence effects when crafting an optimal default; the inclusion of these channels may change the extent to which one aims for opt-out minimization, for example. Such optimal default design will be context-dependent and we leave it to future research to investigate the comparative statics (e.g. default option value and default availability during active search) of reference-dependent search in applied settings.

In our environment, identifying the selection effect requires that the default not be included in the choice set during active choice; choosing the default when it is always available does not reveal whether it was chosen before or after active search. In the field, there are contexts where a default option is always available (e.g., default retirement contribution plans), which may open new psychological channels (e.g., sunk cost fallacy) for the effects of defaults on choice. As this paper focused on documenting the presence of reference and selection effects, these features are beyond its scope, but worthy of future investigation.

In this paper we evaluated the choice change caused by default in terms of the objective ranking of the chosen option, amount of monetary gains, and time invested in search. We leave it for future research to estimate and incorporate psychological effects of default into welfare analysis.

Supplementary material. The supplementary material for this article can be found at <https://doi.org/10.1017/eec.2025.10017>.

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