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DOES UNCERTAINTY CAUSE INERTIA IN DECISION MAKING? AN EXPERIMENTAL STUDY OF THE ROLE OF REGRET AVERSION AND INDECISIVENESS

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Abstract

Previous research has shown that often there is clear inertia in individual decision making—that is, a tendency for decision makers to choose a status quo option. I conduct a laboratory experiment to investigate two potential determinants of inertia in uncertain environments: (i) regret aversion and (ii) ambiguity-driven indecisiveness. I use a between-subjects design with varying conditions to identify the effects of these two mechanisms on choice behavior. In each condition, participants choose between two simple real gambles, one of which is the status quo option. I find that inertia is quite large and that both mechanisms are equally important. (JEL Codes: C91, D01, D03, D81)

Keywords: status quo, inertia, reference-dependent preferences, regret aversion, ambiguity, indecisiveness.

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1 Introduction

In many decision situations there is a *status quo* option, which may be the result of a previous choice, or may simply be the option designated as the 'default' (i.e., the alternative that ensues if no action is taken). *Inertia*—the tendency to stick with the status quo—has been widely documented.[1] Two commonly cited drivers of inertia in *uncertain* environments are the decision makers' perception that a default option comes with an implicit endorsement from the default setter (Madrian and Shea 2001), and decision avoidance when there is a large number of alternatives (Dean 2008) or when individuals find it hard to understand the options (Thaler and Sunstein 2009).[2] Yet, two theories of choice under uncertainty suggest two other important mechanisms: (i) *regret aversion* and (ii) *ambiguity-driven indecisiveness*. A person may experience regret when the outcome of a choice compares unfavorably to the outcome that would have occurred had she made a different choice. On the other hand, a person who understands the options may still be indecisive if she does not know the probability distributions over the relevant outcomes—that is, if the options are ambiguous. These two mechanisms might induce substantial inertia even if the choice involves two simple options, the status quo does not come with a suggestion of relative value, and physical switching costs are negligible.

In a laboratory experiment, I investigate whether uncertainty generates inertia in incentivized choices through regret aversion and indecisiveness. The first mechanism is captured by Reference-Dependent Subjective Expected Utility (Sugden 2003; Kőszegi and Rabin 2006, 2007) (henceforth R-D SEU). This theory assumes that people encode outcomes as gains and losses relative to a reference point; it also implies that in certain situations people perceive the status quo option as the reference point. If after switching an individual learns that she would have achieved a better outcome had she retained the status quo, she will experience a sensation of loss. Thus, she will regret having switched. A regret-averse individ-

[1] Samuelson and Zeckhauser (1988) use the term *status quo bias* to refer to this phenomenon. Inertia has been shown to affect several important real-life decisions. These are organ donation (Johnson and Goldstein 2003), the choice of electrical service provider (Hartman et al. 1991), car insurance (Johnson et al. 1993), health insurance (Samuelson and Zeckhauser 1988), investment portfolio (Agnew et al. 2003), contractual choice in health clubs (DellaVigna and Malmendier 2006), and retirement savings (Samuelson and Zeckhauser 1988; Madrian and Shea 2001; Choi et al. 2004; Cronqvist and Thaler 2004). In his 2009 survey of findings from behavioral economics in the field, DellaVigna regarded inertia as "one of the most robust results in the applied economics literature of the last ten years" (DellaVigna 2009, p. 322).

[2] Although these are two mechanisms through which uncertainty may produce inertia, they do not solely apply to decision situations with uncertainty.

ual that anticipates this possibility may stick with the status quo simply to avoid experiencing regret.

On the other hand, the hypothesis that indecisiveness may cause inertia in choice under uncertainty is the core of Knightian Decision Theory (Bewley 2002) (henceforth KDT). This theory is based on the premise that *ambiguity* may induce an incomplete preference. This premise implies that an individual may be indecisive between some options when she does not know the probability distributions over outcomes. KDT predicts that an indecisive individual will stick with the status quo when the status quo is not clearly dominated by any other option.

The experiment features a between-subjects design with several conditions. In each condition, I randomly (and privately) assign participants one of two possible tickets to play an individual lottery. Right before the lottery is resolved, I allow participants to switch tickets if they so desire. If they switch, they will receive a small bonus in addition to what they get from the lottery. At this point, they make a private keep-or-switch decision, and then they play their individual lottery. In each condition, participants play a different lottery.

The lotteries differ along two dimensions. First, they differ in the degree of uncertainty: some lotteries are ambiguous—participants do not know the winning probabilities of the tickets, and some are fair—participants know that the winning chance of either ticket is 0.5. Second, the lotteries differ in participants' knowledge about the counterfactual outcome: in some lotteries, participants anticipate that they will learn what the outcome would have been had they played with the rejected ticket; in other lotteries, they know that this information will not be available. By manipulating the degree of uncertainty of the lotteries, I am able to assess the effect of ambiguity-driven indecisiveness on inertia. By manipulating participants' knowledge about the counterfactual outcome, I affect the potential for regret after a switch that results in a failure to win; hence, I can assess the effect of anticipated regret on inertia.

The experiment is divided into two parts. First, I use a baseline condition to test if regret aversion and indecisiveness *jointly* create inertia; then, I use additional conditions to investigate the *individual* effect of each mechanism. To carry out the joint test, I use an ambiguous lottery in which participants learn the counterfactual outcome. In the baseline condition, I randomly assign each participant either a Red Ticket or a Blue Ticket. In a room next door, an assistant sets up a bag with 10 red and blue balls. Participants know that the bag contains 8 balls of one color and 2 of the other color, but the assistant is the only person in the lab who knows which is the dominant color. At the end of the session, she will draw a ball in front of each participant. The assistant does not see a participant's ticket until after drawing a ball. A ticket pays the prize if its color matches the color of the ball drawn. Right before the lottery is resolved, I inform participants that they can switch tickets for a small bonus. Then they make the keep-or-switch decision and play the lottery.

As I show, all theories of choice under uncertainty make sharp predictions for choice behavior in this setting. The experimental design enables a clear separation between the set of theories that predict that participants will switch tickets and the set of theories that predict that participants will not switch. Most theories imply that the Alternative Ticket clearly dominates the Original Ticket as it offers a bonus, and hence predict that participants will switch tickets. By contrast, because the winning chances with either ticket are ambiguous, KDT implies that participants will be indecisive. Indecisiveness is *not* resolved with a small switching bonus. As a result, participants should stick with the Original Ticket. R-D SEU, in turn, implies that individuals perceive a switch that results in a failure to win as regrettable, as they would have won had they not switched. A small switching bonus is insufficient to override the influence of anticipated regret. Hence, R-D SEU also predicts that participants will not switch tickets.

Seventy-percent of participants from the baseline condition keep the Original Ticket. Using a control condition that accounts for potential confounds (such as inattention and carelessness, among others), I demonstrate that most of the inertia is jointly driven by regret aversion and indecisiveness. The baseline condition, however, does not distinguish between the two mechanisms of interest. To disentangle the individual effects, I then tweak the baseline in additional conditions.

To assess whether anticipated regret generates inertia, I face participants with a fair lottery in which the counterfactual outcome is known. Because the lottery is fair, indecisiveness cannot play a role in choice behavior. To investigate whether ambiguity-driven indecisiveness produces inertia, I face participants with a choice between two ambiguous tickets, each corresponding to a different lottery. Since only the chosen lottery is resolved, the counterfactual outcome is unknowable. This feature shuts down the regret channel posed by R-D SEU. Then, in another condition, I make a concession to a broader conception of regret, by which it is not necessary to *know* the counterfactual outcome to experience regret. Using the additional conditions, I find that both mechanisms are individually significant and that they generate about the same amount of inertia.

Overall, anticipated regret and indecisiveness induce a strong reluctance to switch to the Alternative Ticket when the opportunity to switch is a surprise.

I find, however, that when either ticket is known to have a winning chance of 0.5, inertia greatly diminishes if participants *anticipate* the opportunity to switch tickets. This finding is predicted by R-D SEU under the hypothesis that reference points are determined by expectations (Kőszegi and Rabin 2006, 2007). The result suggests that the expectation to use the Original Ticket, rather than mere possession of it, leads regret-averse individuals to refuse to switch.

This paper contributes to at least three bodies of literature. First, the hypothesis that *anticipated* regret affects choice behavior has received support from psychology studies using hypothetical choices (for a review, see Zeelenberg and Pieters [2007]); there is, however, little work that examines real choices among uncertain options. Most closely related to my paper are the studies by Bar-Hillel and Neter (1996) and van de Ven and Zeelenberg (2011).[3] Bar-Hillel and Neter (1996) show that many participants from a series of lotteries refuse to switch tickets despite being offered a switching bonus. Although the authors attribute inertia to anticipated regret, the amount of inertia does not seem to depend on knowledge about the counterfactual outcome. While Bar-Hillel and Neter's design cannot rule out superstitious beliefs (Risen and Gilovich 2007), my design controls for this potential confound. Building upon Bar-Hillel and Neter's design, van de Ven and Zeelenberg (2011) show that asymmetry in feedback about the outcomes of the chosen and rejected tickets affects people's willingness to switch tickets. Although van de Ven and Zeelenberg's results are consistent with regret aversion, their account cannot explain my results with regard to the influence of anticipated regret on choice behavior.[4] Moreover, van de Ven and Zeelenberg's experimental design is not explicitly connected to formal theories of anticipated

[3]Other studies that investigate whether anticipated regret affects incentivized choices are Filiz-Ozbay and Ozbay (2007); Katuščák, Michelucci, and Zajíček (2015); and Strack and Viefers (2015). Filiz-Ozbay and Ozbay (2007) and Katuščák, Michelucci, and Zajíček (2015) conduct laboratory experiments to test whether the anticipation of regret affects bidding behavior in one-shot first-price sealed-bid auctions. In their experiments, they manipulate the type of post-auction feedback that participants receive, e.g. by letting winners know the second highest bid (which may induce winner regret) or letting losers know the winning bid (which may induce loser regret). The evidence is mixed. While the results presented by Filiz-Ozbay and Ozbay suggest that bidders anticipate loser regret and hence bid more aggressively than in the standard risk-neutral Nash equilibrium, Katuščák, Michelucci, and Zajíček do not find any systematic effect of feedback on the average bid/value ratio. Strack and Viefers (2015) study—both theoretically and experimentally—whether anticipated regret affects stopping behavior in dynamic choice problems. In the theoretical analysis, they show that an agent who experiences regret over past decisions and has failed to stop at the best past offer will continue gambling until she receives a payoff matching the best past offer. The results from the laboratory experiment support this prediction.

[4]Specifically, van de Ven and Zeelenberg's account cannot explain why (i) participants are reluctant to switch when they learn the outcome of **both** tickets (and hence feedback is symmetric), and (ii) inertia diminishes when the opportunity to switch tickets is anticipated.

regret. By contrast, my design enables a clear distinction among different theories that incorporate regret aversion. In particular, I show that only R-D SEU predicts the effect of anticipated regret on inertia that I find in the experiment.[5]

Second, my paper adds to the recent experimental research that tests Kőszegi and Rabin's (2006, 2007) hypothesis that reference points are shaped by expectations (Ericson and Fuster 2011; Sprenger 2015). Most closely related to my paper is the study by Ericson and Fuster (2011), who endow participants with a mug and randomize the probability that they will be allowed to exchange it for a pen. Each participant knows this probability from the beginning. The authors find that participants that are more likely to expect to keep the mug (as they have a low probability of being allowed to exchange) are more likely to retain the mug if given the opportunity to exchange. This finding suggests that it is the expectation of continued ownership, rather than ownership per se, that induces a reluctance to exchange. My approach is complementary in three respects. First, I test Kőszegi and Rabin's (2006, 2007) hypothesis in the domain of gambles, rather than using a choice between two certain options. Second, by manipulating whether or not participants know that they will have the opportunity to switch tickets, I am able to test the hypothesis when the choice set is a surprise. Third, I assess whether the expectation to keep the status quo might create inertia by influencing the potential for regret after a switch. Regret does not play a role in Ericson and Fuster's (2011) setting. Our studies find converging evidence on the importance of expectations in shaping reference points.

Finally, this paper contributes to our understanding of decision making under ambiguity. A large decision-theoretic literature implies that choice behavior in ambiguous environments could be inconsistent with SEU (Ellsberg 1961; Gilboa and Schmeidler 1989; Bewley 2002; Ghirardato et al. 2004; Klibanoff et al. 2005, 2012; Maccheroni et al. 2006). In particular, Bewley (2002) forcefully argued that people might have an incomplete preference over ambiguous options, and

[5] My paper is also complementary to Arlen and Tontrup (2014). Based on research in psychology (e.g., Zeelenberg et al. [1998]), the authors conjecture that people anticipate regret over parting with an entitlement whose future value is uncertain only when they feel responsible for the decision to trade their entitlement. Therefore, when entitlement-holders have the option to transact through institutions that divide responsibility for the transaction between multiple actors (such as agency relationships and voting), they should be significantly more willing to trade. The authors test this prediction in the laboratory and online. They assign participants one of two lottery tickets, each of which has a 50 percent winning chance; then they give participants the opportunity to exchange their ticket for the other ticket plus a small monetary bonus. The authors compare the propensity to trade when participants have to decide by themselves to situations in which participants can delegate the trading decision to an agent or to a majority vote. The proportion of participants who trade is substantially larger in the agency and voting conditions, which supports Arlen and Tontrup's conjecture.

hence might remain indecisive at times. He proposed a theory of choice (KDT) in which indecisiveness may lead to inertia when there is a status quo option. Despite KDT's intuitive appeal, a sharp test of the theory has not been performed to date. Maltz and Romagnoli (2016) compare choices among gambles with and without a status quo gamble under different types of uncertainty. Specifically, their aim is to assess the extent to which introducing ambiguity in the choice problem (by making the status quo and/or the alternatives ambiguous) affects the presence and magnitude of the status quo bias. While the authors examine whether KDT and R-D SEU are able to explain their results ex-post, their experiment is not explicitly designed to provide a sharp test of these theories. For this reason, Maltz and Romagnoli need to make additional assumptions when looking at how the theories fit their data. By contrast, in my experiment KDT clearly predicts inertia in the choice between ambiguous gambles under minimal assumptions, and hence inertia stands as a behavioral marker of indecisiveness. I demonstrate that ambiguity-driven indecisiveness is real, and I separate its effect on choice behavior from that of anticipated regret.[6]

2 Theoretical Framework

Consider the following decision situation that involves three stages. At $T = 0$, a decision maker (DM) receives one of two tickets to play a lottery that offers a prize of $\$x$ ($x > 0$). I shall refer to the ticket that the DM originally holds as the Original Ticket and to the remaining ticket as the Alternative Ticket. There are two possible states of the world: S and S^C. The Original Ticket pays the prize if state S occurs, while the Alternative Ticket pays the prize if state S^C occurs. At $T = 1$, shortly before the lottery is resolved, the DM has the opportunity to switch tickets. Switching tickets is costless; in addition, if she switches the DM will receive $\$b$ ($0 \leq b \leq x$) in addition to what she gets from the lottery. When the DM receives the Original Ticket at $T = 0$, she may or may not know that she will be able to switch tickets at $T = 1$. I shall say that the opportunity to switch

[6] Cettolin and Riedl (2013) document choice behavior that is consistent with an incomplete preference over uncertain options, but do not provide a test of KDT. In their experiment, participants have to choose between an ambiguous gamble and a series of risky gambles. In any given choice situation, participants can avoid an active choice by selecting a fair chance device that eventually assigns them one of the two gambles. The authors find that most participants choose the chance device in at least two choice situations, and show that this behavior cannot be reconciled with standard theories assuming complete preferences. But since KDT does not make sharp behavioral predictions in the absence of a status quo, in principle it cannot be tested using Cettolin and Riedl's design.

is a *surprise* to the DM if she learns about it at $T = 1$. At $T = 1$ the DM must make a keep-or-switch decision. Finally, at $T = 2$ the lottery is resolved. Figure I illustrates the timing of the decision situation. I shall say that the DM's choice displays *inertia* if the DM retains the Original Ticket at $T = 1$.[7]

[Figure I about here]

Let $(S : y_S,\ S^C : y_{S^C})$ denote a gamble yielding outcome y_S if state S occurs and outcome y_{S^C} otherwise. Outcomes are nonnegative real numbers designating money. Let w be the DM's initial wealth (i.e., her wealth before participating in the lottery). Notice that both tickets can be expressed as gambles over final wealth (i.e., the DM's wealth after the lottery). The Original Ticket is the gamble $(S : w + x,\ S^C : w)$ and the Alternative Ticket is the gamble $(S : w + b,\ S^C : w+b+x)$. Figure II displays the keep-or-switch decision as a choice between these two gambles.

[Figure II about here]

I assume that in this environment the DM holds *beliefs*. A belief $P(S)$ is a subjective probability that S will occur. I consider two sets of lotteries. Within the set of *fair* lotteries, the DM knows that the likelihood of S is 0.5—hence she holds the belief $P(S) = 0.5$. Within the set of *ambiguous* lotteries, the DM does not know the likelihood of S; I assume that she just knows that the likelihood of S lies in a symmetric range around 0.5. Denote this range by $[1 - p,\ p]$, where $0.5 < p \leq 1$.[8] The DM is clueless about the probability distribution of the likelihood of S over the range $[1 - p,\ p]$. Some theories assume that the DM holds a single belief in ambiguous lotteries, while other theories assume that she holds multiple beliefs. If the DM holds a single belief, I assume that $P(S) = 0.5$.[9] On the other hand, if the DM entertains multiple beliefs, I assume that the set of beliefs equals $[1 - p,\ p]$.

[7] In the empirical analysis from Section 3, I use the proportion of individuals who retain the Original Ticket in a given lottery as the relevant measure of the amount of inertia from that lottery.

[8] The symmetry assumption matches the experimental setting I describe in Section 3. This assumption is key to identifying the effects of regret aversion and indecisiveness on choice behavior.

[9] The DM could come to entertain such belief by applying the *principle of insufficient reason*: since she has no reason to view one state as more likely than the other, she could assign each state a probability of 0.5. (See Gilboa [2009], p. 14.) Also, $P(S) = 0.5$ is sometimes referred to as the 'ignorance prior' (see Fox and See [2003]).

Now consider how the DM evaluates outcomes. A prize of x dollars added to wealth w yields a *consumption utility* of $m(w+x)$. The function $m(.)$ is continuous and strictly increasing, and $m(0) = 0$. An outcome, however, need not be evaluated in isolation—that is, it need not yield *only* consumption utility. In particular, counterfactual outcomes constitute *reference levels* that might affect the overall utility of an outcome. An outcome that is greater than its reference level might be encoded by the DM as a gain, whereas an outcome that is smaller than its reference level might be encoded as a loss. Let $u(w+x|w+r)$ be the overall utility of $w+x$ dollars given a reference level of $w+r$ dollars:

$$u(w+x|w+r) = m(w+x) + \mu(m(w+x) - m(w+r)).$$

The function $\mu(.)$ captures the *gain-loss utility* of $w+x$ dollars relative to the referent, $w+r$ dollars. The outcome $w+x$ is encoded as a gain relative to $w+r$ if $x > r$, and it is encoded as a loss if $x < r$. When gains and losses relative to the referent do not affect utility (i.e., $\mu(.) \equiv 0$), we say that preferences are *reference-independent.* On the other hand, when preferences are *reference-dependent*, the function $\mu(.)$ has the properties of the Kahneman-Tversky value function (Kahneman and Tversky 1979). Specifically, following Section II in Kőszegi and Rabin (2006), I assume that $\mu(.)$ satisfies the following properties:

A0. $\mu(z)$ is continuous for all z, twice differentiable for $z \neq 0$, and $\mu(0) = 0$.

A1. $\mu(z)$ is strictly increasing.

A2. $\mu'_-(0)/\mu'_+(0) \equiv \lambda > 1$, where $\mu'_+(0) \equiv \lim_{z\to 0} \mu'(|z|)$ and $\mu'_-(0) \equiv \lim_{z\to 0} \mu'(-|z|)$.

A2 captures *loss aversion* for small stakes: the DM feels small losses around the reference level more severely than she feels equal-sized gains. The degree of loss aversion is captured by the coefficient λ.[10]

The prize x is a small stake relative to the DM's wealth w, which matches the experimental setting I describe in Section 3. Because this feature of the prize implies that the function $m(.)$ can be taken as approximately linear (Rabin 2000; Kőszegi and Rabin 2006, 2007), in what follows I assume that $m(w+x) = w+x$.

Last, the DM's beliefs and the utility she anticipates from different outcomes jointly determine how the DM evaluates the tickets. Reference levels might vary

[10] In Section 2.2.2 I discuss the implication for choice behavior of assuming $\lambda \leq 1$ instead of $\lambda > 1$. Although a vast amount of evidence indicates that $\lambda > 1$ for most people with reference-dependent preferences, a couple studies find support for the hypothesis that $\lambda \leq 1$ (see Harinck et al. [2007]; Ert and Erev [2013]).

across states of the world for a given ticket. Thus, we can think of the reference point for that ticket as a gamble over state-contingent reference levels. Let $R_O \equiv (S : w + r_{O,S},\ S^C : w + r_{O,S^C})$ and $R_A \equiv (S : w + r_{A,S},\ S^C : w + r_{A,S^C})$ denote the reference points when the DM evaluates the Original Ticket and the Alternative Ticket. Notice that R_O and R_A might be different gambles. Given a belief $P(S)$ and a referent R_O, the utility of the Original Ticket is

$$\begin{aligned} U(Original|R_O) &= W(P(S))\ u(w + x|w + r_{O,S}) \\ &\quad +(1 - W(P(S)))\ u(w|w + r_{O,S^C}) \\ &= w + W(P(S))\ x \\ &\quad +W(P(S))\ \mu(x - r_{O,S}) \\ &\quad +(1 - W(P(S)))\ \mu(-r_{O,S^C}), \end{aligned} \tag{1}$$

where $W(.)$ is some strictly increasing probability weighting function, with $W(0) = 0$ and $W(1) = 1$. Similarly, given a belief $P(S)$ and a referent R_A, the utility of the Alternative Ticket is

$$\begin{aligned} U(Alternative|R_A) &= (1 - W(P(S^C)))\ u(w + b|w + r_{A,S}) \\ &\quad +W(P(S^C))\ u(w + b + x|w + r_{A,S^C}) \\ &= w + b + W(P(S^C))\ x \\ &\quad +(1 - W(P(S^C)))\ \mu(b - r_{A,S}) \\ &\quad +W(P(S^C))\ \mu(b + x - r_{A,S^C}). \end{aligned} \tag{2}$$

The general description of preferences encompasses all major theories of choice under uncertainty.[11] The theories, however, differ in their assumptions about beliefs, reference points, and decision rules. Next, I specialize the general framework to indicate the prediction of each theory for the DM's choice behavior. I organize the discussion by dividing the set of theories into two groups: those that predict that the DM will always switch tickets, and those that predict that the DM will not switch in some lotteries.

[11] Strictly speaking, although (1) and (2) are general enough to cover most theories, they do not exactly match utilities in models of ambiguity aversion. For expositional convenience, I prefer to stick to (1) and (2) throughout the main text and modify them only when I describe the models of ambiguity aversion in Appendix A.

2.1 Theories that Predict a Switch

Several theories of choice under uncertainty predict that the DM will switch tickets provided that switching is rewarded with a bonus (i.e., $b > 0$). These theories are Subjective Expected Utility (Savage 1954), Rank-Dependent Utility (Quiggin 1982), Maxmin Expected Utility (Gilboa and Schmeidler 1989), Smooth Ambiguity Preferences (Klibanoff, Marinacci, and Mukerji 2005, 2012), Variational Preferences (Maccheroni, Marinacci, and Rustichini 2006), Prospect Theory (Kahneman and Tversky 1979), Regret Theory (Bell 1982; Loomes and Sugden 1982), and Disappointment Theory (Bell 1985; Loomes and Sugden 1986).[12] Moreover, these theories predict that the DM will switch regardless of whether the possibility of switching is a surprise or is anticipated. The switching bonus b is the key parameter affecting the keep-or-switch decision. All theories imply that the DM would be indifferent between the tickets in the absence of a bonus ($b = 0$); a strictly positive switching bonus breaks indifference in favor of the Alternative Ticket.

The best-known theory within this set is Subjective Expected Utility (henceforth SEU). In this theory, preferences are complete and reference-independent. In all lotteries the DM holds a single belief ($P(S) = 0.5$). The probability weighting function equals the identity function. In the absence of a switching bonus, the tickets are ex-ante identical and hence the DM is indifferent between them. But when there is a bonus the DM strictly prefers the Alternative Ticket, and hence will switch tickets. In Appendix A I show that all the other theories I mentioned above make the same prediction as SEU.

2.2 Theories that Predict that the DM Will Not Switch

Two theories of choice under uncertainty imply that the DM's choice between tickets might display inertia—even in presence of a small switching bonus. These theories are Knightian Decision Theory (Bewley 2002) and Reference-Dependent Subjective Expected Utility (Sugden 2003; Kőszegi and Rabin 2006, 2007). KDT

[12] Although Regret Theory is the name by which Bell's (1982) and Loomes and Sugden's (1982) theories are usually referred to, this name is quite misleading for the purposes of this paper. Regret Theory is actually a theory of reference-dependent preferences that assumes that when the DM evaluates a ticket, her reference point is the other ticket. Thus, the statement that Regret Theory predicts a switch of tickets does not necessarily imply that regret aversion is incompatible with inertia. Rather, it implies that regret aversion is incompatible with inertia *when the reference point of either ticket is the other ticket.* Indeed, in Section 2.2.2 I show that regret aversion may lead to inertia when the reference point to which both tickets are compared is the Original Ticket.

and R-D SEU, however, do *not* sharply predict that the DM will *never* switch. When the opportunity to switch is a surprise, R-D SEU predicts that the DM's choice will display inertia in any lottery; KDT, on the other hand, predicts that the DM will not switch only in ambiguous lotteries. When the option to switch is anticipated, R-D SEU predicts that the DM's choice will display inertia in any lottery only under a particular hypothesis about the reference point; KDT is vague with respect to ambiguous lotteries.

2.2.1 Knightian Decision Theory (KDT)

Preferences are reference-independent. When the lottery is ambiguous the DM entertains multiple beliefs. The probability weighting function equals the identity function. The DM prefers the Original Ticket if and only if

$$U_{KDT}(Original) \geq U_{KDT}(Alternative) \quad \text{for } \textit{all } P(S) \in [1-p,\ p]. \tag{3}$$

Conversely, the DM prefers the Alternative Ticket if and only if

$$U_{KDT}(Original) \leq U_{KDT}(Alternative) \quad \text{for } \textit{all } P(S) \in [1-p,\ p]. \tag{4}$$

That is, for a ticket to be preferred to the other, it must yield a higher consumption utility for **all** beliefs. When neither (3) nor (4) hold, the DM finds the tickets incomparable. I shall say that in this case the DM is *indecisive.* In the language of choice theory, indecisiveness is a manifestation of an *incomplete preference.* Notice that when the DM faces a fair lottery, she is able to compare the tickets and behaves as a SEU maximizer. In other words, indecisiveness could arise only in ambiguous lotteries. Next, I show exactly when the DM is indecisive, and I explain why the inability to compare the tickets may generate inertia.

Consider an ambiguous lottery. Simplifying (1) and (2), and combining them with (3), we conclude that the DM prefers the Original Ticket if and only if $1-p \geq 0.5\ (1+\frac{b}{x})$. Conversely, putting (1), (2), and (4) together, we conclude that the DM prefers the Alternative Ticket if and only if $p \leq 0.5\ (1+\frac{b}{x})$. Notice that for the DM to prefer the Original Ticket, $1-p$ must be at least 0.5 for any values of x and b. Since I assumed $p > 0.5$, it follows that the DM *never* prefers the Original Ticket when the lottery is ambiguous. The reason is simple: $1-p < 0.5$ means that the Alternative Ticket might offer a larger winning probability than the Original Ticket does; in addition, the Alternative Ticket might offer a bonus. On the other hand, the DM *might* prefer the Alternative Ticket; given the assumption

$p > 0.5$, she will if $0.5 < p \leq 0.5\ (1+\frac{b}{x})$. Figure *III* illustrates the DM's preference over tickets for different values of p.

[Figure *III* about here]

Notice that in the absence of a switching bonus, the DM does not prefer the Alternative Ticket. Consequently, when there is no bonus the DM is indecisive: neither ticket is preferred to the other. Now consider the reservation bonus—the smallest value of b that induces a strict preference for the Alternative Ticket given a prize x. Let $\tilde{b}$ denote the reservation bonus as a fraction of the prize x. We have $\tilde{b} \equiv (2p - 1)$. When $p = 0.51$, the DM requires a 2% bonus to switch tickets. Because $\tilde{b}$ is increasing in p, a Knightian DM will require *at least* a 2% bonus to switch in *any* ambiguous lottery.[13]

A switching bonus smaller than 2% will leave the DM indecisive between the tickets. What will an indecisive DM choose? As it turns out, KDT makes a sharp prediction when the opportunity to switch tickets is a surprise. The theory, however, is vague when the DM becomes aware of the option to switch as soon as she receives the Original Ticket.

Choice Behavior when the Opportunity to Switch Is a Surprise

In Bewley's (2002) model, the DM makes a plan about a choice that will be put into practice later; she makes up her mind to pick a certain alternative among the ones that she *expects* to be available. Suppose that shortly before the choice is put into practice, an alternative that was previously unavailable and whose arrival was unexpected becomes feasible. In this scenario, the DM must decide whether to stick with the original plan or switch to the new alternative. To predict choice behavior, Bewley invoked the *Inertia Assumption*. This assumption states that "if any decision problem occurs by surprise, the decision maker changes his program only if the new program dominates the old one in the new situation" (Bewley 2002, p. 90). In other words, the DM will switch to the new alternative *only if* it is *strictly preferred* to the planned alternative. This implies that if the DM is indecisive, she will stick with her plan.[14] In the choice between tickets when the option to switch becomes available by surprise, there is clearly a unique initial plan—playing the Original Ticket, and a new unanticipated alternative—playing

[13]The DM's reservation bonus could be substantially larger than 2%. For example, for $p = 0.6$ the reservation bonus is 20%, for $p = 0.8$ it is 60%, and for the extreme case $p = 1$ it is 100%.

[14]Bewley notes that it would be equally rational to switch to the new alternative because the DM has no compelling reason to choose either option when she is indecisive. The Inertia Assumption is just "an extra assumption that is consistent with rationality" (Bewley 2002, p. 84).

the Alternative Ticket. Therefore, as the DM is indecisive, KDT predicts that she will keep the Original Ticket.[15]

Choice Behavior when the Opportunity to Switch Is Anticipated

Now suppose that as soon as the DM receives the Original Ticket, she learns that she will be able to switch tickets. Because the option to switch is expected, the DM could plan to play either ticket. Notice, however, that as the tickets are incomparable, the DM will be indecisive at the moment of making an initial plan. The same reason that motivates the Inertia Assumption—choices between incomparable alternatives would be arbitrary without the assumption—now restricts the predictive power of KDT. The model predicts that the DM will stick with her planned choice once she gets to make the keep-or-switch decision, but it does not predict the DM's initial plan. Thus, KDT does not provide a testable implication when an indecisive DM anticipates the opportunity to switch.[16]

2.2.2 Reference-Dependent Subjective Expected Utility (R-D SEU)

This theory combines two different basic models: Sugden (2003) and Kőszegi and Rabin (2006, 2007). The DM has a single belief. The probability weighting function equals the identity function. Preferences are complete and reference-dependent. The utility function, which features state-contingent gains and losses, is that of Sugden (2003).[17]

The reference point is the same for both tickets. I consider two competing hypotheses about how it is determined. On one hand, Sugden (2003) assumes that the referent is the ticket with which the DM is endowed—namely, the Original Ticket. This is the *endowment hypothesis*.[18] On the other hand, Kőszegi and Rabin

[15] It could be argued that playing the Original Ticket is not actually a plan because the Original Ticket was allocated to the DM rather than chosen by her. Yet, the key feature in this situation is that the DM **expects** to play the Original Ticket since the opportunity to switch is a surprise. Whether the DM chose the Original Ticket or just received it is not essential to KDT.

[16] Of course, KDT makes a sharp prediction when the DM strictly prefers the Alternative Ticket, which occurs if and only if $0.5 < p \leq 0.5\ (1 + \frac{b}{x})$. (See Figure III.) In this case, the DM will plan to switch tickets. Indeed, she will switch tickets regardless of whether the opportunity to switch is a surprise or is anticipated.

[17] Taken at face value, Kőszegi and Rabin's (2006, 2007) model predicts that the DM will switch tickets in any lottery provided that there is a switching bonus. This prediction hinges on the specification of the utility function, which differs from Sugden (2003). In Kőszegi and Rabin's model, the DM compares outcomes across states of the world, rather than per states of the world. Yet, the main feature of Kőszegi and Rabin's model is the specification of the reference point, rather than the specification of the utility function. This is the reason why, in the present setting, I regard RD-SEU as a blend of Sugden (2003) and Kőszegi and Rabin (2006, 2007).

[18] The hypothesis that mere ownership of a good results in the good becoming the DM's

(2006, 2007) posit that the referent is the ticket that the DM *expected* to play between the time she first focused on the lottery and shortly before it is resolved. This is the *expectations hypothesis*. When the opportunity to switch tickets is a surprise to the DM, her expectation is to play the Original Ticket—the only one that was initially available to her. In this case, the expectations hypothesis (like the endowment hypothesis) implies that the DM perceives the Original Ticket as the reference point.[19] When instead the option to switch tickets is anticipated, the expectations hypothesis (unlike the endowment hypothesis) implies that the DM's reference point is the Alternative Ticket. (I show this below.)

Choice Behavior when the Opportunity to Switch Is a Surprise

When the opportunity to switch tickets is a surprise, the DM's reference point is the Original Ticket: $R_O = R_A = R \equiv (S : w + x,\ S^C : w)$. This feature of the model has two implications: (i) a failure to win is more painful when it results from switching than when it results from not switching, and (ii) a win is more enjoyable when it follows a switch than when it stems from not switching.[20] Because the DM perceives the Original Ticket as the reference point, the tickets are asymmetric in terms of their potential for regret and rejoicing. The asymmetry is clearly captured by the expressions for the utilities of tickets; simplifying (1) and (2), we obtain

$$\begin{aligned} U_{RD}(Original|R) &= w + 0.5\ x \\ U_{RD}(Alternative|R) &= w + b + 0.5\ x + [0.5\ \mu(b - x) + 0.5\ \mu(b + x)]\,. \end{aligned}$$

reference point when she considers a keep-or-switch decision was originally put forward by Thaler (1980). Sugden (2003) extrapolates the original endowment hypothesis to a setting in which there is uncertainty, taking account of the fact that endowments can be state-dependent.

[19] The key premise behind this prediction is that the DM is not expecting to make a choice once she receives the Original Ticket. We can accommodate the surprise by assuming an expectation to face the choice set {*Original Ticket*} with near certainty and the choice set {*Original Ticket*, *Alternative Ticket*} with very small probability. In this situation, the reference point is the Original Ticket independent of the set {*Original Ticket*, *Alternative Ticket*} or what the DM could have expected to choose from such set (if she ever thought about it).

[20] There is some psychological evidence on these two implications. The evidence comes from research on the role of counterfactuals in the *anticipation* of regret and rejoicing. (See Kahneman and Tversky [1982]; Landman [1987]; and Gleicher et al. [1990].) Using vignettes and hypothetical questions, this research has presented two key findings. First, people tend to *imagine* experiencing greater regret over negative outcomes that result from actions taken than over equally negative outcomes that stem from actions foregone. Second, people tend to *imagine* experiencing greater joy over positive outcomes following actions than over equally positive outcomes following failures to act. The finding about *anticipated* regret, however, contrasts with a finding about *experienced* regret reported by Gilovich and Medvec (1995). When people look in retrospect and express their biggest regrets in life, they tend to focus on their failures to act rather than on their actions. The model I describe here is concerned with how the anticipation of regret affects choice behavior, but does not speak to long-term feelings of regret.

Since the Original Ticket is the referent, holding on to it yields only consumption utility. By contrast, in addition to yielding consumption utility, the Alternative Ticket might also involve a loss or a gain. On one hand, the DM anticipates that she would regret switching if she failed to win—because she would have won had she just held on to the Original Ticket. The utility loss from regret would be $\mu(b - x)$. On the other hand, the DM thinks that a win would bring special joy after switching—because she would not have won had she not switched. The utility gain from rejoicing would be $\mu(b + x)$. The DM believes that regret and rejoicing are equally likely. Thus, when she evaluates the Alternative Ticket at the moment of the keep-or-switch decision, she weighs the potential loss and the potential gain accordingly.

Define $\triangle U_{RD}(R) \equiv U_{RD}(Alternative|R) - U_{RD}(Original|R)$. Then,

$$\triangle U_{RD}(R) = b + 0.5 \ [\mu(b - x) + \mu(b + x)] .$$

First suppose that there is no switching bonus—so that the gain and the loss that might result from switching are of equal size (x). Since the DM is *regret-averse*, it follows that $[\mu(-x) + \mu(x)] < 0$ and hence $\triangle U_{RD}(R) < 0$: the DM strictly prefers sticking with the Original Ticket to switching.[21]

Now suppose that switching is rewarded with a bonus. To pin down the reservation bonus $\tilde{b}$ (again as a fraction of the prize), I make two additional assumptions. First, following Section IV of Kőszegi and Rabin (2006), the gain-loss utility function μ is piecewise-linear:

$$\mu(z) = \begin{cases} \eta z & \text{if } z \geq 0 \\ \eta \lambda z & \text{if } z < 0 \end{cases} .$$

The parameter $\eta > 0$ captures the relative weight on gain-loss utility, and $\lambda > 1$ is the coefficient of loss aversion. Second, following Sprenger (2015), $\eta = 1$; this assumption enables me to focus on the (relative) impact of the parameter λ on utility. With these assumptions, given the belief $P(S) = 0.5$,

$$\triangle U_{RD}(R) > 0 \text{ if and only if } b/x > \tilde{b},$$

where $\tilde{b} \equiv \frac{\lambda - 1}{\lambda + 3}$. A loss-averse DM with an extremely low degree of loss aversion

[21]If instead gains loomed larger than equal-sized losses, then $[\mu(-x) + \mu(x)] > 0$ and hence $\triangle U_{RD}(R) > 0$: the DM would strictly prefer the Alternative Ticket. This preference would also hold for $b > 0$. Therefore, when $b > 0$ R-D SEU would be observationally equivalent to the theories that never predict a switch.

($\lambda = 1.1$) requires a 2.4% bonus to switch tickets.[22] Since $\tilde{b}$ is increasing in λ, *any* loss-averse DM will require *at least* a 2.4% bonus to switch.[23] When the opportunity to switch is a surprise and switching is rewarded with less than a 2.4% bonus, R-D SEU predicts that the DM will not switch.

Choice Behavior when the Opportunity to Switch Is Anticipated

Now consider the case in which the DM learns in advance about the opportunity to switch. Like in the previous case, the endowment hypothesis implies that the DM perceives the Original Ticket as the reference point. Therefore, the DM's choice behavior is the same as when the option to switch is a surprise. That is, she will stick with the Original Ticket if switching is rewarded with less than a 2.4% bonus.

The expectations hypothesis posits that, in principle, the DM could plan to play either ticket. Her plan will determine her reference point at the moment of the actual keep-or-switch decision. If the DM plans to stick with the Original Ticket, her utility-maximizing behavior will be to follow through on her plan—provided that the bonus is a small fraction of the prize. Holding on to the Original Ticket is a consistent plan—in the words of Kőszegi and Rabin (2006), it is a *personal equilibrium*. Alternatively, the DM could initially plan to switch. If she does, she will perceive the Alternative Ticket as her reference point at the moment of the keep-or-switch decision. Then, it will be optimal for her to pursue her plan to switch—switching is also a personal equilibrium for any $b \geq 0$.[24] In sum, *either* plan is consistent in the absence of a switching bonus or when the bonus is small.

Suppose that switching is rewarded with less than a 2.4% bonus. Which plan will the DM make and pursue according to the expectations hypothesis? Notice that the DM's *equilibrium* expected utility when she keeps the Original Ticket is $w + 0.5\, x$, while her *equilibrium* expected utility when she switches is $w + b + 0.5\, x$. The DM anticipates that she will attain the highest ex-ante expected utility if she plans to switch and then pursues this plan. Hence, playing the Alternative Ticket

[22] A loss-averse DM with a lower degree of loss aversion is hardly distinguishable from one who is not loss-averse ($\lambda = 1$). The combination of parameters ($\eta = 1$, $\lambda = 1.1$)—together with the linearity of consumption utility—implies that losses are felt 1.05 times as severely as gains. A smaller λ would imply that losses are felt essentially as severely as gains.

[23] The reservation bonus could be substantially larger than 2.4%. For example, a DM with $\lambda = 1.5$ demands a 11% bonus to switch, and one with $\lambda = 3$ requires a 33% bonus. It is worth noting that the often–discussed empirical benchmark in the literature on loss aversion is ($\eta = 1$, $\lambda = 3$); that is, losses are felt on average twice as severely as gains (Tversky and Kahneman 1992; Kőszegi and Rabin 2006, 2007; Sprenger 2015).

[24] To see why switching is also a consistent plan, write the reference point as $R' \equiv (S : w + b, S^C : w{+}b{+}x)$ and notice that $\triangle U_{RD}(R') = b{-}0.5\,[\mu(x - b) + \mu(-x - b)]$. Clearly, $\triangle U_{RD}(R') > 0$ for any $x > 0$, $b \geq 0$.

is her *preferred personal equilibrium* (Kőszegi and Rabin 2006). When the option to switch tickets and receive a bonus is anticipated, the expectations hypothesis predicts that the DM will switch.

2.3 Differentiating between the Theories

Suppose that we could put a series of lotteries into practice to investigate whether indecisiveness and regret aversion cause inertia. Conceptually, I approach this investigation in two steps. First, I pick a baseline lottery to achieve a clean separation between the set of theories that predict a switch and the set of theories that predict that the DM will not switch. Thus, the baseline reveals whether regret aversion and indecisiveness *jointly* generate inertia. If they do, the second step is to pick a few other lotteries that identify the *individual* influence of each mechanism. Next, I describe a series of lotteries that will guide the empirical analysis of choice behavior. Table *I* summarizes the features of each lottery. The experiment I discuss in Section 3 puts these lotteries into practice.

[Table *I* about here]

2.3.1 Do Regret Aversion and Indecisiveness Jointly Generate Inertia?

The BASE Lottery (BASE for *baseline*) is an ambiguous lottery in which the DM learns the counterfactual outcome. To distinguish between the set of theories that predict a switch and the set of theories that predict that the DM will not switch, the BASE lottery must have two additional features. First, switching must be rewarded with a small bonus. Otherwise, most theories (the ones that never predict that the DM's choice will display inertia, and R-D SEU based on the expectations hypothesis) imply that choice is indeterminate as the DM is indifferent between the tickets. Second, the option to switch tickets must be a surprise. When instead this option is anticipated, KDT is vague; and R-D SEU based on the expectations hypothesis is observationally equivalent to the theories that never predict that the DM's choice will display inertia. Therefore, I assume that the BASE lottery is ambiguous, the opportunity to switch tickets is a surprise, and switching is rewarded with a 1% bonus. SEU, Rank-Dependent Utility, the models of ambiguity aversion, Prospect Theory, Regret Theory, and Disappointment Theory all predict that the DM will switch tickets in the BASE lottery, while KDT and R-D SEU predict that the DM will not switch. Inertia reveals that the DM is indecisive, regret-averse, or both.

2.3.2 Separating the Effects of Regret Aversion and Indecisiveness

Suppose, in the remainder of this section, that the DM's choice in the BASE lottery displays inertia. The next step is to identify the underlying mechanisms.[25] To this end, let me first illustrate the fundamental differences between KDT and R-D SEU with respect to the BASE lottery. These differences will guide the selection of lotteries that I will use to distinguish between indecisiveness and regret aversion.

According to KDT, the utility of an outcome with either ticket is unaffected by counterfactual outcomes. The DM's preference between tickets is affected only by the set of probability distributions $(P(S) : w+x, 1-P(S) : w)$ and $(P(S) : w+b, 1-P(S) : w+b+x)$ that the tickets generate over the outcomes. The fact that the lottery is ambiguous turns out to be crucial, as ambiguity prevents the DM from comparing the tickets. Ambiguity makes the DM indecisive; and it is indecisiveness—combined with the Inertia Assumption—that leads the DM to keep the Original Ticket. If the lottery were fair, she would be able to compare the tickets—and she would switch.

Compare to R-D SEU. Comparisons across tickets within states of the world result in a preference for the Original Ticket. In particular, because the Original Ticket is the reference point, a failure to win after a switch would be regrettable, and regret aversion induces inertia. Importantly, the influence of this mechanism is unaffected by the fact that the BASE lottery is ambiguous. Although the DM does not know the likelihood of S, she holds the belief $P(S) = 0.5$. Her behavior would be the same if the lottery were fair.

Now consider one variation of the BASE lottery. The REG lottery (REG for *regret*) differs from the BASE lottery *only* in that it is a fair lottery. Because ambiguity is removed, KDT predicts that the DM will switch.[26] On the other hand, since the regret channel remains the same as in the BASE lottery, R-D SEU predicts that the DM will not switch. Then, inertia in the REG lottery identifies a regret-averse DM.[27]

[25] In this setting, it would be hard to achieve further separation within the set of theories that predict a switch. What makes further separation difficult is the fact that all these theories make the same prediction regardless of (i) whether the lottery is fair or ambiguous, (ii) whether the option to switch tickets is a surprise or is anticipated, and (iii) the value of the switching bonus.

[26] Strictly speaking, it might be impossible to *eliminate* ambiguity altogether. To guarantee the removal of ambiguity from the REG lottery, we would need the DM to verify that the likelihood of S is indeed 0.5—but this might be infeasible in practice. Fortunately, the prediction of KDT that the DM will switch in the REG lottery still holds if the DM *believes* that the likelihood of S is 0.5. I will return to this point in Section 3 when I describe the experiment.

[27] In the experiment, around 20 minutes elapsed before I surprised participants with the opportunity to switch. Although participants did not make the keep-or-switch decision under time pressure, they decided within a couple minutes. R-D SEU coupled with the expectations

Suppose that the DM's choice in the REG lottery displays inertia. According to R-D SEU, regret aversion causes inertia because the Original Ticket is perceived as the reference point. As we have seen, there are two different hypotheses as to *why* the Original Ticket is the DM's reference point. The DM might perceive it as the referent just because she was endowed with it. Alternatively, she might perceive it as the referent because it is the ticket that she expects to play until she learns that switching is possible. To differentiate between the endowment hypothesis and the expectations hypothesis, consider the END lottery (END for *endowment*). The END lottery differs from the REG lottery in just one feature: when the DM receives the Original Ticket, she learns that later she will be able to switch tickets. While the endowment hypothesis predicts that the DM's choice will display inertia, the expectations hypothesis predicts that the DM will switch. Therefore, the END lottery offers a clean test between the two hypotheses.

Now consider the IND lottery (IND for *indecisiveness*), another variation of the baseline lottery that I will use to investigate indecisiveness. Recall that in the BASE lottery the two tickets correspond to the same lottery. By contrast, in the IND lottery the DM must choose between two tickets that correspond to two *different* lotteries offering the same prize x. The Original Ticket, which allows the DM to play the Original Lottery, pays the prize with probability q. The Alternative Ticket, which allows the DM to play the Alternative Lottery, pays the prize with probability $1 - q$. (Thus, the Original Ticket is the gamble $(q : w + x, 1 - q : w)$ and the Alternative Ticket is the gamble $(q : w + b, 1 - q : w + b + x)$.) The DM does not know q, but she knows that it lies within the range $[1 - p, p]$. Like in the BASE lottery, the opportunity to switch tickets is a surprise. After the keep-or-switch decision, the chosen lottery is resolved, but the rejected lottery is *not* resolved.

The IND lottery has two key features. First, each ticket generates the same set of probability distributions over outcomes as its counterpart in the BASE lottery. In other words, ambiguity is the same as in the BASE lottery. This implies that the DM will maintain the same beliefs as in the BASE lottery. Second, because

hypothesis implies that the reference point is the Original Ticket because the expectations hypothesis assumes that reference points do not adjust within a couple minutes. Whether or not this assumption is correct, however, is ultimately an empirical matter, and I do not test this assumption. It might be the case that some regret-averse participants whose reference point is given by expectations quickly come to perceive the Alternative Ticket as the referent. These participants will switch tickets. But under R-D SEU, those who do *not* switch tickets *must* be regret-averse individuals who perceive the Original Ticket as the referent (regardless of whether the referent is given by their endowment or their expectations). Therefore, it is still true that inertia in the REG lottery must be attributed to regret aversion.

only the chosen lottery is resolved, the DM is aware that she will never know what the outcome would have been had she chosen the other ticket. This shuts down the regret channel. Notice the implications for choice behavior: KDT predicts that the DM's choice will display inertia, whereas R-D SEU predicts that the DM will switch. Thus, inertia in the IND lottery identifies an indecisive DM.[28]

The predictions for choice behavior can be summarized as follows. (See Table *I*.) Inertia in the BASE and REG lotteries, but not in the IND lottery, is consistent with R-D SEU alone. Inertia in the BASE and IND lotteries, but not in the REG lottery, is consistent with KDT alone. Inertia in the BASE, REG, and IND lotteries is consistent with both R-D SEU and KDT. Last, if the REG lottery reveals that the DM is regret-averse, the END lottery distinguishes between the endowment hypothesis and the expectations hypothesis. Inertia in the END lottery is consistent with the endowment hypothesis, while a switch is consistent with the expectations hypothesis.

3 Experiment

3.1 General Aspects of the Design

Drawing upon the theoretical framework, I conducted a laboratory experiment on the campus of the University of California, Los Angeles. I ran the sessions at the Anderson Behavioral Lab between November 2013 and October 2014, with students drawn from the laboratory's subject pool. The experiment features a between-subjects design with seven conditions, each of which has around 50 participants. I carried out each condition through several sessions, with between three and twelve participants per session.

I conducted the experiment with paper-and-pencil. In each session, upon arrival at the lab, participants were seated at individual carrels; then I gave them a series of handouts containing general and specific instructions (which I also read aloud) and they filled out a few forms. Towards the end of the session participants made an incentivized choice.[29] All payments from a given session (including a $6 show-

[28] One drawback of the IND Lottery is that it may not shut down the regret channel completely if we allow for a broader conception of regret. If the DM switches tickets and fails to win, she could regret having switched just because she *might* have won had she not switched. Unfortunately, the IND Lottery does not remove the influence of this kind of anticipated regret on choice behavior. To address this issue, the experimental design includes one more lottery, which I describe in Section 3.5. Using the additional lottery, I test for the broader conception of regret and identify the effect of indecisiveness on choice behavior.

[29] In all conditions but one (the BCR condition), participants made a single choice. In the

up fee) were made by the lab manager through a deposit to participants' university accounts in the following two or three weeks.[30] The sessions lasted between 30 and 35 minutes; I ran them with the help of one or two assistants, whom I introduced as I read the first portion of instructions.[31]

The structure of a session was common to all conditions. At the beginning of the session, I endowed participants with one of two tickets to take part in an individual lottery that offered a $10 prize. The lottery was to be resolved at the end of the session. After the first round of instructions, participants filled out a few questionnaires and received a reminder about the upcoming lottery. Before the lottery was resolved, I gave them the opportunity to switch tickets; switching was rewarded with a $0.10 bonus. Finally, participants made the keep-or-switch decision privately and played the lottery. The conditions differed only in the particular characteristics of the lottery. Table *II* summarizes the features of each condition; it also reports the main results in the last two rows. Appendix Table A1 shows that participants seem to be broadly balanced on observable characteristics across conditions.[32] Appendix Table A2 provides details about each session conducted, including date, time, and number of participants. I also summarize the results for each individual session in Appendix Table A2. Appendix E contains more details about procedures, as well as full instructions and a sample of the forms that participants filled out.

[Table *II* about here]

BCR condition, one of the several choices was selected to be played out using the random-lottery method.

[30] This payment method is uncommon in economic laboratory experiments, as participants are usually paid out in cash immediately after the experiment. One concern with the delay in payment is that it may add perceived uncertainty to the choice situation, which may affect participants' behavior. The delay in payment, however, is unlikely to have increased perceived uncertainty among most participants from this experiment. Payment through a deposit to participants' university accounts is the standard procedure in the Anderson Behavioral Lab; participants become aware of this procedure before they participate in any experiment since it is explicitly mentioned in an online consent form that they have to fill out to be included in the lab's subject pool. (See the lab's webpage: http://www.anderson.ucla.edu/faculty/marketing/behavioral-lab) In addition, because the majority of participants from this experiment had previously participated in other experiments conducted at the lab (see Appendix Table A1), they had already verified that the lab manager delivers payments as promised. (Also, Appendix Table A1 shows that the proportion of participants who previously participated in other experiments conducted at the Anderson Behavioral Lab is not statistically different across conditions except for one condition.)

[31] The assistants varied across sessions. The protocol could have been carried out with only one assistant per session, but in most sessions I used two to run the sessions faster. I told participants that the two assistants would proceed independently, and that each assistant would interact with roughly half of the participants in the session. (See instructions in Appendix E.) Therefore, in what follows I describe the protocol as if I had used a single assistant in all sessions.

[32] See Appendix B for a list of academic majors.

3.2 The Joint Effect of Regret Aversion and Indecisiveness on Choice Behavior

3.2.1 The Baseline

The BASE condition puts the BASE Lottery into practice. In a typical session, I showed participants an empty black bag sitting on the front desk. The assistant was standing behind the front desk while I read the first portion of instructions. I informed participants that the assistant would take the bag with her to the adjacent room and fill it with 10 red and blue balls in total. The bag would be used at the end of the session to play an individual lottery. I told participants that they would go, one at a time, to the adjacent room, where the assistant would randomly draw a ball from the bag in front of them. (I told participants that the balls would be drawn with replacement.)

Then I told participants that there were two possible tickets to play the lottery—Red and Blue—and that they would be randomly assigned one of the tickets. Specifically, I informed participants that they would pick a closed envelope containing a ticket, and that half of the tickets were Red and the other half Blue. The Red Ticket would pay the \$10 prize if the assistant drew a red ball from the bag at the end of the session (and it would pay nothing otherwise). Conversely, the Blue Ticket would pay the \$10 prize if the assistant randomly drew a blue ball (and it would pay nothing otherwise).

Participants knew that the bag would contain 8 balls of one color and 2 balls of the other color; they did not know, however, which of the two possible compositions would be the actual composition of the bag. In particular, I told participants that the assistant would pick one of the two possible compositions as she pleased. I emphasized that the assistant would set the bag without seeing any participant's ticket and check the ticket only after drawing a ball.

After this first round of instructions, the assistant went to the adjacent room and stayed there until the end of the session. Once she had left the main room, I walked around holding a box with closed envelopes and asked each participant to pick an envelope.[33] Then, participants answered some demographic questions and filled out the first part of a 44-item "Big Five" personality questionnaire (John, Donahue, and Kentle 1991).[34] The questionnaire served two purposes. First, it

[33] After handing in the envelopes, I asked participants to check which ticket they had gotten. I allowed them to look inside the envelope whenever they wanted. The envelope remained on each participant's desk until they grabbed it to play the lottery in the adjacent room.

[34] This questionnaire was previously used by Ericson and Fuster (2011) in a related experiment about reference-dependent preferences.

allowed time for participants to adapt to the new reference point, in case preferences over gambles are reference-dependent. Becoming psychologically accustomed to the reference point might take some time (see, for instance, Strahilevitz and Loewenstein [1998]). Second, the questionnaire also served as a decoy for the main decision of interest, which took place at the end of the session (see Ericson and Fuster [2011]). This second role of the questionnaire was intended to attenuate experimental effects. After participants finished answering the first 22 questions, I reminded them about the instructions with regard to the lottery, to make sure they understood and also to make them focus on the upcoming lottery.

After they answered the second 22 questions, participants received a Decision Form. Through this form I informed them that they had the opportunity to switch tickets, if they so desired. The form also stated that if they switched, they would receive $0.10 in addition to what they got from the lottery. Participants indicated whether they wanted to keep the Original Ticket or switch to the Alternative Ticket by checking the corresponding option. Once they had made a decision, participants folded the Decision Form, placed it inside the envelope, and lined up to play the lottery.[35]

I collected data from 50 participants. The proportion of participants from the BASE condition whose choices displayed inertia was quite large: seventy percent kept the Original Ticket. At the 95% significance level, the probability of retaining the Original Ticket fell between 57% and 83%.

RESULT 1: *A substantial proportion of participants from the BASE condition made choices that displayed inertia.*

3.2.2 Accounting for Potential Confounds

Result 1 suggests that regret aversion and indecisiveness are jointly significant determinants of inertia. The BASE condition, however, might have failed to control for other determinants of inertia. Next I describe six potential confounds—divided into two groups—and I discuss two additional conditions that address them.

A. Lack of Trust in the Experimenter

A participant from the BASE condition could not verify that the tickets had in fact been randomly assigned and that the experimenter did not know her ticket. Hence, she might have been suspicious about the unexpected option to switch

[35] Recall that all payments (including the $0.10 bonus) were made through a deposit to participants' university accounts rather than by cash. This procedure eliminated the potential cost of carrying $0.10 after the session, which might have discouraged participants from switching tickets.

tickets and get a bonus. Mistrust could have created inertia. Thus, it is crucial to separate the inherent uncertainty about the composition of the bag (one of the deep parameters of interest) from a participant's lack of trust in the experimenter.

I used the TRUST condition to test if lack of trust had affected choice behavior in the BASE condition. The TRUST condition is a variation of the baseline in which it is impossible to rig the lottery.[36] In a typical session, I walked around the room holding a small bag that contained one red ball and one blue ball. Participants checked the bag out. Then, I asked them to *randomly* draw a ball from the bag, check the color without revealing it to anyone else, and put the ball back into the bag. Once I had left their carrels, they wrote the color down on a blank card, placed the card inside an empty envelope, and closed the envelope. Next, I told them that the card was a ticket to play an individual lottery, and I described the lottery—which was identical to the one from the baseline. The remainder of the session was exactly the same as in the BASE condition. Because each participant was the only person in the lab who knew her own ticket until the lottery was resolved, it was impossible to rig the lottery. This feature removed any potential influence of lack of trust on choice behavior.[37]

I collected data from 51 participants. Seventy-eight percent retained the Original Ticket. A two-tailed test of differences in proportions fails to reject the null hypothesis that this percentage is equal to the one from the BASE condition ($p = 0.333$). This result indicates that participants from BASE believed that the lottery had not been rigged.

[36]The situation faced by a participant from BASE resembles the 'Monty Hall' or 'three doors' problem (Engel & Venetoulias 1991; Tierney 1991; vos Savant 1990a, 1990b, 1991). In the television program *Let's Make a Deal*, Monty Hall, the host, placed a car behind one of three closed doors. There was a goat behind each of the other two doors. In this game, a participant could win the car. The participant's first task was to choose one of the doors. After the initial door was selected, Monty opened one of the two remaining doors to reveal a goat. The subject's choice, then, was whether to stick with her initial choice or switch to the remaining, unopened door. As we have seen, regret aversion might induce inertia. In addition, because most people do not figure out that switching doors maximizes the probability of getting the car, confusion about probabilities might also lead to inertia. Finally, mistrust in Monty, who knows what is behind each door, might also make a participant reluctant to switch. Notice that if Monty did not know whether the car is behind the originally chosen door or the remaining, unopened door, a participant would not have any reason to mistrust Monty. This is precisely what I attempt to achieve in the TRUST condition.

[37]I want to emphasize that the tickets were *randomly* assigned rather than chosen by participants, as participants drew a random ball from the bag. Random assignment avoided any psychological attachment with the Original Ticket that could have resulted from letting participants choose the ticket. Indeed, in a related experiment I show that letting participants choose the Original Ticket increases inertia relative to a situation in which the Original Ticket is randomly assigned. (See Sautua [2016], Result 2.)

B. Other Factors

Carelessness. Participants might have failed to react to the \$0.10 switching bonus because \$0.10 was too small an incentive for them to care about the keep-or-switch decision.

Inattention. Because participants had to make an explicit choice to move on, the keep-or-switch decision was salient. Some participants, however, might not have paid enough attention and hence might have had a tendency to pick the first option that was listed on the Decision Form. I partially addressed this issue by randomizing the order of the options on the Decision Form across participants within a session. This feature of the design reduced the impact of inattention on choice behavior, but it failed to eliminate it.

Concern About the Experimenter's or Assistant's Judgment. Participants might have believed that switching for just \$0.10 would make them appear too greedy in front of the experimenter or the assistant. Thus, they might have kept the Original Ticket simply to avoid this negative judgment.

Belief in Fate. If participants considered the tickets to be identical ex-ante, they might have thought that by switching tickets they would be 'tempting fate'—that is, they might have had the 'gut feeling' that a switch could reduce their chances of winning the lottery (Risen and Gilovich 2007). Inertia might have been driven by a profound aversion to switching that stems from the fear of tempting fate. The \$0.10 bonus may have been too small to override the influence of this superstitious belief.

Experimental Effects. Although the personality questionnaire served as a decoy for the keep-or-switch decision, it did not necessarily remove all potential experimental effects. For example, some participants might have believed that the experimenter expected people to switch because they were offered a monetary incentive to do so. Based on such belief, they might have construed the decision as a test of their conformity tendencies (Ross and Nisbett 1991). By refusing to switch, these participants might have wanted to show the experimenter that they 'do not behave like most people'—for whom switching was supposed to be the normal choice.

I used the CONTROL condition to assess to what extent these other factors could have induced inertia in the BASE condition. The CONTROL condition identifies the amount of inertia that such factors create themselves when regret aversion and indecisiveness do not play a role.

In a typical session from the CONTROL condition, participants saw two transparent plastic cups and two identical ten-sided dice on their desks. I invited them to inspect these objects. Once they were done, I asked participants to place one die inside each cup. Each cup was placed in front of a sticker, which served as a label. One of the stickers had a Vertical Stripe, while the other had a Horizontal Stripe; they were otherwise identical. In some sessions, I told participants that they would use the die labeled with the Vertical Stripe to play a lottery at the end of the session; in other sessions I told participants that they would use the die labeled with the Horizontal Stripe. I told them that the lottery worked as follows: they would grab the designated die from their carrel, go to the adjacent room, and roll the die in front of the assistant. If a number from 0 through 4 came out, they would win the $10 prize; if a number from 5 through 9 came out, they would get nothing. Before they played the lottery, they received a Decision Form through which I gave them the option to use the other die. Switching dice was rewarded with a $0.10 bonus.

The design has three key features. First, because I faced participants with a choice between two 50-50 gambles, they could not be indecisive. Hence, KDT predicts a switch.[38] Second, since I allowed participants to roll only one die, the counterfactual outcome was unknowable to a participant. This feature blocked the influence of anticipated regret. Hence, R-D SEU also predicts a switch. Third, other factors should all have exerted the *same* influence on choice behavior as they did in the BASE condition. Together, these three features make the CONTROL condition a suitable benchmark for the BASE condition. Therefore, *excess inertia* from BASE identifies the amount of inertia jointly driven by regret aversion and indecisiveness.

I collected data from 49 participants. Thirty-one percent retained the Original Die. A one-tailed test of differences in proportions rejects the null hypothesis that the percentage in BASE is smaller than or equal to the one in CONTROL in favor of the alternate hypothesis that the percentage in BASE is larger ($p < 0.001$). Moreover, excess inertia from BASE is quite large: it is 1.26 times as large as the amount of inertia found in CONTROL.[39]

[38] Although it was impossible for participants to make sure that the dice were identical, they did believe so. In a Post-Decision Questionnaire, I asked participants whether they thought the winning chance of the chosen die was higher than, lower than, or equal to the chance of the rejected die, or whether they could not tell. (Participants answered this question after the keep-or-switch decision but before playing the lottery.) Forty-five out of 49 participants replied that the chances were the same; 3 out the remaining 4 said that they could not tell, but still switched dice. This provides further support for the claim that participants were not indecisive in the sense of KDT.

[39] There are two subtle confounds that might contaminate the comparison between BASE and CONTROL:

RESULT 2: *Regret aversion and indecisiveness were jointly significant determinants of inertia in the BASE condition.*

The data from BASE, TRUST, and CONTROL indicate that anticipated regret and indecisiveness jointly affect the choice between tickets. The design, however, does not enable me to establish whether excess inertia from the BASE condition is driven by regret aversion, indecisiveness, or both. The following step is to assess the *individual* influence of these two mechanisms on the choice between tickets. Next, I examine the effect of regret aversion. Then, I turn to the effect of indecisiveness.

3.3 The Effect of Regret Aversion on Choice Behavior

The REG condition assesses the effect of regret aversion on choice behavior by putting the REG lottery into practice. In a typical session participants saw a transparent plastic cup and a ten-sided die on their desks, and were invited to inspect them.[40] Then I collected all the dice with a large plastic cup. Next, I asked the assistant to randomly pick one die from the large cup in front of participants. I also asked her to pick a transparent plastic cup (like the one that each participant had on her desk) from a pile of cups sitting on the front desk. I informed participants that they would play an individual lottery that the assistant would resolve at the end of the session. To resolve the lottery, the assistant would use the die and the cup that she had picked. I told participants that they would go, one at a time, to the adjacent room, where the assistant would roll the die (using the cup) in front of them.

Then I informed participants that there were two possible tickets to play the lottery—Odd and Even—and that they would be randomly assigned one of the

(1) While in BASE it is the assistant who resolves the lottery (by drawing a ball in front of the participant), in CONTROL the participant resolves the lottery herself (by rolling the die). Yet, the analysis of the REG condition, which I describe in Section 3.3, indicates that this difference between BASE and CONTROL is inconsequential. In particular, in a robustness check of the REG condition—whose lottery is also resolved by rolling a die, I find that it does not matter who rolls the die (i.e., inertia remains the same).

(2) The BASE condition fails to fully control for the influence of the intrinsic preference over colors on choice behavior. To see why this might be a problem, consider the following decision rule that consists of two steps: (i) choose the ticket that maximizes the preference over gambles; (ii) if indecisive between the two tickets, pick the ticket with the most preferred color. Such a decision rule could artificially create inertia: those indecisive participants who happen to be assigned their preferred color end up keeping the Original Ticket. Yet, in Appendix C I show that excess inertia from BASE is too large to be entirely driven by the preference over colors.

[40] The dice and cups were identical to the ones used in a typical session from the CONTROL condition.

tickets. Specifically, I told participants that they would pick a closed envelope containing a ticket, and that half of the tickets were Odd and the other half Even. The Odd Ticket would pay the \$10 prize if an odd number (1, 3, 5, 7, or 9) came out when the assistant rolled the die (and it would pay nothing otherwise). Conversely, the Even Ticket would pay the prize if an even number (0, 2, 4, 6, or 8) came out (and it would pay nothing otherwise). After this first round of instructions, the assistant left the main room and the session proceeded as in the BASE, TRUST, and CONTROL conditions. In particular, participants made an unanticipated keep-or-switch decision before they got to play the lottery.

I collected data from 52 participants. Fifty-four percent kept the Original Ticket. A one-tailed test of differences in proportions rejects the null hypothesis that this percentage is smaller than or equal to that from CONTROL in favor of the alternate hypothesis that the percentage from REG is larger ($p = 0.009$). In addition, excess inertia from REG is large: it represents 75% of the amount of inertia found in CONTROL. There is, however, one subtle difference between CONTROL and REG that might have biased excess inertia upward. In the CONTROL condition participants rolled the die themselves, while in the REG condition the assistant rolled the die. Some participants might have had the 'gut feeling' that rolling the die themselves would increase their winning chance—that is, they might have had an 'illusion of control' (Langer 1975). Such illusion of control might have mitigated inertia in CONTROL, but it could not have played any role in REG. To eliminate the potential bias, I ran a variation of REG in which participants rolled the die themselves. Inertia, however, remained almost the same: 49% of participants kept the Original Ticket. Thus, an illusion of control did not affect excess inertia.

Another concern about the REG condition involves perceived ambiguity. As I argued in Section 2.3.2, removing ambiguity is crucial to separating the effect of regret aversion from that of indecisiveness. Yet, the claim that the REG condition eliminates ambiguity might be challenged. For instance, some participants might have doubted that the die was fair. It turns out that perceived ambiguity, if anything, seems to have had a negligible effect on choice behavior in REG. In a Post-Decision Questionnaire, I asked participants to compare the winning chances of both tickets.[41] Five out of the 28 participants who kept the Original Ticket replied that they could not compare the winning chances based on the information

[41] I asked them to select one answer out of the following: the chosen ticket had a higher chance, a smaller chance, an equal chance, or they could not tell. Participants answered this question after the keep-or-switch decision but before playing the lottery.

they had. Suppose that these were indecisive individuals who had retained the Original Ticket as a result of perceived ambiguity. If I remove them from the sample, the proportion of participants who kept the Original Ticket drops from 54% to 49%, which still yields substantial excess inertia. A one-tailed test of differences in proportions rejects the null hypothesis that this percentage is smaller than or equal to the one from CONTROL ($p = 0.033$).

In sum, excess inertia from REG was unaffected by an illusion of control or perceived ambiguity. Thus, the data indicate that regret aversion is a significant determinant of inertia.

RESULT 3: *Regret aversion was a significant determinant of inertia in the REG condition.*

According to R-D SEU, regret aversion induced inertia in the REG condition because regret-averse participants perceived the Original Ticket as the reference point. This is consistent with both the endowment hypothesis and the expectations hypothesis. The END condition distinguishes between the two hypotheses by putting the END lottery into practice.

The END condition features only one difference with respect to the REG condition. The twist is the following: as soon as I informed participants that they would randomly get either an Odd Ticket or an Even Ticket, I also announced that they would have the opportunity to switch tickets (and receive a \$0.10 bonus) before they played the lottery. I told them that they would indicate their decision on a Decision Form shortly before the assistant resolved the lottery. Later on, as I reminded them about the upcoming lottery, I also reminded them about the option to switch tickets. Then the session proceeded as in the REG condition. If the endowment hypothesis describes the behavior of most regret-averse participants, the REG and END conditions should display about the same amount of inertia. By contrast, if the expectations hypothesis fits the behavior of a significant proportion of regret-averse participants, inertia should drop in the END condition.

I collected data from 47 participants. Thirty-six percent kept the Original Ticket. A one-tailed test of differences in proportions rejects the null hypothesis that this percentage is greater than or equal to that of REG in favor of the alternate hypothesis that the percentage from END is strictly smaller ($p = 0.039$). Furthermore, almost all of the excess inertia from the REG condition vanished when participants could plan to switch tickets in advance. A two-tailed test of differences in proportions fails to reject the null hypothesis that the amount of inertia from END is the same as that from CONTROL ($p = 0.564$).

RESULT 4: *When participants could plan to switch tickets in advance, regret aversion no longer generated inertia.*[42]

3.4 The Effect of Indecisiveness on Choice Behavior

The IND condition assesses the effect of indecisiveness on choice behavior by putting the IND lottery into practice. In a typical session I showed participants two empty black bags sitting on the front desk. The bags were labeled Bag 1 and Bag 2. I informed participants that the assistant would take the bags with her to the adjacent room and would fill each bag with 10 red and blue balls in total. The bags would be used to play an individual lottery at the end of the session. I told participants that they would go, one at a time, to the adjacent room, where the assistant would draw a ball from *one* of the bags in front of them. (I told participants that the balls would be drawn with replacement.)

I randomly assigned participants a ticket to play one of two possible lotteries. (They picked a closed envelope from a box as in BASE, TRUST, REG, and END.) They could receive a Red-1 Ticket or a Red-2 Ticket. If a participant ended up playing a Red-1 Ticket, the assistant would draw a ball from Bag 1; the participant would win the \$10 prize if the assistant drew a red ball. Conversely, if a participant ended up playing a Red-2 Ticket, the assistant would draw a ball from Bag 2; the participant would win the \$10 prize if the assistant drew a red ball.

Participants knew that one of the bags would contain 8 red balls (and 2 blue balls) and the other would contain 2 red balls (and 8 blue balls); they did not know, however, which bag would contain more red balls. In particular, I told participants that the assistant would set the bags as she pleased.[43] I emphasized that the assistant would set the bags without seeing any participant's ticket. After this first round of instructions, the session proceeded as in BASE, TRUST, REG,

[42] In principle, there is one potential confound in REG and END whose effect is not removed by a comparison with CONTROL. Some participants might have chosen a ticket based on their preferences over numbers (even vs. odd) rather than based on their preferences over gambles. Such a decision rule might have artificially created inertia: those participants who happened to be assigned their preferred set of numbers might have ended up keeping the Original Ticket. This hypothesis, however, is inconsistent with the observed pattern of inertia in REG and END. To see why, notice that someone who keeps the Original Ticket in REG based on her preferences over numbers would make the same choice in END. Then, the virtual elimination of excess inertia when we move from REG to END indicates that the preference over numbers was not a significant determinant of inertia in REG and END.

[43] I also announced that the assistant would never reveal the compositions of the bags, not even after resolving the lottery.

and CONTROL. In particular, participants made an unanticipated keep-or-switch decision before they got to play the lottery.

I collected data from 48 participants. Seventy-nine percent kept the Original Ticket. A one-tailed test of differences in proportions rejects the null hypothesis that this percentage is smaller than or equal to the percentage from CONTROL in favor of the alternate hypothesis that the percentage from IND is larger ($p < 0.001$). Also, excess inertia is 1.55 times as large as the amount of inertia found in CONTROL.

In Section 2.3.2, I argued that (excess) inertia from IND should be attributed to indecisiveness because IND shuts down the regret channel from BASE while preserving the degree of ambiguity. Notice, however, that IND and BASE have the same amount of inertia.[44] In principle, this reveals an inconsistency in the interpretation of results. On one hand, since IND identifies the effect of indecisiveness, the equality of inertia in IND and BASE implies that regret aversion plays no role in BASE. On the other hand, Result 3 (about REG) implies that regret aversion *does* play a role in BASE. How can we resolve this contradiction? The reason why the amount of inertia in IND is the same as that from BASE may be that IND does not actually shut down the regret channel. Although IND removes the possibility of experiencing regret after learning the counterfactual outcome—simply because the counterfactual outcome is unknowable, this condition fails to account for a broader conception of regret. Unlike what the conventional notion of regret states, it may not be necessary to *know* the counterfactual outcome to experience regret after a choice (Gilovich and Medvec 1995). If the DM switches tickets and fails to win, she could regret having switched just because she *might* have won had she not switched. The IND condition does not remove the influence of this kind of regret on choice behavior. It is possible, however, to set an *upper bound* on the amount of inertia driven by regret aversion in IND. Inertia beyond this bound should be attributed to indecisiveness.

To bound the amount of inertia driven by regret aversion, I just need to make one straightforward assumption. I assume that the DM experiences less regret when the counterfactual outcome is unknowable than she does when the counterfactual outcome is known. This premise implies that the amount of inertia attributable to regret aversion in the IND condition cannot be larger than it is in the REG condition. Thus, if inertia from IND were entirely produced by anticipated regret and factors other than indecisiveness (like carelessness, belief in fate,

[44] A two-tailed test of differences in proportions fails to reject the null hypothesis that the amount of inertia is the same in both conditions ($p = 0.298$).

etc.), the level of inertia would not exceed the one from REG. A one-tailed test of differences in proportions rejects the null hypothesis that inertia from IND is smaller than or equal to that from REG in favor of the alternate hypothesis that inertia from IND is larger ($p = 0.004$). This means that some (if not all) of the excess inertia from the IND condition must have been driven by indecisiveness.

RESULT 5: *Indecisiveness was a significant determinant of inertia in the IND condition.*

3.5 Comparing The Effect of Regret Aversion with that of Indecisiveness

Thus far, the data indicate that both regret aversion and indecisiveness are significant determinants of inertia. A natural question is which mechanism, if any, causes more inertia. To answer this question, however, I need to improve upon the IND condition to obtain a clean measure of the effect of indecisiveness. I will use the BCR condition (BCR for *broad conception of regret*) to obtain such measure. This condition is guided by an extension of R-D SEU that accommodates the broader conception of regret introduced in Section 3.4.

Consider a loss-averse DM whose reference point is the Original Ticket. Suppose that this DM would always regret switching tickets if she switched and failed to win—even if the counterfactual outcome were unknowable. Suppose, in addition, that this DM is bayesian, and hence judges the prior winning chance of either ticket to be 0.5. Now think about the utility loss that she would experience right after switching tickets and failing to win. Intuitively, the utility loss would increase with the probability that the DM would have won with the Original Ticket, *given* that she failed to win with the Alternative Ticket. A similar logic applies to the utility gain that would result from switching and winning the lottery. The utility gain would increase with the probability that the DM would have failed to win had she not switched, *given* that she won with the Alternative Ticket.

R-D SEU can be reinterpreted and extended in a way that fits the above description. In the model I described in Section 2.2.2, the counterfactual outcome is certain. After a switch, the DM learns what would have happened had she not switched. We can restate this feature introducing probabilities explicitly. If after a switch the DM fails to win, she learns that the Original Ticket would have won with probability 1—and hence experiences the full loss $\mu(b - x)$. On the other hand, if the DM wins with the Alternative Ticket, she learns that the Original Ticket would have won with probability 0—and hence experiences the full gain

$\mu(b+x)$. When the counterfactual outcome is unknowable rather than known, gains or losses are weighed by their *posterior* probability of occurrence. Let $P(O\ wins|A\ fails)$ denote the probability of a counterfactual win given a failure to win with the Alternative Ticket. Similarly, let $P(O\ fails|A\ wins)$ denote the probability of a counterfactual failure to win given a win with the Alternative Ticket. As before, the utility of the Original Ticket is $U(Original|R) = w + 0.5\ x$; but now the utility of the Alternative Ticket is[45]

$$\begin{aligned} U(Alternative|R) &= w + b + 0.5\ x \\ &+0.5\ [P(O\ wins|A\ fails)\ \mu(b-x) + P(O\ fails|A\ fails)\ \mu(b)] \\ &+0.5\ [P(O\ wins|A\ wins)\ \mu(b+x-x) \\ &+P(O\ fails|A\ wins)\ \mu(b+x)]. \end{aligned} \tag{5}$$

This extension of R-D SEU enables a precise characterization of the role of regret in the IND condition. Because the DM knows that one bag is 'dominant red' while the other is 'dominant blue,' the outcome of the Alternative Ticket contains relevant information about the winning chance of both tickets. Being bayesian, the DM realizes that a failure to win with the Alternative Ticket suggests that a win would have been *more* likely with the Original Ticket. Similarly, she realizes that a win with the Alternative Ticket suggests that a win would have been *less* likely with the Original Ticket. Specifically, since one bag has 8 red balls and the other has 2 red balls, it follows that $P(O\ wins|A\ fails) = P(O\ fails|A\ wins) = 0.68$ and $P(O\ fails|A\ fails) = P(O\ wins|A\ wins) = 0.32$.[46]

Compare to the CONTROL condition, in which the counterfactual outcome is also unknowable. The DM will regret switching dice if she uses the Alternative Die to resolve the lottery and fails to win. In the CONTROL condition, however, the outcome when the Alternative Die is used is uninformative about the counterfactual outcome, as both outcomes are independent. In particular, $P(O\ wins|A\ fails) = P(O\ wins|A\ wins) = P(O\ fails|A\ wins) = P(O\ fails|A\ fails) =$

[45] Notice that if both tickets resulted in the same outcome (for example, in the IND condition), the DM would experience a gain of b because the Alternative Ticket pays the bonus.

[46] To compute $P(O\ wins|A\ fails)$, write

$P(O\ wins|A\ fails) = P(O\ wins|A\ fails,\ O\ Bag\ dominant\ red)\ P(O\ Bag\ dominant\ red|A\ fails) + P(O\ wins|A\ fails,\ O\ Bag\ dominant\ blue)\ P(O\ Bag\ dominant\ blue|A\ fails)$.

If the Original Bag is 'dominant red,' the winning chance of the Original Ticket will be 0.8; but if instead the Original Bag is 'dominant blue,' the winning chance will be 0.2. Now, it follows from Bayes' Rule that $P(O\ Bag\ dominant\ red|A\ fails) = 0.8$. (I am assuming that the prior probability that the Original Bag is 'dominant red' is 0.5.) In turn, this implies that $P(O\ Bag\ dominant\ blue|A\ fails) = 0.2$. Replacing all the probabilities in the above equation, we get $P(O\ wins|A\ fails) = 0.68$.

0.5. Assuming that $\mu(.)$ is piecewise linear as in Section 2.2.2, it follows from equation (5) that the expected utility of the Alternative Ticket is smaller in IND than in CONTROL. Then, regret aversion might induce more inertia in IND than in CONTROL. If this were the case, excess inertia from IND would be affected by anticipated regret; hence, it would not cleanly identify the amount of inertia generated by indecisiveness. The BCR condition resolves this issue. Its key feature is that the Alternative Ticket yields the same expected utility to a regret-averse DM as it does in the CONTROL condition.

The BCR condition differs from the IND condition only in the way the compositions of the two bags are determined. In IND participants know that one bag is 'dominant red' while the other is 'dominant blue.' By contrast, in BCR the compositions are *independent*. The assistant draws two numbers between 0 and 10 from a cup in front of participants; she draws the numbers with replacement.[47] She is the only person in the lab that knows these two numbers.[48] The first number determines the number of red balls in Bag 1; the second number determines the number of red balls in Bag 2. (Recall that each bag contains 10 red and blue balls in total.) Because the compositions of the bags are independent, the outcome of the Alternative Ticket is uninformative about the proportion of red balls in the original bag; then, $P(O\ wins|A\ fails) = P(O\ wins|A\ wins) = P(O\ fails|A\ wins) = P(O\ fails|A\ fails) = 0.5$. This implies that the expected utility of the Alternative Ticket to a regret-averse DM is the same in the CONTROL and BCR conditions. Hence, excess inertia from BCR identifies the effect of indecisiveness.

I collected data from 49 participants.[49] Forty-nine percent retained the Origi-

[47] The cup contains 11 pieces of paper, each one featuring a different number between 0 and 10.

[48] As in the IND condition, I told participants that the assistant would never reveal the compositions of the bags, not even after resolving the lottery.

[49] Because in BASE, TRUST, CONTROL, REG, END, and IND participants made a single incentivized decision, I could not check consistency of choice behavior at the individual level. In the BCR condition I added a price-list task to perform a basic consistency check. After participants made the keep-or-switch choice with a \$0.10 switching bonus, I collected their Decision Form. Then I asked them—again by surprise—to make a series of similar choices for different values of the switching bonus, ranging from \$0.20 to \$1 in steps of \$0.10. The series of choices was displayed in a table on Decision Form Part II (see Appendix E). I told participants that once they had made all their choices, I would randomly select the choice-that-counted by rolling a die in front of them. For an individual's choice behavior to be considered consistent, the individual must feature a single switch point (if any). Reassuringly, only one participant had multiple switch points; I exclude this participant from the analysis. The analysis focuses exclusively on the keep-or-switch decision with a \$0.10 bonus. I do not use the price-list task for further analyses because it is unclear how to interpret switch points if individuals have expectations-based reference points. (See Section IV in Kőszegi and Rabin [2006] for discussion.)

nal Ticket. Based on the above discussion, next I examine three hypotheses. First, I test whether regret aversion induced a stronger reluctance to switch in the IND condition than it did in the BCR condition. The original R-D SEU predicts that regret-driven inertia should be the same (and equal to zero) in both conditions; in contrast, extended R-D SEU is consistent with larger inertia in the IND condition. A one-tailed test of differences in proportions rejects the null hypothesis that inertia from IND is smaller than or equal to that from BCR in favor of the alternate hypothesis that inertia from IND is larger ($p = 0.001$). Second, I test whether the amount of regret-driven inertia from the IND condition is about the same as that from the REG condition.[50] If this were the case, the additional inertia from IND relative to that from BCR should equal excess inertia from REG. I cannot reject this hypothesis ($p = 0.606$).[51]

RESULT 6: *Although the counterfactual outcome is unknowable in the IND condition, regret aversion appears to have induced about the same amount of inertia as in the REG condition. This is not consistent with original R-D SEU, but it is consistent with an extension of R-D SEU that accounts for a broader conception of regret.*

Third, I test whether regret aversion and indecisiveness induced about the same reluctance to switch tickets. To this end, I compare inertia between the REG and BCR conditions. A two-tailed test of differences in proportions fails to reject the null hypothesis that the proportion of participants who kept the Original Ticket is the same in both conditions ($p = 0.625$).

RESULT 7: *Regret aversion and indecisiveness generated about the same amount of inertia.*

Last, notice that Result 7 is remarkably consistent with excess inertia from BASE. Excess inertia from REG, which measures the effect of regret aversion, is 23%. Excess inertia from BCR, which measures the effect of indecisiveness, is

[50] Notice that we must reinterpret excess inertia from REG in light of extended R-D SEU. Strictly speaking, excess inertia from REG identifies the effect of anticipated regret when the counterfactual is known, compared to a situation in which the counterfactual is unknowable but the two possible counterfactual outcomes are equally likely.

[51] To test this hypothesis, I ran a linear regression of the keep-or-switch choice on dummy variables for CONTROL, REG, IND, and BCR: $y = \alpha_1\ CONTROL + \alpha_2\ REG + \alpha_3\ IND + \alpha_4\ BCR$, where y equals one if a participant kept the Original Ticket (and zero otherwise), and the dummy for Condition i equals one if a participant took part in Condition i (and zero otherwise). The coefficients from this regression capture the amount of inertia from each condition. The null hypothesis is $H_0 : \alpha_2 - \alpha_1 = \alpha_3 - \alpha_4$, which can be restated as $H_0 : \alpha_2 - \alpha_1 - \alpha_3 + \alpha_4 = 0$. Then, I carried out a standard asymptotic test that uses the delta method to compute the standard error of $\hat{\alpha}_2 - \hat{\alpha}_1 - \hat{\alpha}_3 + \hat{\alpha}_4$.

18%. These two figures add up to 41%—virtually the same excess inertia as that from BASE, which measures the joint effect of regret aversion and indecisiveness.

4 Conclusions

In a laboratory experiment, I investigated whether uncertainty creates inertia in real choices through anticipated regret and indecisiveness. I randomly assigned each participant one of two tickets to play an individual lottery; each participant then decided whether to keep the Original Ticket or switch to the Alternative Ticket (and receive a small bonus). In each condition, participants took part in a different lottery. The lotteries differed in the degree of uncertainty and in the potential to induce regret after a switch. Overall, I documented that inertia was quite large when the opportunity to switch tickets was a surprise. I showed that both anticipated regret and ambiguity-driven indecisiveness were significant determinants of the refusal to switch. In addition, both mechanisms had an equally strong effect. When participants knew that either ticket had a winning chance of 0.5, inertia was substantially lower if they anticipated the opportunity to switch. This finding supports Kőszegi and Rabin's (2006, 2007) hypothesis that reference points are shaped by expectations.

In the conditions with ambiguous lotteries, the Original Ticket and the Alternative Ticket were equally ambiguous. One important drawback of this feature of the experimental design is that it does not match many real-life situations; outside the laboratory, the status quo is often better known than are its alternatives and hence may be modeled as an option that is more certain than other choice options. Individuals may decide to stick with the status quo just because it is better known than are its alternatives. Yet, I believe the results from the conditions with (equally) ambiguous lotteries yield some insight about choice behavior in real-life situations. In particular, the results suggest that even if people did *not* have more information about the status quo, they might still have a disproportionate tendency to stick with it. Additional information about the status quo may increase the amount of inertia *beyond* this significant baseline level. How large the additional inertia is (relative to the baseline level) remains to be established through further experiments.

There is another feature that we find in many real-life situations but is absent in the experiment: usually, the status quo is not just the 'default' set by a third party, but is selected by the DM. For example, people decide whether to stick to a career or to a relationship that they have previously chosen, and policy makers decide whether to stick to a policy that they have implemented. In these cases, there may be reasons other than indecisiveness and anticipated regret that lead the DM to stick with the status quo, such as avoiding the need to admit past mistakes, the associated loss of face, and the social and political costs involved. The advantage of randomly assigning the status quo to participants is that I am able to isolate the pure effect of indecisiveness and anticipated regret on inertia from the effect of these other factors. The drawback, however, is that I am not able to assess the effect of responsibility for the choice of the status quo on inertia, and agency may be an important factor in many real-life situations. Agency in the original choice may also increase the intensity of regret after a switch; hence, it may increase inertia relative to a situation in which the status quo was not chosen by the DM. This is, indeed, what I found in a related laboratory experiment (see Sautua [2016]); the experimental results from Roca et al. (2006) also support this conjecture. Yet, a comprehensive analysis of the effect of agency in the choice of the status quo on inertia is still missing.

An interesting question for future research is how sensitive inertia is to the arrival of new information about unknown probabilities. For example, imagine an ambiguous lottery like the ones from the IND and BCR conditions, in which the DM has a Red Ticket and decides whether to play with the Original Bag or the Alternative Bag. Suppose that the assistant draws one ball from each bag (with replacement) before the participant makes the keep-or-switch decision, and the participant observes these draws. Choice behavior should be unaffected—relative to the current experiment—if both balls are the same color. But how would an R-D SEU maximizer and a Knightian DM react if the assistant drew a blue ball from the Original Bag and a red one from the Alternative Bag? Would this piece of information mitigate inertia? If so, by how much? R-D SEU predicts more switching but KDT does not speak directly to this issue, as it does not specify how a DM that entertains multiple priors updates beliefs. The feedback between further theoretical developments and empirical work can shed more light on the effect of information on choice under ambiguity, and on inertia in particular. Epstein and Schneider (2007) take an important step on the theoretical side by introducing a model of learning under ambiguity in which agents have multiple priors. In Sautua (2016), I take a step on the empirical side by measuring inertia after participants observe one realization of the status quo and its alternatives.

Another question concerns the correlation between regret aversion and ambiguity-driven indecisiveness. Knowing this correlation could be useful to predict how a *given* individual that behaves in a certain way in one context would behave in other contexts that differ in the degree of uncertainty and in the potential to induce regret. Because every participant from the experiment takes part in a single lottery, I cannot assess this correlation. A within-subjects design is needed to address this question. Such a design, for instance, could face every participant with the CONTROL, REG, and BCR lotteries. A drawback of a within-subjects design like this one, however, is that experimental effects are more likely to arise than in a between-subjects design.

Finally, R-D SEU and KDT can be applied to study choice behavior in several domains in which uncertainty is large and salient, such as technology adoption, financial investment, choice of health care, and choice among alternative insurance programs. (In Appendix D I briefly discuss the first three applications.) Yet, the theories might severely fail to predict behavior in other important situations. The type of uncertainty-averse behavior typically predicted by R-D SEU and KDT appears to be inconsistent with the optimistic beliefs and expectations that people exhibit in many surveys (e.g., Weinstein [1980], [1987]). Self-reported beliefs tend to reveal an *optimism bias*—a tendency to overestimate the likelihood of encountering positive events in the future and to underestimate the likelihood of experiencing negative events. There is some evidence that optimism leads to risk-prone behavior.[52] How could uncertainty-averse behavior and optimistic behavior be reconciled? To nail down the connection between these two opposite types of behavior, we need to better understand (i) how individuals form beliefs in ambiguous environments, and (ii) how these beliefs interact with loss aversion. Much work remains to be done in this area.

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[52] For instance, Camerer and Lovallo (1999) show that overconfidence causes excess entry in experimental games that emulate competitive markets. When participants' post-entry payoffs are based on their own skill, individuals tend to overestimate their chances of relative success and enter more frequently (compared to a condition in which payoffs do not depend on skill). Surprisingly, excess entry is even larger in sessions in which participants self-select knowing their success will depend partly on their skill (and that others have self-selected too).

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Tables

Table I
Summary of Lotteries and Predictions for Choice Behavior

	Lottery			
	BASE	REG	END	IND
Type of lottery	Ambiguous	Fair	Fair	Ambiguous
Counterfactual outcome	Known	Known	Known	Unknowable
Option to switch tickets	Surprise	Surprise	Anticipated	Surprise
Switching bonus	1%	1%	1%	1%
Theories that predict inertia	R-D SEU, KDT	R-D SEU	R-D SEU	KDT
Mechanisms	Regret aversion (EN & EX)* Indecisiveness	Regret aversion (EN & EX)	Regret aversion (EN)	Indecisiveness

* EN: endowment hypothesis; EX: expectations hypothesis

Table II
Design Features and Main Results

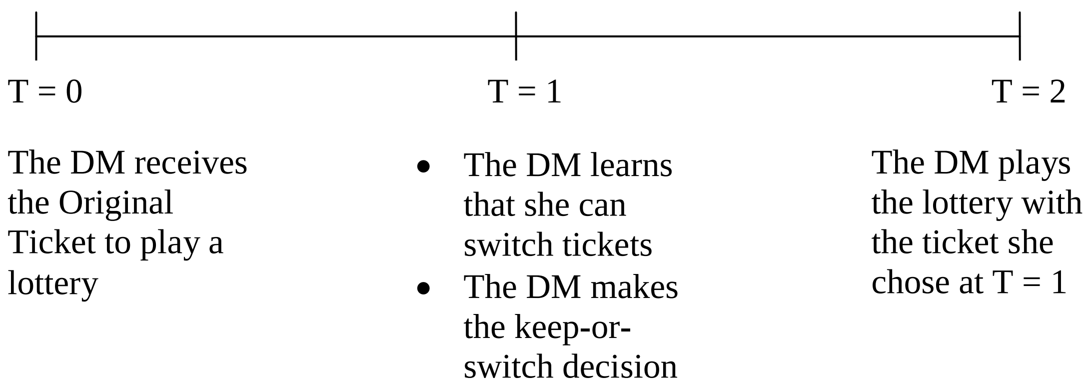
	Condition						
	BASE	TRUST	CONTROL	REG	END	IND	BCR
Lottery	BASE	Robustness check of BASE condition	CONTROL	REG	END	IND	Robustness check of IND condition
Winning probabilities	Unknown; 0.2 or 0.8	Unknown; 0.2 or 0.8	Known; 0.5	Known; 0.5	Known; 0.5	Unknown; 0.2 or 0.8	Unknown; between 0 and 1
Prize	$10	$10	$10	$10	$10	$10	$10
Switching bonus	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10
Number of participants	50	51	49	52	47	48	49
Number of Keep choices	35	40	15	28	17	38	24
Percentage of Keep choices							
Point estimate	70%	78%	31%	54%	36%	79%	49%
Confidence interval (95%)	(57%, 83%)	(67%, 90%)	(18%, 44%)	(40%, 67%)	(22%, 50%)	(68%, 91%)	(35%, 63%)
Excess inertia*	39%	47%	---	23%	5%	48%	18%
Result**	$p < 0.001$	$p < 0.001$	---	$p = 0.009$	$p = 0.282$	$p < 0.001$	$p = 0.032$

* Excess inertia from a given condition is defined as the difference between the amount of inertia from such condition and the amount of inertia from the CONTROL condition.
** Results are from one-tailed tests of differences in proportions (null hypothesis: excess inertia is smaller than or equal to zero; alternate hypothesis: excess inertia is positive).

Figures

Figure I
Timeline of the Decision Situation

Panel A - The Opportunity to Switch Tickets Is a Surprise



Panel B - The Opportunity to Switch Tickets Is Anticipated

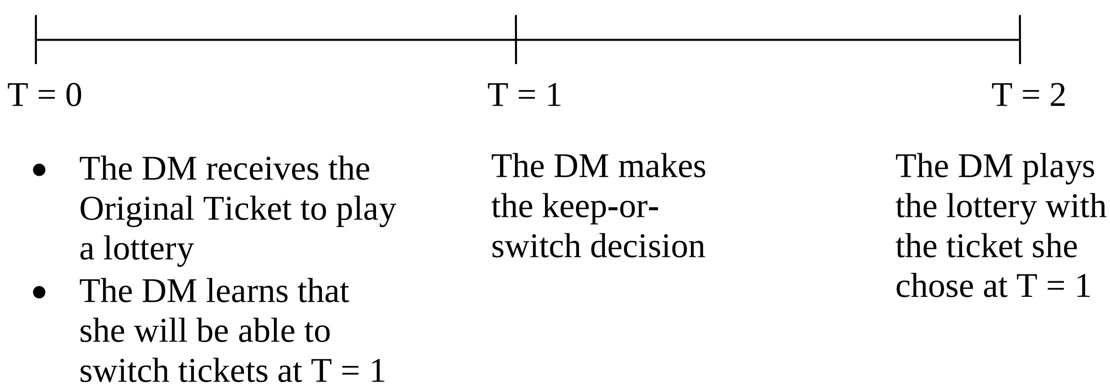


Figure II
The Keep-or-Switch Decision

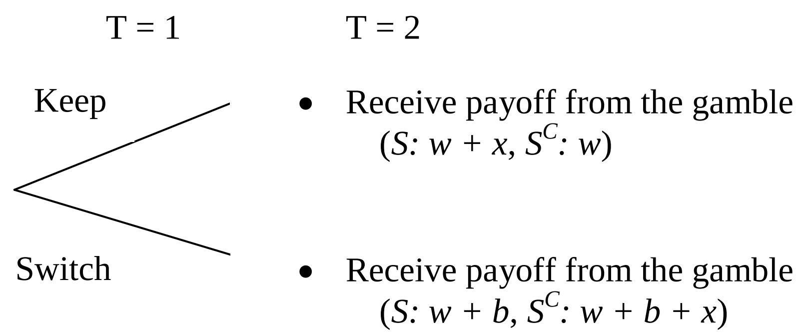
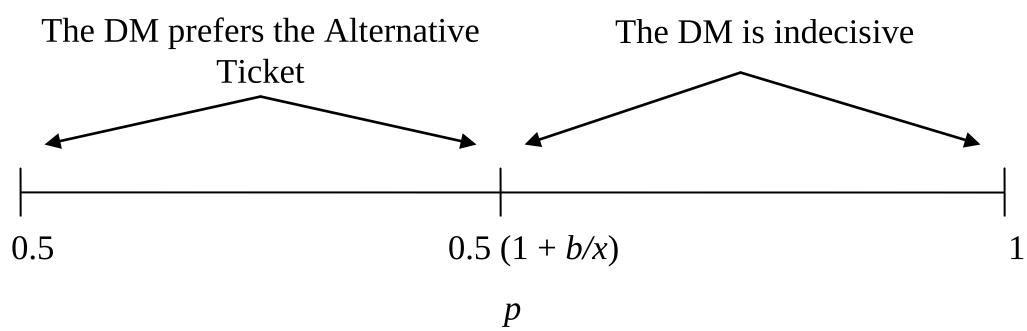


Figure III
The DM's Preference over Tickets in KDT



Note: The figure illustrates the DM's preference over tickets in KDT for different values of p, given a switching bonus b that is smaller than the prize x.