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RISK, AMBIGUITY, AND DIVERSIFICATION

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Abstract

Attitudes toward risk influence the decision to diversify among uncertain options. Yet, because in most situations the options are ambiguous, attitudes toward ambiguity may also play an important role. I conduct a laboratory experiment to investigate the effect of ambiguity on the decision to diversify. I find that diversification is more prevalent and more persistent under ambiguity than under risk. Moreover, excess diversification under ambiguity is driven by participants who stick with a status quo gamble when diversification among gambles is not feasible. This behavioral pattern cannot be accommodated by major theories of choice under ambiguity. (JEL Codes: C91, D01, D03, D81)

Keywords: risk, ambiguity, inertia, diversification, reference-dependent preferences, indecisiveness, ambiguity aversion.

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1 Introduction

Sometimes, when individuals face an important choice under uncertainty, they have the opportunity to *diversify* among choice options. For instance, financial investors pick a portfolio of assets; entrepreneurs allocate a budget among projects; participants from a defined contribution saving plan distribute their contribution among different funds; and farmers decide which crops to plant and how much to invest in each of them. While individuals' attitudes toward risk are a key determinant of the extent of diversification in situations like these, other factors may also play an important role. In particular, in most situations there is not just uncertainty about outcomes—known as *risk*—but also uncertainty about probability distributions over outcomes—known as *ambiguity*.[1] Prior empirical research has widely documented that attitudes toward ambiguity may have an effect on choice behavior beyond the effect of attitudes toward risk.[2] Yet, the influence of attitudes toward ambiguity on the extent of diversification has remained largely unexplored.[3] In this paper, I report the results of a laboratory experiment in which I investigate how ambiguity affects the decision to diversify among uncertain options.

The experimental design is motivated by the theoretical observation that attitudes toward risk and attitudes toward ambiguity combine to affect choice under ambiguity. For example, someone who is risk-averse may diversify among ambiguous options regardless of her attitude toward ambiguity—the mere uncertainty about outcomes might lead her to diversify. Therefore, it is usually hard to infer the *pure* effect of ambiguity on the decision to diversify directly from a situation with ambiguity.

This difficulty becomes evident when we examine the results of previous experimental work on diversification. For example, Bossaerts et al. (2010) find that many participants hold a portfolio that yields identical wealth across ambiguous states of the world for an open set of asset prices and state probabilities. Although this finding is consistent with preferences that display ambiguity aversion (as the authors show

[1] The distinction between risk (known probabilities) and ambiguity (unknown probabilities) dates back to Knight (1921) and Ellsberg (1961). Knight used the term uncertainty instead of ambiguity; here I use uncertainty as a generic term that encompasses situations of risk and ambiguity.

[2] See the recent survey of Machina and Siniscalchi (2014), who also summarize the vast theoretical literature on the topic. For recent applications, see Bossaerts et al. (2010), Bryan (2013), and Sautua (2016).

[3] A notable exception is Bossaerts et al. (2010), who conducted a laboratory experiment to study the effect of attitudes toward ambiguity on portfolio choices and asset prices in competitive financial markets.

carefully), it can also be explained (at least partially) by *loss aversion*. Indeed, in a similar experimental task, Choi et al. (2007) also find that several participants choose nearly safe portfolios for an open set of prices when either of the two states of the world could occur with *known* probability 0.5. As the authors show, disappointment aversion—which is an instance of loss aversion—can produce this behavior. I contribute to this research by presenting a simple experimental design that achieves a clear separation between the effects of risk and ambiguity on diversification.

To separate the effects of risk and ambiguity, I use a between-subjects design with two conditions—one in which the options are risky and another in which they are ambiguous. In the RISK condition, participants have the option to either play one of two independent gambles that pay a $10 prize with a 50 percent chance, or diversify between the two gambles. If a participant diversifies, she plays both basic gambles, but now each one offers a prize of $5 instead of $10. In the AMBIGUITY condition, the only difference is that the two gambles pay the $10 prize with unknown probabilities. The actual probabilities are independent between gambles and uniformly distributed between 0 and 1. Consequently, the ambiguous gambles are 'mean-preserving spreads in probabilities' of their risky counterparts. Thus, while behavior in the RISK condition identifies the effect of risk on the propensity to diversify, the *difference* in behavior between RISK and AMBIGUITY identifies the effect of ambiguity.

The experimental design builds upon the one I used in a recent paper, Sautua (2016). In that paper, participants chose whether to retain a status quo gamble that had been randomly assigned to them or switch to an alternative gamble for a small bonus. In some conditions, the two gambles were equally risky, whereas in others the gambles were equally ambiguous. In the present experiment, participants face three successive tasks, each of which constitutes a stage of the experiment. In the First Stage, I replicate the keep-or-switch decision from the previous experiment with a little twist—participants choose the status quo themselves. After participants make the keep-or-switch decision, in the Second Stage they decide whether to retain the chosen gamble or diversify. In the Third Stage, participants make a similar decision—play one of the two basic gambles or the diversified one—in a different situation. In the RISK condition, the winning probabilities differ between the basic gambles. In the AMBIGUITY condition, participants observe one realization of each basic gamble as practice, and then decide which of the three gambles to play for real.

This design enables me to investigate several features of diversification under uncertainty, with a focus on the differential effect of ambiguity relative to risk. Within each condition, Second-Stage behavior establishes the *baseline prevalence* of diversification when both basic gambles are equally uncertain. Third-Stage behavior reveals the *sensitivity* of diversification to the arrival of new information about the choice options; in the RISK condition, the new information takes the form of a change in objective probabilities, whereas in the AMBIGUITY condition it is conveyed by past outcomes. The inclusion of the First Stage is intended to uncover the relationship between the tendency to diversify and the tendency to retain the status quo—which I shall refer to as *inertia*—when diversification is not feasible. The three central questions for this paper are: (i) is diversification more prevalent in AMBIGUITY than in RISK? (ii) does ambiguity increase the *joint* likelihood that a participant sticks with the status quo gamble in the First Stage and diversifies in the Second Stage? (iii) is diversification less sensitive to new information that is supposed to reduce its appeal in AMBIGUITY than in RISK?

The data show a clear influence of ambiguity on choice behavior. First, although there is substantial inertia in the First Stage of both conditions, there is *excess* inertia in the AMBIGUITY condition. This result, which is in line with the findings from Sautua (2016), is predicted by Knightian Decision Theory (Bewley 2002). Second, the propensity to diversify in the Second Stage is higher under ambiguity than under risk. Moreover, *excess* diversification from the AMBIGUITY condition is driven by participants whose choices displayed inertia in the First Stage. Thus, the data reveal an interesting relationship between ambiguity, inertia, and the propensity to diversify. Yet, as I show below, neither of the major theories of choice under ambiguity (including Knightian Decision Theory and models of ambiguity aversion) predicts this relationship. Last, the proportion of participants who continue to diversify in the Third Stage after the arrival of new information is substantially larger in AMBIGUITY than in RISK. Put differently, participants' choice to diversify displays significantly more inertia under ambiguity than under risk.

One potential application of the results is to defined contribution pension plans. Participants from these plans allocate their retirement contributions among assets whose returns are, for the most part, ambiguous. In particular, the behavior of participants from TIAA-CREF—the pension plan from the Teachers Insurance and Annuity Association—during the 1980s nicely illustrates the relevance of the experimental results. For many years, this defined contribution pension plan—the largest in the world—offered two funds: TIAA (a portfolio of bonds, commercial loans, mortgages, and real estate) and CREF (a broadly diversified common stock fund). Besides determining the amount of her annual contribution, a participant's main decision was to allocate her premium between the two funds. Each year, she could change her allocation at no cost. Samuelson and Zeckhauser (1988, pp. 31-33) show that participants' allocation choices displayed two salient features. First, almost half of all participants originally split their contributions equally between TIAA and CREF. Second, the changes in premium allocations year by year were insignificant.[4] Thus, the 50-50 allocation between TIAA and CREF was the most common choice and was highly persistent. The experimental finding that ambiguity increases the prevalence and persistence of diversification relative to risk may help to understand, at least in part, such behavioral pattern. I return to this point in the concluding section.

2 Experimental Design

2.1 General Aspects of the Design

The experiment took place between late February and early March 2015 on the campus of the University of California, Los Angeles. Participants were drawn from the Anderson Behavioral Lab's subject pool.[5] Importantly, none of the participants had taken part in the related experiment I report in Sautua (2016). The experiment features a between-subjects design with two conditions: RISK (51 participants) and AMBIGUITY (49 participants). I carried out each condition through four sessions, with between 9 and 16 participants per session.

I conducted the experiment with paper-and-pencil. In each session, upon arrival at the room, participants were seated at individual desks; 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. Throughout the session participants made a few incentivized choices; at the end, one of these choices was selected to be played out

[4] See, for instance, Table 12 on page 32 from Samuelson and Zeckhauser's article. Thaler and Sunstein (2009, p. 34) point out that more than half of the participants made exactly no changes to their asset allocations over the course of their careers.

[5] All participants but one were UCLA students. The remaining participant was a UCLA staff member.

using the random-lottery method. All payments from a given session (including a $8 show-up fee) were made by the lab manager through a deposit to participants' university accounts in the next few weeks.[6] The sessions lasted around 45 minutes; I ran them with the help of two assistants, whom I introduced as I read the first portion of instructions.[7]

In Table *I* I summarize some demographic characteristics of the pool of participants.[8] For each experimental condition, the table shows the percentage of participants who previously participated in other experiments (at any lab on campus and at the Anderson Behavioral Lab in particular), are women, are Asian, are undergraduate students, pursue an academic major that is Math-intensive or is intensive in formal logic, and are native English speakers.[9] For each of these observable characteristics, the last column of the table displays the result of a chi-square test of differences in proportions across conditions. Participants are clearly balanced on observable characteristics. Next, I describe each condition. Appendix D contains full instructions and a sample of the forms that participants filled out.

[Table *I* about here]

[6] 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 Table *I*), they had already verified that the lab manager delivers payments as promised. (Also, Table *I* shows that the proportion of participants who previously participated in other experiments conducted at the Anderson Behavioral Lab is not statistically different across conditions.)

[7] The protocol could have been carried out with only one assistant per session, but 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 D.) Therefore, in what follows I describe the protocol as if I had used a single assistant.

[8] Participants reported this information on one of the forms that they filled out.

[9] For a classification of academic majors, see Appendix A.

2.2 The RISK Condition

At the beginning of the session, participants picked five different numbers between 0 (inclusive) and 9 (inclusive) and wrote them down on a blank card. Then they picked a die—Die 1 or Die 2—and wrote it down on another blank card. Participants placed each card into an empty envelope (one was labeled 'Numbers' and the other 'Die'); the envelopes remained closed on their desks until the end of the session. Once participants had made their choices, I told them that they would use the cards to play an individual lottery.

In the room next door, the assistant would hold two identical ten-sided dice with numbers 0 through 9.[10] She would label one of the dice Die 1 and the other Die 2. At the end of the session, each participant would go to the room next door, where the assistant would roll the die the participant had picked and written on the card. If any of the five numbers the participant had picked came up, she would get $10; if any of the remaining five numbers came up, she would get nothing. After participants had completed two forms that were unrelated to the lottery, I reminded them about the instructions with regard to the lottery.[11] Then, participants received Decision Form #1, through which I gave them the option to switch dice. Switching dice was rewarded with a $0.10 bonus—if they switched, participants would receive $0.10 in addition to what they got from the lottery. Participants indicated whether they wanted to keep the original die or switch to the alternative die by checking the corresponding option. This was the First Stage of the session.

Next, I informed participants that they could either play this lottery (using the chosen die) or play another lottery. If they played the other lottery, the assistant would roll *both* dice. The roll of a given die would pay $5 if successful (i.e., if any of the five numbers on the participant's card came up) and nothing otherwise. Thus, the lottery would pay $10 if both rolls were successful, $5 if only one roll were successful, and nothing if neither of the rolls were successful. I emphasized that the lottery in which both dice were rolled would not pay the $0.10 bonus; a participant would

[10] I allowed participants to examine a sample die as I described the lottery.

[11] On one of the forms participants provided demographic information, and on the other they answered the first part of the 'Big Five' personality questionnaire (John, Donahue, and Kentle 1991). The personality questionnaire served two purposes. First, it allowed time for participants to adapt to a reference point other than their initial wealth, in case preferences are reference-dependent. (See the discussion in Section 3.) Second, the questionnaire also served as a decoy for the decisions in which I was interested. This was intended to attenuate experimental effects.

receive the bonus only if she had previously switched to the alternative die and now decided to use this die alone. On Decision Form #2, participants indicated which lottery they wanted to play by checking the corresponding option. This was the Second Stage of the session.

Finally, I told participants that they would make a similar decision as that from the Second Stage for different probabilities of success of a roll of Die 1 or Die 2. There were four different scenarios for such probabilities: Die 1 30%-Die 2 70%; Die 1 40%-Die 2 60%; Die 1 60%-Die 2 40%; and Die 1 70%-Die 2 30%.[12] For each scenario, participants had to choose whether to use Die 1, Die 2, or both. As before, using the alternative die alone (i.e., the die that a participant had not written on the card originally) would pay a $0.10 bonus. I told participants that we would randomly pick one of the scenarios (including the one from the Second Stage) after they had made their choices and implement their choice for the selected scenario. On Decision Form #3, participants indicated their choice for each scenario. This was the Third (and final) Stage of the session.

2.3 The AMBIGUITY Condition

At the beginning of the session, participants picked a color—red or blue—and wrote it down on a blank card. Then they picked a bag—Bag 1 or Bag 2—and wrote it down on another blank card. Participants placed each card into an empty envelope (one was labeled 'Color' and the other 'Bag'); the envelopes remained closed on their desks until the end of the session. Once participants had made their choices, I told them that they would use the cards to play an individual lottery.

There were two empty black bags sitting on the front desk, labeled Bag 1 and Bag 2. I informed participants that the assistant would take the bags to the room next door and fill each bag with red and blue balls—each bag would have 10 balls in total. At the end of the session, each participant would go to this room, where the assistant would draw a ball from the bag the participant had picked and written on

[12] I did not frame the task in terms of probabilities. Rather, I asked participants to write down four sets of numbers on the back side of the card from the envelope labeled 'Numbers.' By adding to or subtracting from the five numbers they had picked originally, they came up with one set of three numbers, one of four, one of six, and another of seven. We used these sets of numbers to put the four scenarios into practice. For example, in one scenario a roll of Die 1 would be successful if any of the three final numbers came up, while a roll of Die 2 would be successful if any of the seven final numbers came up. This corresponded to the 'Die 1 30%-Die 2 70%' scenario.

the card. (I told participants that the balls would be drawn with replacement.) If the color of a participant's ticket matched the color of the ball drawn by the assistant, the participant would get $10; otherwise, she would get nothing. To determine the composition of each bag, the assistant drew two numbers between 0 and 10 from a cup in front of participants; she drew the numbers with replacement.[13] Importantly, she was the only person in the lab that knew these two numbers. The first number determined the number of red balls in Bag 1; the second number determined the number of red balls in Bag 2.[14]

After participants had completed the same two forms that I used in the RISK condition, they received Decision Form #1. Through this form I informed participants that they had the option to switch bags. Switching bags was rewarded with a $0.10 bonus. Participants indicated whether they wanted to keep the original bag or switch to the alternative bag by checking the corresponding option. This was the First Stage of the session.

Next, I informed participants that they could either play this lottery (using the chosen bag) or play another lottery. If they played the other lottery, the assistant would draw a ball from *each* bag. A given draw would pay $5 if successful (i.e., if the color of a participant's ticket matched the color of the ball) and nothing otherwise. Thus, the lottery would pay $10 if both draws were successful, $5 if only one draw were successful, and nothing if neither of the draws were successful. I emphasized that the lottery in which a ball was drawn from each bag would not pay the $0.10 bonus; a participant would receive the bonus if she had previously switched to the alternative bag and now decided to use this bag alone. On Decision Form #2, participants indicated which lottery they wanted to play by checking the corresponding option. This was the Second Stage of the session.

Finally, I gave participants the opportunity to change their choice of lottery after observing the outcomes of two practice draws. The assistant would draw one ball from each bag in front of the participant and then put the ball back into the bag. For each of the four possible scenarios (red ball from each bag, blue ball from each bag, red ball from Bag 1 and blue ball from Bag 2, and vice versa), participants had to choose whether to use Bag 1, Bag 2, or both. As before, using the alternative

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

[14] I told participants that the assistant would never reveal the compositions of the bags, not even after resolving the lottery.

bag alone (i.e., the bag that a participant had not written on the card originally) would pay a $0.10 bonus. On Decision Form #3, participants made a choice for each possible scenario before the assistant performed the practice draws. After the practice draws, the assistant implemented a participant's choice for the actual scenario. This was the Third (and final) Stage of the session.

3 Predictions

In this section I discuss the predictions of all major theories of choice under uncertainty for choice behavior in each condition. I focus on the predictions that concern *diversification* in the Second and Third Stages—*when* a participant is expected to choose the lottery in which both dice or bags are used.[15] In Table *II* I summarize the predictions for the First and Second Stages of each condition; Panel A corresponds to RISK, whereas Panel B corresponds to AMBIGUITY.

[Table *II* about here]

3.1 RISK Condition

In the First Stage of RISK, the decision-maker (henceforth DM) chooses between the Original Lottery—which is resolved by rolling the original die—and the Alternative Lottery—which is resolved by rolling the alternative die. Each lottery is a 50-50 gamble over $x > 0$ dollars and 0 dollars. The Alternative Lottery, however, pays a 1% bonus (i.e., it pays an additional $0.01x$ regardless of the outcome of the lottery). Almost all major theories of choice under uncertainty predict that the DM will switch to the Alternative Lottery. By contrast, an extended version of Reference-Dependent Subjective Expected Utility (Sugden 2003) predicts that the DM will *not* switch, even though switching comes with a bonus.[16]

[15] For a detailed discussion of *inertia*—and its underlying mechanisms—in the First Stage, I refer the reader to Sautua (2016).

[16] I derive this prediction in Appendix B. Inertia follows from an aversion to a potential loss that might result from switching. The DM anticipates that she will *regret* a switch that results in a bad outcome, because she might have done better had she not switched. Hence, the DM sticks with the Original Lottery to avoid experiencing regret. Factors other than anticipated regret might also induce inertia in the First Stage. For a discussion of these factors, see Sautua (2016, Section 3.2.2., 'Other Factors').

HYPOTHESIS R1: *The choices made by some participants from the RISK condition in the First Stage display inertia.*

In the Second Stage, the DM must decide whether to play the lottery she chose in the First Stage or switch to the Diversified Lottery—which is resolved by rolling both dice. The Diversified Lottery pays x with probability 0.25, $0.5x$ with probability 0.5, and 0 with probability 0.25. In Appendix B I show that most theories, including Reference-Dependent Subjective Expected Utility, predict that the DM will stick with the lottery chosen in the First Stage.

HYPOTHESIS R2: *Participants from RISK who did not switch lotteries in the First Stage also stick with the Original Lottery in the Second Stage.*

By contrast, two theories predict that the DM is likely to diversify in the Second Stage. These are Disappointment Theory (Bell 1985; Loomes and Sugden 1986) and Krähmer and Stone's (2013) theory. Consider how the DM evaluates outcomes according to these two theories. A prize y added to initial wealth w yields a *consumption utility* of $m(w+y)$. The function $m(.)$ is continuous and strictly increasing, and $m(0) = 0$. An outcome, however, is not evaluated in isolation—that is, it does not yield *only* consumption utility. The overall utility of an outcome is affected by a comparison to a *reference level*—preferences are reference-dependent. An outcome that is greater than its reference level is encoded by the DM as a *gain*, whereas an outcome that is smaller than its reference level is encoded as a *loss*. Let $u(w+y|w+r)$ be the overall utility of $w + y$ dollars given a reference level of $w + r$ dollars:

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

The function $\mu(.)$ captures the *gain-loss utility* of $w + y$ dollars relative to the referent, $w + r$ dollars. The outcome $w + y$ is encoded as a gain relative to $w + r$ if $y > r$, and it is encoded as a loss if $y < r$. Following Section II of 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.

A lottery L is evaluated according to its expected utility:

$$U(L) = \int u(w + y|w + r) \; dL(y). \quad (1)$$

Because in the experiment prizes are small stakes relative to the DM's initial wealth w, the function $m(.)$ can be taken as approximately linear (Rabin 2000; Kőszegi and Rabin 2006, 2007). Thus, in what follows I assume that $m(w + y) = w + y$. Importantly, the linearity of $m(.)$ for small stakes does not imply risk neutrality when preferences are reference-dependent. The assumption just implies that small-scale risk aversion cannot be attributed to decreasing marginal utility of wealth; rather, it is driven by loss aversion (Rabin 2000).

While both Disappointment Theory and Krähmer and Stone's theory assume that preferences are reference-dependent, they differ with regard to the reference point. Let us first examine the DM's behavior according to Disappointment Theory. The reference level relative to which the DM evaluates an outcome of a lottery is the certainty equivalent of the lottery, based on its consumption utility.[17] When the outcome exceeds the certainty equivalent, the DM experiences elation; when instead the outcome falls short of the certainty equivalent, the DM experiences *disappointment*.

In the First Stage, the utilities of the Original and Alternative Lotteries are

$$\begin{aligned} U_{DT}(Original) &= w + 0.5x + [0.5 \; \mu(x - 0.5x) + 0.5 \; \mu(0 - 0.5x)] \quad (2) \\ U_{DT}(Alternative) &= w + 0.51x + [0.5 \; \mu(1.01x - 0.51x) + 0.5 \; \mu(0.01x - 0.51x)] \, . \end{aligned}$$

Loss aversion implies *disappointment aversion*: disappointment resulting from a loss is felt more severely than elation following an equal-sized gain. Disappointment aversion, however, does not affect the DM's choice in the First Stage. We can see from (2) that the Alternative Lottery strictly dominates the Original one regardless of the DM's degree of loss aversion—both lotteries feature the same potential for disappointment and elation but the Alternative one yields higher consumption utility. Hence, the DM switches lotteries in the First Stage.

[17] Notice that the assumption that $m(w + y) = w + y$ implies that the certainty equivalent of a lottery is equal to its expected payoff.

Then, in the Second Stage the DM chooses between the Alternative Lottery and the Diversified Lottery. The utility of the Diversified Lottery is

$$U_{DT}(Diversified) = w + 0.5x + \left[0.25\ \mu(x - 0.5x) + 0.5\ \mu(0.5x - 0.5x) + 0.25\ \mu(0 - 0.5x)\right]. \tag{3}$$

To predict choice behavior in the Second Stage, we need to make an assumption about the functional form of the gain-loss utility function μ. Following Section IV of Kőszegi and Rabin (2006), μ is piecewise-linear:

$$\mu(z) = \begin{cases} z & \text{if } z \geq 0 \\ \lambda z & \text{if } z < 0 \end{cases}, \tag{4}$$

where $\lambda > 1$ is the coefficient of loss aversion. Combining (2), (3), and (4), we conclude that a disappointment-averse DM prefers the Diversified Lottery if and only if $\lambda > 1.08$. To understand why a disappointment-averse DM is willing to diversify, notice that the Diversified Lottery is a 'mean-preserving shrink' of the Alternative Lottery. The Alternative Lottery yields a potential gain of $0.5x$ with probability 0.5 and an equal-sized potential loss also with probability 0.5. Gains and losses from the Diversified Lottery are of the same size as those from the Alternative Lottery, *but they are half as likely.* The most likely outcome in the Diversified Lottery is a prize of $0.5x$, which does not create gain-loss utility as it coincides with the reference level. A disappointment-averse DM finds the Diversified Lottery attractive because it features a substantially smaller probability of experiencing disappointment than the Alternative Lottery.

Now let us examine behavior according to Krähmer and Stone's theory. Imagine the DM facing a choice between two lotteries. To make a decision, she tries to anticipate how she would evaluate each outcome if it happened. Given an outcome, the reference level is the *posterior* expected payoff of the lottery that has the largest expected payoff given the DM's *ex-post* knowledge about the lotteries. It turns out that all lotteries from RISK have an *objective* expected payoff that is known ex-ante. In the First Stage, when the DM chooses between the Original and Alternative Lotteries, the Alternative Lottery has the largest expected payoff. Hence, in the First Stage the expected payoff of the Alternative Lottery is the reference level relative to which all possible outcomes are evaluated. The utilities of the lotteries from the First

Stage are

$$U_{KS}(Original) = w + 0.5x + [0.5\ \mu(x - 0.51x) + 0.5\ \mu(0 - 0.51x)] \quad (5)$$
$$U_{KS}(Alternative) = w + 0.51x + [0.5\ \mu(1.01x - 0.51x) + 0.5\ \mu(0.01x - 0.51x)] .$$

Since the Alternative Lottery strictly dominates the Original Lottery, the DM switches lotteries. Then, in the Second Stage the DM chooses between the Alternative Lottery and the Diversified Lottery. Because the expected payoff of the Alternative Lottery is larger than that of the Diversified Lottery, it is again the reference level for all outcomes. The utility of the Diversified Lottery is

$$U_{KS}(Diversified) = w + 0.5x + [0.25\ \mu(x - 0.51x) + 0.5\ \mu(0.5x - 0.51x) + 0.25\ \mu(0 - 0.51x)] . \quad (6)$$

To determine when a Krähmer-Stone DM chooses the Diversified Lottery, combine (5), (6), and (4). The DM diversifies in the Second Stage if and only if her coefficient of loss aversion λ exceeds 1.17. The rationale for diversification is similar to the one from Disappointment Theory. Compared to the Alternative Lottery, the Diversified Lottery may result in a slightly smaller gain from the best outcome or a slightly larger loss from the worst outcome. Yet, the gain from the best outcome and the loss from the worst outcome are *half as likely* in the Diversified Lottery as in the Alternative Lottery. The significant reduction in the likelihood of a loss from the worst outcome makes the Diversified Lottery appealing to a Krähmer-Stone DM.

HYPOTHESIS R3: *Some participants from RISK who switched lotteries in the First Stage choose the Diversified Lottery in the Second Stage.*

After making a choice in the Second Stage, the DM faces the Third (and final) Stage. In the Third Stage, the probability distributions associated with the Original, Alternative, and Diversified Lotteries change with respect to the ones from the Second Stage. Now, the Original Lottery pays x with known probability p, with $p \in \{0.3, 0.4, 0.6, 0.7\}$. The Alternative Lottery pays x with probability $1-p$ and offers a 1% bonus. The Diversified Lottery pays x with probability $p(1-p)$, $0.5x$ with probability $p^2 + (1-p)^2$, and 0 with probability $p(1-p)$. The DM must choose again among the three lotteries. Most theories predict that the DM will not diversify for any value of p. By contrast, Disappointment Theory and Krähmer and Stone's theory imply that the DM may continue to diversify in the Third Stage. Nevertheless, both theories predict that the DM is less likely to diversify in the Third Stage than in the Second Stage. In addition, the DM is less likely to diversify when $p = 0.3$ or $p = 0.7$ than when $p = 0.4$ or $p = 0.6$.[18]

HYPOTHESIS R4: *Participants from RISK are less likely to diversify in the Third Stage than in the Second Stage. In addition, participants are less likely to diversify in the '70-30' or '30-70' scenarios than in the '60-40' or '40-60' scenarios.*

I now turn to the predictions for the AMBIGUITY condition, focusing on how they compare to those for the RISK condition.

3.2 AMBIGUITY Condition

In the First Stage of AMBIGUITY, the DM chooses between the Original Lottery—which is resolved by drawing a ball from the original bag—and the Alternative Lottery—which is resolved by drawing a ball from the alternative bag. The Original Lottery pays x with probability Q_o and 0 with probability $1 - Q_o$. The Alternative Lottery pays x with probability Q_a and 0 with probability $1 - Q_a$; in addition, it pays a 1% bonus. The actual winning probabilities Q_o and Q_a are *unknown* to the DM. All the DM knows is that Q_o and Q_a are independent and uniformly distributed in $[0, 1]$. Almost all major theories of choice under uncertainty predict that the DM will switch to the Alternative Lottery. By contrast, Knightian Decision Theory (Bewley 2002) and an extended version of Reference-Dependent Subjective Expected Utility predict that the DM will *not* switch, even though switching comes with a bonus. (See the discussion in Appendix B.) Recall that Reference-Dependent Subjective Expected Utility makes the same prediction for the RISK condition, but Knightian Decision Theory predicts a switch in RISK.[19]

HYPOTHESIS A1: *Choices in the First Stage of AMBIGUITY display excess inertia compared to RISK.*

[18] While a disappointment-averse DM may continue to diversify when $p = 0.3$ or $p = 0.7$, a Krähmer-Stone DM does not.

[19] According to Reference-Dependent Subjective Expected Utility, the mechanism that drives inertia is exactly the same as in the RISK condition—that is, the DM seeks to avoid the regret that may follow a switch. Knightian Decision Theory presents a different mechanism—inertia follows from the DM's *indecisiveness* between the two lotteries. Ambiguity about the winning probabilities of the lotteries is the key factor that triggers such indecisiveness.

In the Second Stage, the DM must decide whether to play the lottery she chose in the First Stage or switch to the Diversified Lottery—which is resolved by drawing a ball from each bag. The Diversified Lottery pays x with probability Q_oQ_a, $0.5x$ with probability $Q_o(1-Q_a)+(1-Q_o)Q_a$, and 0 with probability $(1-Q_o)(1-Q_a)$. In Appendix B I show that Knightian Decision Theory and Reference-Dependent Subjective Expected Utility predict that the DM will continue to stick with the Original Lottery.

HYPOTHESIS A2: *Like in RISK, participants from AMBIGUITY who did not switch lotteries in the First Stage also stick with the Original Lottery in the Second Stage.*

Most of the theories that predict a switch in the First Stage also predict that the DM will choose the Alternative Lottery again in the Second Stage.[20] In particular, the major models of ambiguity aversion share this prediction. Next, I show that the Maxmin Expected Utility Model (Gilboa and Schmeidler 1989), the Smooth Ambiguity Preferences Model (Klibanoff, Marinacci, and Mukerji 2005, 2012), and the Variational Preferences Model (Maccheroni, Marinacci, and Rustichini 2006) predict no diversification in the Second Stage.[21]

To write down the utilities of the Second-Stage lotteries, I follow Machina's (2014) approach of expressing the choice among ambiguous gambles as a choice among *mixed risky/ambiguous gambles*.[22] These are ambiguous gambles whose outcomes consist of risky gambles (see Anscombe and Aumann [1963]). Winning probabilities (Q_o, Q_a) could take on values $(q_o, q_a) \in [0,1] \times [0,1]$; each value (q_o, q_a) defines an event. The Alternative Lottery yields the outcome $(x,\ q_a;\ 0,\ 1-q_a)$ on event (q_o, q_a). The Diversified Lottery yields the outcome $(x,\ q_oq_a;\ 0.5x,\ q_o(1-q_a)+(1-q_o)q_a;\ 0,\ (1-q_o)(1-q_a))$ on event (q_o, q_a). Let Π denote the family of all subjective probability distributions (priors) over events.

First, consider the Maxmin Expected Utility Model. The utilities of the lotteries

[20]In Appendix B I show that Subjective Expected Utility (Savage 1954), Kőszegi and Rabin's (2007) model of Reference-Dependent Subjective Expected Utility, Prospect Theory (Kahneman and Tversky 1979), and Regret Theory (Bell 1982; Loomes and Sugden 1982) make this prediction.

[21]In contrast to these three models, the Rank Dependent (or Choquet) Model (Schmeidler 1989) does not make a clear prediction. Yet, the DM will make the same choice in AMBIGUITY as in RISK. This follows from the fact that the DM *knows* that $Q_o, Q_a \sim U[0,1]$ and hence entertains a subjective probability distribution that coincides with its objective counterpart from RISK.

[22]Machina uses the term mixed objective/subjective bets.

from the Second Stage are

$$\begin{aligned} U_{MEU}(Alternative) &= Min_{\ \pi\in\Pi} \int_0^1 \int_0^1 [w + 0.01x + q_a x]\ \pi(q_o, q_a)\ dq_o dq_a \\ U_{MEU}(Diversified) &= Min_{\ \pi\in\Pi} \int_0^1 \int_0^1 [w + 0.5(q_o + q_a)x]\ \pi(q_o, q_a)\ dq_o dq_a. \end{aligned}$$

The DM evaluates each lottery in the most pessimistic way, given the set of priors Π. Notice that because the DM knows that $Q_o, Q_a \sim U[0,1]$, it follows that she has the unique prior $\pi(q_o, q_a) \equiv 1$. This implies that $U_{MEU}(Alternative) = w + 0.01x + 0.5x$ and $U_{MEU}(Diversified) = w + 0.5x$. Thus, the DM chooses the Alternative Lottery again in the Second Stage.[23]

Now consider the Smooth Ambiguity Preferences Model. The utilities of the Second-Stage lotteries are

$$\begin{aligned} U_{SP}(Alternative) &= \int_{\pi\in\Pi} \phi\left(\int_0^1 \int_0^1 [w + 0.01x + q_a x]\ \pi(q_o, q_a)\ dq_o dq_a\right)\ d\mu(\pi(.)) \\ U_{SP}(Diversified) &= \int_{\pi\in\Pi} \phi\left(\int_0^1 \int_0^1 [w + 0.5(q_o + q_a)x]\ \pi(q_o, q_a)\ dq_o dq_a\right)\ d\mu(\pi(.)), \end{aligned}$$

for some increasing function $\phi(.)$, the family Π of all priors $\pi(.)$ over events, and subjective probability distribution $\mu(.)$ over Π. For any given lottery, each prior $\pi \in \Pi$ is associated with an expected utility; the DM may be averse to the uncertainty in these expected utility levels that results from her subjective uncertainty about (Q_o, Q_a) as represented by $\mu(.)$. Ambiguity aversion is captured by concavity of $\phi(.)$.

[23] Ghirardato et al. (2004) introduce a generalization of the Maxmin Model called the *α-Maxmin Model*. Given some $\alpha \in [0,1]$, the utilities of the Second-Stage lotteries are

$$\begin{aligned} U_{\alpha MEU}(Alternative) &= \alpha Min_{\ \pi\in\Pi} \int_0^1 \int_0^1 [w + 0.01x + q_a x]\ \pi(q_o, q_a)\ dq_o dq_a \\ &\quad +(1-\alpha) Max_{\ \pi\in\Pi} \int_0^1 \int_0^1 [w + 0.01x + q_a x]\ \pi(q_o, q_a)\ dq_o dq_a \\ U_{\alpha MEU}(Diversified) &= \alpha Min_{\ \pi\in\Pi} \int_0^1 \int_0^1 [w + 0.5(q_o + q_a)x]\ \pi(q_o, q_a)\ dq_o dq_a \\ &\quad +(1-\alpha) Max_{\ \pi\in\Pi} \int_0^1 \int_0^1 [w + 0.5(q_o + q_a)x]\ \pi(q_o, q_a)\ dq_o dq_a. \end{aligned}$$

Notice that the Maxmin Model corresponds to $\alpha = 1$. The α-Maxmin Model also implies a strict preference for the Alternative Lottery over the Diversified Lottery.

In the current setting, however, the DM has the single prior $\pi(q_o, q_a) \equiv 1$; hence, there is no uncertainty in expected utility levels. The utilities of the lotteries reduce to $U_{SP}(Alternative) = \phi(w + 0.01x + 0.5x)$ and $U_{SP}(Diversified) = \phi(w + 0.5x)$. Since $\phi(.)$ is increasing, the DM strictly prefers the Alternative Lottery over the Diversified Lottery.

Last, consider the Variational Preferences Model. The utilities of the Second-Stage lotteries are

$$\begin{aligned} U_{VP}(Alternative) &= Min_{\ \pi\in\Pi} \left(\int_0^1 \int_0^1 [w + 0.01x + q_a\ x]\ \pi(q_o, q_a)\ dq_o dq_a + \eta(\pi(.)) \right) \\ U_{VP}(Diversified) &= Min_{\ \pi\in\Pi} \left(\int_0^1 \int_0^1 [w + 0.5(q_o + q_a)x]\ \pi(q_o, q_a)\ dq_o dq_a + \eta(\pi(.)) \right), \end{aligned}$$

for the family Π of all priors $\pi(.)$ over events and nonnegative convex function $\eta(.)$ over Π. Appealing once again to the fact that the DM has the single prior $\pi(q_o, q_a) \equiv 1$, we obtain that $U_{VP}(Alternative) = w + 0.01x + 0.5x + \eta(\pi(.))$ and $U_{VP}(Diversified) = w + 0.5x + \eta(\pi(.))$. It follows that the DM strictly prefers the Alternative Lottery over the Diversified Lottery.

While most theories predict no diversification in the Second Stage, Disappointment Theory and Krähmer and Stone's theory predict that the DM is likely to diversify. Consider Disappointment Theory first. A disappointment-averse DM is bayesian and hence ambiguity-neutral; she proceeds *as if* $Q_o = Q_a = 0.5$. This has two implications. First, in the Second Stage (as well as in the First Stage) all subjective probability distributions over prizes coincide with their objective counterparts from the RISK condition. Second, reference levels are the same as in RISK, since the ex-ante certainty equivalent of an ambiguous lottery is the same as that from its risky counterpart. It follows from these two implications that in the Second Stage a disappointment-averse DM makes the *same* choice in AMBIGUITY as in RISK—that is, she chooses the Diversified Lottery provided that $\lambda > 1.08$.

Krähmer and Stone's theory also concerns a bayesian DM. Again, this implies that in the first two stages all subjective probability distributions over prizes coincide with their objective counterparts from the RISK condition. Reference levels, however, are not the same as in RISK. To see this, recall that the DM compares an outcome to the *posterior* expected payoff of the lottery that has the largest expected payoff given the DM's *ex-post* knowledge about the lotteries. While the prior knowledge about the lotteries is the same as the ex-post knowledge in the RISK condition, this is not the case in the AMBIGUITY condition. When a Krähmer-Stone DM chooses between two ambiguous lotteries, she expects the outcome of the chosen lottery to reveal information about this lottery's actual probability distribution over prizes.[24] This affects the DM's reference point.

Consider, for instance, how a Krähmer-Stone DM evaluates a choice in the First Stage. If the DM wins the prize, she will infer that the chosen lottery was the best choice and will update her belief about its winning probability from 0.5 to 0.625.[25] In this case, she will compare x to the posterior expected payoff of the *chosen* lottery. On the other hand, if the DM fails to win, she will infer that the rejected lottery—whose winning probability still is 0.5—would have been the best choice.[26] Now, the DM will compare the zero payoff to the posterior expected payoff of the *rejected* lottery.[27] Thus, the utilities of the lotteries from the First Stage are

$$\begin{aligned} U_{KS}(Original|First\ Stage) &= w + 0.5x + [0.5\ \mu(x - 0.625x) + 0.5\ \mu(0 - 0.51x)] \\ U_{KS}(Alternative|First\ Stage) &= w + 0.51x \\ &\quad +[0.5\ \mu(1.01x - 0.625x - 0.01x) \\ &\quad +0.5\ \mu(0.01x - 0.5x)]. \end{aligned} \tag{7}$$

Because the Alternative Lottery strictly dominates the Original Lottery, the DM switches lotteries. Then, in the Second Stage the DM chooses between the Alternative

[24] Notice that in the First Stage the outcome of the chosen lottery does not reveal anything about the probability distribution of the *rejected* lottery, since the distributions are independent.

[25] Let $P(win|good\ outcome)$ denote the posterior winning probability of the chosen lottery after a good outcome. To compute this probability, first write $P(win|good\ outcome) = P(win|good\ outcome, q \geq 0.5)\ P(q \geq 0.5|good\ outcome) + P(win|good\ outcome, q < 0.5)\ P(q < 0.5|good\ outcome)$; here, $q \geq 0.5$ denotes the event in which the *actual* winning probability of the chosen lottery is at least 0.5. Next, notice that $P(win|good\ outcome, q \geq 0.5) = P(win|q \geq 0.5) = 0.75$ and $P(win|good\ outcome, q < 0.5) = P(win|q < 0.5) = 0.25$. (This follows from the fact that $q \sim U[0, 1]$.) Then, use Bayes' rule to obtain $P(q \geq 0.5|good\ outcome) = 0.75$; this, in turn, implies that $P(q < 0.5|good\ outcome) = 0.25$. Last, replace the probabilities on the right-hand side of the above expression for $P(win|good\ outcome)$ to obtain $P(win|good\ outcome) = 0.625$.

[26] In this case, the DM updates the subjective winning probability of the chosen lottery from 0.5 to 0.375.

[27] Notice that, strictly speaking, we need to slightly modify expression (1)—which describes how the DM evaluates a lottery—to fully capture the assessment of the chosen lottery made by a Krähmer-Stone DM. In expression (1), all the outcomes of the lottery L are compared to the *same* reference level r. While this is true for the RISK condition, it does not hold for the AMBIGUITY condition. When the lotteries are ambiguous, the reference level may vary with the outcome, since different outcomes convey different information about the largest posterior expected payoff.

Lottery and the Diversified Lottery. How would she assess the choice of the Alternative Lottery in the Second Stage? After a win, she would infer that she made the right choice. Hence, she would compare the payoff ($1.01x$) to the posterior expected payoff of the Alternative Lottery ($0.625x + 0.01x$). On the other hand, after a failure to win the DM would infer that the Diversified Lottery would have been the best choice. In this case, she would compare the payoff ($0.01x$) to the posterior expected payoff of the Diversified Lottery ($0.4375x$). Thus, the utility of the Alternative Lottery in the Second Stage is

$$\begin{aligned} U_{KS}(Alternative|Second\ Stage) &= w + 0.51x \\ &+[0.5\ \mu(1.01x - 0.625x - 0.01x) \\ &+0.5\ \mu(0.01x - 0.4375x)]. \end{aligned} \tag{8}$$

How would the DM assess the choice of the Diversified Lottery? If both draws had the same outcome, the DM would infer that the Alternative Lottery would have been the best choice. (Its posterior expected payoff would be $0.01x + 0.625x$ after two good draws and $0.01x + 0.375x$ after two bad draws.) If only the draw from the original bag were good, the DM would infer that diversifying was indeed better than playing the Alternative Lottery. (The expected payoff of the Diversified Lottery would continue to be $0.5x$.) Conversely, if only the draw from the alternative bag were good, the DM would infer that the Alternative Lottery would have been the best choice. (Its posterior expected payoff would be $0.01x + 0.625x$.) Thus, the utility of the Diversified Lottery is

$$\begin{aligned} U_{KS}(Diversified) &= w + 0.5x \\ &+[0.25\ \mu(x - 0.01x - 0.625x) + 0.25\ \mu(0.5x - 0.5x) \\ &+0.25\ \mu(0.5x - 0.01x - 0.625x) + 0.25\ \mu(0 - 0.01x - 0.375x)]. \end{aligned} \tag{9}$$

To determine when the DM diversifies, combine (8), (9), and (4). The DM chooses the Diversified Lottery if and only if $\lambda > 1.27$. Notice that a Krähmer-Stone DM is marginally *less* likely to diversify in the Second Stage of AMBIGUITY than in the Second Stage of RISK.[28]

[28] This prediction remains the same if we assume that the DM updates the subjective probability of a good draw from 0.5 to 0.6 (rather than 0.625) after a good draw and to 0.4 (rather than 0.375)

HYPOTHESIS A3: *Like in RISK, some participants from AMBIGUITY who switched lotteries in the First Stage choose the Diversified Lottery in the Second Stage. Yet, the probability that a participant switches lotteries in the First Stage and diversifies in the Second Stage is slightly lower in AMBIGUITY than in RISK.*

After the DM makes a choice in the Second Stage, she faces the Third (and final) Stage. In the Third Stage, the DM observes one draw from the original bag and another from the alternative bag before the lottery she chose in the Second Stage is resolved. She has the opportunity to change her choice after observing the outcomes of these practice draws. So once again, the DM chooses between the Original Lottery, the Alternative Lottery, and the Diversified Lottery. As before, the Alternative Lottery pays a 1% bonus. While most theories predict that the DM will not choose the Diversified Lottery after the practice draws, Disappointment Theory and Krähmer and Stone's theory imply that the DM may continue to diversify.

The practice draws result in one of four scenarios: (i) a good draw from each bag ('good draw-good draw'); (ii) a bad draw from each bag ('bad draw-bad draw'); (iii) a good draw from the original bag and a bad draw from the alternative bag ('good draw-bad draw'); (iv) a bad draw from the original bag and a good draw from the alternative bag ('bad draw-good draw'). Given a scenario, a disappointment-averse DM and a Krähmer-Stone DM update their beliefs about the probability of a good draw using Bayes' Rule.[29] Although the DM may continue to diversify in the Third Stage, she is less likely to diversify than in the Second Stage.[30] Moreover, she is less likely to diversify when the practice draws yield different outcomes than when they yield the same outcome.[31]

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after a bad draw. In this case, the DM chooses the Diversified Lottery if and only if $\lambda > 1.25$.

[29] In practice people may process the information conveyed by the practice draws in a different way. For instance, they may use a heuristic that involves some form of *reinforcement*, where one is more likely to choose options associated with good past outcomes than options associated with bad past outcomes. The reinforcement heuristic is a 'win stay-lose shift' heuristic (Charness and Levin 2005). Because bayesian updating and the reinforcement heuristic are aligned in the present setting, I cannot distinguish between them. Charness and Levin (2005) use a clever experimental design to examine what happens when the two approaches prescribe different courses of action.

[30] Strictly speaking, a Krähmer-Stone DM is less likely to diversify in all scenarios from the Third Stage except for the 'bad draw-bad draw' scenario—in which she is marginally more likely to diversify. Yet, the difference in the likelihood of diversification between the 'bad draw-bad draw' scenario and the Second Stage is negligible. (The DM diversifies in the 'bad draw-bad draw' scenario if and only if $\lambda > 1.23$, whereas she diversifies in the Second Stage if and only if $\lambda > 1.27$.)

[31] The DM may diversify when both draws have the same outcome; if she does not, then she chooses the Alternative Lottery. While a disappointment-averse DM may also choose the Diversified

HYPOTHESIS A4: *Participants from AMBIGUITY are less likely to diversify in the Third Stage than in the Second Stage. In addition, participants are less likely to diversify when the practice draws yield different outcomes than when they yield the same outcome.*

I next turn to the empirical results from the experiment.

4 Results

In Table *III* I summarize participants' choice behavior in the First and Second Stages of each condition; Panel A corresponds to RISK, while Panel B corresponds to AMBIGUITY.

[Table *III* about here]

I begin with an analysis of the extent of inertia in the First Stage. Based on the theoretical analysis from Section 3, we expect inertia in both conditions—but more inertia in AMBIGUITY than in RISK (Hypotheses R1 and A1). The first result supports these predictions.

RESULT 1: *In the First Stage of both conditions, a substantial proportion of participants made choices that displayed inertia. Yet, there was excess inertia in AMBIGUITY relative to RISK.*

Forty-seven percent of participants from the RISK condition kept the Original Lottery in the First Stage, while 61 percent of participants from the AMBIGUITY condition did so. A one-tailed test of differences in proportions rejects the null hypothesis that the percentage from AMBIGUITY is smaller than or equal to the one from RISK in favor of the alternate hypothesis that the percentage from AMBIGUITY is larger ($p = 0.078$). As I pointed out in Section 3.2, excess inertia from AMBIGUITY is predicted by Knightian Decision Theory. This theory implies that the DM is indecisive between the Original and Alternative Lotteries from the AMBIGUITY condition because the winning chances are ambiguous, and indecisiveness induces inertia. Importantly, ambiguity-driven excess inertia appears to be a consistent finding:

Lottery when the draws yield different outcomes, a Krähmer-Stone DM does not. See Appendix C for a detailed derivation.

the magnitude of excess inertia from this experiment (14 percentage points) is almost the same as the one I found in Sautua (2016) (18 percentage points).

The following result further elaborates on how inertia compares between the two experiments.[32]

RESULT 2: *Letting participants pick the original die or bag increased inertia in the First Stage relative to a situation in which the original die or bag were randomly assigned to participants.*

Although excess inertia from the First Stage replicates that from the previous experiment, the *level* of inertia in either condition is higher than that from its counterpart in the previous experiment.[33] The proportion of participants from RISK who refused to switch lotteries is 16 percentage points higher than in the previous experiment (47 percent versus 31 percent). This difference is statistically significant ($p = 0.046$, one-tailed test of differences in proportions). Similarly, the proportion of participants from AMBIGUITY who did not switch lotteries is 12 percentage points higher than in the previous experiment (61 percent versus 49 percent). The difference is marginally significant ($p = 0.112$, one-tailed test of differences in proportions).

Why are the levels of inertia from this experiment higher than those from the previous experiment? The two experiments differ in how the status quo lottery was determined. In the present experiment participants picked the original die or bag, whereas in the previous experiment these were randomly assigned. Compared to random assignment, the act of choice appears to have strengthened the attachment to the Original Lottery, thus producing an 'agency effect' in the First Stage.[34] One

[32]Because in the previous experiment I focused exclusively on the analysis of inertia in choice under uncertainty, participants faced only the keep-or-switch decision from the First Stage.

[33]The counterpart from RISK in the previous experiment is the CONTROL condition. For a description of CONTROL, see Sautua (2016, Section 3.2.2). Similarly, the counterpart from AMBIGUITY in the previous experiment is the BCR condition. For a description of BCR, see Sautua (2016, Section 3.5). Appendix Tables A1 and A2 show that participants from both experiments are balanced on several demographic characteristics.

[34]Roca et al. (2006) also provided experimental evidence of an 'agency effect' with regard to gambles. In one condition of their Experiment 2, participants were given three ambiguous gambles by the experimenter and then had the opportunity to either keep each gamble or exchange it for a risky gamble. In another condition, participants were presented with the same three ambiguous gambles, asked to choose one of them, and then offered the option to exchange the chosen gamble for a risky one. (The risky gamble was the same as its counterpart from the first condition.) The authors found that participants were more likely to retain an ambiguous gamble if they had chosen it than if they had received it from the experimenter.

possible explanation for this 'agency effect' is that choosing the status quo reinforces the sense of endowment, and hence increases the anticipated *intensity* of the regret that might result from a switch. When a bad outcome occurs, the DM may feel more responsible for the 'mistake' of having switched if she chose the status quo herself than if the status quo was randomly assigned. The 'agency effect' is remarkable in this setting, because participants made the initial choice without even knowing that the original die or bag would be a ticket to play a lottery—the lottery was introduced once they had made the initial choice.[35],[36]

Next, I analyze the extent of diversification in the Second Stage. First, I consider those participants who switched lotteries in the First Stage. Based on the theoretical analysis from Section 3, we expect some of these participants to diversify in either condition (Hypotheses R3 and A3). The data are consistent with this prediction.

RESULT 3: *In both conditions, a large proportion of those participants who switched lotteries in the First Stage diversified in the Second Stage. In addition, the proportion of participants who switched lotteries in the First Stage and diversified in the Second Stage was not statistically different across conditions.*

Of the 27 participants who switched lotteries in the First Stage of RISK, 16 (59 percent) diversified in the Second Stage. Similarly, of the 19 participants who switched in the First Stage of AMBIGUITY, 14 (74 percent) chose the Diversified Lottery in the Second Stage. Thus, the probability of diversifying *conditional* on having switched in the First Stage is significantly different from zero in both conditions. Also, 31 percent of participants from RISK switched lotteries in the First Stage and then diversified, while 29 percent of participants from AMBIGUITY did so. I cannot reject the null hypothesis that the *joint* probability of switching in the First Stage and diversifying in the Second Stage is the same across conditions ($p = 0.76$, two-tailed

[35] Participants, however, might have *guessed* that they would use the original die or bag to play a lottery based on the information they received when they signed up for the experiment. When they signed up a few days earlier, participants learned that they would fill out some questionnaires and play an individual lottery during the session. Nevertheless, they certainly did not know anything about the characteristics of the lottery.

[36] Besides being different in how the status quo was determined, the RISK condition and its counterpart from the previous experiment have another subtle difference. In the previous experiment, participants rolled the chosen die themselves, while here the assistant rolled the die. If some people have an 'illusion of control' (Langer 1975), they may *feel* that rolling the die themselves increases their winning chances, and this feeling might mitigate inertia. Yet, in Sautua (2016) I showed that an illusion of control did not affect behavior within the previous experiment. Therefore, an illusion of control is unlikely to have contributed to the difference in the levels of inertia across experiments.

test of differences in proportions). Result 3 provides support to the premise that loss aversion may induce people to diversify.

Now I analyze Second-Stage diversification among those participants who did not switch lotteries in the First Stage. We expect no diversification among these participants in either condition (Hypotheses R2 and A2). The data, however, are inconsistent with this prediction.

RESULT 4: *In both conditions, a substantial proportion of those participants who did not switch lotteries in the First Stage chose to diversify in the Second Stage. The proportion of participants who refused to switch in the First Stage and diversified in the Second Stage was higher in AMBIGUITY than in RISK.*

Of the 24 participants who refused to switch lotteries in the First Stage of RISK, 13 (54 percent) chose the Diversified Lottery in the Second Stage. Similarly, of the 30 participants who did not switch lotteries in the First Stage of AMBIGUITY, 20 (67 percent) diversified in the Second Stage. Because the theories that predict that participants will keep the Original Lottery in the First Stage make the same prediction for the Second Stage, Result 4 is inconsistent with any major theory of choice under uncertainty. The data also reveal an interesting relationship between ambiguity, First-Stage inertia, and Second-Stage diversification. In particular, a participant was more likely to refuse to switch lotteries and then diversify in AMBIGUITY than in RISK. While almost 41 percent of participants from AMBIGUITY refused to switch in the First Stage and diversified in the Second Stage, 25.5 percent of participants from RISK displayed this behavior. The difference across conditions is statistically significant ($p = 0.052$, one-tailed test of differences in proportions).

Put together, Results 3 and 4 indicate that (i) there was *excess diversification* in the Second Stage of AMBIGUITY compared to RISK (69 percent versus 57 percent), and (ii) excess diversification was driven by participants whose choices displayed inertia in the First Stage. This pattern of behavior is not predicted by current theories of choice under ambiguity.

Now I turn to the analysis of behavior in the Third Stage. In Table *IV* I summarize observed choice behavior in all three stages of RISK, and in Table *V* I provide a similar summary of AMBIGUITY.

[Table *IV* about here]

[Table *V* about here]

The next two results document that the extent of diversification responds to changes in the objective probability distributions over prizes (Result 5) and the outcomes of the practice draws (Result 6). The results are in line with Hypotheses R4 and A4, which state that participants are less likely to diversify in the Third Stage than in the Second Stage.

RESULT 5: *In the RISK condition, the propensity to diversify dropped in the Third Stage, when the probability of a successful roll differed between dice.*

In both the '40-60' and '60-40' scenarios, the proportion of participants who chose the Diversified Lottery dropped by 14 percentage points relative to the Second Stage. The proportion of participants who diversified decreased even more in the '30-70' and '70-30' scenarios. In the '30-70' scenario, such proportion dropped by 29 percentage points relative to the Second Stage; and in the '70-30' scenario it dropped by 25 percentage points.[37] Thus, we see that the larger the gap in the probabilities of success across dice, the smaller the proportion of participants who diversified.[38] Nevertheless, a significant proportion of participants from RISK revealed a strong preference for diversification. Of the 51 participants, 10 (almost 20 percent) *always* chose the Diversified Lottery—that is, they diversified in all four scenarios from the Third Stage as well as in the Second Stage.[39]

[37] For each scenario, a one-tailed sign test rejects the null hypothesis that the probability of choosing the Diversified Lottery did not decrease compared to the Second Stage ($p = 0.025$ for the '40-60' and '60-40' scenarios; $p < 0.01$ for the '30-70' and '70-30' scenarios).

[38] The proportion of participants who chose the Diversified Lottery is significantly smaller in the '30-70' scenario than in the '40-60' scenario ($p < 0.01$, one-tailed sign test). Similarly, there is less diversification in the '70-30' scenario than in the '60-40' scenario ($p < 0.01$, one-tailed sign test).

In addition, in all four scenarios from the Third Stage, most participants chose the die that gave the largest probability of success. In the '60-40' and '70-30' scenarios, 53 percent and 67 percent, respectively, chose the Original Lottery; in the '40-60' and '30-70' scenarios, 51 percent and 67 percent, respectively, chose the Alternative Lottery. Overall, participant's behavior was fairly consistent across scenarios. Only 1 participant switched lotteries in the First Stage, diversified in the Second Stage, and went back to the Alternative Lottery when its winning probability was 0.4 (see Panel A from Table *IV*).

[39] Overall, the results from the Third Stage of RISK are in line with the experimental findings from Loomes (1991). In his experiment, there are three possible states of the world A, B, and C, where $pr(A) > pr(B) > pr(C)$. If state C occurs, the participant wins nothing. The participant can divide £20 between A and B, and she gets the amount assigned to a state if that state occurs. Only a few participants put all the money in A. Rather, most divided the £20 in proportion to $pr(A)/pr(B)$.

RESULT 6: *In the AMBIGUITY condition, the propensity to diversify dropped in the Third Stage when (i) the outcomes of the practice draws were different, or (ii) both practice draws were successful. By contrast, when both draws were unsuccessful, the proportion of participants who diversified remained the same as in the Second Stage.*

Participants' propensity to diversify dropped by almost the same magnitude in the 'good draw-bad draw' and 'bad draw-good draw' scenarios. In these scenarios, the proportion of participants who chose the Diversified Lottery dropped by 10-12 percentage points compared to the Second Stage.[40],[41] By contrast, participants' propensity to diversify after two identical draws varied depending on whether the draws were successful or unsuccessful. After two successful draws, diversification decreased by 8 percentage points.[42] On the other hand, diversification increased by 2 percentage points after two unsuccessful draws, although a sign test does not reject the null hypothesis of no change ($p = 0.38$, two-tailed test). Thus, participants were 10 percentage points less likely to diversify in the 'good draw-good draw' scenario than in the 'bad-draw-bad draw' scenario. At the same time, participants were 10 percentage points more likely to play the Alternative Lottery in the 'good draw-good draw' scenario than in the 'bad draw-bad draw' scenario.[43] Although diversification decreased in three out of four scenarios from the Third Stage, a substantial proportion of participants revealed a strong preference for the Diversified Lottery. Of the 49 participants from AMBIGUITY, 24 (49 percent) diversified in all four scenarios as well as in the Second Stage.

Next, I further investigate the sensitivity of Second-Stage choices to the changes introduced in the Third Stage. I consider all choices—not just the choice of the Diversified Lottery.

[40] For each scenario, a one-tailed sign test rejects the null hypothesis that the probability of choosing the Diversified Lottery did not decrease ($p < 0.01$ for the 'good draw-bad draw' scenario and $p = 0.02$ for the 'bad draw-good draw' scenario).

[41] Two participants displayed changes in behavior between the Second Stage and the 'good draw-bad draw' scenario that are inconsistent. These participants continued to choose the Original Lottery in the Second Stage, but then switched to the Alternative Lottery in the 'good draw-bad draw' scenario (see Panel A from Table *V*).

[42] A one-tailed sign test rejects the null hypothesis that the probability of choosing the Diversified Lottery did not decrease ($p < 0.01$).

[43] A one-tailed sign test rejects the null hypothesis that a participant was less likely to choose the Alternative Lottery in the 'good draw-good draw' scenario than in the 'bad draw-bad draw' scenario ($p < 0.01$).

RESULT 7: *In the Third Stage there was substantial excess inertia in AMBIGUITY compared to RISK. That is, participants were significantly more likely to repeat their Second-Stage choice in AMBIGUITY than in RISK.*

To what extent did participants repeat their Second-Stage choice in the Third Stage? To set a meaningful comparison of behavioral persistence across conditions, I restrict the analysis to two scenarios from RISK—'60-40' and '40-60'—and two scenarios from AMBIGUITY—'good draw-bad draw' and 'bad draw-good draw.' The '60-40' scenario is comparable to 'good draw-bad draw,' while '40-60' is comparable to 'bad draw-good draw.'[44] Within each condition, I identify participants who repeated their Second-Stage choice in *both* Third-Stage scenarios—that is, those participants whose choices consistently displayed *inertia* in the Third Stage. Figure I depicts the extent of inertia in the Third Stage, by condition.[45] Overall, 35 percent of participants from RISK made choices that consistently displayed inertia, whereas 76 percent from AMBIGUITY did so. The percentage from AMBIGUITY is significantly larger ($p < 0.01$, one-tailed test of differences in proportions).[46]

Interestingly, excess inertia from AMBIGUITY in the Third Stage was common to all choice options. If we divide participants into two groups based on their Second-Stage choices—those who diversified and those who did not, we see stronger behavioral persistence in AMBIGUITY within each group. Figure II displays the extent of inertia within each group, by condition. Of those who diversified in the Second Stage, 79 percent consistently repeated their choice in AMBIGUITY, while 48 percent did so in RISK. Similarly, of those who did not diversify in the Second Stage, 67 percent consistently repeated their choice in AMBIGUITY, whereas 18 percent did so in RISK. For both groups, the percentage from AMBIGUITY is significantly larger ($p < 0.01$, one-tailed test of differences in proportions).[47]

[44] As discussed in Section 3.2, a bayesian DM would update the subjective probability of success from a given bag to 0.625 after a good draw and 0.375 after a bad draw.

[45] Appendix Table A3 organizes the data I used to build Figures I, II, and III. (I describe Figures II and III below.) The table divides participants from each condition into those who consistently displayed inertia in the Third Stage and those who did not, for each combination of First- and Second-Stage choices.

[46] This test and the ones I mention below yield the same results if I drop the 3 participants (1 from RISK and 2 from AMBIGUITY) who made inconsistent choices in the Third Stage as defined in footnotes 38 and 41.

[47] In principle, I could test whether excess inertia from AMBIGUITY is different across groups. Consider the regression $Repeat_i = \alpha_0 + \alpha_1 * AMB_i + \alpha_2 * Div_i + \alpha_3 * AMB_i * Div_i + \epsilon_i$, where $Repeat_i$ equals 1 if participant i repeated her Second-Stage choice in both Third-Stage scenarios

If we further divide those who diversified in the Second Stage into two groups based on their First-Stage choices, we still find excess inertia in AMBIGUITY within each group. Figure III depicts the extent of inertia in the choice to diversify, by condition and First-Stage choice. Of those who switched in the First Stage and diversified in the Second Stage, 86 percent continued to diversify in AMBIGUITY, whereas 44 percent did so in RISK. The percentage from AMBIGUITY is significantly larger ($p < 0.01$, one-tailed test of differences in proportions). Similarly, of those who did not switch in the First Stage and diversified in the Second Stage, 75 percent continued to diversify in AMBIGUITY, while 54 percent did so in RISK. The percentage from AMBIGUITY is marginally larger ($p = 0.104$, one-tailed test of differences in proportions).

5 Conclusions

In a laboratory experiment, I investigated the effect of ambiguity on the prevalence and persistence of diversification among uncertain options. Overall, I found a significant influence of ambiguity on choice behavior. I reported three main findings. First, participants' propensity to diversify was higher when the gambles were equally ambiguous than when they were equally risky. Second, excess diversification under ambiguity was driven by participants who had previously stuck with the status quo gamble when diversification was not feasible. Third, diversification was significantly more persistent after the arrival of new information about the choice options when these options were ambiguous than when they were risky. Interestingly, none of the major theories of choice under uncertainty predicts these findings.

These results may help to explain behavior in naturally-occurring ambiguous environments where people have the opportunity to diversify among choice options. As I pointed out in the introduction, the behavior of teachers and professors who were associated to the TIAA-CREF pension plan during the 1980s provides a nice example. Most participants originally chose a 50-50 division of contributions between the two funds (TIAA and CREF), and this allocation was highly persistent. Ambigu-

and 0 otherwise; AMB_i equals 1 if participant i belongs to the AMBIGUITY condition and 0 if she belongs to RISK; and Div_i equals 1 if participant i diversified in the Second Stage and 0 otherwise. The OLS estimate of α_3 is -0.17; that is, excess inertia from AMBIGUITY is 17 percentage points larger among those who did not diversify in the Second Stage. Yet, a t-test does not reject the null hypothesis that α_3 is equal to zero ($p = 0.36$). The inability to detect a difference is probably due to lack of power.

ity might have played a significant role in this behavior. Perhaps many participants were *indecisive* among the options. The complexity of the options may have been an important determinant of such indecisiveness (Thaler and Sunstein 2009); but the experimental results suggest that even if it had been easier to understand the options, mere ambiguity might still have created indecisiveness. In this context, the 50-50 split might have been a *rule of thumb* to which many indecisive participants resorted originally (Benartzi and Thaler 2001; Thaler and Sunstein 2009); *inertia* in the application of this rule of thumb might have also been the result of ambiguity-driven indecisiveness.[48] Further investigation of the link between ambiguity, diversification, and inertia may help us better understand behavior and inform policy in this and other domains.

On the other hand, the result that ambiguity increases diversification relative to risk contrasts with the fact that a large number of households hold *underdiversified* investment portfolios (i.e., portfolios made up of far fewer securities than are necessary to eliminate idiosyncratic risk).[49] One possible explanation for underdiversification is that some individuals may hold optimistic beliefs about the payout of some potential investments and hence do not fully diversify their portfolios.[50] The contrast between the experimental data and the data on investor portfolio holdings suggests that the extent of diversification may be affected by the *source* of ambiguity. While the ambiguity about the number of good balls leads some individuals to increase diversification among gambles, the ambiguity about the future returns of stocks may lead some people to be optimistic about a few stocks and thus reduce diversification. Beliefs, then, may play a key role in explaining these different reactions across sources of ambiguity. How people form (and update) beliefs in ambiguous settings that are not as controlled as the one presented in this paper is an open question for future research.

[48] Of course, other factors like inattention, loss aversion, and procrastination may have also contributed to the inertia in the 50-50 allocation.

[49] For example, Mitton and Vorkink (2007) document this fact using a record of monthly portfolio holdings from a sample of about 65,000 households at a major U.S. discount brokerage house. (The database they use contains portfolio positions for the period of January 1991 through November 1996.) See Mitton and Vorkink's article for additional references.

[50] See Brunnermeier, Gollier, and Parker (2007) for a model that makes this prediction.

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Tables

Table I
Demographic Characteristics of Participants

	Condition		Chi-Square Test
	RISK	AMBIGUITY	p-value*
Variable	(N = 51)	(N = 49)	
Other Experiments	82%	81%	0.887
Anderson Lab	75%	73%	0.857
Female	75%	72%	0.808
Asian	47%	44%	0.741
Undergraduate	94%	94%	0.939
Math-Related Major	37%	35%	0.849
English 1st Language	80%	83%	0.705

* The p-values are for chi-square tests of differences in proportions. For each variable, the null hypothesis is that the percentage of participants with the relevant characteristic is the same in both experimental conditions.

Table II
Predicted Choice Behavior for the First and Second Stages of Each Condition

Panel A: RISK Condition

	Second Stage	
First Stage	Diversified Lottery	Previous Choice
Original Lottery		Reference-Dependent SEU (λ > 1.08) (Sugden)
Alternative Lottery	Disappointment Theory (λ > 1.08) Krahmer & Stone's Theory (λ > 1.17)	Subjective Expected Utility Models of Ambiguity Aversion Prospect Theory (Linear in Probabilities) Reference-Dependent SEU (Kőszegi & Rabin) Knightian Decision Theory Regret Theory

Panel B: AMBIGUITY Condition

	Second Stage	
First Stage	Diversified Lottery	Previous Choice
Original Lottery		Reference-Dependent SEU (λ > 1.08) (Sugden) Knightian Decision Theory
Alternative Lottery	Disappointment Theory (λ > 1.08) Krahmer & Stone's Theory (λ > 1.27)	Subjective Expected Utility Models of Ambiguity Aversion Prospect Theory (Linear in Probabilities) Reference-Dependent SEU (Kőszegi & Rabin) Regret Theory

Table III

Observed Choice Behavior in the First and Second Stages of Each Condition

Panel A: RISK Condition

	Second Stage		
	Diversified Lottery	Previous Choice	Total
First Stage			
Original Lottery	25.5% (13/51)	21.6% (11/51)	47.1% (24/51)
Alternative Lottery	31.4% (16/51)	21.6% (11/51)	53% (27/51)
Total	56.9% (29/51)	43.2% (22/51)	100% (51/51)

Panel B: AMBIGUITY Condition

	Second Stage		
	Diversified Lottery	Previous Choice	Total
First Stage			
Original Lottery	40.8% (20/49)	20.4% (10/49)	61.2% (30/49)
Alternative Lottery	28.6% (14/49)	10.2% (5/49)	38.8% (19/49)
Total	69.4% (34/49)	30.6% (15/49)	100% (49/49)

Table IV
Observed Choice Behavior in All Stages of the RISK Condition

Panel A: "60-40" Scenario

	Diversified			Original			Alternative		
	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total
Original	15.69%	5.88%	21.57%	9.80%	15.69%	25.49%	0%	0%	0%
Alternative	17.65%	3.92%	21.57%	11.76%	15.69%	27.45%	1.96%	1.96%	3.92%
Total	33.33%	9.80%	43.14%	21.57%	31.37%	52.94%	1.96%	1.96%	3.92%

Panel B: "40-60" Scenario

	Diversified			Original			Alternative		
	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total
Original	17.65%	5.88%	23.53%	0%	5.88%	5.88%	7.84%	9.80%	17.65%
Alternative	15.69%	3.92%	19.61%	0%	0%	0%	15.69%	17.65%	33.33%
Total	33.33%	9.80%	43.14%	0%	5.88%	5.88%	23.53%	27.45%	50.98%

Panel C: "70-30" Scenario

	Diversified			Original			Alternative		
	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total
Original	13.73%	3.92%	17.65%	11.76%	17.65%	29.41%	0%	0%	0%
Alternative	11.76%	1.96%	13.73%	19.61%	17.65%	37.25%	0%	1.96%	1.96%
Total	25.49%	5.88%	31.37%	31.37%	35.29%	66.67%	0%	1.96%	1.96%

Panel D: "30-70" Scenario

	Diversified			Original			Alternative		
	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total
Original	15.69%	3.92%	19.61%	0%	5.88%	5.88%	9.80%	11.76%	21.57%
Alternative	7.84%	0%	7.84%	0%	0%	0%	23.53%	21.57%	45.10%
Total	23.53%	3.92%	27.45%	0%	5.88%	5.88%	33.33%	33.33%	66.67%

Table V

Observed Choice Behavior in All Stages of the AMBIGUITY Condition

Panel A: "Good Draw-Bad Draw" Scenario

	Diversified			Original			Alternative		
	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total
Original	32.65%	0%	32.65%	8.16%	16.33%	24.49%	0%	4.08%	4.08%
Alternative	24.49%	0%	24.49%	4.08%	2.04%	6.12%	0%	8.16%	8.16%
Total	57.14%	0%	57.14%	12.24%	18.37%	30.61%	0%	12.24%	12.24%

Panel B: "Bad Draw-Good Draw" Scenario

	Diversified			Original			Alternative		
	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total
Original	30.61%	4.08%	34.69%	0%	16.33%	16.33%	10.20%	0%	10.20%
Alternative	24.49%	0%	24.49%	0%	0%	0%	4.08%	10.20%	14.29%
Total	55.10%	4.08%	59.18%	0%	16.33%	16.33%	14.29%	10.20%	24.49%

Panel C: "Good Draw-Good Draw" Scenario

	Diversified			Original			Alternative		
	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total
Original	38.78%	0%	38.78%	2.04%	16.33%	18.37%	0.00%	4.08%	4.08%
Alternative	22.45%	0%	22.45%	0%	0%	0%	6.12%	10.20%	16.33%
Total	61.22%	0%	61.22%	2.04%	16.33%	18.37%	6.12%	14.29%	20.41%

Panel D: "Bad Draw-Bad Draw" Scenario

	Diversified			Original			Alternative		
	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total	Diversified Lottery	Previous Choice	Total
Original	38.78%	2.04%	40.82%	2.04%	16.33%	18.37%	0%	2.04%	2.04%
Alternative	26.53%	4.08%	30.61%	0%	0%	0%	2.04%	6.12%	8.16%
Total	65.31%	6.12%	71.43%	2.04%	16.33%	18.37%	2.04%	8.16%	10.20%

Figures

Figure I
Inertia in the Third Stage, by Condition

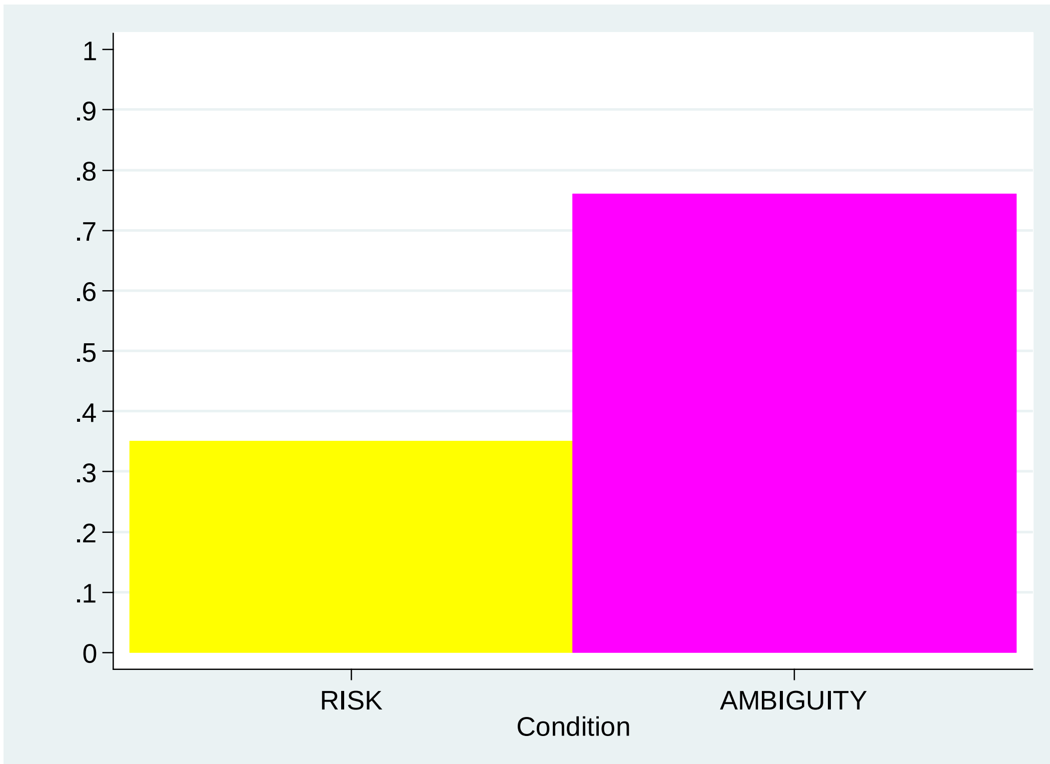

Figure II
Inertia in the Third Stage, by Condition and Second-Stage Choice

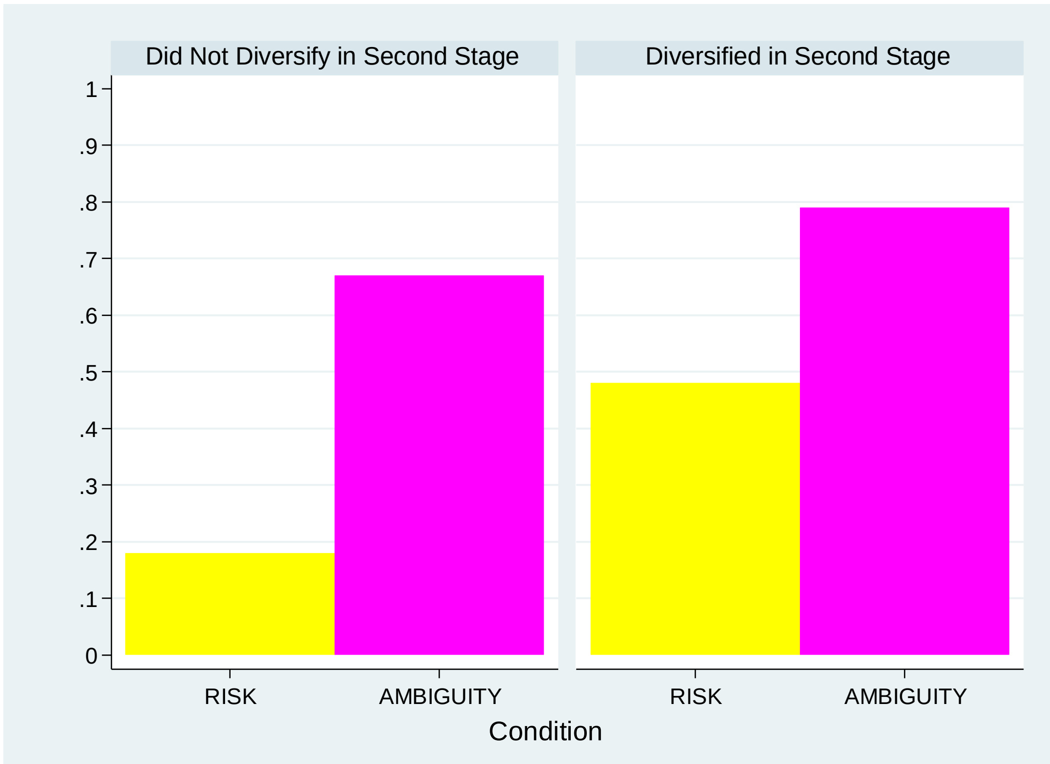

Figure III
Inertia in the Choice to Diversify, by Condition and First-Stage Choice