Behavior when the Chips are Down: An Experimental Study of Wealth Effects and Exchange Media*

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Abstract:
In this experimental study, we implement a lottery-type game that is similar to Imas (2016) and Gneezy and Potters (1997) to examine if the form of the exchange medium influences wealth effects and risk taking in general. We argue that reduced moneyness should lead to increased risk taking and decreased wealth effects (i.e., the break-even and house-money effects). We find that when the lottery task is conducted using tokens (with monetary value), there is a significant break-even effect but an insignificant house-money effect. However, when the lottery task is conducted using a digital media of exchange, what we label “e-coins,” there is a significant house-money effect and no break-even effect. Finally, with cash, there are both significant break-even and house-money effects. We find that subjects risk a bit more when using tokens compared to cash, but risk significantly more when using e-coins.

Keywords: wealth effects; mental accounting; medium of exchange; laboratory lottery tasks.

JEL Classification: G40, D81, D91

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1. Introduction

Abundant evidence demonstrates financial decision-making is path-dependent (Kaustia (2010); Deaves, Miele and Tsang (2019)).¹ For example, wealth effects are commonly reported, whereby risk taking is influenced by prior changes in wealth. These wealth effects include the house-money effect (i.e., increased risk taking after gains; e.g., Thaler and Johnson (1990); Post et al. (2008)), the reverse or negative house-money effect (i.e., decreased risk taking after gains; e.g., Schneider et al. (2016); Rüdisser et al. (2017)), the break-even effect (i.e., increased risk taking after losses; e.g., Gneezy and Potters (1997); Langer and Weber (2008); Coval and Shumway (2005); Post et al. (2008)), and the reverse break-even effect (i.e., decreased risk taking after losses; e.g., Shiv et al. (2005); Cameron and Shah (2015); Cassar, Healy, and Kessler (2017)). Because both the effect and its opposite have been reported, modality (i.e., is an effect or its opposite more common?) and contributing factors (i.e., what environmental factors induce the different effects?) are important questions. As for the former, house money appears more frequently than its reverse, while break-even appears more frequently than its reverse (Deaves, Kluger, and Miele (2018)). Importantly, the framing of the experimental task can significantly impact results, with Weber and Zuchel (2005) manipulating the presentation format of the decision problem and then finding that all the above wealth effects appear depending on the decision frame used.

The principal purpose of our paper is to consider whether another factor, namely the medium of exchange of transactions/payments, mediates wealth effects. In particular, different exchange media are likely to lead to different perceptions of “moneyness.” One can receive explicit cash in payment or something else that, while exchangeable for cash, might be perceived

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¹ The disposition effect and various wealth effects appear to be the two most researched path-dependent financial behaviors. Kaustia (2010) extensively reviews the disposition effect, as do Deaves, Miele, and Tsang (2019) for wealth effects. Different authors use the term “wealth effects” in different ways. By wealth effects, we mean the house-money effect, the break-even effect and their opposite behaviors (as described in this paragraph).
as having a lower degree of moneyness. Hochman, Ayal, and Ariely (2014) manipulate moneyness by incorporating into their experiment both prepayment and post-payment treatments, concluding that “when money is represented as something more tangible than its dollar amount [where they view prepayments as more tangible], it is more likely… [that a decline in value is] to be viewed as a loss.”

One common way to manipulate moneyness is to have separate treatments for cash and cash representations. An example is a separate “tokens” (normally something akin to poker chips) treatment. Mazar, Amir, and Ariely (2008) employ this approach and demonstrate that moneyness impacts the likelihood that someone will be less than fully honest: with tokens (versus cash) as the exchange medium, participants in their study were less honest. An even larger reduction in moneyness can be effected by eliminating the physicality of money altogether. For example, Falk et al. (2016) find that mobile payments (compared to cash) result in a significant increase in a customer’s willingness to pay.

Recent work by Imas (2016) (hereafter ‘Imas16’) follows the original paradigm of Gneezy and Potters (1997) and documents that an important driver of the break-even effect versus its reverse is whether losses are realized or unrealized (i.e., they remain as paper losses). Specifically, while subjects increase risk taking after losses, they only do so when the losses are unrealized, which he terms the “realization effect.” Relatedly, Meyer and Pagel (2018) find strong evidence that investors take less risk after experiencing realized losses, and Liu, Tsai, Wang, and Zhu (2010) find decreased risk taking after both realized and unrealized losses among market-makers in Taiwan. On the other hand, Merkle, Müller-Dethard and Weber (2018) (hereafter ‘MMW18’) provide evidence that the realization effect requires a positively-skewed lottery and is therefore not generalizable.
Previous work on the role of mental accounting is also pertinent. Mental accounting has been defined as a set of cognitive operations used by individuals and households to organize, evaluate, and keep track of financial activities (Thaler (1999)). Research has shown that individuals tend to view different types or sources of funds differently, and therefore may separate them into different mental accounts such that decisions are made differently within each account (e.g., Thaler (1985); Thaler (1999); Tversky and Kahneman (1981)). Logically, different media of exchange may facilitate slotting funds into different mental accounts. In our study, we consider whether in a dynamic-choice setting different exchange media have different impacts on wealth effects. To the best of our knowledge, this is the first study to investigate the possible link between these two strands of the literature: exchange media/mental accounting and wealth effects.

Moneyness has also been found to affect risk-taking behavior. In a between-subject design, Stenstrom et al. (2018) assign participants into a money condition (where they are given a sorting task with 80 $20 bills) and a neutral condition (sorting 80 plain pieces of paper with the same size dimensions as $20 bills). The participants in these two conditions are subsequently given the same financial risk-taking task to complete. Their results show that the subjects who are in the money condition are significantly more risk-averse than those in the neutral condition. Mills and Nower (2019) find that cryptocurrency trading is linked to problem gambling and high-risk stock trading. Therefore, we would expect less risk aversion when moneyness is decreased. In related works, Soman (2003) and Raghubir and Srivastava (2008) demonstrate that the degree of moneyness (here, in terms of a difference in transparency) affects consumer spending. Wang and Qin (2015) find that digitizing payment of fines (e.g., traffic tickets, library fines) temporarily makes the penalties less effective compared to cash payments. In these studies, even though the cash-alternatives are represented in dollar amounts, they nevertheless lead to significantly different
choices made. It appears that the less transparent is the form of exchange medium, the lower may be the pain in parting with money (i.e., lower loss aversion).

Not only might moneyness affect risk aversion, it might also influence wealth effects. In prospect theory, risk aversion is a function of the parameters of the utility function (curvature in both domains and loss aversion) and the probability weighting function (reverse-S-shaped curvature in the more common single-parameter version) (Wakker (2010)). Importantly, research has shown that the decision environment can impact these parameter values. Dhar and Wertenbroch (2000) show that emotional forces can increase loss aversion, as do Rottenstreich and Hsee (2001) for probability weighting. Moneyness is clearly part of the decision environment, and loss aversion is an important driver of wealth effects. To see the latter, consider a stripped-down version of prospect theory with loss aversion but neither utility function curvature (in either domain) nor probability weighting. Given gamble integration (i.e., adding the result of a previous gamble to possible outcomes for the next gamble), either a positive or negative change in wealth makes decision-makers risk-neutral for gambles small enough to keep them in the same domain versus the risk aversion that is present at or in the neighborhood of the original wealth level (thus implying both the house money and the break-even effects).²

A low degree of moneyness may reduce the magnitude of wealth effects by creating an environment with less loss aversion. This is likely why (as noted above) risk aversion (largely driven by loss aversion) declines with lower moneyness (Stenstrom et al. (2018); Mills and Nower (2019)). Our principal conjectures are two: first (H1), that there is a positive relationship between

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² It complicates things to bring in utility function curvature, but for most reasonable parameter values the modal wealth effects (i.e., the house-money and break-even effects) result. See Appendix A for more details and an example.
moneyness and risk aversion; and, second (H2), that there is a positive relationship between moneyness and the magnitude of wealth effects.

We conduct our investigation experimentally. The experimental design is based on the investment.lottery game of Imas16 and Gneezy and Potters (1997). Thus, we have both realized and unrealized treatments. To start, in what we term Study 1, we add a second dimension that includes different exchange media: one treatment employs cash as the payment medium, while another treatment uses physical tokens with identical monetary value. These treatments are referred to as “realized tokens,” “unrealized tokens,” “realized cash,” and “unrealized cash.” We will also merge unrealized and realized treatments (when deemed appropriate) and simply refer to them as cash treatments and tokens treatments.

To further reduce moneyness, in Study 2 we use digital “e-coins” as our medium of exchange. Since realization versus non-realization is less meaningful in the e-coin environment, our design mirrors the unrealized versions of the previous two designs. A digital currency should be less transparent than physical cash or tokens, so we hypothesize that this should lead to subjects placing a lower subjective value on e-coins, meaning moneyness is lower for e-coins than for the physical media.

To preview the results, we find the expected pattern of risk-taking behavior in support of H1. Across all four rounds, the e-coins treatment shows the highest amount of risk taking; the tokens treatments show the second-highest levels of risk taking; and the cash treatments show the lowest levels of risk taking, coming in slightly below tokens. Further, the average amount bet in all rounds is significantly higher for e-coins compared to physical cash and physical tokens (which are not significantly different). We also find that exchange media impact wealth effects. Consistent with H2, only the cash treatment (which embodies the highest degree of moneyness)
has both statistically significant house-money and break-even effects, with the two reduced-moneyness treatments having only one statistically significant wealth effect. More specifically, for cash treatments there is no difference in magnitudes between the house-money and break-even effects (and, as just stated, they are both statistically significant); for the tokens treatments the break-even effect dominates house money (meaning risk taking increases significantly more following losses compared to gains); and for the e-coins treatment, the house-money effect dominates the (non-existent) break-even effect.

The rest of the paper proceeds as follows. We detail in Section 2 our experimental design and methodology. Section 3 describes the results of the experiment and provides some perspective. Section 4 concludes.

2. Experimental Design

Upon arriving at the experimental lab, each subject was given a copy of the experimental instructions and the experimenter read the instructions aloud to the subjects and answered any questions. Students had been told in advance that they were being recruited for a financial-decision making study and were guaranteed an appearance fee of $5 with the opportunity to make substantially more. Table 1 shows some summary statistics on the subjects. In total for Study 1 (not including a pilot study), 203 subjects were recruited, with the subjects about evenly split

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3 We recruited from the general student population at the University of Wisconsin-La Crosse. The experimental sessions for Study 1 took place between February and April 2018, and Study 2 took place in October 2019. See Appendix B for the subject instructions for all treatments. These differ slightly by treatment. After the experimenter finished reading the instructions, subjects were asked to complete a comprehension test regarding details of the experiment. Next, the experimenter went over the answers to ensure every subject understood the instructions. In Study 1, we encouraged students to count their tray of tokens/quarters, to reaffirm that they did in fact have physical funds in front of them, even though decisions were made on the computer. Note as well that subjects were asked to complete a short demographic survey.
between the four different treatments. In Study 2, 57 subjects were recruited. Across all treatments, undergraduate students were about evenly distributed across years of study and gender.

[Insert Table 1 about here]

The purpose of our experimental Study 1 is two-fold: 1) to compare subjects’ risk-taking behavior when the medium of exchange is tokens (in the form of small plastic poker chips) versus cash, and 2) to compare subjects’ risk-taking behavior after earnings are realized versus unrealized. Figure 1 displays our 2x2 design for Study 1. The experiment was conducted using ZTree (Fischbacher (2007)).

[Insert Figure 1 about here]

2.1 Tokens vs. cash

We employ the same general layout for all four treatments in Study 1. To illustrate, we will describe the experimental procedure using the tokens treatments. At the start of the tokens treatment, subjects are given a tray of 32 tokens to play in a game of chance. The tokens are small, blue, plastic poker chips (about half an inch in diameter). Each token is valued at 25 cents; thus, the total value of the endowment is $8. Subjects are told before starting that at the end of the experiment, they can exchange the tokens for 25 cents each. The experiment consists of four rounds. In each round, subjects can buy what we term “lottery tickets” using these tokens for chances to win a prize. They can buy from one to eight lottery tickets with each ticket costing a token, or they have the option not to buy any. Thus, the highest amount they can purchase/bet is $2 worth of tokens per round.

While physical tokens are given to the subjects, the game takes place on a computer. At the start of each round, a random number is displayed on each subject’s computer screen. The
random number may come up as 1, 2, 3, 4, 5 or 6, and that is the subject’s number for this particular round. Next, the subject chooses how many tickets she wishes to buy with her tokens by entering her decision into the computer. After all subjects have made their choices, the experimenter rolls a 6-sided die, which can be seen by all subjects on the overhead projector. If the number of the die roll is the same as the subject’s number, she will win seven times the number of tokens risked/tickets purchased; otherwise, she will win nothing. Thus, the subject has a one out of six chance of winning a prize that is seven times the value of tickets she purchased, and a five out of six chance of winning nothing. Note that this part is identical to the experimental design of Imas16, except we use 32 tokens (or 32 quarters in the cash treatments) instead of seven $1 bills and four quarters. One other difference in our design compared to the Imas16 study is that all our subjects have independent random numbers, while Imas16 provides all subjects with the same random number in a given round.

At the end of a round, the subjects’ current experimental wealth is updated to reflect earnings up to that point. In the tokens treatment, the earnings are shown as the number of tokens. In contrast, in the cash treatments where subjects are given a tray of 32 quarters (instead of tokens), all earnings are shown in terms of dollars-and-cents (instead of as the number of tokens).4

2.2 Realized vs. unrealized

In the realized treatments, at the end of the third round (of four) the experimenter goes to each subject to deposit any gains or collect any losses that the subject has made up to that point. This way, any gains or losses are realized and physically transferred before subjects proceed into the fourth and final round. In contrast, in the unrealized treatments gains or losses are not realized

4 The subject instructions in Appendix B contain some sample screenshots of what the subjects’ computer screens displayed.
until after the fourth round has ended. To avoid confounds it is important to make the treatments as close to identical as possible. One way we do this is to ensure that the time lapse between Rounds 3 and 4 is similar between the realized and unrealized treatments. Remembering that the realized treatments take a few minutes to settle cash or tokens, in the unrealized treatments at the end of Round 3 we tell subjects that we need to check everything on our computer to be sure all data has been recorded correctly. After about a couple of minutes, we then go around the room to each subject’s computer screen to confirm that their current earnings are displayed correctly.\textsuperscript{5}

2.3 Study 2: e-coins treatment

The e-coins treatment in Study 2 is conducted similarly to the four treatments in Study 1, except a digital currency is used as the medium of exchange, whereby we tell subjects that they would virtually be assigned 32 “e-coins.” All earnings are shown to subjects in terms of the number of e-coins. Subjects are told that each e-coin could be exchanged at the end of the experiment for 25 cents each. No physical medium is provided and therefore no realization occurs after Round 3. We otherwise keep the procedure and time between rounds the same as in Study 1. Therefore, we wait a few minutes before Round 4 to keep the waiting time the same as the realized treatments and go around to check each subject’s computer screen to confirm their current earnings.

3. Results and Discussion

3.1 Final-round wealth effects

We examine the difference in the amount wagered (i.e., the dollar value of lottery tickets purchased) going into the final round (i.e., compare Round 4 to Round 3) for each of the treatments in Study 1. This is shown in Table 2. The analysis is conducted by treatment (Columns 1 to 4). In

\textsuperscript{5} This procedure is similar to that of Imas16.
Row 1 of Panel A, we show the choices unconditional on the wealth path of the first three rounds. Next, in Rows 2-7, we then condition on whether a subject has experienced gains or losses.

Conditioning is done in three ways. First, following Imas16, if a subject has won her bet at least once in the first three rounds, she is deemed to have generated gains (these situations are shown in Row 2 and labeled as Gains1); otherwise they are deemed to have suffered losses (these situations are shown in Row 3 and labeled as Losses1). Alternatively, because we believe it better reflects true gains and losses, we separate subjects based on whether they have \textit{net} gains (Gains2 in Row 4) or \textit{net} losses (Losses2 in Row 5) going into the final round.\footnote{Depending on bets, those experiencing “gains” or “losses” according to this first method may \textit{not} have experienced true \textit{net} gains/losses.} Note that subjects whose wealth has not changed in the first three rounds would not show up in either Gains2 or Losses2. Thus, those sample sizes may differ. Third, to account for subjects who may take a more myopic view, we condition on only previous-round gains and losses (these situations are shown in Rows 6 and 7 and labeled as Gains3 and Losses3, respectively). Note that, given the gamble probabilities there are few Gains3 instances.

\[\text{Insert Table 2 about here}\]

\textit{3.1a Unconditional behavior}

Referring to Row 1, we find that, on average, subjects significantly (at a 5\% level or stronger) increase the amount risked going into the final round, with the average amount increased ranging from $0.15 to $0.20 depending on the treatment. We call this a “termination effect,” a tendency which is also present in Xing et al. (2019), McKenzie et al. (2016), and Imas16, but not in all treatments in MMW18, Shiv et al. (2005), and Coval and Shumway (2005).
3.1b Behavior conditional on gains and losses

In Rows 2-7 we look at gains and losses separately. Since the results are mostly quite similar using all three definitions of gains/losses, we will concentrate our discussion on Gains2 and Losses2 in Rows 3 and 4. Beginning with gains, while subjects in this category increase risk taking in all cases, the increase is only significant in the unrealized cash treatment (at the 10% level). In the unrealized cash treatment subjects with a net gain on average increase their bet by $0.23 from Round 3 to Round 4, while this amount ranges from only $0.07 to $0.13 in the other treatments. Those with losses also increase risk taking in the final round, and in all four treatments this finding is statistically significant at the 5% level or stronger, with the average amount risked increasing from $0.18 to $0.27 across the four treatments.

Also, unlike Imas16, but consistent with MMW18 and Weber and Zuchel (2005), the realization effect is not present in our data. This is possibly due to the fact that we frame the decision as buying lottery tickets rather than making an investment, as Weber and Zuchel show that framing decisions as lottery purchases amplifies the break-even effect. Specifically, we find that subjects given physical media who are facing losses always increase risk taking going into the final round, regardless of whether the losses (or gains) were realized or unrealized. Indeed, the magnitude of the increase is quite similar between realized and corresponding unrealized cases. While subjects in the unrealized cash treatment do increase their bet more than their counterparts in the realized cash treatment, conversely, in the case of tokens, the unrealized treatment subjects increase their bet less than those in the realized treatment. In neither case, however, is the difference statistically significant.
3.1c Final-round gain vs. loss

Panel B investigates whether behavior after gains significantly differs from behavior after losses. We take the average change in the amount risked by subjects from Round 3 to Round 4 for those who have experienced losses and subtract that same average for those who have experienced gains. Given the paucity of Gains3 observations, we restrict ourselves to Gains1 minus Losses1, and Gains2 minus Losses2.

The results show that, while none of the differences between gains and losses is statistically significant, the difference does seem to be much larger for the two tokens treatments compared to the two cash treatments. This is especially so for Gains2 minus Losses2, the measure that we believe to be a better reflection of true gains and losses. In the two tokens treatments, subjects facing net losses increase their bet by $0.15 to $0.17 more than those facing net gains in the same treatment. This difference is only $0.05 for the realized cash treatment and is slightly negative for the unrealized cash treatment. In sum, these findings lend some support to H2: in the case of the cash treatments, the two wealth effects are similar and statistically significant (for unrealized cash), but this is not so for the tokens treatments, with the wealth effects varying more in magnitude and only one of them statistically significant. It is also apparent, once again, that there is little difference between realized and unrealized treatments (i.e., there is no observable realization effect).

3.1d Final-round cash vs. tokens

We now compare cash treatments and tokens treatments more carefully. Given that we observe no significant realization effect, we pool treatments by medium of exchange. In other words, we merge unrealized and realized treatments into merged-cash and merged-tokens treatments. The
results are shown in Panel A of Table 3. Again, without loss of generality, we focus our discussion on Gains2 and Losses2 (Rows 4 and 5).

Losing subjects increase their risk taking more than winning subjects do when the medium of exchange is tokens (a point estimate of 0.25 compared to 0.10), a result that is significant at a level of 10% in the case of Gains2 versus Losses2. This means that the break-even effect is statistically significant, but the house-money effect is not. However, we do not observe this pattern when cash is used, where both point estimates are 0.18 and significant at least at a 5% level. In short, there is suggestive evidence that the break-even effect is stronger than the (insignificant) house-money effect when tokens are used, but the two effects are practically identical when cash is used.

To quantify the difference in behavior between winners and losers, we show the average difference in amount risked after losses versus gains in Panel B. While for the cash treatments the gain/loss difference in risk taking is indistinguishable from zero ($0.01 on average), for the tokens treatments those who have experienced losses increase their risk taking significantly more (by a total of $0.16 using Losses2 versus Gains2) than those who have experienced gains. Thus, the results point in the direction of media of exchange influencing wealth effects.

3.1e Comparing all media of exchange

Table 3 also shows the results for the e-coins treatment in Study 2. First, the unconditional change in amount risked going into the final round is lower in this treatment than for cash or tokens ($0.11 for e-coins compared to $0.17 and $0.19 for cash and tokens, respectively). However, the house-money effect based on either Gains1 or Gains2 is stronger with e-coins (an average bet increase of
$0.28 compared to $0.10 and $0.18 for tokens and cash, respectively). Also, there is no evidence of a break-even effect as subjects actually decrease their bet by $0.07 when facing a loss (though insignificantly so). In support of H2 is the fact that with e-coins (as in the case of tokens) we again observe only one of the modal wealth effects. With cash, the two modal effects are present and close to equal in magnitude. The lack of a break-even effect also means that losing subjects in the e-coins treatment do not display the termination effect.

We also show in Table 4 differences across treatments, based on either having a net loss (Losses2) or a net gain (Gains2). We find that subjects provided with cash do not behave significantly differently from those provided with tokens, irrespective of whether they are facing a gain or loss going into the final round. However, the subjects provided with e-coins do change their bets by a significantly (at a 5% level) different amount when facing a net loss compared to the two physical-medium treatments. Subjects facing a net loss in the tokens treatments increase their bet by $0.33 more than those facing a net loss in the e-coins treatment, and this difference is $0.26 when comparing cash to e-coins. We also see a stronger house-money effect in the e-coins treatments (a bet $0.18 higher on average compared to the tokens treatments, and $0.10 higher compared to the cash treatments), but it is not significantly different from the other media of exchange. These results further lend some support for H2 and continue to show that the different levels of moneyness inherent in the various media of exchange may influence wealth effects.

[Insert Table 4 about here]

Next, we examine risk taking in general by reporting the average amount bet for each of the three media of exchange. Panel A of Table 5 shows the average amount bet, unconditional on gains or losses, for each round. The final column shows the average across all four rounds. We
can observe that subjects given physical tokens bet a bit more than those given physical cash ($0.84 across all rounds for tokens compared to $0.81 for cash), but this difference is small. However, it appears that subjects in the e-coins treatment bet substantially more than in either physical medium, as the average bet for subjects given e-coins is $1.01. This difference is stronger in the first three rounds than in the last. Interestingly, in all treatments, the general pattern is for subjects to decrease their bet after Round 1, keep the same bet for Round 3 as in Round 2, and then increase their bet going into the final round.

Panel B shows the differences in the numbers reported in Panel A, differenced across the media of exchange. In each of the first 3 rounds, subjects given e-coins bet significantly more than subjects given physical cash or tokens (at a 5% level of significance). These subjects bet anywhere from $0.18 to $0.25 more in the first three rounds compared to the subjects provided with physical media. In Round 4, again subjects given e-coins bet more ($0.12 to $0.15 more), but this difference is not statistically significant.

Averaging across all rounds, subjects in the e-coins treatment bet $0.18 more than those in the tokens treatments and $0.20 than those in the cash treatments. It should also be noted that tokens and cash are never more than $0.07 different (Round 1), and on average are only different by $0.02. Thus, general risk taking for tokens is a bit higher than for cash, but only slightly. On the other hand, risk-taking for e-coins is significantly higher than for either physical medium. Arguably, this is due to physical tokens compared to physical quarters representing only a small decline in moneyness versus the larger decline in moneyness moving from tokens to e-coins. In sum, the results in Table 5 lend strong support in favor of H1.

[Insert Table 5 about here]
3.2 Earlier-round wealth effects

To this point, we have only discussed behavior in the last round. In looking at earlier-round behavior, we continue to use the same definitions for gains and losses as before, with the proviso that now only Gains1/Losses1 and Gains2/Losses2 are relevant.

Relevant results are shown in Table 6. We begin in Panel A by looking at the change in subject bets between Rounds 2 and 3. First, we find that for the merged-tokens treatment there is almost no change in risk taking between Rounds 2 and 3, both unconditionally and conditional on prior gains or losses. For the merged-cash treatment, when we look at the full sample (unconditional on prior rounds), there is no change in risk taking. For gains, however, there is marginally significant (at a 10% level) evidence of a decrease in risk taking going into the third round, which indicates a reverse house-money effect. For the e-coins treatment, the average unconditional change in the amount bet is zero, and the same holds conditional on winning and losing.

[Insert Table 6 about here]

Finally, we examine the change in risk taking between Rounds 1 and 2, with results reported in Panel B of Table 6. Note the two (surviving) definitions of gains/losses coalesce. Once again, the full sample (or unconditional) results show that for all media of exchange, there is no significant change in risk taking between the first two rounds. Those experiencing first-round gains in the merged-tokens treatment significantly (at a 1% level) decrease their investment. This is consistent with reverse house money. The other two media of exchange show no significant results.

In sum, we do not witness the break-even or house-money effects in earlier rounds as we
do in the final round. If anything, earlier-round behavior provides a hint of reverse house money, though, given its paucity and anomalousness, one is tempted to ascribe this to randomness. In any case, it should be noted that, due to our lottery-type problem being positively skewed with a small, finite number of rounds, the absence of wealth effects in earlier rounds need not be surprising. Indeed, the dynamic prospect-theory models of Barberis (2012) and MMW18 can explain why subjects might simply choose to wait until the final round: subjects, who are not forced to bet more to break even until the final round (they can break even earlier with the same or lower bet as in the previous round), may not want to increase their bets after a win in earlier rounds as doing this repeatedly could result in a net loss. MMW18 indeed find that their subjects behave in this manner in the final round regarding the break-even effect: they increase their bet up to the point where they would end up with a net gain after a win.

3.3 Discussion

We find that the medium of exchange, and in particular its degree of moneyness, impacts both general risk-taking behavior and wealth effects. In Study 1, we see slightly more risk taking when tokens rather than cash are used (H1), and we see a less pronounced (and insignificant) house-money effect (H2) for this medium versus cash. Still, the findings are weak. The stronger support for our hypotheses comes from comparing Study 2 to Study 1. Based on the average amount bet reported in Table 5, subjects in the e-coins treatment take on significantly more risk than in the two physical-medium treatments. Also, the e-coins treatment is the only time the break-even effect does not manifest itself going into the final round.

These findings are consistent with physical cash and physical tokens being closer to each other in terms of moneyness than both are to e-coins. Since digital e-coins are less transparent, subjects are more likely to place a lower subjective value on them compared to physical cash and
tokens and display less loss aversion and less risk aversion, consistent with existing research (Soman (2003); Raghbir and Srivastava (2008); Stenstrom et al. (2018); Wang and Qin (2015); Falk et al. (2016)).

Our design (based on Imas16) is in essence a gamble, and the “tokens” given to subjects are essentially small plastic poker chips. In the presence of electronic gaming devices (e.g. slot machines and video poker), casinos operate in a manner similar to our e-coins treatment. The games take place electronically using electronic currencies with various conversion rates, and the gamblers only interact with real money when they put the money into a machine and then (if cashing out) again after taking a machine-printed ticket to the casino cashier. Therefore, our results have a potential real-world implication in a casino setting. Our findings that participants take more risk with e-coins is consistent with gamblers behaving in the best interest of the casino. Further, if cash were to be used in a casino setting, we suggest that wealth effects in both domains are more likely to be present compared to when another medium of exchange is used.

Our e-coins treatment results could be extended to Bitcoin and cryptocurrencies in general. Based on our results, we would expect that Bitcoin investors exhibit less loss aversion and less pronounced wealth effects. Bitcoin/crypto investors may not chase losses as much as investors holding other financial assets, but they are likely to take more risk in general. Also, we suggest that consumers that shop with Bitcoins would be likely to spend more. It might be fruitful for future research to investigate the prevalence of wealth effects for different financial assets that may belong in different mental accounts, such as cryptocurrencies, stocks, and stock options. It may also be worthwhile to examine both the currency aspect and investment aspect of cryptocurrencies and how it may impact consumer and investor behavior.
4. Conclusion

In this experimental study, we analyzed changes in risk-taking behavior and wealth effects in a four-round lottery-type game where gains and losses were either unrealized or realized, and the medium of exchange varied in terms of moneyness, from (with most moneyness) cash (quarters) to tokens (small plastic poker chips), down to (with least moneyness) digital e-coins. Our basic design followed the experiment of Imas16, while adding a second treatment dimension for the medium of exchange. Our aim was to investigate whether different forms of payment, which could potentially constitute different mental accounts and reference points, impact wealth effects as well as risk taking in general.

Several noteworthy behavioral patterns emerged. First, there was no evidence of a realization effect as in Imas16, and this was true both for the cash and tokens treatments in Study 1. One possibility is that this occurred due to the framing of our experiment as a lottery game rather than an investment game, but it further shows that the realization effect is not ubiquitous. Second, some evidence of a termination effect was found, whereby subjects on average increase their risk taking going into the final round of an experiment. We extend the literature on this effect by showing that while it exists with physical media of exchange it may not hold for digital media, as those facing losses in the e-coins treatment do not increase their risk taking.

Third, and most importantly, we provided evidence that the three media of exchange herein examined lead to varying wealth effects and different levels of risk taking. In Study 1, we found a significant break-even effect but an insignificant house-money effect when tokens were used as the medium of exchange, whereas the two effects were both statistically significant when cash was used as the medium of exchange. However, since these two physical media of exchange may be fairly similar in terms of moneyness, comparing the results in Study 1 to those in Study 2 might
be more insightful. When we did so, we found support for our two main hypotheses, thus concluding, first, that risk taking increases as moneyness is reduced and, second, that wealth effects diminish as moneyness is reduced. The house-money effect dominated a non-existent break-even effect when e-coins were used as the medium of exchange. This means that when tokens are used, individuals increase their risk taking significantly more following losses than gains, and vice versa when e-coins are used. We also witnessed somewhat more risk taking with tokens compared to cash (but not significantly so), and significantly more risk taking with e-coins compared to either physical medium. This matches the likely perceived moneyness of the three media: cash followed closely by physical tokens, with e-coins likely having much less perceived moneyness. The term “e-coins” may itself prime subjects to take more risk, as they may think of volatile Bitcoin or other cryptocurrencies. While not all our experimental results support H2, it is clear that both risk taking and differences in risk taking following changes in wealth are significantly impacted by the medium of exchange.

The specific patterns we find and our general conclusion that media of exchange influence risk taking and wealth effects, while important in and of itself, is only a prelude to future research. Pinpointing the exact operative mechanisms, whether psychological or non-psychological, that drive the observed behaviors, and whether these regularities are robust to somewhat different environments, is a needed endeavor, especially if it has the potential to ameliorate suboptimal decision-making through debiasing efforts.
REFERENCES


Figure 1: Four Treatments in Study 1

<table>
<thead>
<tr>
<th></th>
<th>Tokens:</th>
<th>Cash:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Realized earnings:</td>
<td>Tokens – Realized</td>
<td>Cash – Realized</td>
</tr>
<tr>
<td>Unrealized earnings:</td>
<td>Tokens – Unrealized</td>
<td>Cash – Unrealized</td>
</tr>
</tbody>
</table>
Table 1: Summary statistics

This table shows some basic summary statistics of the participants across both Study 1 and Study 2. All participants were students (all but one at the undergraduate level) at the University of Wisconsin-La Crosse. We recruited from the general student body, advertising a research study in financial decision-making. The first row shows the number (N) of subjects in total across both studies, the number of male subjects, the number of female subjects, and the number in each year of study. The bottom row shows the number in each treatment.

<table>
<thead>
<tr>
<th>Total (Study 1 and Study 2)</th>
<th>Male</th>
<th>Female</th>
<th>Freshman</th>
<th>Sophomore</th>
<th>Junior</th>
<th>Senior or above</th>
</tr>
</thead>
<tbody>
<tr>
<td>N:</td>
<td>260</td>
<td>127</td>
<td>133</td>
<td>53</td>
<td>60</td>
<td>88</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unrealized tokens</th>
<th>Realized Tokens</th>
<th>Unrealized cash</th>
<th>Realized cash</th>
<th>E-Coins (Study 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N by treatment:</td>
<td>50</td>
<td>50</td>
<td>48</td>
<td>55</td>
</tr>
</tbody>
</table>
Table 2: Final Round Results

Panel A shows the average change in subjects’ amount risked going into the final round (Round 4 compared to Round 3) for each of the four treatments. First, the full-sample results for each treatment are given (unconditional on gains or losses). Then, we report the results for those who won in at least one of the first three rounds (Gains1), followed by those who lost in all three rounds (Losses1). We then split the subjects by those who have a net gain going into the final round (Gains2) versus those who have a net loss (Losses2). Finally, we show the results for those who won in Round 3 only (Gains3) and those who lost in Round 3 only (Losses3). The number of subjects in each category is given as well.

Panel B shows the difference of the amount of the increased bet between Rounds 3 and 4 from Panel A within treatments for the two ways of splitting the subjects. First, the difference between those who lost in one of the first three rounds and those who won in at least one round is shown (Losses1-Gains1). The average of this difference is reported. In the next row, we report the difference between those who faced a net loss going into the final round and those who had a net gain (Losses2-Gains2).

\( t \)-stats are reported in parentheses. *** indicates significantly different from zero at 1%, ** at 5%, and * at 10%.

<table>
<thead>
<tr>
<th></th>
<th>Tokens-realized</th>
<th></th>
<th>Cash-realized</th>
<th></th>
<th>Tokens-unrealized</th>
<th></th>
<th>Cash-unrealized</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>( \Delta ) $ \text{risked} )</td>
<td>N</td>
<td>( \Delta ) $ \text{risked} )</td>
<td>N</td>
<td>( \Delta ) $ \text{risked} )</td>
<td>N</td>
<td>( \Delta ) $ \text{risked} )</td>
</tr>
<tr>
<td>Full sample</td>
<td>50</td>
<td>$0.20^{***}$ (3.04)</td>
<td>55</td>
<td>$0.15^{**}$ (2.02)</td>
<td>50</td>
<td>$0.19^{**}$ (2.25)</td>
<td>48</td>
<td>$0.20^{***}$ (2.47)</td>
</tr>
<tr>
<td>Gains1</td>
<td>22</td>
<td>$0.11$ (1.19)</td>
<td>26</td>
<td>$0.13$ (0.99)</td>
<td>20</td>
<td>$0.15$ (0.96)</td>
<td>24</td>
<td>$0.22^{*}$ (1.68)</td>
</tr>
<tr>
<td>Losses1</td>
<td>28</td>
<td>$0.27^{***}$ (2.98)</td>
<td>29</td>
<td>$0.17^{**}$ (2.02)</td>
<td>30</td>
<td>$0.21^{**}$ (2.28)</td>
<td>24</td>
<td>$0.19^{**}$ (1.83)</td>
</tr>
<tr>
<td>Gains2</td>
<td>19</td>
<td>$0.12$ (1.07)</td>
<td>24</td>
<td>$0.13$ (0.91)</td>
<td>17</td>
<td>$0.07$ (0.45)</td>
<td>23</td>
<td>$0.23^{*}$ (1.68)</td>
</tr>
<tr>
<td>Losses2</td>
<td>29</td>
<td>$0.27^{***}$ (3.08)</td>
<td>30</td>
<td>$0.18^{**}$ (2.13)</td>
<td>28</td>
<td>$0.24^{**}$ (2.32)</td>
<td>23</td>
<td>$0.20^{**}$ (1.84)</td>
</tr>
<tr>
<td>Gains3</td>
<td>9</td>
<td>$0.03$ (0.43)</td>
<td>13</td>
<td>$0.00$ (0.00)</td>
<td>6</td>
<td>$-0.13$ (-0.31)</td>
<td>10</td>
<td>$-0.13$ (-0.67)</td>
</tr>
<tr>
<td>Losses3</td>
<td>41</td>
<td>$0.24^{***}$ (3.30)</td>
<td>42</td>
<td>$0.20^{**}$ (2.21)</td>
<td>44</td>
<td>$0.23^{***}$ (2.98)</td>
<td>38</td>
<td>$0.29^{***}$ (3.32)</td>
</tr>
</tbody>
</table>

Panel B: Differences within Treatments

<table>
<thead>
<tr>
<th></th>
<th>Tokens-realized</th>
<th>Cash-realized</th>
<th>Tokens-unrealized</th>
<th>Cash-unrealized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Losses1 – Gains1</td>
<td>$0.15$ (1.18)</td>
<td>$0.05$ (0.31)</td>
<td>$0.06$ (0.32)</td>
<td>$-0.03$ (-0.19)</td>
</tr>
<tr>
<td>Losses2 – Gains2</td>
<td>$0.15$ (1.06)</td>
<td>$0.05$ (0.31)</td>
<td>$0.17$ (0.86)</td>
<td>$-0.03$ (-0.19)</td>
</tr>
</tbody>
</table>
Table 3: Final Round Results for Merged Cash, Merged Tokens, and E-Coins Treatments

Here, we show the same results as in Table 2, but we merge the two tokens treatments (realized and unrealized) and the two cash treatments (realized and unrealized). We also report the results of our E-Coins treatment. Panel A shows the average change in subjects’ amount risked going into the final round (Round 4 compared to Round 3) for each treatment. First, the full-sample results for each treatment are given (unconditional on gains or losses). Then, we report the results for those who won in at least one of the first three rounds (Gains1), followed by those who lost in all three rounds (Losses1). We then split the subjects by those who have a net gain going into the final round (Gains2) versus those who have a net loss (Losses2). Finally, we show the results for those who won in Round 3 only (Gains3) and those who lost in Round 3 only (Losses3). The number of subjects in each category is given as well.

Panel B shows the difference of the amount of the increased risk between Rounds 3 and 4 from Panel A within treatments for the two ways of splitting the subjects. First, the difference between those who lost in one of the first three rounds and those who won in at least one round is shown (Losses1-Gains1). The average of this difference is reported. In the next row, we report the difference between those who faced a net loss going into the final round and those who had a net gain (Losses2-Gains2).

\( t \)-stats are reported in parentheses. *** indicates significantly different from zero at 1%, ** at 5%, and * at 10%.

<table>
<thead>
<tr>
<th>Panel A: Results by Merged Treatment</th>
<th>Tokens-merged</th>
<th>Cash-merged</th>
<th>E-Coins</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Δ $ risked</td>
<td>N</td>
<td>Δ $ risked</td>
</tr>
<tr>
<td>Full sample</td>
<td>100</td>
<td>$0.19***</td>
<td>103</td>
</tr>
<tr>
<td></td>
<td>(3.67)</td>
<td>(3.19)</td>
<td></td>
</tr>
<tr>
<td>Gains1</td>
<td>42</td>
<td>$0.13*</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>(1.48)</td>
<td>(1.88)</td>
<td></td>
</tr>
<tr>
<td>Losses1</td>
<td>58</td>
<td>$0.24***</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>(3.72)</td>
<td>(2.75)</td>
<td></td>
</tr>
<tr>
<td>Gains2</td>
<td>36</td>
<td>$0.10</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>(1.02)</td>
<td>(1.83)</td>
<td></td>
</tr>
<tr>
<td>Losses2</td>
<td>57</td>
<td>$0.25***</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>(3.80)</td>
<td>(2.83)</td>
<td></td>
</tr>
<tr>
<td>Gains3</td>
<td>15</td>
<td>-$0.03</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>(-0.18)</td>
<td>(-0.52)</td>
<td></td>
</tr>
<tr>
<td>Losses3</td>
<td>85</td>
<td>$0.23***</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>(4.45)</td>
<td>(3.87)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Differences within Merged Treatments</th>
<th>Tokens-merged</th>
<th>Cash-merged</th>
<th>E-Coins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Losses1 – Gains1</td>
<td>$0.11</td>
<td>$0.01</td>
<td>-$0.35**</td>
</tr>
<tr>
<td></td>
<td>(0.97)</td>
<td>(0.08)</td>
<td>(-1.86)</td>
</tr>
<tr>
<td>Losses2 – Gains2</td>
<td>$0.16*</td>
<td>$0.01</td>
<td>-$0.35**</td>
</tr>
<tr>
<td></td>
<td>(1.35)</td>
<td>(0.07)</td>
<td>(-1.76)</td>
</tr>
</tbody>
</table>
Table 4: Differences Across Treatments
Using the net gain/loss definition (Losses2 and Gains2), we show the difference in amount risked across the three media of exchange. We compare this change in amount risked going into the final round for those with net losses (Losses2) to the same number in another treatment. The average of this difference is reported, and the $t$-stat of the difference in the two series is reported in parentheses.

*** indicates significantly different from zero at 1%, ** at 5%, and * at 10%.

<table>
<thead>
<tr>
<th>Media Comparison</th>
<th>Losses2</th>
<th>Gains2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tokens – Money</td>
<td>$0.07</td>
<td>-$0.08</td>
</tr>
<tr>
<td></td>
<td>(0.75)</td>
<td>(-0.58)</td>
</tr>
<tr>
<td>Tokens – E-coins</td>
<td>$0.33**</td>
<td>-$0.18</td>
</tr>
<tr>
<td></td>
<td>(2.16)</td>
<td>(-1.03)</td>
</tr>
<tr>
<td>Money – E-coins</td>
<td>$0.26**</td>
<td>-$0.10</td>
</tr>
<tr>
<td></td>
<td>(1.71)</td>
<td>(-0.58)</td>
</tr>
</tbody>
</table>
Table 5: Amount Bet in Each Round

Panel A of this table shows the average amount bet in each round for each medium of exchange (with tokens and cash each having their realized and unrealized treatments merged). These amounts are unconditional on current wealth. Panel B shows the difference of these average bets in each round across the media of exchange. $t$-stats are reported in parentheses. *** indicates significantly different from zero at 1%, ** at 5%, and * at 10%.

<table>
<thead>
<tr>
<th></th>
<th>Round 1 Bet</th>
<th>Round 2 Bet</th>
<th>Round 3 Bet</th>
<th>Round 4 Bet</th>
<th>All rounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tokens</td>
<td>$0.83</td>
<td>$0.78</td>
<td>$0.78</td>
<td>$0.97</td>
<td>$0.84</td>
</tr>
<tr>
<td>Cash</td>
<td>$0.76</td>
<td>$0.77</td>
<td>$0.77</td>
<td>$0.94</td>
<td>$0.81</td>
</tr>
<tr>
<td>E-coins</td>
<td>$1.00</td>
<td>$0.98</td>
<td>$0.98</td>
<td>$1.09</td>
<td>$1.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Round 1</th>
<th>Round 2</th>
<th>Round 3</th>
<th>Round 4</th>
<th>All rounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tokens vs e-coins</td>
<td>-$0.18**</td>
<td>-$0.20**</td>
<td>-$0.20**</td>
<td>-$0.12</td>
<td>-$0.18**</td>
</tr>
<tr>
<td></td>
<td>(-1.76)</td>
<td>(-1.73)</td>
<td>(-1.71)</td>
<td>(-0.98)</td>
<td>(-1.78)</td>
</tr>
<tr>
<td>Cash vs e-coins</td>
<td>-$0.25***</td>
<td>-$0.20**</td>
<td>-$0.21**</td>
<td>-$0.15</td>
<td>-$0.20**</td>
</tr>
<tr>
<td></td>
<td>(-2.57)</td>
<td>(-1.85)</td>
<td>(-1.81)</td>
<td>(-1.18)</td>
<td>(-2.14)</td>
</tr>
<tr>
<td>Tokens vs cash</td>
<td>$0.07</td>
<td>$0.01</td>
<td>$0.01</td>
<td>$0.02</td>
<td>$0.02</td>
</tr>
<tr>
<td></td>
<td>(0.81)</td>
<td>(0.07)</td>
<td>(0.06)</td>
<td>(0.23)</td>
<td>(0.32)</td>
</tr>
</tbody>
</table>
Table 6: Change in Amount Risked in Earlier Rounds

Panel A of this table shows the average change in subjects’ amount risked going into Round 3 (Round 3 compared to Round 2) for tokens, cash, and e-coins. As in Table 3, the unrealized and realized treatments are combined into one for cash and tokens. First, the full-sample results for each treatment are given (unconditional on gains or losses). Then, we report the results for those who won in at least one of the first two rounds (Gains1), followed by those who lost in both Rounds 1 and 2 (Losses1). Then, we split the subjects by those who have a net gain going into Round 3 (Gains2) versus those who have a net loss (Losses2). The number of subjects in each category is given as well.

Panel B shows these results going into Round 2. Here, the results are split based only on winning (Gains1) and losing (Losses1) in Round 1, with unconditional results shown as well. *t*-stats are reported in parentheses. *** indicates significantly different from zero at 1%, ** at 5%, and * at 10%.

Panel A: Round 2 to Round 3

<table>
<thead>
<tr>
<th></th>
<th>Tokens-merged</th>
<th></th>
<th>Cash-merged</th>
<th></th>
<th>E-Coins</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Δ $ risked</td>
<td>N</td>
<td>Δ $ risked</td>
<td>N</td>
<td>Δ $ risked</td>
</tr>
<tr>
<td>Full sample</td>
<td>100</td>
<td>-$0.01 (-0.11)</td>
<td>103</td>
<td>-$0.00 (-0.10)</td>
<td>57</td>
<td>$0.00 (0.00)</td>
</tr>
<tr>
<td>Gains1</td>
<td>33</td>
<td>$0.06 (0.57)</td>
<td>33</td>
<td>-$0.12* (-1.47)</td>
<td>23</td>
<td>-$0.09 (-0.68)</td>
</tr>
<tr>
<td>Losses1</td>
<td>67</td>
<td>-$0.04 (-0.90)</td>
<td>70</td>
<td>$0.05 (0.90)</td>
<td>34</td>
<td>$0.06 (1.03)</td>
</tr>
<tr>
<td>Gains2</td>
<td>27</td>
<td>-$0.03 (-0.27)</td>
<td>31</td>
<td>-$0.13* (-1.48)</td>
<td>21</td>
<td>-$0.10 (-0.68)</td>
</tr>
<tr>
<td>Losses2</td>
<td>66</td>
<td>$0.00 (0.07)</td>
<td>68</td>
<td>$0.05 (0.83)</td>
<td>33</td>
<td>$0.05 (0.80)</td>
</tr>
</tbody>
</table>

Panel B: Round 1 to Round 2

<table>
<thead>
<tr>
<th></th>
<th>Tokens-merged</th>
<th></th>
<th>Cash-merged</th>
<th></th>
<th>E-Coins</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Δ $ risked</td>
<td>N</td>
<td>Δ $ risked</td>
<td>N</td>
<td>Δ $ risked</td>
</tr>
<tr>
<td>Full sample</td>
<td>100</td>
<td>-$0.04 (-0.90)</td>
<td>103</td>
<td>$0.02 (0.39)</td>
<td>57</td>
<td>-$0.03 (-0.42)</td>
</tr>
<tr>
<td>Gains1</td>
<td>17</td>
<td>-$0.16*** (-2.86)</td>
<td>20</td>
<td>-$0.13 (-1.27)</td>
<td>12</td>
<td>-$0.15 (-1.00)</td>
</tr>
<tr>
<td>Losses1</td>
<td>83</td>
<td>-$0.02 (-0.33)</td>
<td>83</td>
<td>$0.05 (1.07)</td>
<td>45</td>
<td>$0.01 (0.08)</td>
</tr>
</tbody>
</table>
Appendix A: Prospect Theory Parameters and Wealth Effects

This appendix illustrates that prospect theory (hereafter ‘PT’; Kahneman and Tversky (1979); Quiggin (1982); Tversky and Kahneman (1992)) coupled with the integration of outcomes can account for modal wealth effects of either sign (i.e., house money and break-even). Additionally, we show that wealth effects are likely to be reduced in lower-moneyness environments provided that lower moneyness is associated with lower loss aversion.

The main characteristics of PT are: 1) utility is a function of changes from the initial wealth level (which is often referred to as the status quo or reference point, or functionally speaking the origin); 2) losses are felt more keenly than gains (loss aversion); 3) while utility function concavity exists in the gain domain (as in expected utility theory), convexity (suggesting risk seeking) exists in the loss domain; and 4) a non-linear inverted-S-shaped probability weighting function is used to weight utilities. The key attribute of PT driving wealth effects is loss aversion coupled with outcome integration (which is not part of original PT but is discussed in later research). We first simplify by using a stripped-down version of PT, which assumes a two-part linear utility function with a kink at the origin and a steeper slope in the loss domain (reflecting loss aversion) and no probability weighting. After a change in wealth of either sign, the investor moves away from the loss-averse kink. If fresh risky choices are unlikely to move the investor into the other domain, risk taking should rise (i.e., both house money and break-even result). As illustrated in Figure A-1, loss aversion dictates that fair (say $100) coin-flip gambles are avoided. However, if a wealth change resulting from a winning/losing coin flip moves the decision-maker far enough away from the initial wealth level so that a second coin-flip gamble, when integrated with this wealth change, is either entirely in the gain/loss domain, then risk neutrality (which implies a rise in risk taking relative to the risk aversion induced by loss aversion inherent in the original coin flip) is present.

The situation is somewhat complicated by utility function curvature. Suppose for simplicity that curvature is identical in the positive and negative domains (i.e., the power function coefficients are the same in both domains), and we continue to assume no probability weighting (rather than probability distortion). First, assume there is no loss aversion. Then decision-makers would be risk-neutral toward coin flips, but after winning a coin flip and integrating this outcome with future choices they would be risk-averse towards the next coin flip given utility function concavity in the
positive domain. So reverse house-money behavior results. A similar result in the negative domain produces reverse break-even behavior.

Despite this complication, most of the time it is likely that loss aversion “swamps” utility function curvature. To see this, let’s use Tversky and Kahneman’s (1992) estimates of the prospect theory parameters for an average individual. Their power function coefficient is .88 (in both domains) and their loss aversion coefficient is 2.25. To see that house money (for example) continues to exist, at the original wealth level one would be indifferent between accepting or rejecting a coin flip if the coin has been rigged to yield a winning flip 69.23% of the time (implying an expected gain of $38.46). On the other hand, after winning the first coin flip, one would be indifferent between accepting or rejecting a new coin flip if the coin has been rigged to yield a winning flip 54.34% of the time (implying an expected gain of $8.67). Thus, house money is present for this average decision-maker. But other decision-makers might have more curvature and less loss aversion, to the point where reverse house money is implied. Since in reality there is heterogeneity in behavior (e.g., Deaves, Kluger and Miele (2018)), this is exactly what we should expect.

Finally, we show that less loss aversion implies reduced house money (and reduced break-even in the negative domain).vii To demonstrate, we keep the parameters as above but with one change, namely that the loss aversion coefficient drops from 2.25 to 1.625 (i.e., it moves halfway towards unity). In this case, at the original wealth level one would be indifferent between accepting or rejecting a coin flip if the coin has been rigged to yield a winning flip 61.90% of the time (implying an expected gain of $23.81). After a winning coin flip, loss aversion does not come into play, so the previous probability of 54.34% (implying an expected gain of $8.67) continues to hold. Since the gap between the two cases in terms of expected gain is lower in the presence of lower loss aversion, the implication is that the house-money effect is reduced. A similar result holds for the break-even effect in the negative domain.viii
FIGURE A-1: Wealth effects under PT

\[ u = \frac{1}{2} \cdot 100(100)^2 - 100^2 - 100 \]

$u$ of coin flip
(+$100$ integrated)

$\Delta w$

$u$ of coin flip
($-100$ integrated)

A

E

D

C

B

u
REFERENCES


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i This appendix borrows heavily from Deaves, Miele, and Tsang (2019).
ii There is evidence that PT does a better job explaining the behavior of decision-makers confronting risky choices than does expected utility theory (e.g., Post, Van den Assem, Baltussen, and Thaler (2008)).
iii For example, see Thaler and Johnson (1990) and Benartzi and Thaler (1995).
iv This figure is the same as Figure 2 in Deaves, Miele, and Tsang (2019).
v The power function is the conventional functional form for the utility function under PT (Wakker (2010)).
vi Note that those modeling PT to account for path dependence routinely ignore probability weighting. An example is Grinblatt and Han’s (2005) model of momentum and the disposition effect based on PT.
vii The logic behind loss aversion falling as moneyness falls is that psychologically speaking the loss of something less money-like is less painful.
viii It is also theoretically possible that in a situation where there is less moneyness there is a reduced tendency to integrate outcomes, and it is this that leads to what we find. However, it is not obvious why this should be so, which is which is why we favor an explanation based on a change in loss aversion as spelled out in this paragraph.
ix These are references not included in the main reference list.
Appendix B: Subject Instructions

A. EXPERIMENTAL INSTRUCTIONS FOR MONEY REALIZED TREATMENT

- Welcome to this experimental study of decision-making involving money and risk. Once you go through these brief instructions and have questions answered, the experiment will take about 15-20 minutes.
- The computer that you have been assigned to will be used for this experiment. It is important that during the experiment you do not communicate in any way with other participants! Also, please fully turn off your phone now! And computers should only be used to participate in the experiment.
- You will all receive a show-up fee of $5 at the end. In a few minutes you will also receive a plastic tray containing 32 quarters. (In other words, you have $8 in the tray. Note that at the end of the experiment any quarters you have can be exchanged – 4 quarters per dollar bill – for dollar bills.) You may be able to increase your experimental wealth by purchasing lottery tickets over a series of rounds. It is also possible that in doing so your experimental wealth will go down.
- There will be 4 rounds. In each round you can buy from 1 to 8 lottery tickets (each costing a quarter). (You have the option to not buy any tickets in any round!) With a 1/6 chance (16%) you will win a prize of 7 quarters per ticket purchased. (For example, if you bought 4 tickets and you are successful you will win 28 quarters.) But with a 5/6 (84%) chance you will win nothing.
- Each round will work like this. First refer to Screenshot A. Notice both the Beginning Experimental Wealth of $8 and the Current Experimental Wealth which starts at $8 are shown. Since it’s at the beginning there’s no difference. Over time Current Experimental Wealth can rise or fall. Also notice that you need to ‘click’ to receive a random number (a number between 1 and 6). You may want to note this random number in the box at the bottom of the next page. This process will be repeated in all 4 rounds.

Screenshot A

![Screenshot A](image)

Screenshot B

![Screenshot B](image)
• Then you must decide how many tickets to buy (if any). You should type in your choice in the appropriate box (see Screenshot B) and click ‘save.’ After all students have made their choice, the experimenter will roll a normal 6-sided die. (The die roll will be shown on the overhead projector.) If the number of the die roll is the same as your number, you will win the prize; otherwise you will win nothing. After the die roll the experimenters will come around to confirm you have entered the number of the die roll correctly. Please do NOT click ‘continue’ until one of the experimenters has given you permission.

• You might be wondering if you will increase your experimental wealth on average by buying tickets. The answer is yes. On average you will increase your experimental wealth because the prize (7 quarters per ticket) is high enough to offset the fairly low probability of success (1/6). But you only have 4 rounds. Based on these probabilities, there is a 48% chance your number will never come up, and a 52% chance that it will come up at least once.
• After the die roll, your computer screen will show you the latest level of Current Experimental Wealth.
• At the end of the 3rd round (of 4) one of the experimenters will come to collect any losses you have made up to that point. You should take the required amount from your tray and give it to the experimenter.
• If your experimental wealth has increased up to that point the experimenter will give you this amount which you should deposit in your tray.
• After this wealth adjustment the 4th round starts as usual. As in previous rounds a random number will appear on your computer screen and you must choose how many lottery tickets to buy.
• After the 4th and final round die roll we will call you up one at a time to pay you your Final Experimental Wealth (based on how many quarters you end up with). Also, at this point the $5 show-up fee is paid to each student.
• After the final settling is done for ALL students, the experiment is complete.
• We thank you in advance for your very helpful participation!
• Please wait till everyone has read through these instructions. Then as we said there will be an opportunity to ask questions. After this, before beginning the actual experiment, you will need to answer 3 questions on the computer screen to make sure that you understand how the experiment will work. We will also ask for some basic information on another screen before Round 1 begins. Once everybody has completed this very brief task, the first round will begin…

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B. EXPERIMENTAL INSTRUCTIONS FOR MONEY UNREALIZED TREATMENT

- Welcome to this experimental study of decision-making involving money and risk. Once you go through these brief instructions and have questions answered, the experiment will take about 15-20 minutes.

- The computer that you have been assigned to will be used for this experiment. It is important that during the experiment you do not communicate in any way with other participants! Also, please fully turn off your phone now! And computers should only be used to participate in the experiment.

- You will all receive a show-up fee of $5 at the end. In a few minutes you will also receive a plastic tray containing 32 quarters. (In other words, you have $8 in the tray. Note that at the end of the experiment any quarters you have can be exchanged – 4 quarters per dollar bill – for dollar bills.) You may be able to increase your experimental wealth by purchasing lottery tickets over a series of rounds. It is also possible that in so doing your experimental wealth will go down.

- There will be 4 rounds. In each round you can buy from 1 to 8 lottery tickets (each costing a quarter). (You have the option to not buy any tickets in any round!) With a 1/6 chance (16%) you will win a prize of 7 quarters per ticket purchased. (For example, if you bought 4 tickets and you are successful you will win 28 quarters.) But with a 5/6 (84%) chance you will win nothing.

- Each round will work like this. First refer to Screenshot A. Notice both the Beginning Experimental Wealth of $8 and the Current Experimental Wealth which starts at $8 are shown. Since it’s at the beginning there’s no difference. Over time Current Experimental Wealth can rise or fall. Also notice that you need to ‘click’ to receive a random number (a number between 1 and 6). You may want to note this random number in the box at the bottom of the next page. This process will be repeated in all 4 rounds.

  Screenshot A  

  ![Screenshot A](image1.png)  

  Screenshot B  

  ![Screenshot B](image2.png)

- Then you must decide how many tickets to buy (if any). You should type in your choice in the appropriate box (see Screenshot B) and click ‘save.’ After all students have made
their choice, the experimenter will roll a normal 6-sided die. (The die roll will be shown on the overhead projector.) If the number of the die roll is the same as your number, you will win the prize; otherwise you will win nothing. After the die roll the experimenters will come around to confirm you have entered the number of the die roll correctly. Please do NOT click ‘continue’ until one of the experimenters has given you permission.

- You might be wondering if you will increase your experimental wealth on average by buying tickets. The answer is yes. On average you will increase your experimental wealth because the prize (7 quarters per ticket) is high enough to offset the fairly low probability of success (1/6). But you only have 4 rounds. Based on these probabilities, there is a 48% chance your number will never come up, and a 52% chance that it will come up at least once.

- After the die roll, your computer screen will show you the latest level of Current Experimental Wealth.

- After the 4th and final round die roll we will call you up one at a time to pay you your Final Experimental Wealth (based on how many quarters you end up with). Also, at this point the $5 show-up fee is paid to each student.

- After the final settling is done for ALL students, the experiment is complete.

- We thank you in advance for your very helpful participation!

- Please wait till everyone has read through these instructions. Then as we said there will be an opportunity to ask questions. After this, before beginning the actual experiment, you will need to answer 3 questions on the computer screen to make sure that you understand how the experiment will work. We will also ask for some basic information on another screen before Round 1 begins. Once everybody has completed this very brief task, the first round will begin…

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C. EXPERIMENTAL INSTRUCTIONS FOR REALIZED TOKENS TREATMENT

- Welcome to this experimental study of decision-making involving money and risk. Once you go through these brief instructions and have questions answered, the experiment will take about 15-20 minutes.

- The computer that you have been assigned to will be used for this experiment. It is important that during the experiment you do not communicate in any way with other participants! Also, please fully turn off your phone now! And computers should only be used to participate in the experiment.

- You will all receive a show-up fee of $5 at the end. In a few minutes you will also receive a plastic tray containing 32 tokens. Each is worth 25 cents. (In other words, you have $8 worth of tokens in the tray. Note that at the end of the experiment any tokens you have will be exchanged into money.) You may be able to increase your experimental wealth by purchasing lottery tickets over a series of rounds. It is also possible that in so doing your experimental wealth will go down.

- There will be 4 rounds. In each round you can buy from 1 to 8 lottery tickets (each costing a token). (You have the option to not buy any tickets in any round!) With a 1/6 chance (16%) you will win a prize of 7 tokens per ticket purchased. (For example, if you bought 4 tickets and you are successful, you will win 28 tokens.) But with a 5/6 (84%) chance you will win nothing.

- Each round will work like this. First refer to Screenshot A. Notice both the Beginning Experimental Wealth of 32 tokens (worth $8) and the Current Experimental Wealth which starts at 32 tokens (worth $8) are shown. Since it’s at the beginning there’s no difference. Over time Current Experimental Wealth can rise or fall. Also notice that you need to ‘click’ to receive a random number (a number between 1 and 6). You may want to note this random number in the box at the bottom of the next page. This process will be repeated in all 4 rounds.

**Screenshot A**

![Screenshot A]

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**Screenshot B**

![Screenshot B]
• Then you must decide how many tickets to buy (if any). You should type in your choice in the appropriate box (see Screenshot B) and click ‘save.’ After all students have made their choice, the experimenter will roll a normal 6-sided die. (The die roll will be shown on the overhead projector.) If the number of the die roll is the same as your number, you will win the prize; otherwise you will win nothing. After the die roll the experimenters will come around to confirm you have entered the number of the die roll correctly. Please do NOT click ‘continue’ until one of the experimenters has given you permission.

• You might be wondering if you will increase your experimental wealth on average by buying tickets. The answer is yes. On average you will increase your experimental wealth because the prize (7 tokens per ticket) is high enough to offset the fairly low probability of success (1/6). But you only have 4 rounds. Based on these probabilities, there is a 48% chance your number will never come up, and a 52% chance that it will come up at least once.

• After the die roll, your computer screen will show you the latest level of Current Experimental Wealth.

• At the end of the 3rd round (of 4) one of the experimenters will come to collect any losses you have made up to that point. You should take the required amount from your tray and give it to the experimenter.

• If your experimental wealth has increased up to that point the experimenter will give you this amount which you should deposit in your tray.

• After this wealth adjustment the 4th round starts as usual. As in previous rounds a random number will appear on your computer screen, and you must choose how many lottery tickets to buy.

• After the 4th and final round die roll we will call you up one at a time to pay you your Final Experimental Wealth (how many tokens in your tray converted to cash). Also, at this point the $5 show-up fee is paid to each student.

• After the final settling is done for ALL students, the experiment is complete.

• We thank you in advance for your very helpful participation!

• Please wait till everyone has read through these instructions. Then as we said there will be an opportunity to ask questions. After this, before beginning the actual experiment, you will need to answer 3 questions on the computer screen to make sure that you understand how the experiment will work. We will also ask for some basic information on another screen before Round 1 begins. Once everybody has completed this very brief task, the first round will begin…

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D. EXPERIMENTAL INSTRUCTIONS FOR UNREALIZED TOKENS TREATMENT

• Welcome to this experimental study of decision-making involving money and risk. Once you go through these brief instructions and have questions answered, the experiment will take about 15-20 minutes.

• The computer that you have been assigned to will be used for this experiment. It is important that during the experiment you do not communicate in any way with other participants! Also, please fully turn off your phone now! And computers should only be used to participate in the experiment.

• You will all receive a show-up fee of $5 at the end. In a few minutes you will also receive a plastic tray containing 32 tokens. Each is worth 25 cents. (In other words, you have $8 worth of tokens in the tray. Note that at the end of the experiment any tokens you have will be exchanged into money.) You may be able to increase your experimental wealth by purchasing lottery tickets over a series of rounds. It is also possible that in so doing your experimental wealth will go down.

• There will be 4 rounds. In each round you can buy from 1 to 8 lottery tickets (each costing a token). (You have the option to not buy any tickets in any round!) With a 1/6 chance (16%) you will win a prize of 7 tokens per ticket purchased. (For example, if you bought 4 tickets and you are successful you will win 28 tokens.) But with a 5/6 (84%) chance you will win nothing.

• Each round will work like this. First refer to Screenshot A. Notice both the Beginning Experimental Wealth of 32 tokens (worth $8) and the Current Experimental Wealth which starts at 32 tokens (worth $8) are shown. Since it’s at the beginning there’s no difference. Over time Current Experimental Wealth can rise or fall. Also notice that you need to ‘click’ to receive a random number (a number between 1 and 6). You may want to note this random number in the box at the bottom of the next page. This process will be repeated in all 4 rounds.

Screenshot A

Screenshot B
Then you must decide how many tickets to buy (if any). You should type in your choice in the appropriate box (see Screenshot B) and click ‘save.’ After all students have made their choice, the experimenter will roll a normal 6-sided die. (The die roll will be shown on the overhead projector.) If the number of the die roll is the same as your number, you will win the prize; otherwise you will win nothing. After the die roll the experimenters will come around to confirm you have entered the number of the die roll correctly. Please do NOT click ‘continue’ until one of the experimenters has given you permission.

You might be wondering if you will increase your experimental wealth on average by buying tickets. The answer is yes. On average you will increase your experimental wealth because the prize (7 tokens per ticket) is high enough to offset the fairly low probability of success (1/6). But you only have 4 rounds. Based on these probabilities, there is a 48% chance your number will never come up, and a 52% chance that it will come up at least once.

After the die roll, your computer screen will show you the latest level of Current Experimental Wealth.

After the 4th and final round die roll we will call you up one at a time to pay you your Final Experimental Wealth (how many tokens in your tray converted to cash). Also, at this point the $5 show-up fee is paid to each student.

After the final settling is done for ALL students, the experiment is complete.

We thank you in advance for your very helpful participation!

Please wait till everyone has read through these instructions. Then as we said there will be an opportunity to ask questions. After this, before beginning the actual experiment, you will need to answer 3 questions on the computer screen to make sure that you understand how the experiment will work. We will also ask for some basic information on another screen before Round 1 begins. Once everybody has completed this very brief task, the first round will begin…

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E. EXPERIMENTAL INSTRUCTIONS FOR E-COINS TREATMENT

- Welcome to this experimental study of decision-making involving money and risk. Once you go through these brief instructions and have questions answered, the experiment will take about 15-20 minutes.
- The computer that you have been assigned to will be used for this experiment. It is important that during the experiment you do not communicate in any way with other participants! Also, please fully turn off your phone now! And computers should only be used to participate in the experiment.
- You will all receive a show-up fee of $5 at the end. In a few minutes you will also virtually be assigned 32 “e-coins”. Each is worth 25 cents. (In other words, you will have $8 worth of e-coins. Note that at the end of the experiment any e-coins you have will be exchanged into cash.) You may be able to increase your experimental wealth by purchasing lottery tickets over a series of rounds. It is also possible that in so doing your experimental wealth will go down.
- There will be 4 rounds. In each round you can buy from 1 to 8 lottery tickets (each costing 1 e-coin). (You have the option to not buy any tickets in any round!) With a 1/6 chance (16%) you will win a prize of 7 e-coins per ticket purchased. (For example, if you bought 4 tickets and you are successful you will win 28 e-coins.) But with a 5/6 (84%) chance you will win nothing.
- Each round will work like this. First refer to Screenshot A. Notice both the Beginning Experimental Wealth of 32 e-coins (worth $8) and the Current Experimental Wealth which starts at 32 e-coins (worth $8) are shown. Since it’s at the beginning there’s no difference. Over time Current Experimental Wealth can rise or fall. Also notice that you need to ‘click’ to receive a random number (a number between 1 and 6). You may want to note this random number in the box at the bottom of the next page. This process will be repeated in all 4 rounds.

Screenshot A

Screenshot B
• Then you must decide how many tickets to buy (if any). You should type in your choice in the appropriate box (see Screenshot B) and click ‘save.’ After all students have made their choice, the experimenter will roll a normal 6-sided die. (The die roll will be shown on the overhead projector.) If the number of the die roll is the same as your number, you will win the prize; otherwise you will win nothing. After the die roll the experimenters will come around to confirm you have entered the number of the die roll correctly. Please do NOT click ‘continue’ until one of the experimenters has given you permission.

• You might be wondering if you will increase your experimental wealth on average by buying tickets. The answer is yes. On average you will increase your experimental wealth because the prize (7 e-coins per ticket) is high enough to offset the fairly low probability of success (1/6). But you only have 4 rounds. Based on these probabilities, there is a 48% chance your number will never come up, and a 52% chance that it will come up at least once.

• After the die roll, your computer screen will show you the latest level of Current Experimental Wealth.

• After the 4th and final round die roll we will call you up one at a time to pay you your Final Experimental Wealth (how many e-coins you have will be converted to cash). Also, at this point the $5 show-up fee is paid to each student.

• After the final settling is done for ALL students, the experiment is complete.

• We thank you in advance for your very helpful participation!

• Please wait till everyone has read through these instructions. Then as we said there will be an opportunity to ask questions. After this, before beginning the actual experiment, you will need to answer 3 questions on the computer screen to make sure that you understand how the experiment will work. We will also ask for some basic information on another screen before Round 1 begins. Once everybody has completed this very brief task, the first round will begin...

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