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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 the investment game of 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.

1. Introduction

Abundant evidence demonstrates financial decision-making is path-dependent.[1] For example, wealth effects are commonly reported, whereby risk taking is influenced by prior changes in wealth, with the house-money effect (i.e., increased risk taking after gains) and the break-even effect (i.e., increased risk taking after losses) commonly reported.[2] Sometimes, however, reverse behaviors (i.e., decreased risk taking after gains or losses) are observed.[3] Since it is difficult to make the case that such tendencies are not suboptimal behaviors, an important research question is what environmental factors induce different wealth effects.[4] Importantly, the framing of the experimental task can significantly impact results, with Weber and Zuchel (2005) finding that manipulating the presentation format of the decision problem induces different wealth effects.

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 as having a lower degree of moneyness. Hochman et al. (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],

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1 The disposition effect and various wealth effects appear to be the two most researched path-dependent financial behaviors. Recent work on the disposition effect includes Talpsepp et al. (2014) and Aspara and Hoffmann (2015). Kaustia (2010) extensively reviews the disposition effect, as do Deaves et al. (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).

2 For example, for the house money effect, see Thaler and Johnson (1990) and Post et al. (2008) and for the break-even effect Gneezy and Potters (1997), Langer and Weber (2008), Coval and Shumway (2005) and Post et al. (2008).

3 For example, for the reverse house-money effect see Schneider et al. (2016) and Rüdisser et al. (2017) and for the reverse break-even effect Shiv et al. (2005), Cameron and Shah (2015) and Cassar et al. (2017). Despite the conflicting evidence, the house money effect appears more frequently than its reverse, while break-even appears more frequently than its reverse (Deaves et al. (2018)).

4 For a discussion of optimality, see Deaves et al. (2019).

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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 et al. (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 et al. (2010) find decreased risk taking after morning losses among leading traders in a Taiwan option market. Merkle et al. (2018) (hereafter 'MMW18') replicate the realization effect of Imas16 using the latter's positively-skewed setting. MMW18 then shows, both theoretically and empirically, that loss chasing (and thus the realization effect) is not predicted to be observed in non-positively-skewed settings.

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, 1999) and 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 (independent of prior changes in wealth). 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 that is independent of prior changes in wealth, it might also influence risk aversion that is conditional on prior changes in wealth, i.e., wealth effects. In prospect theory, risk aversion is a function of the parameters of the utility function and the probability weighting function (e.g., 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).[5]

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 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 four-round investment/lottery game of Imas16 and Gneezy and Potters (1997), although we frame the decision as a lottery rather than an investment. As in Imas16 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

[5] 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 the Appendix A for more details and an example.

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.[6] 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 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.

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. Fig. 1 displays our 2x2 design for Study 1. The experiment was conducted using ZTree (Fischbacher (2007)).

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 zero 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 six-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 as in Imas16. Of course, the main difference between our design and that of Imas16 is that our design is framed as a lottery decision while Imas16 is framed as an investment decision. 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).[7]

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 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 the experimenters tell subjects that they need to check everything on the computer to be sure all data has been recorded correctly. After about a couple of minutes, the experimenters then go around the room to each subject's computer screen to confirm that their current earnings are displayed correctly.[8]

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. We tell subjects that they will 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 can 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.

6 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 the online appendix 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.

7 The subject instructions in the online appendix contain some sample screenshots of what the subjects' computer screens displayed.

8 This procedure is similar to that of Imas16.

Table 1
Summary statistics.

	Total (Study 1 and Study 2)	Male	Female	Freshman	Sophomore	Junior	Senior or above
N:	260	127	133	53	60	88	59
	Unrealized tokens	Realized tokens	Unrealized cash	Realized cash	E-Coins (Study 2)		
N by treatment:	50	50	48	55	57		

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.

Fig. 1. Four treatments in study 1.

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., we 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 (across the columns). In 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 *net* gains (Gains2 in Row 4) or *net* losses (Losses2 in Row 5) going into the final round.[9] Note that subjects whose wealth has not changed in the first three rounds would not show up in either Gains2 or Losses2. Thus, the total sample size may differ compared to the first approach. 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.

3.1.1. 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. (2018), McKenzie et al. (2016), and Imas16, but not in all treatments in MMW18, Shiv et al. (2005), and Coval and Shumway (2005).

[9] Depending on bets, those experiencing "gains" or "losses" according to this first method may *not* have experienced true *net* gains/losses.

3.1.2. 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 4 and 5. Beginning with gains, while subjects in this category increase risk taking in all cases, the increase is only statistically significant in the unrealized cash treatment. In the unrealized cash treatment subjects with a net gain increase their bet by $0.23 on average 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 in all four treatments with the average amount risked increasing from $0.18 to $0.27 across the four treatments.

Unlike Imas16 and MMW18, 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 (2005) show that framing decisions as lottery purchases amplifies the break-even effect. Specifically, we find that subjects who are given physical media and are facing losses *always* increase risk taking going into the final round, regardless of whether the losses (or gains) are 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.

3.1.3. 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 our discussion to Gains1 minus Losses1 and Gains2 minus Losses2.

The results show that, while the difference in behavior is much greater on average in the tokens treatments than in the cash treatments, the differences were not statistically different from zero. 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

Table 2
Final round results.

Panel A: Results by treatment

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

Panel B: Differences within treatments

	Tokens-realized	Cash-realized	Tokens-unrealized	Cash-unrealized
Losses1 – Gains1	$0.15 (1.18)	$0.05 (0.31)	$0.06 (0.32)	−$0.03 (−0.19)
Losses2 – Gains2	$0.15 (1.06)	$0.05 (0.31)	$0.17 (0.86)	−$0.03 (−0.19)

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 average 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). In the next row, we report the average 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%.

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.

3.1.4. 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, 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. 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.

3.1.5. 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, with 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. The coefficient on Losses2 is negative and not statistically different from zero.

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 different amount when facing a net

Table 3
Final round results for merged cash, merged tokens, and e-coins treatments.

Panel A: Results by merged treatment						
	Tokens-merged		Cash-merged		E-Coins	
	N	Δ $ risked	N	Δ $ risked	N	Δ $ risked
Full sample	100	$0.19*** (3.67)	103	$0.17*** (3.19)	57	$0.11 (1.16)
Gains1	42	$0.13* (1.48)	50	$0.17** (1.88)	30	$0.28** (2.11)
Losses1	58	$0.24*** (3.72)	53	$0.18*** (2.75)	27	−$0.07 (−0.54)
Gains2	36	$0.10 (1.02)	47	$0.18** (1.83)	27	$0.28** (1.90)
Losses2	57	$0.25*** (3.80)	53	$0.18*** (2.83)	27	−$0.07 (−0.54)
Gains3	15	−$0.03 (−0.18)	23	−$0.05 (−0.52)	9	$0.17 (0.58)
Losses3	85	$0.23*** (4.45)	80	$0.24*** (3.87)	48	$0.10 (0.99)

Panel B: Differences within merged treatments			
	Tokens-merged	Cash-merged	E-Coins
Losses1 – Gains1	$0.11 (0.97)	$0.01 (0.08)	−$0.35** (−1.86)
Losses2 – Gains2	$0.16* (1.35)	$0.01 (0.07)	−$0.35** (−1.76)

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 average 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). In the next row, we report the average 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%.

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 do not observe any statistical difference in the house-money effect across treatments.

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.

Table 4
Differences across treatments.

	Losses2	Gains2
Tokens – Cash	$0.07 (0.75)	−$0.08 (−0.58)
Tokens – E-coins	$0.33** (2.16)	−$0.18 (−1.03)
Cash – E-coins	$0.26** (1.71)	−$0.10 (−0.58)

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%.

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 more than those in the cash treatments. Note that tokens and cash are never more than $0.07 different 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.

3.2. Earlier-round wealth effects

Now we investigate earlier-round wealth effects. 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.

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.

Table 5
Amount bet in each round.

Panel A: Average amount bet					
	Round 1 bet	Round 2 bet	Round 3 bet	Round 4 bet	All rounds
Tokens	\$0.83	\$0.78	\$0.78	\$0.97	\$0.84
Cash	\$0.76	\$0.77	\$0.77	\$0.94	\$0.81
E-coins	\$1.00	\$0.98	\$0.98	\$1.09	\$1.01
Panel B: Differences across media of exchange					
	Round 1	Round 2	Round 3	Round 4	All rounds
Tokens vs. e-coins	−\$0.18** (−1.76)	−\$0.20** (−1.73)	−\$0.20** (−1.71)	−\$0.12 (−0.98)	−\$0.18** (−1.78)
Cash vs. e-coins	−\$0.25*** (−2.57)	−\$0.20** (−1.85)	−\$0.21** (−1.81)	−\$0.15 (−1.18)	−\$0.20** (−2.14)
Tokens vs. cash	\$0.07 (0.81)	\$0.01 (0.07)	\$0.01 (0.06)	\$0.02 (0.23)	\$0.02 (0.32)

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 6
Change in amount risked in earlier rounds.

Panel A: Round 2 to Round 3						
	Tokens-merged		Cash-merged		E-Coins	
	N	Δ \$ risked	N	Δ \$ risked	N	Δ \$ risked
Full sample	100	−\$0.01 (−0.11)	103	−\$0.00 (−0.10)	57	\$0.00 (0.00)
Gains1	33	\$0.06 (0.57)	33	−\$0.12* (−1.47)	23	−\$0.09 (−0.68)
Losses1	67	−\$0.04 (−0.90)	70	\$0.05 (0.90)	34	\$0.06 (1.03)
Gains2	27	−\$0.03 (−0.27)	31	−\$0.13* (−1.48)	21	−\$0.10 (−0.68)
Losses2	66	\$0.00 (0.07)	68	\$0.05 (0.83)	33	\$0.05 (0.80)
Panel B: Round 1 to Round 2						
	Tokens-merged		Cash-merged		E-Coins	
	N	Δ \$ risked	N	Δ \$ risked	N	Δ \$ risked
Full sample	100	−\$0.04 (−0.90)	103	\$0.02 (0.39)	57	−\$0.03 (−0.42)
Gains1	17	−\$0.16*** (−2.86)	20	−\$0.13 (−1.27)	12	−\$0.15 (−1.00)
Losses1	83	−\$0.02 (−0.33)	83	\$0.05 (1.07)	45	\$0.01 (0.08)

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%.

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 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 affects 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 as money, 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), Raghubir and Srivastava (2008), Stenstrom et al. (2018), Wang and Qin (2015), Falk et al. (2016)).

Our design (based on Imas16, but instead framed as a lottery) 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.

CRediT authorship contribution statement

Adam Stivers: Conceptualization, Formal analysis, Project administration. **Ming Tsang:** Software, Data curation, Investigation. **Richard Deaves:** Methodology, Writing - original draft. **Adam Hoffer:** Writing - review & editing, Resources, Funding acquisition.

Appendix A. Prospect Theory Parameters and Wealth Effects[10]

This appendix illustrates that prospect theory (hereafter 'PT'; Kahneman and Tversky (1979); Quiggin (1979); 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).[11] 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).[12] 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 Fig. A.1, loss aversion dictates that fair (say $100) coin-flip gambles are avoided.[13] 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.

10 This appendix borrows heavily from Deaves et al. (2019).

11 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 et al. (2008)).

12 For example, see Thaler and Johnson (1990) and Benartzi and Thaler (1995).

13 This figure is the same as Figure 2 in Deaves et al. (2019).

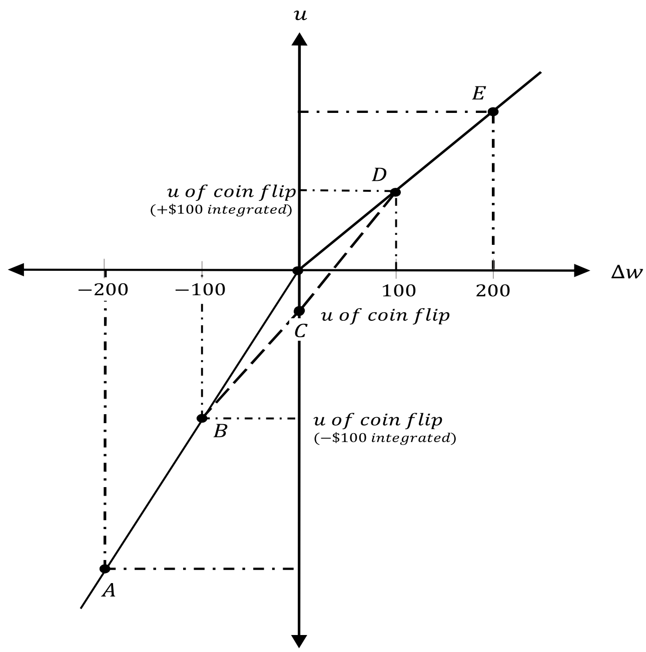

Fig. A.1. This figure shows the utility of a coin flip gamble under different wealth positions: A (−200), B (−100), C (0), D (+100), and E (+200). Utility of the coin flip (with gamble integration and prospect theory) is shown on the vertical axis, and wealth is shown on the horizontal axis.

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),[14] and we continue to assume no probability weighting (rather than probability distortion).[15] First, assume there is no loss aversion. Then decision-makers would be risk-neutral towards 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 us use Tversky and Kahneman (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 et al. (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).[16] 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.[17]

Appendix B. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jbef.2020.100323.

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14 The power function is the conventional functional form for the utility function under PT (Wakker, 2010).

15 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.

16 The logic behind loss aversion falling as moneyness falls is that psychologically speaking the loss of something less money-like is less painful.

17 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 why we favor an explanation based on a change in loss aversion as spelled out in this paragraph.

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