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Windfall Money, Earned Money, and All-Pay Auction: An Experimental Investigation*

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Abstract

I presented the results of a laboratory experiment designed to investigate the influence of house money effect on individuals' bidding behavior in multiple-period all-pay auction environment. The house money effect refers to the tendency for the presence of prior gain to modify individuals' behavior, causing them to spend more frivolously as well as increase their risk-seeking preference. Two distinct types of house money effects were investigated in this study; (1) the effect of prior outcome and (2) the effect of prior *unearned* gain. The results of the experiment showed that the prior outcome did not have any influence on bidders' decision in all-pay auction environment. Results also revealed that bidders, who were endowed with free and unanticipated seed money, placed higher bids relative to bidders who had to *earn* their own seed money. These results implied that windfall money caused individuals to become more spendthrift but not more risk-seeking in all-pay auction environment. The implication from the study is that researchers should be concerned of the usage of *unearned* seed money as it may have an effect on external validity of their experiment.

JEL Classification: C91, D44

Keywords: Experimental Methodology; All-Pay Auction; House Money Effect

1 Introduction

In many classes of economics experiments, researchers are required to endow the participants with initial endowment. For example, in dictator game and ultimatum game, standard experimental design dictates that experimenters endow the participants with initial seed money to be used by the participants to divide among themselves. For experiment with outcome(s) that may yield negative payoff to the participants, research participants are usually provided with initial endowment to ensure

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that their participation in the experiment did not cause them to lose any money[1].

Endowing research participants with money has its own problems as evidences from economics experiment have shown that the house money effect from the initial endowment distorts individuals' behaviors. The house money effect, first described by Thaler and Johnson (1990), refers to the tendency for the presence of prior gain to modify individuals' behavior, causing them to become more frivolous with their spending as well as become more risk-seeking. The term was derived from a casino phase, "playing with house money", which described gambling using money previously won from the casino.

Thaler and Johnson (1990), Keasy and Moon (1996), and Ackert et al. (2006) found that the presence of prior gain induced participants to exhibit risk-seeking behavior when they had to make decisions pertaining risky choices in laboratory experiments. Cherry et al. (2002), Oxoby and Spraggon (2006), and Carlsson et al. (2013) found that, in dictator game, dictators who had been endowed with seed money were significantly more likely to split their money with other participants in contrast to dictators who had to earn their own seed money. Arkes et al. (1994) found that individuals who had received unanticipated cash from the experimenters tend to spend more money on gambling and recreational activities than those who had received anticipated cash. Martinez et al. (2009) found that individuals who recently received cash from the experimenters at the beginning of the experiment exhibited higher tolerance to risk compared to those who received windfall cash three weeks prior to the experiment. The findings on the house money effect therefore challenge the external validity of laboratory experiments that made used of house money.

While experimental economics literature has largely confirmed the existence of the house money effect, the term might have been inadequately defined by economists. There are two distinct types of prior gain that have been encompassed by the term, "the house money effect"; prior *earned* gain and prior *unearned* gain. Prior *unearned* gain, also known as windfall money, refers to the gain that has not been anticipated and has not been earned through a meaningful way by the recipient (Arkes et al., 1994). An example of windfall gain is the initial endowment research participants received at the beginning of dictator game and ultimatum game. Prior *earned* gain, also known as earned money, refers to the gain that has been anticipated and has been rightfully earned by the recipient. Examples of earned money are the payoff research participants received from answering survey as well as the payoff participants received from prior phases(s) of the experiment. Participation fee from economic experiments can be considered as either windfall money or earned money, depending on whether or not it has been anticipated by the recipients. If research participants were informed about the participation fee only after the start of the experiment, then the fee is considered as windfall gain, otherwise it is considered as earned gain. To the best of my knowledge, prior research has not made any distinction between the two distinct types of house money effect.

Based on the above definitions of windfall money and earned money, there are three different types of study on the house money effect. Thaler and Johnson (1990) and Cherry et al. (2002) investigated

1 There can be some ethical dilemmas for experimenters if research participants have to incur a net loss off from their participation in economic experiments.

the house money effect from the different levels of earned gain on individuals' behavior, while Carlsson et al. (2003) and Ackert el al. (2006) investigated the house money effect from the different levels of windfall gain on individuals' behavior. Arkes et al. (1994), Oxoby and Spraggon (2008), and Martinez et al. (2009) investigated the difference between windfall initial endowment and earned initial endowment.

The primary objective of this study was to investigate the influence of two distinct types of house money effect on individuals' bidding behavior in multiple-period all-pay auction environment. First, the study investigated of the influence of free windfall initial endowment and earned initial endowment on individuals' behavior. At the beginning of the experiment, participants in *windfall money treatment* were endowed with windfall money to be used as seed money, while participants in *earned money treatment* had to earn their own money from prior unrelated experiment to be used as seed money.

Second, the study investigated the effect of prior earned gain (as well as prior loss) on individuals' bidding behavior. Participants in both treatments had to take part in 40 rounds of all-pay auction experiment. As participants may gain, lose, or break even during each round, it is possible to study the influence of prior gain and prior loss from the previous round on individuals' bidding behavior in the current round.

The results of the study showed that participants in *windfall money treatment* bided more aggressively than participants in *earned money treatment*. The results also showed that prior gain and loss in the previous round did not influence participants' bidding behavior in the current round.

The study makes a contribution to the field of experimental economics by making a distinction of two different types of house money effect. The study also shows that the house money effect from the usage of windfall initial endowment, has more adverse impact on the external validity of the experiment then the house money effect from the historic gain and loss.

The remainder of this paper is organized as follow: Section 2 describes the design of the experiment. Section 3 presents and discusses the results of the study. Section 4 concludes the paper.

2 Experimental Design

I designed and conducted a laboratory experiment to study the two distinct types of house money effect in all-pay auction environment. In this section, I first described all-pay auction, followed by a description of the experimental treatments, procedures, and research participants.

2.1 All-Pay Auction

This study utilized a multiple-period single-object private-valuation all-pay auction, similar to the one conducted by Noussair and Silver (2006), to study the house money effect. All-pay auction is a special class of auction in which only the highest bidder wins the auction, but all bidders have to pay what they bided regardless of whether they are the highest bidder or not. As it requires bidders to always pay what they bided, bidders stood a chance of incurring a loss every time they placed a nonzero bid. In all-play auction, bidders may submit higher bid to increase their likelihood of becoming the highest bidder at the cost of lower potential gain as well as higher potential loss. This tradeoff is the main feature of any standard all-pay auction.

The nature of multiple-period all-pay auction made it an ideal environment to study the two different types of the house money effect. First, participants were required to own seed money so that they can place bids in all-pay auction. The experimenters can either endow participants with free windfall seed money or give participants a chance to earn their own seed money themselves. Second, as the experiment continues for many rounds, experimenters can evaluate the effect of prior gain and prior loss on individuals' bidding behavior.

Appendix A describes the setup of all-pay auction and the derivation of equilibrium bid for risk-neutral bidders in detail. Based on the derivation, the relationship between both the probability of being the bidder with the highest valuation as well as the equilibrium bid has a non-linear relationship with bidder's valuation. The equilibrium bid and the likelihood of being the bidder with the highest valuation increased at an increasing rate with respect to valuation. Participant with valuation of 22, 47, 63, 80, 97, and 100 had approximately 1%, 10%, 25%, 50%, 90%, and 100%, respectively, chance of being the participant with the highest valuation. The equilibrium bids for risk-neutral participants with valuation of 0, 34, 51, 61, 76, 91, 95, and 100 were 0, 1, 5, 10, 25, 51, 61, and 75, respectively.

2.2 Experimental Treatments

There were two treatments in this study; *earned money treatment* and *windfall money treatment*. In *earned money treatment*, prior to the beginning of the all-pay auction experiment, participants had to participate in an unrelated learning experiment which lasted approximately 2 hours. At the end of the learning experiment, participants were paid based on their performance. After the fee was paid, the participants were asked whether they wished to leave immediately or to continue on with another game by depositing 250 Baht[2], from a portion of their prior earning[3], into the starting account of the new game. The participants were informed that the game to be played had a positive payoff, but they faced a possibility of losing a portion or even all of their deposit if they performed poorly. Every participant decided to participate in the all-pay auction experiment. I conducted a total of nine sessions of *earned money treatment*.

In *windfall money treatment*, participants did not participate in the learning game. At the beginning of the experiment, the experimenters endowed each participants with free windfall money of 250 Baht. The money was placed directly into each participant's starting account. The participants were not informed about this free windfall money at the time of their recruitment. I conducted a total of nine sessions of *windfall money treatment*.

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2 At the time of the experiment, the exchange rate was 1 Thai Baht for 2.7 Japanese Yen or 0.03 US Dollar. The minimum wage for 8 hours of work was 205 Baht (approximately 554 yen or 615 USD). Therefore, the deposit of 250 Baht (approximately 675 yen or 7.5 USD) was a substantial sum of money.

3 The learning experiment was designed such that all participants earned more than 250 Baht.

2.3 Experimental Procedures

Each session of the experiment had four participants. Prior to the beginning of each session, participants were required to sign a participation consent form. After all four participants had signed the consent form, research assistants provided a detailed instruction to them. Appendix B contains the instruction of the experiment, while Appendix C provides an example of bidding ticket and record sheet used in the experiment.

At the beginning of each session, participants in *earned money treatment* were required to use the 250 Baht that they had earned during the learning experiment as the seed money for all-pay auction money. Participants in *windfall money treatment* were given a free windfall money of 250 Baht to use as seed money. Thus, the only difference between *earned money treatment* and *windfall money treatment* was the origin of participants' seed money. The 250 Baht seed money was converted into 500 points and was placed directly into the participant's starting account. If participants earned point(s) from the auction, the point(s) will be added directly into their account. Likewise, if the participants lost point(s) during the auction, point(s) will be removed directly from their account. If participants' account dropped below zero point, participants cannot place any bid for the rest of the experiment.

Participants had to participate in 40 rounds of all-pay auction. The first 20 rounds were considered "practice rounds". All bids made during the practice round were hypothetical only. No real cash can be won or lost. Participants were still required to record their hypothetical payoff and hypothetical cumulative payoff during the practice round. At the end of the first 20 round, participants' accounts were reset back to 500 points. The last 20 rounds were considered "real rounds". The payoff the participants earned and lost in the last 20 rounds affected the monetary payoff participants received at the end of the experiment. The implementation of the practice rounds gave participants the time they needed to learn how all-pay auction work.

At the beginning of each round, each participant had to draw a lot. Each participant's valuation in the particular round was determined by the drawn lot. The valuation on the lot was randomly drawn from a uniform distribution with an interval of [0,100]. After observing their valuation, each participant then placed a single non-negative bid. Participants were specifically told that they can place a bid of zero.

Participant who placed the highest bid was considered the winner of the round. In the event that two or more bidders placed the same highest bid, the bidder with higher valuation was considered as the winner of that round. The winner received point(s) equal to his valuation minus his bid. Other bidders suffered a loss of point(s) equal to their bids. Participants who place a bid of zero did not gain or loss any point.

The experiment ended after the 40^{th} round. At the end of the experiment, each participant was asked to fill in a short questionnaire and was privately paid based on his/her performance during the last 20 rounds.

2.4 Participants

The experiment was conducted in an office of a small factory in sub-urban area of Bangkok, Thailand in February 2010. Participants were recruited through recruitment posters posted in front of the factory. A total of 72 participants took part in the study. 53 of those were females, while 19 were males. Their average age was 25.33 years old. Half of the participants in this study were minimum wage workers while the other half were students or housewives.

3 Experimental Results

The results of the experiment are presented as follows 1) individuals' bidding behavior 2) the influence of earned seed money and free windfall seed money on individuals' bidding behavior and 3) the effect of prior outcome on individuals' bidding behavior.

3.1 Experimental Results - Individuals' Bidding Behavior

Table 1: Individuals' bidding behaviors in practice round (first 20 rounds) of *earn money treatment*

Valuation	E.Mean*	Mean	Median	Bid=0	Underbid**	Overbid**
0	0	2.36	0	**73%**	0%	27%
1-5	0	0.06	0	**97%**	**97%**	3%
6-10	0	3.06	0	**69%**	**69%**	31%
11-15	0	6.04	0	**57%**	**57%**	43%
16-20	0	6.78	0	**67%**	**67%**	33%
21-25	0	9.38	0	**51%**	**51%**	49%
26-30	0	10.24	0	**54%**	**54%**	46%
31-35	0.34	13.31	10	37%	37%	**63%**
36-40	1	10.51	0	**51%**	**51%**	49%
41-45	2.19	12.39	7.5	42%	42%	**58%**
46-50	3.27	17.8	16	33%	37%	**63%**
51-55	5.31	23.44	21.5	28%	41%	**59%**
56-60	7.89	20.21	22.5	37%	45%	**55%**
61-65	11.38	29.85	40	25%	35%	**65%**
66-70	16.04	41.77	50	19%	23%	**77%**
71-75	20.7	49.33	54	12%	18%	**82%**
76-80	27.17	41.04	50	17%	29%	**71%**
81-85	34.98	55.91	55	2%	17%	**83%**
86-90	44.78	57.88	60	6%	22%	**78%**
91-95	54.65	67	70	0%	27%	**73%**
96-100	69.56	68.44	72.5	6%	47%	**53%**

***E.Mean** represents the average of equilibrium bids at a particular valuation interval from risk-neutral bidder. ****Underbid** and **Overbid** represent the percentage of time that bidders bided under and over the risk-neutral equilibrium bid.

Table 2: Individuals' bidding behaviors in real round (the last 20 rounds) of *earn money treatment*

Valuation	E.Mean*	Mean	Median	Bid=0	Underbid**	Overbid**
0	0	0	0	**67%**	0%	0%
1-5	0	2.33	0	**89%**	**89%**	11%
6-10	0	1.56	0	**78%**	**78%**	22%
11-15	0	0.96	0	**74%**	**74%**	26%
16-20	0	3.61	0	**67%**	**67%**	33%
21-25	0	5.08	0	**85%**	**85%**	15%
26-30	0	2.38	0	**78%**	**78%**	22%
31-35	0.39	8.67	0	**58%**	**58%**	42%
36-40	1	10.8	0	**57%**	**59%**	41%
41-45	2.23	11.72	0	**54%**	**54%**	46%
46-50	3.32	7.43	0	**71%**	**71%**	29%
51-55	5.31	17.54	20	40%	40%	**60%**
56-60	8.19	22.74	29	29%	32%	**68%**
61-65	11.36	18.30	0	52%	58%	**42%**
66-70	16.12	30.98	32	26%	33%	**67%**
71-75	20.83	40.97	50	17%	17%	**83%**
76-80	27.63	50.38	56	8%	10%	**90%**
81-85	34.76	43.84	45	11%	41%	**59%**
86-90	44.98	55.02	65	17%	24%	**76%**
91-95	55.62	65.16	70	0%	35%	**65%**
96-100	70.29	68.52	72.5	0%	48%	**50%**

***E.Mean** represents the average of equilibrium bids at a particular valuation interval from risk-neutral bidder. ****Underbid** and **Overbid** represent the percentage of time that bidders bided under and over the risk-neutral equilibrium bid.

Table 3: Individuals' bidding behaviors in practice round (first 20 rounds) of *windfall money treatment*

Valuation	E.Mean*	Mean	Median	Bid=0	Underbid**	Overbid**
0	0	0	0	**100%**	0%	0%
1-5	0	4.90	0	**83%**	**83%**	17%
6-10	0	3.24	0	**85%**	**85%**	15%
11-15	0	3.11	0	**62%**	**62%**	38%
16-20	0	6.13	1.5	**40%**	40%	**60%**
21-25	0	9.75	0	**56%**	**56%**	44%
26-30	0	6.44	0	**65%**	**65%**	35%
31-35	0.44	9.97	5.5	35%	35%	**65%**
36-40	1	9.11	0	**52%**	**59%**	41%
41-45	2.14	14.63	1	49%	**54%**	46%
46-50	3.26	11.83	10	30%	30%	**70%**
51-55	5.34	19.16	2	45%	**53%**	47%
56-60	8.07	25.73	20	32%	39%	**61%**
61-65	11.59	27.14	20	31%	45%	**55%**
66-70	15.78	39.88	54	17%	27%	**73%**
71-75	21.27	51.08	57	8%	16%	**84%**
76-80	27	49.03	60	8%	22%	**78%**
81-85	35.14	54.41	65	3%	21%	**79%**
86-90	45.05	58.29	68	5%	24%	**76%**
91-95	55.60	70.49	80	3%	20%	**80%**
96-100	69.08	62.65	76	8%	43%	**57%**

***E.Mean** represents the average of equilibrium bids at a particular valuation interval from risk-neutral bidder. ****Underbid** and **Overbid** represent the percentage of time that bidders bided under and over the risk-neutral equilibrium bid.

Table 4: Individuals' bidding behaviors in real round (the last 20 rounds) of *windfall money treatment*

Valuation	E.Mean*	Mean	Median	Bid=0	Underbid**	Overbid**
0	0	0	0	**100%**	0%	0%
1-5	0	5.62	0	**79%**	**79%**	21%
6-10	0	1.95	0	**78%**	**78%**	22%
11-15	0	3.33	0	**80%**	**80%**	20%
16-20	0	4.09	0	**73%**	**73%**	27%
21-25	0	3.08	0	**61%**	**61%**	39%
26-30	0	4.64	0	**61%**	**61%**	39%
31-35	0.37	3.22	0	**61%**	**63%**	37%
36-40	1	5.89	0	**61%**	**61%**	39%
41-45	2.32	10.97	1.00	45%	**65%**	35%
46-50	3.48	7.67	2.00	33%	**67%**	33%
51-55	5.41	11.48	0	**59%**	**70%**	30%
56-60	7.97	13.92	5.50	44%	**53%**	47%
61-65	11.28	22.56	10.00	33%	**56%**	44%
66-70	15.77	27.05	26.00	28%	46%	**54%**
71-75	21.14	41.68	49.00	23%	27%	**73%**
76-80	27.69	45.00	58.00	16%	34%	**66%**
81-85	35.83	49.72	61.00	7%	34%	**66%**
86-90	45.77	63.19	70.00	7%	16%	**84%**
91-95	55.71	63.86	72.00	14%	21%	**79%**
96-100	70.22	70.78	81.00	11%	32%	**68%**

***E.Mean** represents the average of equilibrium bids at a particular valuation interval from risk-neutral bidder. ****Underbid** and **Overbid** represent the percentage of time that bidders bided under and over the risk-neutral equilibrium bid.

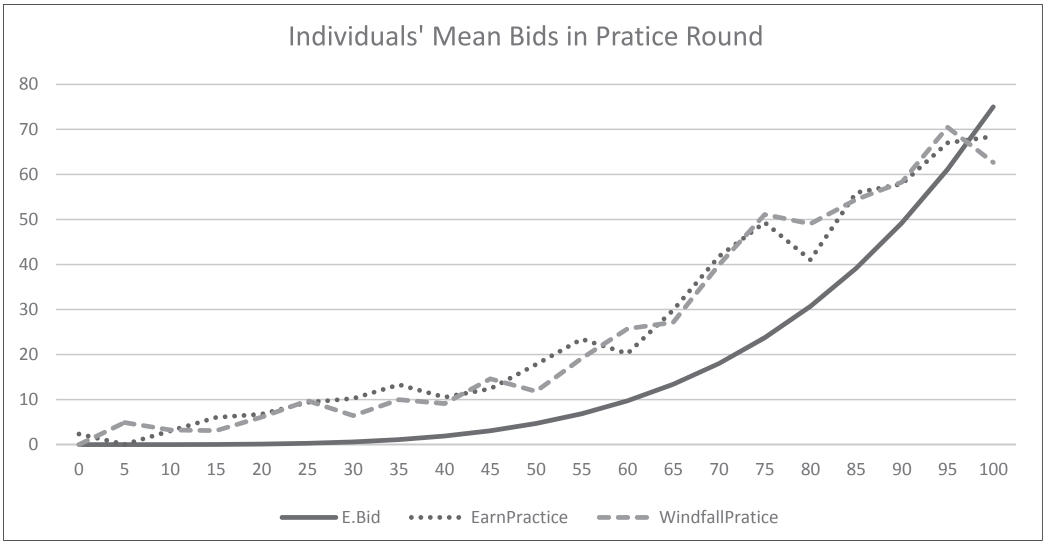

Figure 1

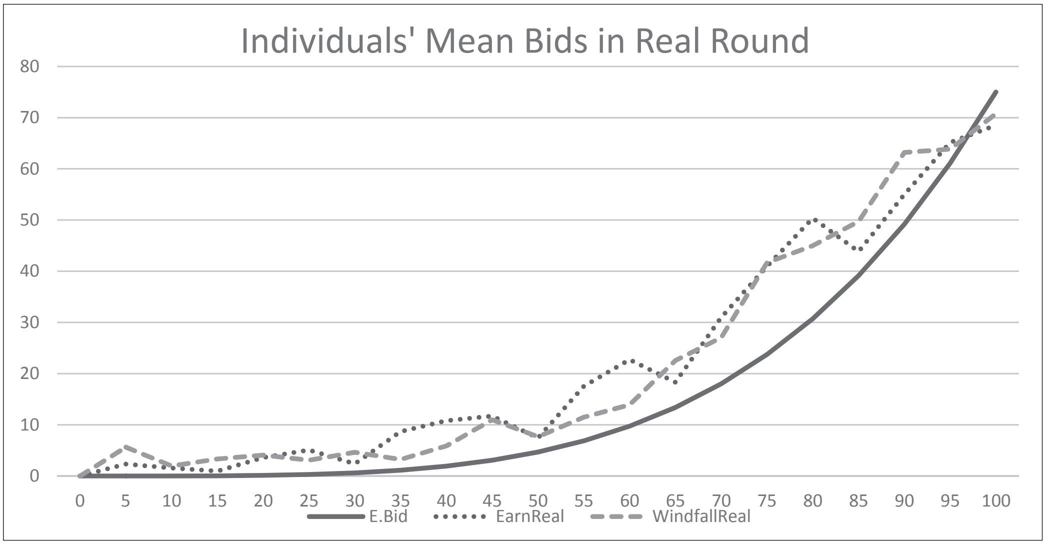

Figure 2

Table 1 to Table 4 provide grouped data of mean and median of bids within 21 different sets of valuation interval. The first set of valuation interval include mean and median bids of all bidders who received a valuation of zero, while the last set of valuation interval include mean and median bids of all bidders who received valuation of ninety-five to one-hundred. Table 1 and Table 2 provide data from the first 20 rounds and the last 20 rounds of *earn money treatment*. Table 3 and Table 4 provide data from the first 20 rounds and the last 20 rounds of *windfall money treatment*. The data also include equilibrium bid, *E.Bid*, as well as the percentage of zero-bid, over-bid, and under-bid[4] within a given valuation interval. Figure 1 is a graphical representation of mean bids in practice round, while Figure 2 is a graphical representation of mean bids in real round.

In both the practice rounds and real rounds of *earned money treatment* and *windfall money treatment*, individuals' bids were almost always increasing at an increasing rate as predicted by the equilibrium bid. At low level of valuation, a majority of bidders placed bids of zero or close to zero. This is consistent with the prediction made by equilibrium bid as participants should place a bid of zero if they received a valuation of 33 or below. For high level of valuation (66 or above), a majority of bidders placed bids that were higher than the equilibrium bid. These findings are similar to the one found in Noussair and Silver's all-pay auction (2006).

Figure 1 and Figure 2 clearly show that average bids in practice round were almost always higher than average bids in the real round in both *earned money treatment* and *windfall money treatment*. There are two possible explanations behind this. First, as biddings in practice round did not have any effect on monetary individuals' payoff, bidders became more aggressive with their bids in order to win the auction. Second, bidders became more experienced as the auction progressed. The negative

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4 Zero-bid occurs when bidder placed a bid of zero. Under-bid occurs when bidder, with valuation v_i, placed a bid that is lower than equilibrium bid of risk-neutral bidder with valuation v_i. Over-bid occurs when bidder, with valuation v_i, placed a bid that is higher than equilibrium bid of risk-neutral bidder with valuation .

feedback from lower potential gain and higher potential loss from placing too high bid induced participants to place lower bids in the later rounds of the auction. Even taking those two factors into account, participants still placed bids that were above the equilibrium bids.

As participants bided above equilibrium bid at high valuation level, they exposed themselves to higher potential lost and lower potential gain. Due to this, participants' payoffs were lower than the equilibrium payoff. The average net payoff, which excluded the seed money of 250 Baht, in this game was -45 Baht. Only 24 participants out of 72 participants managed to earn a net profit from this experiment. After the initial endowment was taken into account, average gross cumulative payoff was 205 Baht.

3.2 Difference between Earned Money and Windfall Money

This section investigates the influence of earned seed money and windfall seed money on individuals' bidding behavior. The results from prior studies showed that participants who used earned money were less likely to be frivolous with their spending as well as were less likely to take risk relative to the participants who used windfall money.

Fibich et al. (2006) had derived the equilibrium bid for risk-averse bidders. Results of their derivation demonstrated that at low valuation level, the equilibrium bids of risk-averse bidder were lower than the equilibrium bids of risk-neutral bidder. At higher valuation, the equilibrium bids of risk-averse bidders were lower than the equilibrium bids of risk-neutral bidder. The interpretations behind these results were quite intuitive. Bidders who received low valuation had very low probability of winning the auction. They were more averse to losing money that they would use to place bid compared to their risk-neutral counterpart, therefore they placed lower bids to minimize their potential loss. Bidders who received high valuation had relatively high probability of winning. They were more averse to not winning the auction then their risk-neutral counterpart. Therefore, at risk-averse bidders with high valuation was willing to place a higher bid relative to risk-neutral bidders with the same valuation and sacrificed their potential gain from winning.

Based on the prediction from equilibrium bids for risk-averse bidders, bidders in *earned money treatment* with high valuation should place higher bids than bidders in *windfall money treatment* with similar valuation. At low valuation, bidders in *windfall money treatment* should place higher bids than bidders in *earned money treatment* with similar valuation.

In contrast, if earned money caused individuals to be less frivolous with their spending, then bidders in *earned money treatment* would place lower bid relative to bidders in *windfall money treatment*. Those two predictions contradicted with each other. This gave me the opportunity to investigate whether windfall money caused individuals to become more frivolous or caused individuals to take more risk.

In order to analyze the effect of earned money and windfall money, I utilized simple pooled OLS regression analysis with the following baseline regression:

$$Bid_{it} = \beta_0 + \beta_1 * V(66to70)_{it} + \cdots + \beta_7 V(95to100)_{it} + \beta_8 * Earned_i * V(66to70)_{it} + \\ \cdots + \beta_{14} * Earned_i * V(95to100)_{it} + \lambda_i + \varepsilon_{it}.$$

Bid_{it} is bidder i bids at time t. $V("X"to"Y")_{it}$ is a binary variable that is equal to 1 when bidder i's valuation at time t is within the interval "X" to "Y" and is equal to zero otherwise. $V("X"to"Y")_{it}$ is used instead of actual valuation due to the non-linear relationship between valuation and bid. The intervals used in the regression were 66-70, 71-75, up to …, 95-100. $Earned_i$ is earned money treatment effect which is equal to 1 if bidder i is in earned money treatment and is equal to zero otherwise. The baseline is *windfall money treatment*. $Earned_i * V(\text{X}to\text{Y})_{it}$ are cross-effect variables. They are used to study the impact of earned money at specific valuation intervals. λ_i is individual's fixed effect. ε_{it} is an error term. I did not control for time fixed effect as it did not influence the results of the regression.

The baseline valuations in this regression were the valuation interval of 61 to 65. I chose to analyze bid with valuation of 61 and above as majority of bidders at lower valuation chose to place bids at zero or close to zero. This was due to the fact that bidders with valuation of 60 and lower had lower than 20% chance of being the bidder with highest valuation. In addition, to prevent the potential bias from zero-bid, zero-bids were filtered from the analysis.

Table 5: Pooled OLS regression analysis of the effect of earned money on individuals' bidding behavior

	(1)	(2)	(3)	(4)
Round:	Practice	Practice	Real	Real
Constant	**39.64** **(2.84)*****	**40.65** **(2.23)*****	**35.33** **(3.17)*****	**36.56** **(2.41)*****
V(66-70)	**8.44** **(4.62)***	**11.95** **(4.59)*****	2.34 (5.01)	3.77 (4.05)
V(71-75)	**15.94** **(4.62)*****	**13.28** **(4.50)*****	**18.60** **(5.90)*****	**23.22** **(4.76)*****
V(76-80)	**13.71** **(4.62)*****	**15.46** **(4.55)*****	**18.00** **(5.06)*****	**18.87** **(4.10)*****
V(81-85)	**16.71** **(4.92)*****	**18.41** **(4.82)*****	**18.07** **(5.06)*****	**28.76** **(4.25)*****
V(86-90)	**21.88** **(4.54)*****	**24.32** **(4.45)*****	**32.59** **(4.53)*****	**33.00** **(3.86)*****
V(91-95)	**32.91** **(4.62)*****	**33.18** **(4.54)*****	**39.16** **(5.25)*****	**39.14** **(4.18)*****
V(96-100)	**28.53** **(4.62)*****	**30.02** **(4.57)*****	**44.03** **(4.78)*****	**44.35** **(4.00)*****
*Earn** V(66-70)	3.62 (5.90)	-6.02 (6.37)	3.94 (5.31)	1.15 (6.10)
*Earn** V(71-75)	0.54 (5.37)	-0.64 (6.03)	-4.44 (6.51)	**-12.42** **(6.84)***
*Earn** V(76-80)	-4.10 (5.99)	-7.78 (6.39)	1.16 (5.20)	**-2.88** **(6.00)*****
*Earn** V(81-85)	-4.10 (5.99)	-3.93 (5.97)	-4.25 (5.33)	**-14.95** **(6.25)****
*Earn** V(86-90)	-0.02 (4.69)	-3.97 (5.97)	-1.89 (4.75)	**-10.12** **(5.94)***
*Earn** V(91-95)	-5.55 (5.54)	**-10.22** **(6.18)***	**-9.33** **(5.38)***	**-15.59** **(6.09)****
*Earn** V)96-100)	4.82 (5.33)	-3.14 (6.10)	**-10.83** **(4.78)****	**-18.30** **(5.95)*****
Individual FE	NO	YES	NO	YES
Adjusted R-Squared	0.147	0.578	0.273	0.665
Observation	510	510	478	478

Table 5 presents the results of the regression analysis. Regression (1) and (2) presented the results of regression analysis for practice round, while regression (3) and (4) presented the results of real round. Individuals' fixed effects were controlled for in regression (2) and (4), but not in regression (1) and (3).

The coefficients of $V("X"to"Y")_{it}$ were always positive and statically significant. In addition, they were almost always increasing as the valuation interval increased. This result showed that individuals' bid were almost always increasing with valuation.

The coefficients of cross-effect variables, $Earned_i * V(\mathrm{X}to\mathrm{Y})_{it}$, were not statistically significant except in one case in regression (1) and (2). The coefficients of $Earned_i * V(\mathrm{X}to\mathrm{Y})_{it}$ were almost always negative. In regression (3), the coefficients were statistically significant for the valuation interval of 91 to 100, while for regression (4), the coefficients were statistically significant for the valuation interval of 81 to 100. The results from the coefficients of the cross-effect variables showed that bidders who used earned money placed lower bid at high valuation relative to the bidders who used windfall money. In addition, this effect only appeared in the real round, but not in practice round. This was reasonable as bidders did not have to be concerned with losing the earned money when bids were only hypothetical in the practice round.

This result implied that the usage of earned money did not cause individuals to be more risk-averse, as risk-averse bidders should place higher bid than risk-loving in all-pay auction environment. The usages of earned money caused bidders to become less frivolous and placed less aggressive bids compared to bidders who were bidding with windfall money.

3.3 The Influence of Prior Outcome

Table 6: Individuals' bidding behaviors in *windfall money treatment* given the payoff of prior round

Valuation	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	Windfall Money	Windfall Money	Windfall Money	Windfall Money	Windfall Money	Windfall Money
Round	Practice	Practice	Practice	Real	Real	Real
Prior Round Payoff	Negative	Break Even	Positive	Negative	Break Even	Positive
0	0	0	0	0	0	-
1-5	11.82	0.87	2.86	0.31	12.2	0.67
6-10	1	4.64	0	0.93	4.09	1.38
11-15	3.89	2.18	3.73	6.47	1.52	1.91
16-20	7.92	0	6.5	3.33	6.16	1.3
21-25	3.91	15.25	7	4.42	1.38	7
26-30	10.92	4.58	5.5	6.2	2.57	8
31-35	15.67	6.57	6.5	2.36	3.84	3.23
36-40	11.23	9.36	2.5	8.9	2.27	7.77
41-45	21	10.6	5	25.38	3.88	10.71
46-50	12.27	11.14	11.67	9.69	6.5	4.71
51-55	26.15	12.88	16.5	10	13.14	9.2
56-60	25.17	29.07	22.58	13.5	14.38	13.75
61-65	7.2	22.86	43.44	23.6	18.31	29.13
66-70	40.72	36.88	49.33	26.1	23.58	34.6
71-75	55.37	49.67	43.44	60.67	33	46.5
76-80	50.78	55.38	30	26.75	45.64	58.7
81-85	52.29	50.75	62.86	37.29	58.53	37.2
86-90	56.8	61.5	78.33	54.5	65.85	67.82
91-95	70.8	70.79	65.8	67.33	60.06	75.75
96-100	56.47	58.83	83.13	77.13	71.55	63.44

Table 7: Individuals' bidding behaviors in e*arned money treatment* given the payoff of prior round

Valuation	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	Earned Money	Earned Money	Earned Money	Earned Money	Earned Money	Earned Money
Round	Practice	Practice	Practice	Real	Real	Real
Prior Round Payoff	Negative	Break Even	Positive	Negative	Break Even	Positive
0	0.2	0.00	5.00	0.00	0.00	NA
1-5	0.12	0.00	0.00	8.71	0.13	0.00
6-10	6.17	0.45	0.89	3.50	0.00	1.25
11-15	5.36	7.3	4.5	1.42	0.6	0.71
16-20	7.79	0	3.75	4.8	2.06	6
21-25	15	2.22	4.17	15	0	2
26-30	16.15	6.16	7.88	5.21	0.36	1.11
31-35	16.75	5.67	19.4	12.55	8.11	3.33
36-40	10.21	4.21	17.71	23.14	4.26	7.57
41-45	14.78	8.08	12.6	16.79	9.95	4.6
46-50	16.09	17	22.83	16	1.36	9.42
51-55	25.58	17.56	21.67	26.33	9.31	22.8
56-60	23.58	14.23	22.5	30.33	16.46	21.17
61-65	28.7	30.11	29.57	27.08	12.2	16
66-70	32.17	47.55	43.63	39.69	22	44.29
71-75	47.13	50.56	57.33	34.36	47.14	47.13
76-80	45.43	42	36.67	51.82	44.5	56.38
81-85	47.16	64.87	59.08	42.62	36.64	55.5
86-90	61.5	48.74	67.3	55.23	52.35	60.67
91-95	58.53	83.57	72.5	56.64	71.21	69
96-100	73	55.8	72.89	57.18	79.94	66.71

This section investigates the influence of prior outcome on individuals' bidding behavior. Table 6 and Table 7 provide grouped data of the mean of individuals' bids within 21 different sets of valuation intervals given the outcome of individual's previous round payoff. Table 6 contains grouped data of biddings in *windfall money treatment,* while Table 7 contains grouped data of bidding in *earned money treatment*. Data in Table 6 and Table 7 showed no obviously pattern regarding how prior outcome may influenced individuals' bidding decision.

In order to analyze the effect of prior outcome on bidders' behavior, I utilized simple pooled OLS regression analysis with the following baseline regression:

$$Bid_{it} = \beta_0 + \beta_1 * V(66to70)_{it} + \cdots + \beta_7 V(95to100)_{it} + \beta_8 * POS_{it-1} * V(61to75)_{it} + \cdots + \beta_{15} * POS_{it-1} * V(95to100)_{it} + \beta_{16} * NEG_{it-1} * V(61to75)_{it} + \cdots + \beta_{23} * NEG_{it-1} * V(95to100)_{it} + \lambda_i + \varepsilon_{it}$$

POS_{it-1} is a binary variable that is equal to 1 when bidder *i* received a positive payoff at time *t-1* and is equal to zero otherwise. NEG_{it-1} is a binary variable that is equal to 1 when bidder *i* received a negative payoff at time *t-1* and is equal to zero otherwise. The baseline case is participants received a payoff of zero at the time *t-1*. This regression can be used to investigate the effect of prior outcome on bidding by comparing individuals' bids after they previously received positive payoff and negative payoff relative to when they previously received a payoff of zero.

Table 8: Pooled OLS regression analysis of the effect of prior gain and prior loss on individuals' bidding behavior

Treatment	(1) Windfall	(2) Earn	(3) Windfall	(4) Earn
Constant	**33.23 (5.54)*****	**34.34 (5.48)*****	**28.86 (6.34)*****	**27.21 (6.65)*****
V(66-70)	8.37 (7.33)	9.01 (6.83)	9.65 (8.15)	12.18 (8.09)
V(71-75)	**27.90 (8.95)*****	**25.21 (8.73)*****	**32.36 (9.51)*****	**20.97 (9.63)****
V(76-80)	**16.77 (7.41)****	**23.63 (6.64)*****	**20.20 (8.42)****	**28.54 (8.17)*****
V(81-85)	**32.89 (6.98)*****	**19.43 (6.94)*****	**36.81 (7.94)*****	**21.79 (8.34)*****
V(86-90)	**35.35 (6.74)*****	**31.56 (6.31)*****	**38.09 (7.56)*****	**33.38 (7.74)*****
V(91-95)	**35.33 (6.92)*****	**30.97 (6.68)*****	**39.60 (7.62)*****	**33.52 (8.14)*****
V(96-100)	**45.90 (6.83)*****	**37.98 (6.22)*****	**46.83 (7.74)*****	**40.3 (7.66)*****
V(61-66)*POS	-0.47 (8.77)	15.64 (10.12)		
V(66-70)*POS	-3.70 (7.31)	1.98 (6.39)		
V(71-75)*POS	-13.05 (9.52)	-4.94 (8.56)		
V(76-80)*POS	7.12 (7.45)	-1.27 (4.86)		
V(81-85)*POS	-3.39 (9.27)	4.77 (6.07)		
V(86-90)*POS	1.58 (6.97)	-4.59 (5.51)		
V(91-95)*POS	6.31 (9.24)	2.21 (5.58)		
V(96-100)*POS	3.03 (7.05)	-4.27 (5.76)		
V(61-75)*NEG			4.23 (8.21)	**18.34 (9.53)***
V(66-70)*NEG			-7.59 (8.81)	**11.37 (6.51)***
V(71-75)*NEG			-0.96 (12.93)	2.64 (8.36)
V(76-80)*NEG			-0.94 (9.64)	4.08 (6.91)
V(81-85)*NEG			-10.58 (9.35)	6.09 (6.86)
V(86-90)*NEG			-4.71 (6.89)	5.95 (6.37)
V(91-95)*NEG			9.52 (9.18)	1.40 (6.39)
V(96-100)*NEG			1.35 (8.12)	-6.49 (5.78)
Individual FE	YES	YES	YES	YES
Adjusted R-Squared	0.664	0.710	0.661	0.600
Observation	164	160	165	191

Table 8 presents the results of the regression analysis on the effect of prior outcome on individuals' bidding behavior. The coefficients of the cross-effect variables $POS_{it-1} * V("X"to"Y")_{it}$ were always not statistically significant, while the coefficients of the cross-effect variables $NEG_{it-1} * V("X"to"Y")_{it}$ were not statistically significant except in two cases. The results showed that the outcome of prior round did not influence individuals' bidding decisions in all-pay auction environment.

4 Conclusion

In this study, I conducted a laboratory experiment to investigate the influence of the house money effect, specifically the effect of historic gain as well as the effect of prior *unearned* gain, on individuals' bidding behaviors in all-pay auction environment. To the best of my knowledge, this study is one of the first studies that made this distinction between the two different types of house money effect.

The results of the study showed that prior outcome, in term of both gain and loss, from prior round did not have any influence on individual's bidding behavior in the current round.

The results also showed that bidders who used windfall money bid more aggressively at high level of valuation relative to bidders who used earned money. In all-pay auction, at high level of valuation, risk-averse bidder place higher bid relative to risk-neutral bidder with similar valuation. This implied that windfall endowment typically cause individuals to become more frivolous and spendthrift but not more risk-seeking.

Another implication from this study is that experimental economists should be concerned with the influence of windfall initial endowment on individuals' decision making. In order to design better experiments, earned wealth rather than windfall wealth should be used.

The last implication from the study is that experimenters should not be too concerned about the effect of prior outcome in an experiment with multiple-rounds setup as this study has shown that prior outcome has no effect on current round.

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Appendix A:
Derivation of Equilibrium Bid for Risk-Neutral Bidder

The setup of all-pay auction in this study is as follows. There are n-bidders, indexed by i, competing to purchase a single object in an auction. At the beginning of each bidding round, bidder i receives a private valuation v_i, which is randomly drawn from a uniform distribution F(v) on the interval [v^{low}, v^{high}]. After observing his own valuation, each bidder submits a single, sealed, non-negative bid, b_i. The bidder who submits the highest bid receives payoff of $v_i – b_i$. In the event of a tie, the bidder with highest valuation among the highest bidder is considered as the highest bidder. Other bidders receive payoff of $–b_i$. At the end of the round, the highest bid is announced to all bidders. The common knowledge in the auction includes the number of bidders, the uniform distribution F(v) from which bidders' valuations are drawn, the number of rounds in the auction and the highest bid at the end of each round.

The derivation of the equilibrium bid for risk-neutral bidders in all-pay auction is based on the derivation by Noussair and Silver (2006). Several assumptions are made for the derivation of the equilibrium bid. First, bidders in the auction are risk-neutral, with utility function, $U_i(x) = x$. Second, each bidder has a common, strictly monotonic bidding strategy, $B_i(v_i)$. Third, the probability that two or more bidders receives the same valuation in a particular round is negligible.

With those assumption in place, bidder i's utility from bidding is as follows:

$$U_i(v_i, b_i) = \begin{cases} v_i - b_i & if\ v_i > v_j \quad for\ all\ i \neq j \\ -b_i & if v_i < v_j \quad for\ all\ i \neq j \end{cases} \qquad (1).$$

The expected payoff of bidder i is as follows:

$$E(\pi_i) = (v_i) * Prob(highest\ bid) - b_i \qquad (2).$$

Where *Prob(highest bid)* is the probability that the bid, b_i, placed by player i is the highest bid. Since every bidder uses a common monotonic bidding strategy, then $B_i(v_i) = B(v)$, the probability of placing the highest is equal to the probability of drawing the highest valuation.

Denote the functional inverse of $B(v)$ as $V(b)$. The probability that the valuation V(b_i) is higher than the valuation *of n-1* opponent is $\left(\frac{V(b_i)}{v^{high} - v^{low}}\right)^{n-1} = Prob(highest\ bid)$. Substitute this equation into equation (2) yields the following expected pay-off function:

$$E(\pi_i) = (v_i) * \left(\frac{V(b_i)}{v^{high} - v^{low}}\right)^{n-1} - b_i \qquad (3).$$

Differentiate equation (3) with the respect to b_i to obtain the following first order condition:

$$\frac{dE(\pi_i)}{db_i} = (n-1) * (v_i) * \left(\frac{V(b_i)}{v^{high} - v^{low}}\right)^{n-2} * \left(\frac{V^{|}(b_i)}{v^{high} - v^{low}}\right) - 1 = 0 \qquad (4).$$

Since $V(b_i)$ is symmetric, it is possible to substitute v_i for $V(b_i)$ to obtain:

$$\frac{(n-1) * V^{|}(b_i)}{(v^{high} - v^{low})^{n-1}} (v_i^{n-1}) = 1 \qquad (5).$$

In addition, since $V(b_i)$ is an inverse of $B(v)$, $V^{|}(b_i)$ is also an inverse of $B^{|}(v_i)$. Substitute $B^{|}(v_i)$ for $V^{|}(b_i)$ into equation (5) to obtain:

$$B^{|}(v_i) = \frac{(n-1)}{(v^{high} - v^{low})^{n-1}} (v_i^{n-1}) \qquad (6).$$

Solve for $B(v_i)$ by integrating equation (6), to obtain the following bidding function:

$$B(v_i) = \left(\frac{(n-1) * (v^{high} - v^{low})}{n}\right) * \left(\frac{v_i}{v^{high} - v^{low}}\right)^{n} + C \qquad (7).$$

In this study, the valuation v_i is randomly drawn from a uniform distribution over the interval [v^{low}, v^{high}] = [0,100]. When a bidder receives the lowest possible valuation, v^{low} = 0, it is optimal for him to place a zero bid to avoid any loss. Thus, the initial condition of equation (7) is *B(0)* = 0. By setting *B(0)* = 0, then C = 0. The number of bidders, *n*, in this particular experiment is 4. Substitute v^{high} =100, $v^{low} = 0$, C = 0, and *n* = 4 into (7) yield the following equilibrium bid for risk-neutral bidder:

$$B(v_i) = 75 * \left(\frac{v_i}{100}\right)^4 \qquad (8).$$

The likelihood that bidder will win an auction given his valuation is as follows:

$$Prob(highest\ bid) = \left(\frac{v_i}{100}\right)^3 \qquad (9).$$

Based on equation (8), bidders should place a bid of zero if he received a bid of 33 or lower. If the bidder received valuation of 100, a bid of 75 should be placed. Based on equation 9, the probability of winning a given round of auction are 1%, 10%, 25%, 50%, 75%, 90% and 100% for the following valuation of 22, 47, 63, 80, 91, and 100, respectively.

Appendix B:
Instructions of All-Pay Auction Experiment

Welcome to our game. Please do not communicate with other participants for the duration of the experiment. If you have any question, please raise your hand.

(For *windfall money treatment* only)

We will give you 250 Baht for your participation in this experiment. This money will be converted into 500 point(s) and will be deposited directly into your account.

(For *earned money treatment* only)

In order to participate in this experiment, you have to deposit 250 Baht you have gained during the previously held experiment into your account. This money will be converted into 500 points and will be deposited directly into your account.

At the beginning of the game, you will receive a record sheet and 40 bidding tickets. Please do not let other participants see your record sheet or bidding tickets at any time during the experiment.

This game consists of 40 periods. During each period you have to make a decision. After you made a decision, you may earn or lose a number of point(s) depending on your decision as well as other participants' decision. Any gain of point(s) that you receive will be deposited directly into your account. Any loss of point(s) that you incur will be deducted directly into your account. If the number of points in your account become zero or lower, you will not be able to make any further decision for the rest of the experiment. At the end of the experiment, the remaining point(s) in your account will be converted to cash at the conversion rate of 0.5 Baht per 1 point and will be given to you in cash. No one other than the experimenter and you will know how much you have been paid. The experiment will take approximately 1 hours.

The rules of the game are as follow. At the beginning of each round, each participant draws a valuation ticket from a box. Each bidding ticket contained a random number which can take any value between 0 to 100. This number is the point(s) that you will receive if you win this round of auction. Other participants will have their own valuation. Please record your valuation into your record sheet.

In order to win, you have to become the individual who submitted the highest bid in that round. The bid you can submit can be any positive number. <u>You will lose point(s) equal to the bid you placed regardless of whether you win or lost.</u> If you wish not to place a bid, please submit a bid of "0". Please write your valuation and bid on the bidding ticket as well as in the "Bid" column of the record sheet. Please submit the bidding ticket once you made your decision.

If you submitted the highest bid, you will obtain point(s) equal to your valuation less the point(s) you use to make the bid. If you did not submitted the highest bid, you will lose point(s) equal to the bid you submitted. If you submitted a bid of "0", you neither gain nor loss any points in that round. If two or more individuals submitted the same highest bid, the individual with higher valuation will be considered as the highest bidder.

Once the experiment received the bidding tickets from every participants, the highest bid of the round will be announced to all participants. No other information will be given.

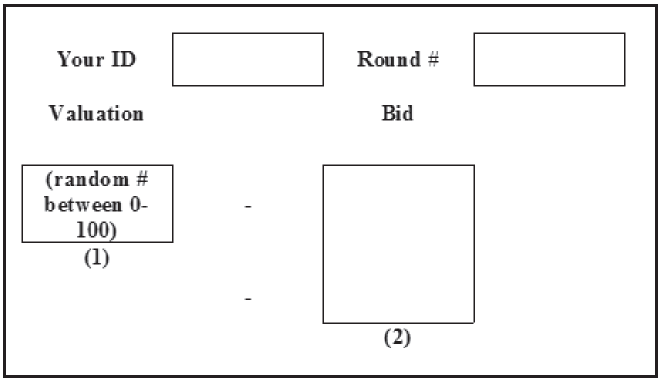
After you have determined whether or not you won the auction, please calculate your payoff and cumulative payoff and write it down under the "Payoff" and "Cumulative Payoff" column on the record sheet.

The game lasts a total of 40 rounds. Round 1 to round 20 are for practice only. The payoff obtained during practice round will be hypothetical only, thus no money will be gain or lost during these rounds. Round 21 to round 40 are the real experiment. The payoff gain or loss during round 21 to 40 will determine the amount of money that you will receive at the end of the experiment.

After the game is over, please fill in the Exit Questionnaire form quietly. Once you have filled the form, you will be privately paid based on your cumulative payoff during rounds 21-40. You will receive 0.5 Baht for every point in your account.

Do you have any question? If you have any question, please raise your hand and I will answer the question privately.

Appendix C:
Props for All-Pay Auction



Bidding Ticket

Round	Value (1)	Bid (2)	Winner Bid (3)	Round`s Payoff (4)	Cumulative Payoff (5)
0	---	---	---	---	500
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
				Total Earning	

Record Sheet