Eliminating Laboratory Asset Bubbles by Paying Interest on Cash

Giusti, Giovanni and Jiang, Janet Hua and Xu, Yiping

University Pompeu Fabra, Bank of Canada, University of International Business and Economics

12 March 2012

Eliminating Laboratory Asset Bubbles by Paying Interest on Cash*

Giovanni Giusti† Janet Hua Jiang‡ Yiping Xu§

March 12, 2012

Abstract

The seminal work of Smith Suchanek and Williams (1988) finds price bubbles are frequently observed in an experimental asset market where a single asset with a finite lifetime is traded. Ever since, many studies have been carried out to understand the reason why bubbles occur in such an environment and to find mechanisms to eliminate bubbles.In this paper, we introduce an interest-bearing savings account to the experimental asset market. We find bubbles disappear with high interest rates. The effect of the interest rate potentially works in two ways. First, the savings account increases the opportunity cost of buying shares, which in turn, reduces the incentive to speculate and alleviates the "active participation" problem as raised in Lei, Noussair and Plott (2001). Second, fixing the dividend process and terminal value of the asset, the time trend of the fundamental value of the asset becomes positive with a high interest rate. An increasing fundamental value is more compatible with subjects' perception that asset prices tend to be flat or increasing in the long run. Therefore, subjects are more likely to follow the fundamental value when they trade and over-pricing is lessened. To disentangle the effects through the two channels, we run a second set of experiments with high interest rate but a lower terminal value to induce the fundamental value of the asset to decrease over time. Bubbles reappear in these sessions, which suggests the time path of the fundamental value is more important for reducing bubbles.

Keywords: Asset Bubbles; Experimental Economics
JEL: C90 G10

*The authors thank participants at the Southern Europe Experimentalists Meeting and International Meeting on Experimental & Behavioral Economics for comments and suggestions. Janet Jiang acknowledges the financial support from Social Sciences and Humanities Research Council of Canada. The views expressed in this paper are those of the authors. No responsibility for them should be attributed to the Bank of Canada.

†University Pompeu Fabra, giovanni.giusti@upf.edu

‡Bank of Canada and University of Manitoba, jjiang@bankofcanada.ca

§University of International Business and Economics, xuyiping@uibe.edu.cn

1 Introduction

Bubbles refer to the phenomena associated with dramatic increases in asset prices (exceeding the asset's fundamental value) followed by collapses. Bubbles occur when asset owners believe that they can resell the asset at an even higher price in the future. The literature offers four major views about the existence of bubbles (refer to Brunnermeier, 2009, for a review). The first strand of models assumes that all investors have rational expectations and common information about the assets. Under this assumption, bubbles, if they appear, must follow an explosive path. In the second class of models, investors are asymmetrically informed and bubbles can emerge under more general conditions because their existence is not common information. The third family of models assumes that there are both rational and behavioral traders in the asset market. Bubbles can persist because rational traders may not be able to eliminate the price impact of behavioral traders due to limits to arbitrage. In the final category of models, bubbles can emerge if investors have heterogeneous beliefs about the fundamental value of the assets (due to psychological biases for instance).

Testing alternative theories of bubbles using field data is very challenging. In many instances, even determining the fundamental value of an asset can be difficult. Experimental studies of asset bubbles have the advantage of allowing researchers to separate the effects of various factors on the occurrence of bubbles. Smith, Suchanek and Williams (1988, hereafter SSW) pioneer this line of research. They find that price bubbles can occur in a very simple experimental asset market environment with a single traded asset with a finite lifetime. At the end of each period, the asset pays a random dividend, which apart from a fixed possible terminal buyout value, is the only source of intrinsic value. The dividend payment is identical for each trader and the distribution of the dividend process is common knowledge to all traders. Surprisingly, rather than tracking the fundamental value, the market-price time series is usually characterized by a hump shape. Initially the mean traded price is below the fundamental value, but it quickly soars above the fundamental price (the "boom") followed by a sudden rapid drop (the "crash") as the experiment approaches the final period.

Following SSW's seminal work, there has been a large body of literature intended to eliminate price bubbles in the laboratory. King, Smith, Williams and Van Boening (1993; KSWV) study the effects of allowing short selling, permitting margin buying, having equal initial endowments for each agent, imposing a fee on transactions, limiting the extent of price changes, adding insiders who are familiar with previous research on the topic and using business people as subjects. None of these treatments successfully eliminated the bubble except for the treatment with informed/experienced insiders. Fisher and Kelly (2000) construct an environment where two asset markets operate simultaneously, and observe bubbles and crashes in both markets. Porter and Smith (1995) study the effects of futures markets and of removing the uncertainty in dividend payoffs. They find that the futures market somewhat reduces the extent of deviations from fundamental values, but certain dividend payoffs do not. Van Boening, Williams, and La Master (1993) investigate asset markets organized as call markets (two-sided sealed-bid auctions), and also observe price bubbles and crashes. Lei, Noussair and Plott (2001; LNP) find that bubbles can still be observed even when speculative opportunities are eliminated. Effective ways to eliminate bubbles include prior participation in the same type of asset market (KSWV; Van Boening, Williams and La Master, 1993; Dufwenberg, Lindgvist and Moore, 2005; Hussan, Porter and Smith, 2008), the tâtonnement pricing mechanism (Lugovskyy, Puzzelo and Tucker, 2010) and running the experiments in a different context ("stocks of a depletable gold mine" instead of "stocks") as shown in Kirchler, Huber and Stockl (forthcoming; KHS).

There are two common features of the papers listed above: zero interest on cash holdings and decreasing fundamental value of the traded asset. In this paper, we intend to investigate whether introducing interest payment on cash holdings (or an interesting-bearing savings account) can eliminate bubbles. Our hypothesis is that bubbles will disappear when the interest rate is high enough. The effect can potentially work in two ways. First, the interest-bearing savings account serves as an alternative investment instrument and increases the opportunity cost of buying shares; this may reduce the incentive to speculate and alleviate the "active participation" problem as raised in LNP. Second, introducing the interest rate also allows us to change the time trend of the fundamental value of the traded asset. In particular, fixing the dividend process and terminal value of the asset, we can induce increasing fundamentals by offering a high enough interest rate on cash holdings. As pointed out by Smith (2010) and Oechssler (2010), because asset prices tend to increase in the long run in real life, subjects may have problems in understanding that the fundamental value path of the asset traded decreases during the session. They may be "confused" by such an environment and consequently trade above the fundamental values. Introducing interest payment allows us to design experiments with increasing fundamentals and create an environment more compatible with subjects' perception about the time trend of asset prices. As a result, subjects are more likely to follow the fundamental value when they trade.

To study whether interest payment can eliminate bubbles and to disentangle the effects through the two channels, we run two sets of experiments. Both sets of experiments have interest payment on cash holdings. The first set has increasing fundamental values. The second set has the same interest rates, but decreasing fundamentals induced by lower terminal buyout values. We find no bubbles in the first set of experiments, which confirms our hypothesis that interest payment can eliminate bubbles. Bubbles reappear in the second set of experiments, which suggests interest payment reduces bubbles mainly through the second channel by inducing an increasing time path of the fundamental value.

Our findings thus confirm the conjecture of Smith (2010) and Oechssler (2010) that the decreasing fundamental value may be the main reason why bubbles are frequently observed in experiments with the SSW design. As such, our paper is also related to several previous studies about the effect of the time trend of the fundamental value on the formation of asset bubbles in the laboratory. These studies generally follow two approaches. The first (as in Stöckl, Huber and Kirchler, 2010, SHK; and Lei and Vesely, 2009) is to follow the SSW design with decreasing fundamentals, but to take extra measures to induce a better understanding of the fundamental value and its decreasing trend. Such measures are shown to be able to reduce "confusion" and in turn bubbles. The second is to break the downward trend of the fundamental value. There are five papers that have flat fundamental prices: Smith, Van Boening and Wellford (2000; SVW), Noussair, Robin and Ruffieux (2000; NRR), Bostian, Goeree and Holt (2006; BGH) and Bostian and Holt (2009; BH) and KHS. In SVW, the asset does not pay dividends. In the absence of a discount factor, the expected fundamental value of the asset is fixed at the expected buyout value. With this treatment, price bubbles only occur in 1 out of 10 sessions. NRR imposes a random carrying cost of the asset whose expected value is set to be the same as the expected value of the dividend payment. They observe price bubbles in 4 sessions out of 8. KHS set the expected value of the dividend payment to zero. No bubbles occur in the 6 sessions of experiments they run. BGH and BH conduct experiments with two assets: cash which earns fixed interest and a stock which pays a random dividend. The fundamental value of the stock is fixed by setting the final period buyout value to the expected present value of the stock. They find bubbles continue to exist in this environment. Noussair and Powell (2010) study the appearance of bubbles when the fundamental value of the asset is non-monotonic. They conduct two sets of experiments. In the "peak" treatment, fundamentals first rise and then fall, while in the "valley" treatment fundamentals first fall and then recover. They find that bubbles still occur in both treatments, but in smaller magnitudes in the peak treatment.

To the best of our knowledge, our study is the first to eliminate bubbles by introducing interest payment on cash holdings, and the first to eliminate bubbles by putting subjects in an environment with increasing fundamentals. We achieve the no-bubble result without extra measures to draw subjects' attention to the time trend of the fundamental value.

The rest of the paper proceeds as follows. We outline our hypothesis and experimental design in Section 2, discuss the experimental results in Section 3 and conclude in Section 4.

2 Hypothesis and Experimental Design

First, we will show how interest payment on cash holdings affects the time slope of the fundamental value of shares. Shares have a finite life of T periods. Each share pays a random dividend at the end of each period from time 1 to T, plus a fixed buyout value, K, at the end of period T. The dividend is a random variable with expected value of d. The distribution of the dividend is iid over time. Cash earns a net interest rate of r per period. We can reinterpret the interest-earning cash as an interest-bearing savings account. Subjects can use money from the savings account to purchase shares, and the revenue from share sales is automatically deposited into the savings account. The fundamental value of the asset at the beginning of period t is calculated as

$$\begin{aligned} FV_t &= d\left[\sum_{\tau=1}^{T-t+1}(1+r)^{-\tau}\right] + K(1+r)^{-(T-t+1)} \\ &= \frac{d}{r}\left[1-(1+r)^{-(T-t+1)}\right] + K(1+r)^{-(T-t+1)} \\ &= \frac{d}{r} + \left(K - \frac{d}{r}\right)(1+r)^{-(T-t+1)} \end{aligned}$$

The time trend of the fundamental value is given by

$$\frac{d(FV_t)}{d_t} = (K - \frac{d}{r})(1+r)^{-(T-t+1)}\ln(1+r),$$

which is negative if $r < \frac{d}{K}$, zero if $r = \frac{d}{K}$, and positive if $r > \frac{d}{K}$. In other words, we can induce rising fundamental values by choosing a high enough interest rate.

Our hypothesis is:

High interest payment on cash holdings can eliminate bubbles through two channels: the first is induced by the high opportunity cost of purchasing shares, and the second is induced by the positive time slope of the fundamental value.

To test the hypothesis, we run two sets of experiments. Both sets of experiments involve interest payment on cash holdings. The difference is that the first set of experiments has increasing fundamental values, while the second set features decreasing fundamental values.[1] Four types of results may occur as described in table 1.

First, bubbles are observed in both sets of experiments. If this is the case, we can conclude that introducing interest payment cannot remove bubbles. Second, bubbles are observed in neither set of experiments. In this case, we can conclude that interest payment helps to remove bubbles, and the reason is because the existence of an alternative investment opportunity makes subjects more careful when they trade stocks. Third, bubbles are observed only in the second set of experiments. In this case, we can conclude again that the interest payment helps to remove bubbles, but the reason is because high interest rates induce a positive time trend of the fundamentals. Finally, bubbles are only observed in the first set of experiments. We think this result very unlikely to occur.

Table 1: Hypothesis testing

Treatment	Increasing fundamentals	Decreasing fundamentals	Conclusion
Bubbles?	yes	yes	Paying interest cannot remove bubbles.
	no	no	Paying interest can remove bubbles; The contributing factor is the existence of alternative investment opportunity.
	no	yes	Paying interest can remove bubbles; The contributing factor is increasing trend of fundamentals.
	yes	no	Unlikely to happen.

We have run 6 sessions (Session 1-6) with increasing fundamental prices, and 4 sessions (Session 7-10) with decreasing fundamental prices. The program used to conduct the experiments is written in z-Tree (Fischbacher, 2007). The number of subjects is 10 in all sessions except in session 9, which has 9 subjects. The number of trading periods, T, is 15 for all sessions except for session 5, which is 12. Each trading period lasts for 150 seconds. Each subject starts the experiment with the same endowment of shares and balance in the savings account. The trading mechanism is a continuous double auction with open order books. Short sales of shares is not allowed. Subjects cannot borrow money to buy shares. The dividend

[1] Please refer to table 2 for the value of d, r, K, T that we use for the experiments.

payment in each period follows an iid discrete uniform distribution and is equal to $0, 8, 28, 60$ with the same probability. The expected dividend payment, d, is therefore 24. We try two values of the interest rate, 10% and 15%. Each session of experiment lasts for 90 minutes. The average earning at UPF is 13 Euros, and 100 RMB at UIBE. More detailed information for the sessions is listed in table 2.

Table 2: Experimental Parameters

Session	1	2	3	4	5	6	7	8	9	10
Date	10/28/11	11/07/11	11/07/11	11/04/11	01/23/12	01/27/12	12/16/11	12/23/11	02/10/12	02/16/12
Location	UPF	UPF	UPF	UIBE	UPF	UPF	UIBE	UIBE	UPF	UPF
Subjects	10	10	10	10	10	10	10	10	9	10
Trading periods	15	15	15	15	12	15	15	15	15	15
Dividend process	(0;8;28;60) same for all sessions									
Initial shares	4, same for all sessions									
Initial cash	2000	2000	2000	2000	745	2000	2000	2000	1022	1054
Interest rate *(r)*	0.1	0.1	0.1	0.15	0.15	0.15	0.1	0.1	0.1	0.1
Buyout *(K)*	720	720	720	720	24	720	72	72	0	24
FV_1	355	355	355	229	186	229	200	200	183	188
FV_{15}	676	676	676	647	282	647	87	87	22	44
FV_{15}/FV_1	1.91	1.91	1.91	2.83	1.52	2.83	0.44	0.44	0.12	0.23
Initial cash asset ratio	1.41	1.41	1.41	2.19	1	2.19	2.5	2.5	1.40	1.40

3 Experimental Results

In this section, we present and analyze the results from the experiments.

Figure 1 presents the behavior of the volume weighted mean price (P_t) relative to the fundamental price (FV_t) in each period. We also graph the trading volume (N_t) in each period. Sessions with increasing fundamentals are grouped in the left panel and those with decreasing fundamentals are presented on the right. From the graph, we can see clearly that for sessions with increasing fundamentals, the average price closely tracks the fundamental price most of the time. This confirms our hypothesis that the existence of interest payment can successfully eliminates bubbles. Compared with a typical SSW setup, the design in the sessions in the left panel has two major deviations: the first is the explicit reference to an alternative investment opportunity other than trading shares and the second is increasing fundamentals. In the second set of experiments, we keep the savings account but lower the buyout value to induce falling fundamental prices. Systematic overpricing is observed in all 4 sessions, which suggests the positive trend of the fundamental price is the main reason why bubbles disappear.

Table 3: Statistics

Session	1	2	3	4	5	6	7	8	9	10	Increasing FV	Decreasing FV	KHS-SSW
RAD	0.090	0.140	0.060	0.040	0.116	0.322	0.780	0.454	1.089	0.630	0.128	0.738	0.414
RD	-0.002	0.040	-0.020	0.040	-0.087	-0.007	0.780	0.454	1.089	0.630	-0.006	0.738	0.296
ST	8.275	4.250	4.475	2.500	6.469	7.400	3.050	3.725	5.778	5.725	5.561	4.569	3.090
PA	0.460	0.809	0.297	0.088	0.323	1.051	1.496	0.711	1.606	0.638	0.505	1.113	1.097

Table 3 provides some pricing and turnover statistics for the 10 sessions we have run. For comparison, we also provide the average statistics for the 6 sessions with increasing fundamentals, the average statistics for the 4 sessions with decreasing fundamentals, and the average statistics for the 6 SSW sessions (with no interest payment and decreasing fundamentals) run by KHS.

Let P_t be the volume-weighted mean price in trading period t, $\overline{FV} = \frac{1}{T}\sum_{t=1}^{T} FV_t$ be the average fundamental value in the market, N_t be the trading volume in period t, and N_0 be the number of outstanding shares ($N_0 = 40$ in sessions with 10 subjects and 36 in sessions with 9 subjects). We calculate 4 measures to describe the trading behavior. There are three measures of price deviation. The relative absolute deviation $RAD = \frac{1}{T}\sum_{t=1}^{T} \frac{|P_t - FV_t|}{\overline{FV}}$ measures the average level of mis-pricing compared to the average fundamental value of the market. The relative deviation $RD = \frac{1}{T}\sum_{t=1}^{T} \frac{P_t - FV_t}{\overline{FV}}$ measures the extent of over or under-valuation. The share turnover $ST = \sum_{t=1}^{T} \frac{N_t}{N_0}$ identifies the trading intensity. The price amplitude $PA = \max_{1 \le t \le T} \left\{ \frac{P_t - FV_t}{\overline{FV}} \right\} - \min_{1 \le t \le T} \left\{ \frac{P_t - FV_t}{\overline{FV}} \right\}$ measures the overall size of the bubble. Note that we use the average fundamental value in the market $\overline{FV}$ to calculate the three measures of price deviation. As argued in SHK, using $\overline{FV}$ has the advantage of allowing comparability between different experimental settings, especially treatments with different paths of fundamental values.[2]

From table 3, one can see that sessions with increasing fundamental values have much lower RAD and RD compared to sessions with decreasing fundamental values. In particular, the increasing fundamental treatment is on average characterized by 0 over-valuation, the treatment with decreasing fundamentals has on average 74% of over-valuation, and the SSW treatment in KHS involves on average 30% of over-valuation.

In addition, we run 12 (2-tailed) Mann-Whitney-U-test to compare the means of the 4 measures among the three different treatments: increasing fundamentals with interest payment, decreasing fundamentals with interest payment, and the SSW treatment in KHS (or decreasing fundamentals with interest payment). The result is presented in table 4. For each test, we list the means of the 4 measures for the pair of treatments being compared, the Z-value, the significance level of the Z-value and the combined sample size of the pair of treatments.

Table 4: Mann-Whitney-U-Test

	RAD	RD	ST	PA
Increasing	0.128	-0.006	5.561	0.505
Decreasing	0.738	0.738	4.570	1.113
Z-value	-2.558	-2.566	0.853	-1.706
Significance level	1%	1%	40%	9%
Sample size	10	10	10	10
Increasing	0.128	-0.006	5.561	0.505
KHS-SSW	0.414	0.296	3.09	1.097
Z-value	-2.562	-2.887	2.562	-2.082
Significance level	1%	0%	1%	3%
Sample size	12	12	12	12
Decreasing	0.738	0.738	4.57	1.113
KHS-SSW	0.414	0.296	3.09	1.097
Z-value	1.919	1.919	2.558	-0.426
Significance level	5%	5%	1%	67%
Sample size	10	10	10	10

[2] RAD and RD are proposed in SHK. Here we follow their spirit to modify the calculation of PA as well (previous literature often uses the fundamental value in the first period, FV_1, in the denominator).

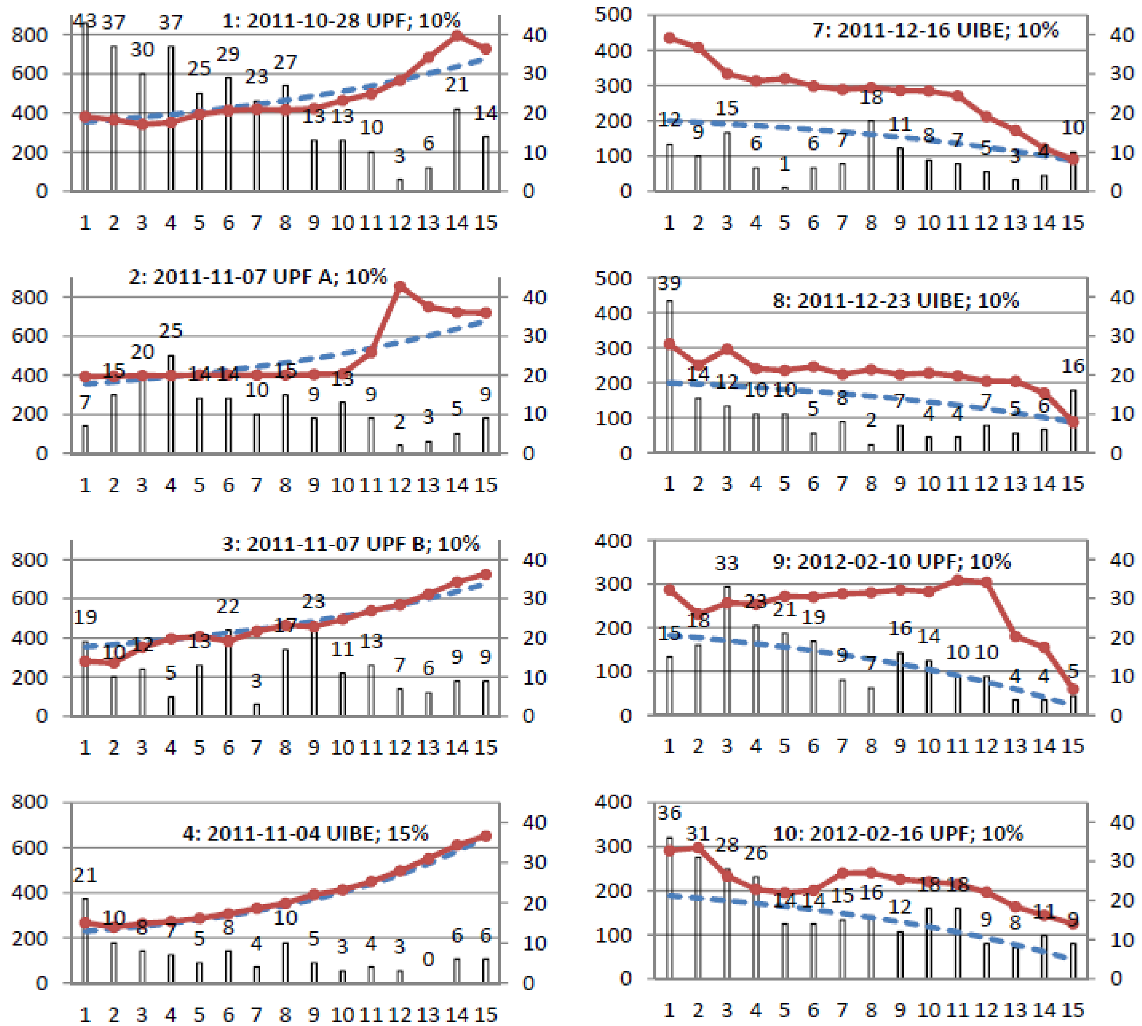
The Mann-Whitney tests show that sessions with increasing fundamentals on average have lower RAD, RD and PA than sessions with decreasing fundamentals. For example, when sessions of increasing fundamentals (the reference treatment) are compared with sessions with decreasing fundamentals and interest payment, the test on RAD has a Z-value of -2.558 (with significance level of 1%), the test on RD has a Z-value of -2.556 (with significance level of 1%), and the test on PA has a Z-value of -0.706 (significance of 9%). When the treatment with increasing fundamentals is compared with the SSW treatment, the test on RAD has a Z-value of -2.562 (with significance level of 1%), the test on RD has a Z-value of -2.887 (with significance level of 0%), and the test on PA has a Z-value of -2.082 (significance of 3%). The results suggest that sessions with decreasing fundamentals on average are characterized by stronger mis-pricing and over-valuation.

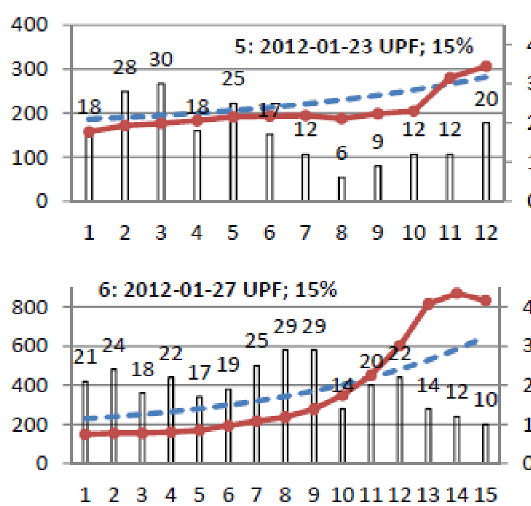
Share turnover is not statistically different between the two treatments with interest payment with a Z-value of 0.853. This suggests that the reason why we could not find bubbles in the increasing fundamental treatment cannot be attributed to the lack of trading activity among subjects. Compared with the two treatments with interest payment, the SSW treatment in KHR has less trading volume. This may be because KHR has shorter trading periods (120 seconds) than us (150 seconds).

We can conclude from the analysis that

1. Paying interest on cash can eliminate bubbles;
2. The mere existence of interest payment is not enough to eliminate bubbles if the fundamental price has a negative time trend;
3. Interest payment can successfully eliminate bubbles if it induces an environment with increasing fundamental prices, which is more consistent with subjects' perception that asset prices tend to rise in the long run.

Figure 1: Experimental results





Notes:

1. Left vertical axis: price;
2. Right vertical axis: number of trades;
3. Horizontal axis: trading period;
4. Solid line: average traded price (P_t);
5. Dashed line: fundamental value (FV_t);
6. Column: volume of trades (N_t)

4 Conclusion

In this paper, we study whether introducing interest payment on cash holdings can eliminate bubbles in the laboratory. Our conjecture is that the interest payment reduces bubbles in two ways. First, the savings account increases the opportunity cost of buying shares, which in turn, reduces the incentive to speculate and alleviates the "active participation" problem as raised in LNP. Second, fixing the dividend process and terminal value of the asset, the time trend of the fundamental value of the asset becomes positive with a high interest rate. An increasing fundamental value is more compatible with subjects' perception that asset prices tend to increase in the long run. As a results, subjects are more likely to track the fundamental value more closely when they trade.

We conduct two sets of experiments with interest payment. The first has increasing fundamentals, and the second has decreasing fundamentals. The results are that bubbles do not exist in the first set of experiments, but appear in the second set of experiments. We conclude that interest payment on cash holdings can eliminate bubbles, and mainly because it can induce an increasing fundamental value. In contrast to decreasing fundamentals as in the SSW design, increasing fundamentals are more consistent with subjects' perception that asset prices tend to rise in the long run. Therefore, subjects are less confused in experiments with increasing fundamentals and are able to track the fundamental value more closely.

References

Bostian, AJ. A., Goeree J. K. , and Charles A. Holt (2006), "Price bubbles in asset market experiments with a flat fundamental value," Discussion paper, University of Virginia.

Bostian, AJ. A. and Charles A. Holt (2009), "Price Bubbles with Discounting: A Web-Based Classroom Experiment", Journal of Economic Education, 40, 27-37.

Brunnermeier, Markus K. (2009), "Bubbles," in The New Palgrave Dictionary of Economics (2nd edition), edited by Steven Durlauf and Lawrence Blume.

Duffy, John, and Utku Ünver (2006), "Asset Price Bubbles and Crashes with Near-zero-intelligence Traders," Economic Theory, 27, 537-63.

Dufwenberg, Martin, Lingqvist, Tobias and Evan Moore (2005), "Bubbles and Experience: an Experiment," American Economic Review, 95, 1731-1737.

Fischbacher, Urs (2007), "Z-Tree: Zurich Toolbox for Ready-made Economic Experiments," Experimental Economics, 10(2), $171-178$.

Fisher, Eric O'N, and Frank Kelly (2000), "Experimental Foreign Exchange Markets," Pacific Economic Review, 5, 365-387.

Kirchler, Michael; Huber, Juergen and Stöckl, Thomas (forthcoming), "Thar She Bursts - Reducing Confusion Reduces Bubbles," American Economic Review.

Hussam, Reshmaan N., Porter, David and Vernon Smith (2008), "Thar She Blows: Can Bubbles Be Rekindled with Experienced Subjects?", American Economic Review, 98, 924-937.

King, Ronald, Smith, Vernon, Williams, Arlington, and Mark Van Boening (1993), "The Robustness of Bubbles and Crashes in Experimental Stock Markets," in Nonlinear Dynamics and Evolutionary Economics, ed. by I. Prigogine, R. Day, and P. Chen, Oxford: Oxford University Press.

Lei, Vivian, Noussair, Charles N., and Charles R. Plott (2001), "Nonspeculative bubbles in experimental asset markets: lack of common knowledge of rationality vs. actual irrationality," Econometrica, 831-859.

Lei, Vivian and Filip Vesely (2009),"Market Efficiency, Evidence from a No-bubble Asset Market Experiment," Pacific Economic Review, 14, $246-258$.

Lugovskyy, Vololymyr, Puzzelo, Daniela, and Steven Tucker (2010), "An Experimental Study of Bubble Formation in Asset Markets Using the Tâtonnement Trading Institution," working paper.

Noussair, Charles and Owen Powell (2010), " Peaks and valleys: Price discovery in experimental asset markets with non-monotonic fundamentals," Journal of Economic Studies, 37(2), 152-180.

Noussair, Charles, Robin, Stephane, and Bernard Ruffieux (2001), "Price Bubbles in Laboratory Asset Markets with Constant Fundamental Values," Experimental Economics, 4, 87-105.

Oechssler, Jörg (2010), "Searching beyond the lamppost: Let's focus on economically relevant questions,"Journal of Economic Behavior and Organization, 73, 65-67.

Porter, David, and Vernon Smith (1995), "Futures contracting and dividend uncertainty in experimental asset markets," Journal of Business, 68, 509-541.

Smith, Vernon, Suchanek, Gerry, and Arlington Williams (1988) "Bubbles, Crashes and Endogenous Expectations in Experimental Spot Asset Markets," Econometrica, 56, 1119-1151.

Smith, Vernon, Van Boening, Mark, and Charissa Wellford (2000), "Dividend Timing and Behavior in Laboratory Asset Markets," Economic Theory, 16, 567-583.

Smith, Vernon (2010), "Theory and experiment: what are the questions?,"Journal of Economic Behavior and Organization, 73, 3-15.

Stockl, Thomas, Huber, Jurgen, and Michael Kirchler (2010), "Bubble Measures in Experimental Asset Markets," Experimental Economics, 13, 284-298.

Van Boening, Mark, Williams, Arlington, and Shawn La Master (1993), "Price Bubbles and Crashes in Experimental Call Markets," Economics Letters, 41, 179-185.