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Hamilton
New Zealand

Nonspeculative Bubbles Revisited

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Working Paper in Economics 1/24

January 2024

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Abstract

In an important contribution, Lei et al. (2001, Econometrica) argue that speculation is not the driver of bubbles in the absence of common knowledge of rationality, suggesting a focus on mistakes and confusion. We revisit Lei et al.'s (2001) design, confirming the existence of bubbles. However, we argue that, although their design removes the ability to speculate, it introduces several unintended design artifacts, inducing bubbles.

JEL Classification

C91

G13

Keywords

speculation

bubbles

cognitive ability

asset market experiment

Acknowledgment

We thank Tim Cason, David Freeman, Georg Kirchsteiger, Volodymyr Lugovskyy, Charles Noussair, Joerg Oechssler, Luba Petersen, Daniela Puzzello, Stefan Trautmann for their constructive comments. We thank the seminar participants at Erasmus School of Economics (finance group) and Simon Fraser University for their valuable suggestions. We also thank participants at the Experimental Finance Conference 2018, HeiKaMaX workshop 2018, External Validity, Generalizability and Replicability of Economic Experiments workshop 2019 (Barcelona GSE) for helpful comments. We gratefully acknowledge financial support from Waikato Management School, University of Waikato. The study has received human ethics approval from the Waikato Management School Human Ethics Committee.

1. Introduction

Despite data in field financial markets being easily accessible, asset market experiments offer unique features and insights that further advance our understanding of market dynamics and the determinants influencing pricing mechanisms (see Huber and Kirchler, 2023 and Kirchler and Weitzel, 2023). A seminal paper in this literature is Smith, Suchanek, and Williams (1988, hereafter SSW). In their experiment, traders have the opportunity to participate in a market with a dividend-bearing asset. As the stream of dividends is the only source of value of the asset, the fundamental value can be estimated, and thus mispricing can be clearly identified. The principal result from the study is that markets consistently produce price bubbles and crashes.

Regarding the mechanisms of bubble formation, both SSW and Plott (1991) conjecture that bubbles occur due to the lack of common knowledge of rationality in the market. In the presence of heterogenous beliefs, agents are more willing to engage in speculative activities. Lei, Noussair, and Plott (2001, hereafter LNP) explicitly tests whether speculation is the driving force behind bubbles by offering a seemingly ingenious design that prohibits the necessary condition for speculative behavior, i.e. the ability to resell. This is achieved by restricting traders' role to a specific side of the market, and thus, traders were prevented from buying low and selling high. Bubbles should be eliminated if speculation is the main reason for bubble formation. Yet, surprisingly, this was not supported by LNP's results and bubbles continue to be observed even when the ability to speculate is removed. Thus, LNP argue that speculation is not a necessary condition for bubble formation. This result has had a profound impact on the literature. It is the first paper that supports the notion that factors other than speculation (e.g., confusion, decision errors) might play a crucial role in bubble formation.

Another important result put forward by LNP is known as the active participation hypothesis, which states that at least some proportion of trading activity in experimental asset markets is due to subjects having no alternative activities, other than trading, in market experiment. This has been conjectured as another factor contributing to bubble formation because bubbles are typically associated with high turnover.

Given the importance of the results and how this paper influences the progression of the field (Camerer et al., 2016; Corgnet et al., 2021, 2022), a revisit of this study is warranted. One of the main concerns of the LNP study is that their results are based upon as few as three observations in the no-speculation conditions. We want to provide a best-case scenario for the LNP design by providing more data on these results. Additionally, there are several design choices in LNP that were thought to be innocuous at the time of data collection but are now considered behaviorally important given advancements in the literature. First, the cash asset ratio differs across treatments and ranges from 1 to 27.8. Within their baseline treatment, the cash to asset ratio also differs substantially (either 2.78 or 27.8). Recent literature has shown an important relationship between the cash to asset ratio and bubble formation, thus confounding interpretations.[1] Second, cash is sometimes treated as a loan while other times treated as a gift. Third, the dividends are drawn from different distributions across treatments. At a minimum, these features induce confounding effects across and within treatments.

In light of these potential issues, we revisit LNP's results to examine whether their finding is robust. We revise the parameters to make them more in line with current practices in the study of experimental asset markets (described in detail in Section 2). The replication allows us to make proper comparison across treatments, without the potential confounding issues caused by variation of the cash to asset ratio across treatments, variation of dividend draws, and variation of the cash endowment provided as gift vs loan.

Our results support the finding of LNP in that large bubbles form and persist when the ability to speculate is prohibited.[2] Additionally, our replication treatment supports the Active Participation Hypothesis in that trading volume significantly decreases when the second market exists. However, we do not find support for LNP's conjecture that the combination of the no-speculation condition and the availability of an alternative activity reduces irrational transactions and diminishes bubbles. Rather, we find that irrationality persists accompanied by large bubbles.

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[1] Higher cash asset ratios have been shown to induce greater mispricing (Caginalp et al., 1998; Caginalp et al., 2001; Caginalp et al., 2002; Haruvy and Noussair, 2006, Noussair and Tucker, 2016; Razen et al. 2017; Kopányi-Peuker and Weber, 2021; among others).

[2] As a robustness check to their main treatments, Janssen et al. (2019) conduct three SSW markets in the spirit of the LNP no-speculation condition, i.e. trading roles were restricted, with each of these sessions being assigned to one of their three main treatment conditions. Thus, too few observations to conduct any statistical analysis. However, the price paths of the three sessions are also consistent with LNP.

Even though our results are mostly consistent with those of LNP, we believe that it is quite possible that the observed behavior in the no-speculation treatments is due to design artefacts. While restricting the role of traders as either a buyer or a seller eliminates speculative motives for capital gains, such restriction is very unnatural for traders in an asset market experiment. At the start, buyers are endowed with only cash but no asset. Thus, the only action they can take is to buy asset. Similarly, sellers are endowed with only asset but no cash and therefore they can only sell the asset. Additionally, each transaction in the market continually reduces the availability of assets and cash in the market. Therefore, not only is the cash to asset ratio changing with each transaction, but the markets also become thinner and potential for changes in perceptions of scarcity towards assets and cash. Thus, we argue that such an intrusive experimental intervention may lead to bubbles despite the prohibiting of speculative behavior. Support of this conjecture is provided by Tucker and Xu (2023) that find bubbles are effectively removed when speculative *motives* (as opposed to the *abilities*) are eliminated while all other aspects of market activity remain intact.

The paper is organized as follows. Section 2 revisits the LNP design and discusses our replication procedures. The results of the replication are reported in section 3. We then conclude in section 4.

2. Experimental Design and Procedures for the Replications of LNP

2.1 General information

Subjects in our experiment have the opportunity to participate in an asset market, trading an asset called X. The market is organized as in Smith et al. (1988), using the double auction rules such that all traders are free to place bids and asks at desired prices and can accept other traders' existing offers. The trading platform is computerized using the z-Tree software (Fischbacher, 2007). Endowments of experimental currency, called francs, are provided to the traders as a gift, together with units of the asset. Assets traded in the market have a finite life of 15 periods. Cash balances and inventories of the asset can be carried over from one trading period to the next.

At the end of each period, each asset pays a random dividend that is independently drawn from a known distribution, allowing for the expected value of the dividend payment to be easily calculated. Dividend earnings are saved in a separate account, and thus do not impact the cash to asset ratio in the market. The value of the dividend payment is the same for all traders. After the final dividend payment in the last period of the market, the asset is worthless. Therefore, the fundamental value of the asset in any given period equals the expected value of the dividend payment multiplied by the number of periods (dividend payments) remaining in the market. It is also useful to define the maximum justifiable price of the asset as the maximum possible dividend value multiplied by remaining number of periods in the market. At the end of the experiment, the accumulated cash balance in francs (including those in the dividends account) were converted to NZD at predetermined exchange rates that was known in advance for all subjects in a session.

2.2 LNP replication treatments

There are four main treatments in LNP. However, it is difficult to directly compare these treatments because there are a number of differences across markets. For instance, the cash endowment is treated as a loan in some treatments and treated as a gift in others. The potential dividend is sometimes 4-point distributed and other times 2-point distributed. The cash to asset ratio ranges from 1 to 27.78 across different treatments. Table 1 summarizes all parameters of different conditions studied in LNP. The large variations make it difficult to compare results across treatments and the number of observations for each parameterization is lower than four.

Table 1. Summary of basic information about the sessions in LNP

Session	Initial Working Capital	Initial Asset Endowment	Number of Subjects	Exchange rate	Possible Dividend	Number of Periods[a]	C/A ratio
NoSpec1	7,200/buyer	20/seller	8	300fr/$	20,40	12	1.00
NoSpec2	7,200/buyer	20/seller	7	300fr/$	20,40	12	1.33
NoSpec3	7,200/buyer	20/seller	8	300fr/$	20,40	12	1.00
TwoMkt1	100,000/trader	10/trader	6	200fr/$	0,8,28,60	18	27.78
TwoMkt2	100,000/trader	10/trader	8	200fr/$	0,8,28,60	18	27.78
TwoMkt3	100,000/trader	10/trader	7	200fr/$	0,8,28,60	18	27.78
TwoMkt4	100,000/trader	10/trader	8	200fr/$	0,8,28,60	18	27.78
TwoMkt5[b]	100,000/trader	10/trader	7	200fr/$	20,40	15	27.78
TwoMkt6	100,000/trader	10/trader	8	200fr/$	20,40	15	27.78
TMkt/NS1	100,000/trader	20/seller	14	200fr/$	20,40	15	13.89
TMkt/NS2	100,000/trader	20/seller	7	300fr/$	20,40	15	18.52
TMkt/NS3	100,000/trader	20/seller	15	300fr/$	20,40	15	15.87
OneMkt1	100,000/trader	10/trader	7	200fr/$	0,8,28,60	15	27.78
OneMkt2	100,000/trader	10/trader	7	200fr/$	20,40	12	27.78
OneMkt3	100,000/trader	10/trader	7	200fr/$	20,40	12	27.78
OneMkt4	10,000/trader	10/trader	7	500fr/$	20,40	12	2.78

Notes: This table is taken directly from LNP.

[a] The number of periods given in the table does not include the one practice period in each session, which did not count toward subjects' final earnings.

[b] In the session TwoMarket5 there existed a final buyout value of 80 units of experimental currency.

To address the difficulties of comparing results across treatments in the original LNP paper, we update the parameters to values more in line with recent studies and make consistent across all treatments. The treatments with updated parameters are summarized in Table 2. As shown in the table, cash is always given to the traders as a gift endowment, the dividends process is the same across treatments with a four-point distribution, and the cash to asset ratio is kept constant across the treatments. We collect 9 sessions of data per LNP's treatment.

Table 2. Treatment Summary

Treatment	Cash	Loan	Assets	Dividend	Periods	C/A ratio	Our Observations
OneMkt	10,000	No	10	0,8,28,60	15	2.78	5
NoSpec	10,000/buyer	No	10/seller	0,8,28,60	15	2.78	9
TwoMkt	10,000	No	10	0,8,28,60	18	2.78	9
TMkt/NS	10,000/buyer	No	10/seller	0,8,28,60	18	2.78	9

The OneMkt is served as a baseline condition, in which a standard asset market operates as in Smith et al. (1988).

The NoSpec treatment physically removes the ability of traders to speculate. Eight subjects in this market are randomly assigned as either buyers or sellers and are allowed to either only buy or only sell units of the asset respectively. Therefore, resale of the asset is prohibited, which ensures that there is no possibility of realizing a capital gain. The only source of value for holding the asset is, therefore, its expected cumulative dividends in the remaining life of the asset. Sellers are of course allowed to sell assets at prices above the fundamental values if buyers are willing to pay those prices. Buyers were endowed with only cash and no assets, and sellers were endowed with assets but no cash. Given the dividend process and endowments of cash and assets, the initial expected wealth of all traders is equal.

In treatment TwoMkt, a second goods market trading a commodity called *Y* (as distinct from asset *X*) operates concurrently with the asset market trading asset *X*. Commodity *Y* has a life of one period, and it is treated as a good or service as in Smith (1962) rather than an asset. Commodity *Y* does not pay dividends in any period, but it has redemption values for agents who consume it at the end of each period. Traders are either buyers or sellers in the goods market. Buyers do not own any units of *Y* at start but are endowed with diminishing personal values for consuming each unit of *Y* (an inverse demand schedule). Sellers are given 10 units of *Y* and are assigned increasing private costs for each unit of *Y* they sell (an inverse supply schedule).[3] The market for *Y* repeats itself every period in which a market clearing price and quantity is found in equilibrium. Inventories of *Y* are reinitialized after each period and goods cannot be carried over from one period to the next. The goods market *Y* opens three periods prior to the asset market for the traders to be familiar with it. This explains why in all two-market conditions, the total number of periods is 18, instead

[3] There are two possible demand schedules and two possible supply schedules that buyers and sellers are randomly endowed with. The marginal valuations for some buyers are 780, 730, 690, 670, 630, 600, 570 for the first through seventh units they purchase. For the rest of the buyers, the marginal valuations are 790, 730, 680, 670, 630, 600, and 570 for the first through seventh unit they purchase. For sellers, some of them have the marginal cost of 570, 620, 660, 690, 720, 750, and 780 for the first through seventh unit they sell. For other sellers, they have marginal cost of 560, 620, 670, 680, 720, 750, and 780 for their first seven units. In each session, we aim to have an equal number of buyers of each type, the same holds for sellers. The competitive equilibrium price is in the range of 670 to 680 francs, the equilibrium quantity amounts to an average of three sales for each seller and three purchases for each buyer. The same demand and supply schedule is used for both TwoMkt and TMkt/NS treatments.

of 15. Traders can freely access both markets trading *X* and *Y* when the market for *X* opens after the third period.

Finally, the fourth treatment is called TMkt/NS, meaning that both the goods market and asset market operate simultaneously and there is no possibility to resale or repurchase the asset. One can think of this treatment as the combination of treatments TwoMkt and NoSpec. It offers the opportunity to test if bubbles can be attenuated by providing an alternative activity and taking away the ability to speculate.

In treatments where traders are not restricted to the single role of either a buyer or a seller, they are all endowed with 10 units of *X*. On the other hand, both in treatments NoSpec and TMkt/NS where trader roles are imposed, sellers are endowed with 10 units of *X*, while buyers do not own any assets at the outset, following the design in LNP. At the end of each trading period, each unit of the asset pays a dividend of either 0, 8, 28, or 60 francs with an equal chance. Every unit of *X* pays the same dividend, regardless of the identity of the owner. Thus, the expected dividend paid on each unit of *X* is 24 francs per period and in total 360 francs over the course of a session because the asset market itself runs for 15 periods. As dividends are the only source of value of *X*, the fundamental value is derived from holding a unit of *X* from the current period until the end of the experiment and collecting the stream of expected dividend payments.

2.3 Lab procedures

A total of 250 subjects participated in our experiment. There are 32 markets in total (see Table 2), which are all conducted in the Waikato Experimental Economics Laboratory in Hamilton, New Zealand. Each market consisted of eight subjects, except for three markets.[4] Trade took place across a series of three-minute periods.[5] The trader composition of the market, period length and number of periods were all made common knowledge to subjects. Each session lasted approximately 100 minutes and subjects earned on average 35 NZD. The experimenter read aloud the instructions for the market experiment, followed by a quiz and private Q&A (available in the

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[4] These three markets have six subjects. due to no-shows, the rest of the three markets have six subjects.
[5] The original LNP markets consist of four-minute periods, while our markets all consist of three-minute periods. We reduced the period duration by one minute to account for the greater efficiency of trader interaction in the more modern zTree program relative to the MUDA program used in the LNP study.

online Appendix). Once everyone successfully answered the comprehension questions in the quiz, a practice period was conducted. Profits or losses made in this period did not count toward the final earnings, and both the cash balance and asset inventories were reinitialized before the start of the first trading period.

3. Results

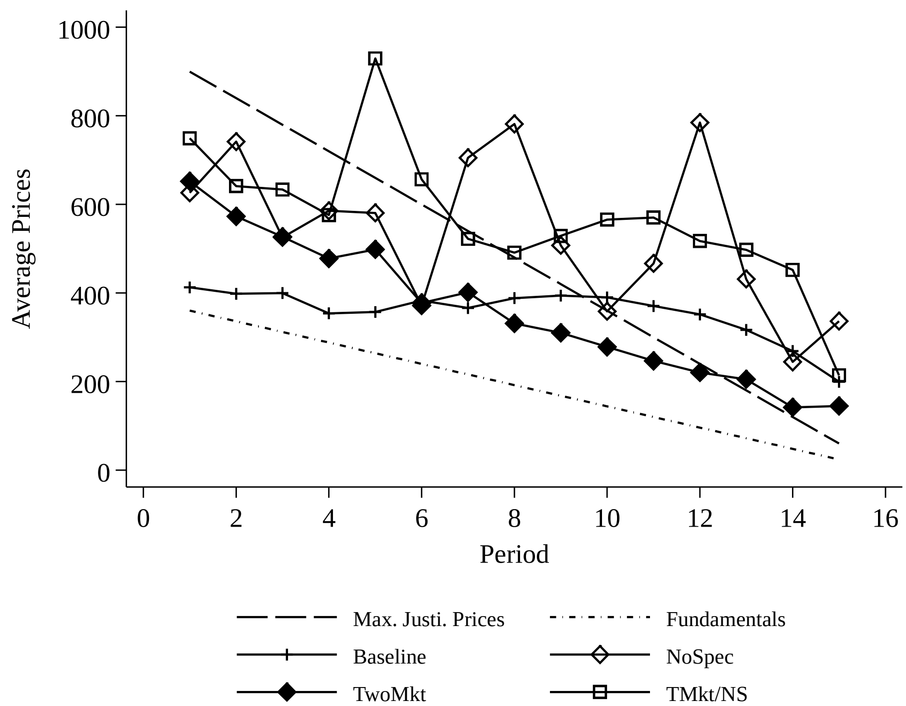
To quantify the magnitude of mispricing and facilitate comparisons, we employ three commonly used bubble measures in the experimental finance literature, Relative Absolute Deviation (RAD), Relative Deviation (RD) and Turnover (Van Boening et al., 1993; Stöckl et al., 2010). RAD is defined as RAD $=\{\sum_t |P_t - FV_t| /(\sum_t (FV_t)/T)\}/T$, where t refers to a specific period and T is the total number of periods in a market session. FV_t is the fundamental value in period t and the term P_t denotes the average price in period t. RAD measures how closely prices track fundamental value. The measure RD is defined as $RD = \{\sum_t (P_t - FV_t)/(\sum_t (FV_t)/T)\}/T$, which indicates whether prices are on average above (RD > 0) or below (RD < 0) fundamental value.[6] Turnover is the total number of transactions in a market session, normalized by the total units of asset available in the market. It is defined as $(\sum_t q_t)/TSU$, where q_t is the quantity of units of the asset exchanged in period t and TSU denotes the total stock of units. In words, it is the total number of transactions over the life of the asset, normalized by the total stock of units in the market. A high Turnover indicates a high volume of trade, which is typically associated with mispricing in experimental markets of the type studied here. Additionally, we calculate an interperiod volatility measure as in Noussair et al. (2016) where $volatility = \sum_{t=2}^{T} |(P_t - FV_t) - (P_{t-1} - FV_{t-1})| /(T-1)$, T is the total number of periods.

Figure 1 depicts the time series of the treatment average prices for all treatments. The vertical axis shows the treatment average prices and the horizontal axis indicates the trading period. We add two reference lines: the long-dashed line represents the highest justifiable value of asset, assuming that all remaining periods pay the maximum possible dividend. The only rational explanation to purchase assets above the maximum justifiable price level is to engage in speculative

[6] The bubble measures Geometric Absolute Deviation (GAD) and Geometric Deviation (GD) introduced by Powell (2016) were also calculated and consistent with measures reported in the paper.

trading, which is ruled out by design. The risk-neutral fundamental values are represented by the dashed-dotted line.

Figure 1. Time series of treatment average prices



Let's first consider the price path of the OneMkt baseline condition. Prices are consistently above fundamental values throughout the entire lifespan of the asset, and in the last third of the market, prices are above the maximally justifiable prices, which is a typical price path frequently observed in the literature (see a review by Palan, 2013).

Comparing the price trajectories of the NoSpec treatment to that of the OneMkt baseline, we observe that prices are much more volatile in NoSpec and consistently above the fundamental value during the entire periods of trade. The volatility measure indicates that prices are almost three times as volatile as the prices in the OneMkt treatment (p-value<0.05, MW-U test), reported in Table 3. The average prices in the NoSpec treatment are greater than the baseline in all but three periods. From period 7 onwards, the average prices in NoSpec are greater than the maximum justifiable prices. The bubble measures RAD and RD in Table 3 indicate that the NoSpec treatment exhibits on average the same extent of mispricing as in the OneMkt baseline, despite being more volatile. Thus, our results for OneMkt and NoSpec treatments are consistent with those of LNP.

Table 3. Treatment median bubble measures

	OneMkt	NoSpec	TwoMkt	TMkt/NS
RAD	0.80	0.96 (0.15)	0.72 (1.00)	2.10* (0.02)
RD	0.70	0.96 (0.44)	0.72 (0.90)	2.10* (0.02)
Volatility	26.49	86.58** (0.045)	65.88* (0.06)	63.93** (0.04)
Turnover[7]	4.18	0.98 [na]	1.78** (0.012)	0.73 [na]

Notes: ***,**,* indicate significant difference between the bubble measure in the entry and the corresponding bubble measure of the OneMkt baseline at 1%, 5%, and 10% level, Mann-Whitney U exact test. The p-values are indicated in the parentheses.

To test the effect of the existence of a goods market on asset market prices, we compare TwoMkt to OneMkt. Prices in TwoMkt treatment are also consistently above the fundamental values and the magnitude of the bubbles appear to be similar to that in the OneMkt baseline treatment. Table 3 shows that the presence of the second market does not suppress bubbles, as the degree of mispricing in TwoMkt is not significantly different from that in OneMkt. Turnover is smaller on average than in the baseline, but this result is not surprising given the presence of the goods market. Our results from TwoMkt are consistent with those of LNP.

When combining both treatment conditions of prohibited speculation and the presence of a goods market (TMkt/NS), assets are still consistently overpriced. The corresponding bubble measures of TMkt/NS suggest that the degree of mispricing is even greater than the OneMkt with both RAD and RD being significantly larger than those in the OneMkt treatment. Turnover in TMkt/NS is again only a quarter of that in the OneMkt due to the role restriction rule.

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[7] It is not informative to test for differences in Turnover between treatments involving LNP's no-speculation condition because, by design, the LNP no-speculation paradigm has a maximum turnover of 1. A superscript [na] is used to indicate the test is not applicable.

Comparing TMkt/NS to TwoMkt, we find that the incidence of dominated transactions (price is above the maximum justifiable value of the asset) is indeed lower in the TMkt/NS (26.62% of all transactions were dominated) than in the NoSpec (43.93% of all transactions were dominated), but the difference is insignificant (p-value>0.50, MW-U Test). Hence, we fail to find support that under NoSpec mechanism, the presence of the second goods market will reduce incidences of dominated transactions. In fact, the RAD and RD in TwoMkt are significantly smaller than the RAD and RD in TwoMkt/NS ($p<0.05$, Mann Whitney U exact test).

4. Discussion of the Results

Our replication results are mostly consistent with those of LNP. First, prohibiting resale (NoSpec) does not mitigate bubble formation. Second, the existence of a goods market in addition to an asset market (TwoMkt) reduces turnover but not prices. This is in line with Porter and Smith (1994, p. 118) who write that "…the claim that subjects trade because they believe they are expected to, merely predicts trade, not bubbles;". Lastly, when combining resale restrictions and the addition of a goods market (TMkt/NS), LNP observed that two of the three market observations did not bubble, and thus leading to them conjecturing that a market with prohibited resale will bubble less when a goods market is available. Our replication fails to support this conjecture. More specifically, bubbles not only persist in our TMkt/NS treatment but are significantly larger than the baseline conditions with 10 of the last 11 periods exhibiting prices greater than the maximum justifiable price.

As for interpretations of the NoSpec results, our replication would seem to provide support of those put forth by LNP. That is, the lack of common knowledge of rationality, and thus speculation, must not be the driving force for bubble formation given that bubbles persist when the necessary condition for speculation (i.e., resale) is prohibited. Therefore, other factors such as decision errors and confusion may play important roles. However, a closer look at the data suggests the existence of behavioral factors induced by the intrusive nature of the experimental design may be attributing to the observed price paths as opposed to the intended effect of simply removing the ability to speculate.

Preventing resale in the market is certainly a clever, clean design to remove the ability to speculate, and thus test the effects of speculation on bubble formation. However, there are at least four market structural implications of preventing resale that have been shown to impact market behavior.

First, prior to the start of the market, the no speculation treatments have extreme initial asymmetric endowments with buyers having only cash but no assets and sellers having assets but no cash. This leads to initial artificial "scarcity" of cash for sellers and assets for the buyers. The scarcity principle in psychology suggests that buyers are willing to pay more to obtain the asset and sellers are willing to sell for less to obtain cash when they perceive scarcity (Cialdini, 1993). Adding to the pressure of scarcity, it has been shown that traders often have a strong preference to balance and achieve a mixed portfolio (Janssen et al., 2019; Weber and Camerer, 1998; King et al 1993). These two effects motivate early transactions in the market as traders attempt to remove the perceived scarcity by diversifying portfolios. Figure 2 presents the proportion of the initial endowment of assets remaining in the market at the end of each period for NoSpec, and Figure 3 shows the number of transactions in each period of NoSpec. From the figures, we see that the almost half of the endowed shares (44%) were transacted in the first period with 91% of traders engaged in trades, and thus diversified their portfolios. An average of 18 trades in the first period implies that the average trader now holds a balanced portfolio, i.e. the number of shares held by buyers is similar to the number of shares held by sellers.

Second, as the market progresses, each transaction reduces the availability of assets and cash due to the unnatural feature of buyer's (seller's) inability to resell (repurchase), which impacts the rate that the cash to asset ratio increases across periods. In all other treatments without the NoSpec features, the cash to asset ratio increases from 2.78 in period 1 to 41.67 in period 15 simply due to the declining fundamental value. In NoSpec, the cash to asset ratio at any given time also depends upon the number of previous transactions and prices of those transactions. Therefore, any transaction with a price less than the cash to asset ratio for that period multiplied by the corresponding fundamental value for that period is going to result in an increase in the cash to asset ratio. For example, any transaction price less than (360 x 2.78 =) 1000.8 in period 1 is going to increase the cash to asset ratio above that of 2.78 in the baseline. The realized cash to asset ratio at the beginning of each period can be found in Figure 4. In all treatments, the cash to asset ratio starts

Figure 2. Proportion of Endowed Shares in Circulation at the End of Each period

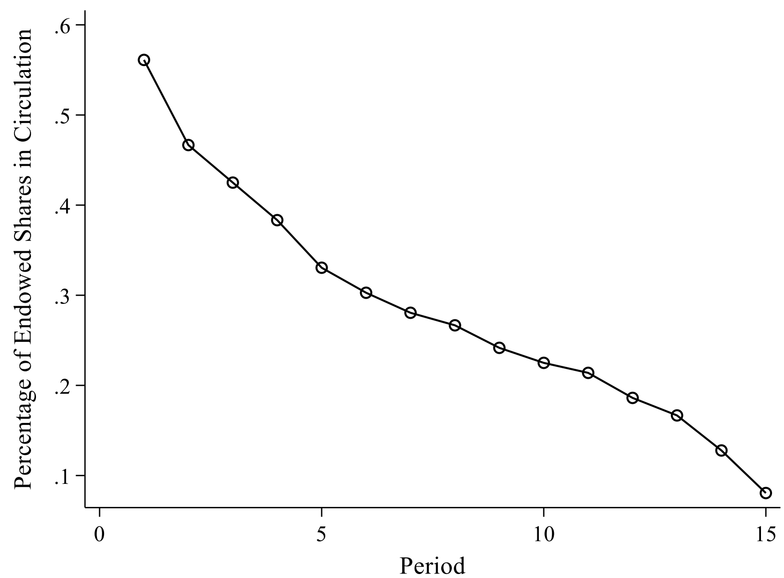


Figure 3. Number of Transactions in Each period of the NoSpec Treatment

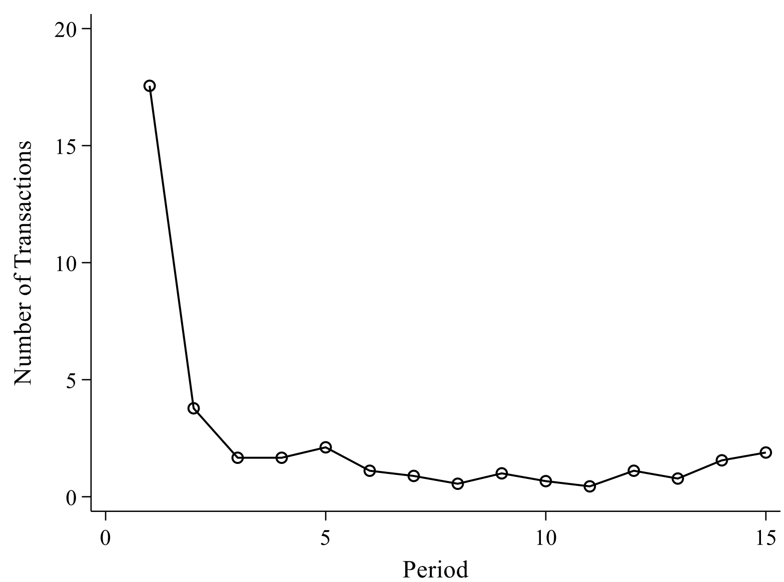
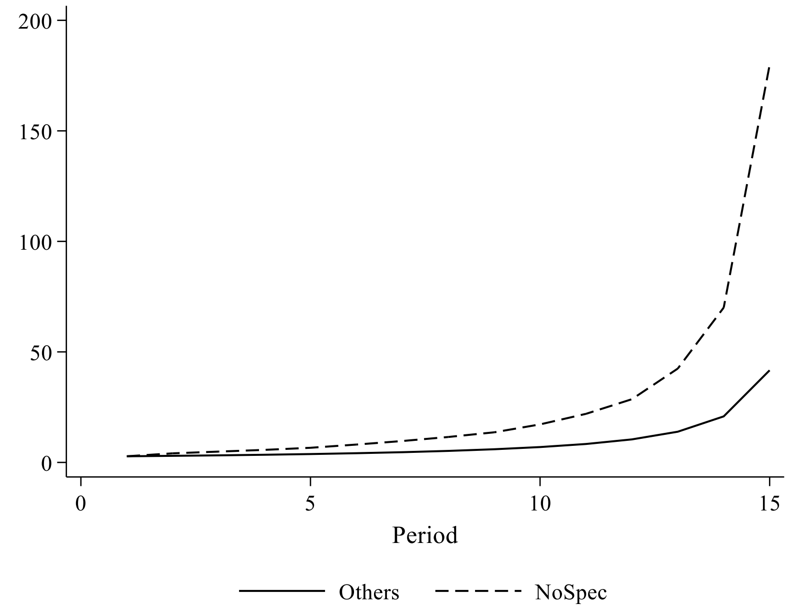


Figure 4. Cash to Asset Ratio Dynamics



Note: This figure plots the realized cash to asset ratio at the beginning of each period. In NoSpec treatments, the realized cash to asset ratio depends on the number of shares in circulation and the among of money the buyers have.

at 2.78 in period 1. After period 1, it can be clearly seen that the cash to asset ratios in the NoSpec treatment are consistently and substantially above the cash to asset ratios in other treatments, exhibiting higher upward pressures on prices. It is worth noting that the cash to asset ratio in the NoSpec treatment is more than 4 times higher than the other treatments in Period 15. Although unknown at the time LNP conducted this research, the positive relationship between cash to asset ratio and mispricing is well established (Caginalp et al., 1998; Caginalp et al., 2001; Caginalp et al., 2002; Haruvy and Noussair, 2006, Noussair and Tucker, 2016; Razen et al. 2017; Kopányi-Peuker and Weber, 2021; among others). Caginalp et al. (2001) estimate that "each dollar per share of additional cash results in a maximum price that is $1 per share higher." Therefore, it is reasonable to assume that the higher cash to asset ratios in NoSpec played at least some role in the overpricing observed.

Third, as transactions accumulate, the combination of the inability to resell and the relatively high cash ratio may have impacted the perceptions of scarcity relative to cash and assets differently. More specifically, each transaction increases the scarcity of available assets and cash in the market, but as transactions continue and periods transpire, scarcity of assets may start to weigh more heavily than that of cash. For example, the average price in period 1 of NoSpec was 631 francs, and thus buyer's cash holdings were only reduced by 6.3% on average, while the seller's asset holdings were reduced by 10%. Additionally, any induced scarcity of cash for buyers is offset at least to some degree due to buyers' purchasing power increasing with each passing period because of the declining fundamental value. Therefore, as periods and transactions transpire, the perceived scarcity of assets surpasses the perceived scarcity of cash. This increase in perceived scarcity of assets and the inability to repurchase may make sellers reluctant to continue to sell, and thus further induce scarcity in assets thereby imposing upward pressure on prices.[8]

Fourth, in addition to continually increasing perceived scarcity of assets, actual scarcity may also be occurring as the markets continually thin due to assets being removed with each transaction. In NoSpec, at least one seller has sold all their assets by the end of the market, and on average, three of the four sellers have sold all their assets. From Figure 2, we see that on average the proportion of asset assets available at the end of the market is less than 10% (3 out of 40 endowed). Thus, the same arguments for actual scarcity do not apply to cash as the average cash balance for buyers at the end of the market is 4,684, which is at least ten times higher than the average transaction prices in the last three periods.

We argue that these four possible behavioral effects associated with LNP's "no resale" design in themselves, or in combination, may have contributed to the bubbles observed in the NoSpec treatment. Tucker and Xu (2023) offer an alternative design that does not limit the traders' ability to resale/repurchase, but forcefully removes the incentives to speculate. The introduction of an 100% capital gains tax effectively attenuated bubbles. Taken together, we cannot rule out speculative behavior as being a driving force behind bubble formation.

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[8] Caballero (2006) and Giglio and Severo (2012) have shown that the supply side of (relative) asset shortage leads to price appreciation.

5. Conclusion

Conventional wisdom in the experimental finance literature has suggested that bubbles are often caused by speculative activities, which result from the lack of common knowledge of rationality (Smith et al., 1988; Plott, 1991). This is analogous to heterogeneity in beliefs in the field due to uncertainty in the intrinsic value of the asset. This interpretation has been challenged by Lei et al.'s (2001) results, which suggest that speculation is not a key ingredient to bubbles. However, financial theory and recent empirical evidence in the literature suggested that speculation does play a key role in bubble formation.

The key of the LNP paper is the NoSpec design where they eliminate the ability for traders to engage in speculative activities. This is achieved by restricting their roles to a specific side of the market such that buyers cannot resale the asset purchased and sellers cannot purchase the asset sold. In another treatment, they also add a second market that operates concurrently with the asset market. The idea is that much of the trading activities found in the experimental asset market is due to the fact that traders have no other activities other than participating the market. This is put forward as the Active Participation Hypothesis.

When reviewing the study by LNP, we notice several potential design issues that were not deemed important and thought to be innocuous at the time of data collection, but now considered important in the literature. We, therefore, decide to replicate their conditions with a modern treatment to be able to carefully study the treatment effects and the role of speculation. We also increase the number of observations to have more convincing statistical inferences, as the original paper only has three markets for the NoSpec treatments.

Our findings corroborate LNP's observation that the prohibition of speculation leads do not mitigate bubble formations. Our data also support the Active Participation Hypothesis, demonstrating a significant reduction in trading volume when a secondary market is present. This is in line with Porter and Smith (1994) who assert that the Active Participation Hypothesis is only about trading volume, not overpricing. Contrary to LNP's conjecture, we find no evidence to suggest that the combination of a no-speculation condition and the presence of an alternative activity (a goods market) curbs bubble formations. Instead, we observed that irrational behavior continues, often accompanied by substantial overpricing.

While our findings largely align with those of LNP, we suspect that the behaviors observed in the no-speculation treatments could be induced by the design artifacts. We argue that such a heavy-handed experimental intervention could result in bubbles, despite the prohibition of speculative behavior. This conjecture is supported by Tucker and Xu (2023), who found that bubbles are effectively eliminated when speculative motives are removed, while all other aspects of market activity remain unchanged.

In conclusion, our results support the results of LNP in that bubbles continue to occur even when the possibility to speculate is removed. However, we argue that this result is due to behavioral anomalies that are induced by the heavy-handed intervention in the NoSpec treatments.

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Appendix: Time series of transaction prices by treatment

Figure A1. Time series of transaction prices: Baseline

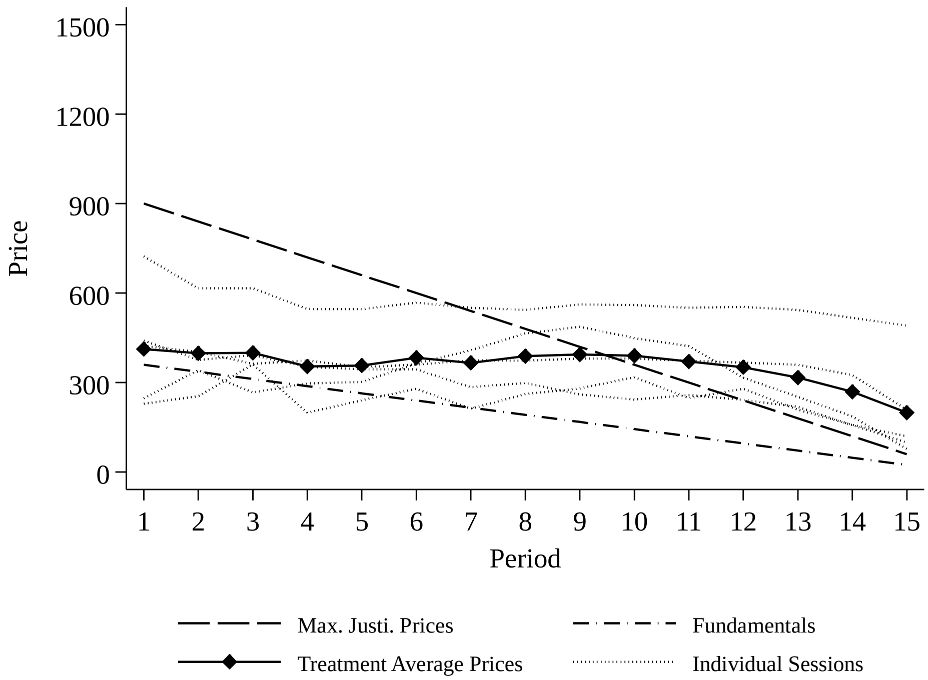

Figure A2. Time series of transaction prices: NoSpec

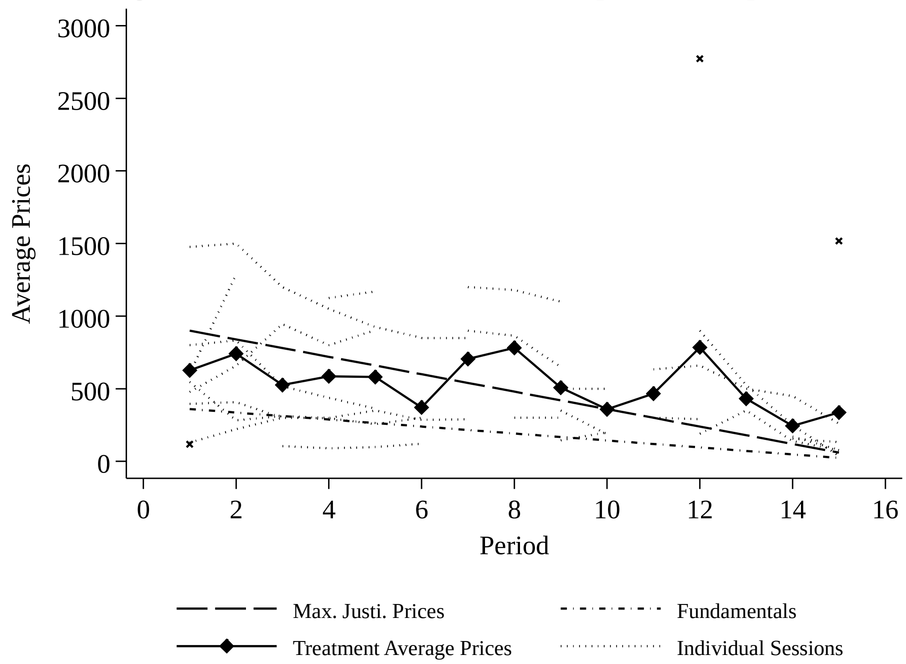

Figure A3. Time series of transaction prices: TwoMkt

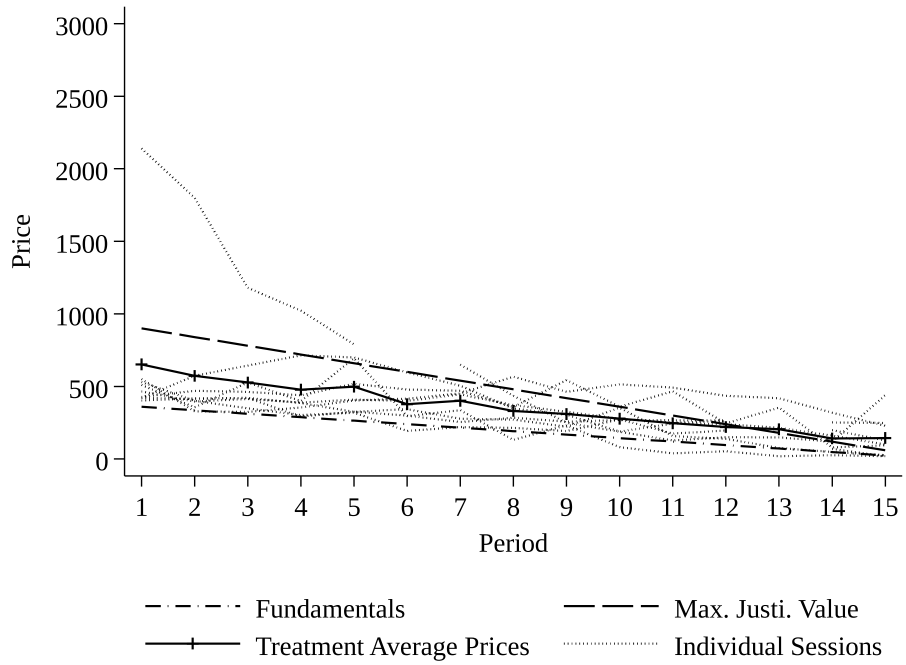

Figure A4. Time series of transaction prices: TMkt/NS