A Study on the Commonality Mechanism Formation Schema of Asset Price Bubbles Based on Experimental Economics

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Abstract: Eight groups of different experimental environment have been set up, based on the differences in the basis value, liquidity value and asset supply volume. These groups adopt the experimental economics approach to validate whether asset price bubble will be formed under a single condition, any two conditions or three conditions of excess liquidity, high benefit expectation as well as the supply of inflexible assets respectively. Firstly, the statistical analysis about the experimental results have been performed based on the Mann-Whitney approach, the three forming conditions listed above have been validated in order to impose a positive effect on the asset price bubble and the effectiveness of the theoretical hypothesis have also been tested. Secondly, the average of the experimental results has been compared using Kruskal-Wallis approach, which has proved that asset price bubble can only be formed when the three forming conditions listed above are satisfied. Finally, the experimental result has revealed the commonality formation path for asset price bubble, which means that the asset price bubble will be formed when over-trading is generated by excess liquidity under the condition of high investment expectation for the investor. It will also be formed when the asset price deviates from the basis price severely under the function of positive feedback mechanism, based on the premise of inelastic asset supply.

1. Introduction

Asset price bubble is a kind of economic characteristic for rapidly booming asset prices, which is generated when the market price of one kind of asset is higher that its base price, obviously under certain economic environment [1]. Since the 16th century, incidents of asset price bubble [2-3] have frequently broken out in different countries in the world, which has then affected the social and economic stability, as well as the development of such countries [4]. However, we have found out that there is similar assistor in the formation of asset price bubble of different economies, by reviewing every asset price bubble incident in the world economic history. This assistor is an internal mechanism that affects the generation of the asset price bubble. Presently, there are studies that mainly focus on whether one particular factor will play the positive pushing function during the

formation process of the asset price bubble [5]. Nevertheless, the formation of asset price bubble is not as a result of a single factor. Dai Yuanchen, a scholar in China [6] has reached the conclusion through the collection of the forming conditions at different times that there is a common formation path for the asset price bubble, but he did not point out the formation path in details. Therefore, to understand the asset price bubble better, we shall study the formation schema of the commonality, based on the forming condition of a single asset price bubble in order to find out the formation path and then control and prevent the occurrence of asset price bubble from the source.

Presently, the theoretical study concerning asset price bubble formation mechanism has mainly experienced three stages: Stage I is from the 17th century to the 20th century, which is known as the empirical study stage. The study in this stage believes that the formation of asset price bubble is due to the irrational behavior [7-8] of the asset market. Stage II is the study under the rational expectation framework, which is obtained from the mid-20th century until now. The main study trend of this stage is based on the partial equilibrium and general equilibrium theory [9]. The study in Stage III is the inter-discipline study stage, which is obtained from the 1980s until now. In this stage, different subjects have developed vigorously, the studied fields have crossed mutually and the development of psychology has particularly provided a new opportunity for financial study [10]. Among which, the rapid development of the behavioral finance has provided more extensive platforms for further study of the asset price bubble [11-12]. However, the liquidity of the asset, the expectation of the investor, the positive feedback information, risk preference as well as other conditions are still the main points to be studied for both the mainstream economics and the newly emerged branches.

Considering liquidity study, Caginalp [13] has created an experiment on the security market, which has tested the relationship between the asset level of the market and the security asset price bubble. The result indicates that there is a positive correlation between mobility and the rising of security prices. Later, the conclusive study of the China Center for Economic Research in Peking University [14-15] indicates that the excess liquidity of the asset is one of the main reasons for the formation of asset price bubble. Along with the gradual emergence of the behavioral finance, the behavior of humans and psychological factors have gradually been included into the experimental economics and people have realized that the risk preference of the traders has greatly affected the asset price [16]. Shiller [17] believes that in future, the behavior of irrational investors will form speculative asset price bubble when the expectation is better. Blnachard and Fiesher [18] found out that there will be no asset price bubble for some assets having specific characteristics, and one common characteristic of these assets is that there will be abundant supply in a short period and it will come with extremely strong competition. Cui Chang, a scholar in China has studied the phenomenon of asset price bubble for fictitious assets through demonstration based on this theory. He summarized the characteristics of assets without asset price bubble, which is the reproductive asset, asset with terminal conditions constraint as well as asset with infinite elasticity which is replaceable.

In particular, the study concerning the current formation mechanism for asset price bubble is becoming advanced and uniform recognition has been formed, which means that the excess liquidity of the real economy, the high benefit expectation for assets in the future as well as the inelastic market asset are all part of the conditions for the formation of asset price bubble. However, the question is whether the asset price bubble will be formed under any of the formation conditions for asset price bubble, or under the mutual function of several factors to one economy? Is there a common formation path for asset price bubble? The current study fails to answer these questions accurately. Therefore, this analysis will summarize the formation conditions for asset price bubble that have been discovered and set three groups of "excess liquidity", "high benefit expectation" and "the asset which supply is inelastic", which will promote the formation of asset price bubble to

study whether asset price bubble will be formed under any single of the formation condition, any two formation conditions or all three conditions in order to find out the common mechanism formation schema of asset price bubble and to reveal the commonality formation path for asset price bubble.

2. A Multi-factor Experimental Simulation of different Conditions of Asset Price Bubble

2.1 Experimental Simulation

The experimental simulation adopts the method which is mainly according to the classic experimental steps previously designed for experimental economics (Smith, 1988). It includes Participants, Initial Endowment, Trading Hour and Dividend, Trading Mechanism, and Incentive and Punishment Mechanism. The initial endowment of each experiment will be given to the trader and corresponding terms of the transaction will be set for the purpose of the experiment. This experiment is called a multi-factor economic experiment method, which aims to verify whether or not the asset price bubble is produced under a given condition, interaction of two conditions or the interaction of three conditions [19].

In the paper, eight different experiments are designed, of which Experiment 1, Experiment 2 and Experiment 3 are conducted with one of the three sets of conditions available. Experiment 4 is set as the control group, which is performed with three sets of conditions unavailable. Experiment 5, Experiment 6 and Experiment 7 are all performed with two of the three sets of conditions available. Experiment 8 is performed with all the three sets of conditions available. In order to make the transaction data effective, each set of experiment is repeated for 3 times and it continues for 40 minutes, under the same experimental environment. There are a total of 24 sets of experiments. The transaction experiment conducted at the experimental economics laboratory in the School of Economics and Management in Xi'an University of Technology was from May 2016 to October 2016. A total of nine experiments is conducted, of which the first one is for the preparation of the experiment and is not included in the scope of statistics [20].

In this paper, Group D is set as an experimental group. There are a total of eight different market environment, and the relevant information are as shown in Table 1. The symbols H_L, H_E and L_S in Table 1 represent three generating conditions of the asset price bubble -- "excess liquidity", "high benefit expectation" and "supply of inflexible assets" respectively; the symbols L_L, L_E and H_S represent the experimental environment for the generating conditions of asset price bubble -- "lack of liquidity", "low-yield expectations" and "supply of flexible assets" respectively.

According to the experiment design of group D, we can obtain the three indexes from the different experimental groups in group D as follows:

(1)Basic Value

Theoretically, in experimental economics, the set of the basic value can be helpful to obtain the expected benefits of the experimental assets with the pre-set dividend probability. However, in this paper, the experimental group is divided into two groups: expected high-yield group and expected low-yield group, according to expected returns. It is called the basic value of experimental assets of group D. In the case of high expectations (e.g. Experiment 2, Experiment 5, Experiment 7 and Experiment 8), the asset price for a particular period is equal to its expected discount value. At this point, the formula for the basic value of the assets of the period t is as follows:

$$P_t^* = \sum_{s=1}^{\infty} \frac{d_{t+s}}{(1+r_{t+1}) \cdots (1+r_{t+s})}$$

(1)

In this formula, r_t represents the real interest rate at the time of t and d_t represents the expected

value of the expected earnings of the asset. In this experiment, under the particular experimental environment with high dividend expectation, namely, Experiment 2, Experiment 5, Experiment 7 and Experiment 8, the formula for the basic value of the asset is a follows:

$$P_{0t} = (40 \times 80\% + 10 \times 20\%) \times (10 + 1 - t)$$

(2)

Table 1: Basic Design of Group D Experiment

Experimental Group	S/N	Initial Cash (Yuan / person)	Expected Dividends	Initial Capital
Experiment 1 ($H_L L_E H_S$)	Experiment D1.1 Experiment D1.2 Experiment D1.3	32,000	RMB 10 Yuan obtained with the probability of 80% RMB 40 Yuan obtained with the probability of 20%	100
Experiment 2 ($L_L H_E H_S$)	Experiment D2.1 Experiment D2.2 Experiment D2.3	17,000	RMB 40 Yuan obtained with the probability of 80% RMB 10 Yuan obtained with the probability of 20%	100
Experiment 3 ($L_L L_E L_S$)	Experiment D3.1 Experiment D3.2 Experiment D3.3	800	RMB 10 Yuan obtained with the probability of 80% RMB 40 Yuan obtained with the probability of 20%	10
Experiment 4 ($L_L L_E H_S$)	Experiment D4.1 Experiment D4.2 Experiment D4.3	8,000	RMB 10 Yuan obtained with the probability of 80% RMB 40 Yuan obtained with the probability of 20%	100
Experiment 5 ($H_L H_E H_S$)	Experiment D5.1 Experiment D5.2 Experiment D5.3	68,000	RMB 40 Yuan obtained with the probability of 80% RMB 10 Yuan obtained with the probability of 20%	100
Experiment 6 ($H_L L_E L_S$)	Experiment D6.1 Experiment D6.2 Experiment D6.3	3,200	RMB 10 Yuan obtained with the probability of 80% RMB 40 Yuan obtained with the probability of 20%	10
Experiment 7 ($L_L H_E L_S$)	Experiment D7.1 Experiment D7.2 Experiment D7.3	1,700	RMB 40 Yuan obtained with the probability of 80% RMB 10 Yuan obtained with the probability of 20%	10
Experiment 8 ($H_L H_E L_S$)	Experiment D8.1 Experiment D8.2 Experiment D8.3	6,800	RMB 40 Yuan obtained with the probability of 80% RMB 10 Yuan obtained with the probability of 20%	10

From the given formula above, we can clearly see that the basic value of the asset will reduce as the trading cycle continues to advance. If an asset is negotiated at a much higher price than its actual value in a trade experiment, it is assumed that the asset price bubble already exists on the asset. Therefore, in this transaction experiment, as the trading cycle is known and the investors are defined, the asset price bubble in the transaction emerges as an unreal bubble. In each set of transactions, although the expected probabilities are pre-set, the variance is distributed in the same

way, in order to make sure that the difference in risk of different assets will not be directly affected by the experimental results.

(2)Value of Liquidity

In this paper, the initial capital with high liquidity is defined to be twice the actual asset price. Based on this, Experiment 1, Experiment 5, Experiment 6 and Experiment 8 can all be defined as "Excess Liquidity Group". However, in a low-liquidity environment, the participants can only perform trading activities with half of their total assets.

The liquidity value (L) in this paper is represented by the following formula:

$$L = M/N = m_0 n/n_0 \; n = m_0/n_0$$

(3)

In the given formula above, M represents the total amount of capital owned by the trader at the initial stage of the transaction; N represents the number of available assets for the trader; n represents the market as a whole; while m_0 and n_0 represent the cash and assets each investor.

In the eight experiments performed for this study, m_0 is for RMB 32,000, RMB 17,000, RMB 800, RMB 8,000, RMB 68,000, RMB 3,200, RMB 1,700 and RMB 6,800 respectively; n_0 is for RMB 100, 100, 10, 100, 100, 10, 10 and 10 respectively. The liquidity value of the eight experiments is RMB 320, 170, 80, 80, 680, 320, 170 and 680 Yuan respectively by the substitution of m_0 and n_0 into Formula 2.2.

(3)Asset Supply

In this experiment, the supply elasticity of the assets is expressed in terms of the amount of assets actually owned by each group of investors who are involved in the experimental cycle. In the experimental group with less flexibility (Experiment 3, Experiment 7, Experiment 6 and Experiment 8), each investor has 10 units of assets that are less flexible in the short term. In the experimental group with full flexibility (Experiment 1, Experiment 2, Experiment 4 and Experiment 5), the investors have 100 units of assets with adequate supply. This experiment aims to study the performance of traders as well as their roles in the formation of the asset price bubble under the three different factors. The variables in this experiment are liquidity, expected returns and asset elasticity. Other relevant variables remain constant throughout the experiment. Therefore, the conclusion can be drawn that the differences in the experimental data of these eight sets of experiments are essentially caused by the lack or satisfaction of generating conditions of a certain asset price.

2.2 Experimental Results and Analysis

In this experiment, the asset price bubble is calculated by the measure formula mainly involved in most of literatures, namely, the average asset price bubble in a trading cycle of each experiment, as well as the accumulated asset price bubble, which is expressed as follows:

$$B_t = P_t - P_t^*$$

(4)

The cumulative price bubble is used to measure the overall price of the asset within 10 cycles of each set of experiment that are above or below the basic value. After n experimental cycles, the asset price bubble is represented as follows:

$$B = \sum_{t=1}^{n} (P_t - P_t^*)$$

(5)

P_t represents the average transaction price for transactions in period t;

P_t^* represents the basic value of assets in period t.

(1)Statistical Test of the Experimental Results

Based on the statistics of the average asset price bubble in each cycle of 24 transactions in group D, the ratio of bubble in the first five transaction periods of this experiment is negative and the asset price bubble appears in the 6th cycle and disappears in the 10th cycle with price tending to be in rational level. In this present section, only the experimental data of five cycles (from the 6th cycle to the 10th cycle) are selected as the target data.

In this paper, the three factors including liquidity, expectations and asset elasticity are tested via parameter comparison to see whether or not they play positive role in the asset price bubble. The assets are re-grouped according to liquidity, expectations of investors and asset elasticity, in order to make further study by carrying out the Mann-Whitney test. The following are relevant information of the mobility group as an example in order to illustrate the test process:

The experimental group is divided into two groups: the excess liquidity group and liquidity shortage group. The data of average price bubble from the 6th cycle to the 10th cycle of both the excess liquidity group and the liquidity shortage group are compared in Figure 1. The data series of 24 tests on the two groups are carried out by Mann-Whitney test, and the results are shown as follows:

$$z=-2.111, \quad p = 0.035 \ N1 = 72, \quad N2 = 24 \tag{6}$$

Among them, $N1$ represents the sample size of the excess liquidity group, while $N2$ represents the sample size of the liquidity shortage group. The test results are shown in Table 2, indicating that at a significance level of 5%, the excess liquidity group has a high frequency in bubble generation and the ratio of bubble is significantly larger than that of the liquidity shortage group.
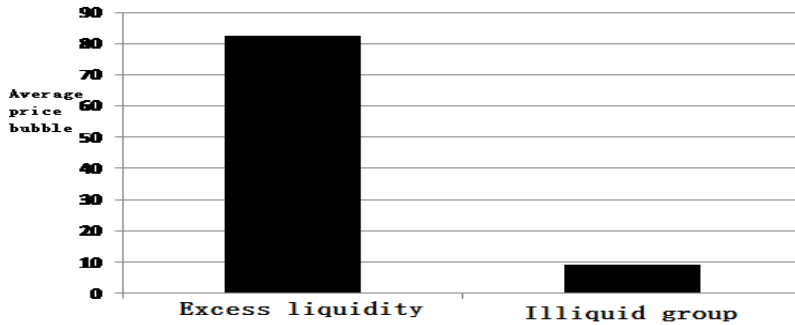

Figure 1: Comparison of the Average Price Bubble between the Excess Liquidity Group and the Liquidity Shortage Group

Table 2: Results of the Mann-Whitney Test for both the Excess Liquidity Group and the Liquidity Shortage Group

Total N		96	
Mann-Whitney U	614.500	Standard Error	118.183
Wilcoxon W	914.500	Standardized Test Statistics	-2.111
Test Statistics	614.500	Progressive Significance (2-sided test)	0.035*

Note: * represents significance at a significance level of 5%; N represents the number of experimental samples, $N = N_1 + N_2$

Therefore, we can obtain the following conclusion: excess liquidity obvious has a positive effect

on the generation of asset price bubble.

Additionally, the experimental group is further divided into two groups: the expected high-yield group and expected low-yield group; as well as the excess elasticity group and elasticity shortage group. Mann-Whitney test is carried out on each group. The conclusion drawn is as follows: the high expected return clearly has a positive effect on the generation of the asset price bubble, as well as the elasticity shortage. To a certain degree, this result supports our theoretical hypothesis that excess liquidity, high expected returns and elasticity shortage have a significantly positive impact on the asset price bubble. However, further analysis and judgment need to be conducted on whether or not the asset price bubble can be produced with any one of the three conditions, or with any two conditions, or with all three conditions.

(2)Further Analysis of the Experimental Results

A. Basic Experimental Results

Based on the pre-set experimental rules, eight different groups of experiments are repeated three times with each experiment having a total of 10 trading cycles. The basic experimental data obtained are shown below in Table 3:

Table 3: Basic Results of Group D Experiment

S/N	Initial Cash (Yuan / person)	Initial Capital	Total Price Bubble	Average Price Bubble
Experiment D1.1 Experiment D1.2 Experiment D1.3	32,000	100	-87.34 -19.92 -71.58	-59.61
Experiment D2.1 Experiment D2.2 Experiment D2.3	17,000	100	-71.38 -73.43 -69.74	-72.32
Experiment D3.1 Experiment D3.2 Experiment D3.3	800	10	-111.31 -72.62 -69.74	-84.56
Experiment D4.1 Experiment D4.2 Experiment D4.3	8,000	100	-92.18 -74.46 -97.88	-88.17
Experiment D5.1 Experiment D5.2 Experiment D5.3	68,000	100	-66.59 -19.66 -33.31	-39.85
Experiment D6.1 Experiment D6.2 Experiment D6.3	3,200	10	-39.04 -26.06 -62.88	-42.66
Experiment D7.1 Experiment D7.2 Experiment D7.3	1,700	10	-69 -47.6 -28.98	-48.53
Experiment D8.1 Experiment D8.2 Experiment D8.3	6,800	10	108.94 86.58 69.27	88.26

From Table 3, we can clearly see that the asset price bubble will not be produced, or it may be produced occasionally if one generating condition is met, or any two generating conditions are met. In the case where three different sets of generating conditions are available, asset price bubble will

also be at different levels. This information shows that only three sets of conditions available at the same time and mutually interactive with each other can lead to the transaction price of assets deviate from its basic value, which therefore results in in asset price bubble.

B. Mean Comparison of the Experimental Results

In the following, we use econometrics in order to determine whether or not these eight sets of experimental results are statistically different. In this paper, the 24 experiments were divided into 8 different groups according to the initial generating conditions. Then, Kruskal-Wallis test was performed on these 8 groups. The results obtained were compared with each other in order to determine whether or not these different groups were statistically different.

As shown in Table 4, the non-parametric test shows that there is no significant difference between the experimental results of Experiment 1, Experiment 2 and Experiment 3 with only one generating condition and Experiment 4 without any condition at a confidence level of 5%; while the experimental results of Experiment 5, Experiment 6 and Experiment 7, which meet the two generating conditions are significantly different from those of Experiment 8 with three generating conditions. Therefore, we conclude that there is no significant difference between the experimental results of the following three groups, namely, Experiment 5 and Experiment 6, Experiment 5 and Experiment 7, as well as Experiment 6 and Experiment 7.

Table 4: Paired Comparison of Non-parametric Tests of Independent Samples

Sample 1 - Sample 2	Test Statistics	Standard Error	Standardized Test Statistics	Significant Probability
Sample 1 - Sample 2	-10.370	6.377	-3.592	0.436
Sample 2 - Sample 4	7.396	6.377	1.102	0.252
Sample 3 - Sample 4	-18.329	6.377	-3.271	0.378
Sample 5 - Sample 8	-14.067	6.377	-2.206	0.012*
Sample 6 - Sample 8	-5.700	6.377	-0.894	0.027*
Sample 7 - Sample 8	0.933	6.377	0.146	0.007*
Sample 5 - Sample 6	-20.700	6.377	-3.246	0.371
Sample 1 - Sample 2	6.633	6.377	1.040	0.298
Sample 5 - Sample 7	-19.767	6.377	-3.100	0.884

Note: * represents significance at a significance level of 5%.

Based on the non-parametric test results and the statistical analysis of the experimental results, we can clearly see that when the three sets of generating conditions of asset price bubble are not fully available in the market, they cannot exert a significant impact on the asset price, thus, the asset price bubble will not be produced. Hence, the three sets of generating conditions available can produce the asset price bubble.

3. Reveal of the Commonality Formation Path for Asset Price Bubble

Based on Figure 2, the specific demonstration of the commonality formation path for asset price bubble is as follows.
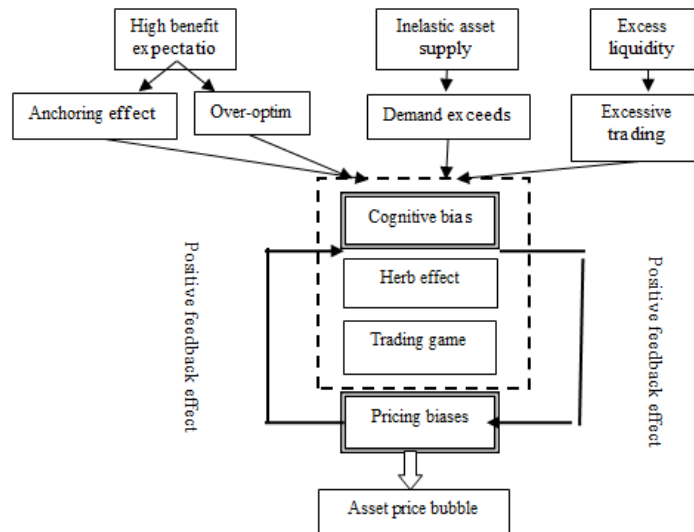

Figure 2: Commonality formation path for asset price bubble

A certain pre-condition is required for the formation of price bubble for any asset, which is the inelastic asset supply. The market price will deviate the basis value when the demand is strong if the supply quantity cannot increase along with the increase of the demand quantity in a short term for a certain asset. The specific transmission route is as follows.

1) Firstly, the asset price will increase rapidly if stimulated by a certain external and favorable condition, the increase in price will attract some investors to hoard such asset. If the quantity of this asset fails to increase rapidly or produce substitute goods rapidly in a short term, then the demand of the asset will exceed the supply, which will then provide the pre-condition for price derivation.

2) Secondly, since the participants are not rational agents, the recognition will include over-confidence, excessive trading, anchoring effect as well as other recognition derivations. These recognition derivations will be produced under certain stimulation, for example, consumers will be stimulated to have over-optimistic purchasing desire by high benefit expectation, the excess liquidity will then trigger excessive trading behaviors etc. These behaviors of the consumers will then provide the important condition for the formation of asset price bubble.

3) Lastly, the root cause for the actual derivation of asset price relies in the positive feedback mechanism effect. Under the function of the positive feedback mechanism, some investors have produced herb effect to blindly follow the investment strategies of others, which will then trigger the self-reinforcement fluctuation of the asset price. The other investors will have the "great fool" trading transaction motive, due to the promotion of the transaction game behavior because they understand the basis value of the assets. Then they will wait for the occurrence of the next "fool" and expect to get relevant benefits from their own investments. Therefore, the asset price will constantly rise under the function of the positive feedback mechanism due to the complete pre-condition and the preparation conditions. This will cause the price to deviate severely from the value and then the asset price bubble will be formed.

Through the above elaboration about the conditions for commonality formation of asset price bubble, the asset price bubble will be formed under the positive feedback mechanisms when a

certain asset has met the three basic conditions: "excess liquidity", "high benefit expectation" and "inelastic assets supply". Kindleberger described the famous asset price bubble phenomena in the world history, saying that they are mainly gotten from the dual function of excess liquidity and positive economic expectation. The the experiment of this analysis has provided evidence for this.

4. Conclusion and Future Research Prospects

The main study conclusion of this analysis is as follows:

Firstly, we found out that the asset price bubble is greater than the insufficient group when any of the above mentioned experimental conditions (i.e.: "excess liquidity", "high benefit expectation" and "inelastic asset supply") is available while combining the testing results of Experiment 1, Experiment 2 and Experiment 3 by adopting the Mann-Whitney analysis, which indicates that these three market conditions have definitely imposed an obvious positive function to the formation of the asset price bubble.

Secondly, the experimental results indicate that no obvious effect will be imposed to the asset price, which means that the asset price bubble will not be formed when the above mentioned formation condition for asset price bubble is unavailable in the market. It also means that only asset price bubble will be formed in the asset market when the three above mentioned conditions are available. Therefore, our experiment indicates that a single formation condition can only impose positive pushing function to the asset price bubble and it also indicates asset price bubble can only be formed in the market environment when the three conditions are available. This experiment has then proven that the three asset market conditions: "excess liquidity", "high benefit expectation" and "inelastic asset supply" are the main conditions for commonality formation of asset price bubble.

Lastly, the author summarizes that the path for asset price bubble will be formed when the asset is along with the three commonality formation conditions namely: "excess liquidity", "high benefit expectation" and "inelastic asset supply", under the positive feedback function in the asset market based on the experimental conclusion of this analysis.

The experimental economics is the simulation conducted in order to solve uncontrollable variables in the real market environment, which has provided the simple path for scholars to analyze the theoretical hypothesis and the model method. Further study is required to be conducted in order to understand how to apply the experimental conclusion into the real market environment. Additionally, the evolutionary process of the asset price bubble is the complex and dynamic system, and the formation and operational condition will consequently change along with the change of the environment. The factors that affect the formation of the asset price bubble will also change along with the change of the psychology of the investor, then the operational path of the bubble will be changed through the resulting circulation interrupt or reversion. Thus, these are all key problems that should be further analyzed in our subsequent studies.

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