Impact of Fluctuations on Individual Investment Behavior in Asset Market -- Based on the Double Auction Mechanism

西安交通大學
XI'AN JIAOTONG UNIVERSITY

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Team member: Zijing Zhao, Youcheng Li, Tai Zhang, Yufeng Wang

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01

Background

- *Experimental Asset Market*
- *Double Auction Mechanism*
- *Bubbles in Asset Market*

Experimental Asset Market

Experimental Economics:

It provides new empirical research methods, tests many existing economic theories and assumptions, and breaks the thinking mode that people have always adhered to.

Experimental asset market:

For the purpose of simulating the decision-making environment of the real economy and verifying the theoretical model, the simulation method is used to create a laboratory environment similar to the real economy, observe and analyze how the test subjects who are motivated by material rewards make decisions under a series of trading mechanisms in the asset market, so as to study people's behavior decisions.

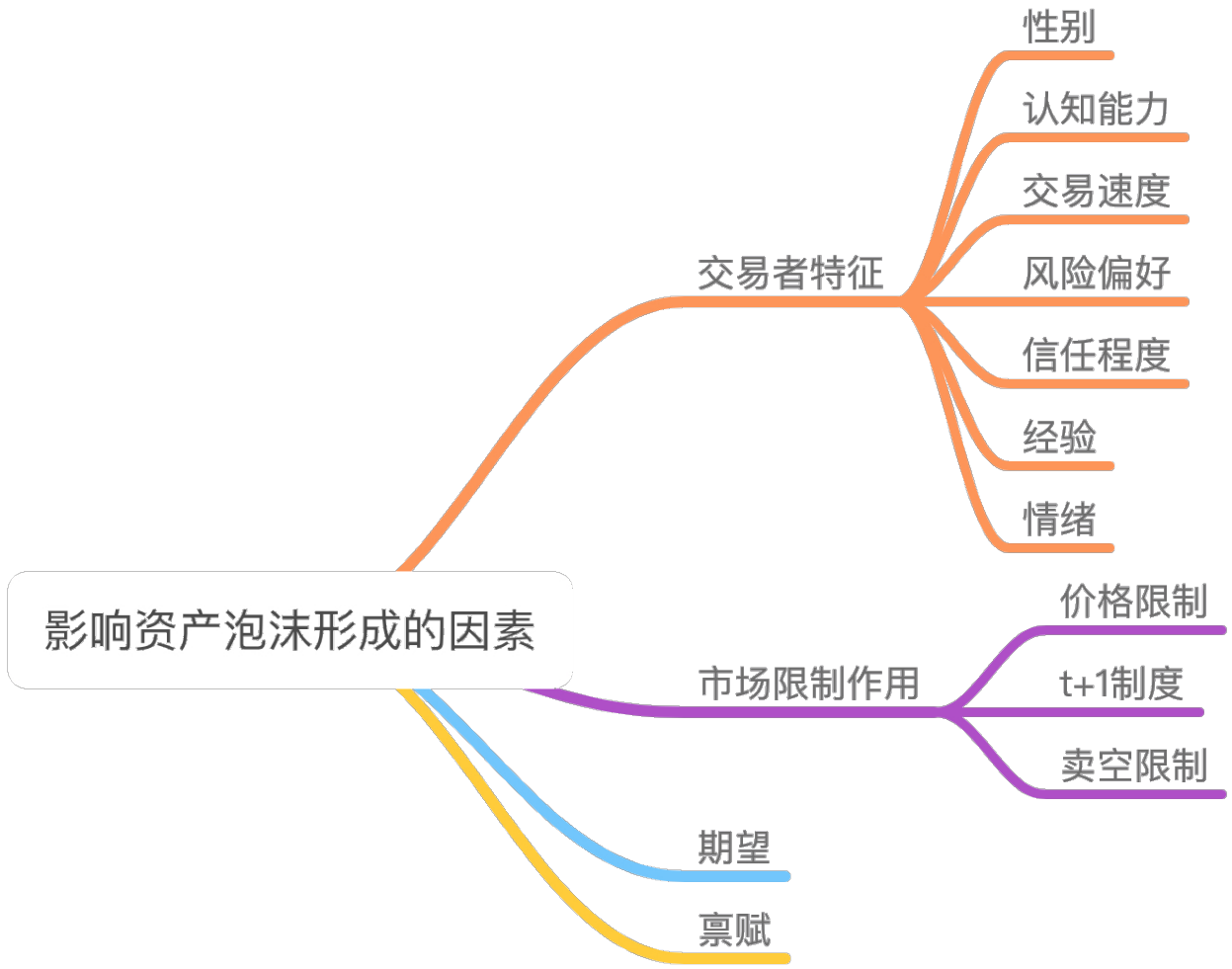
Double Auction?

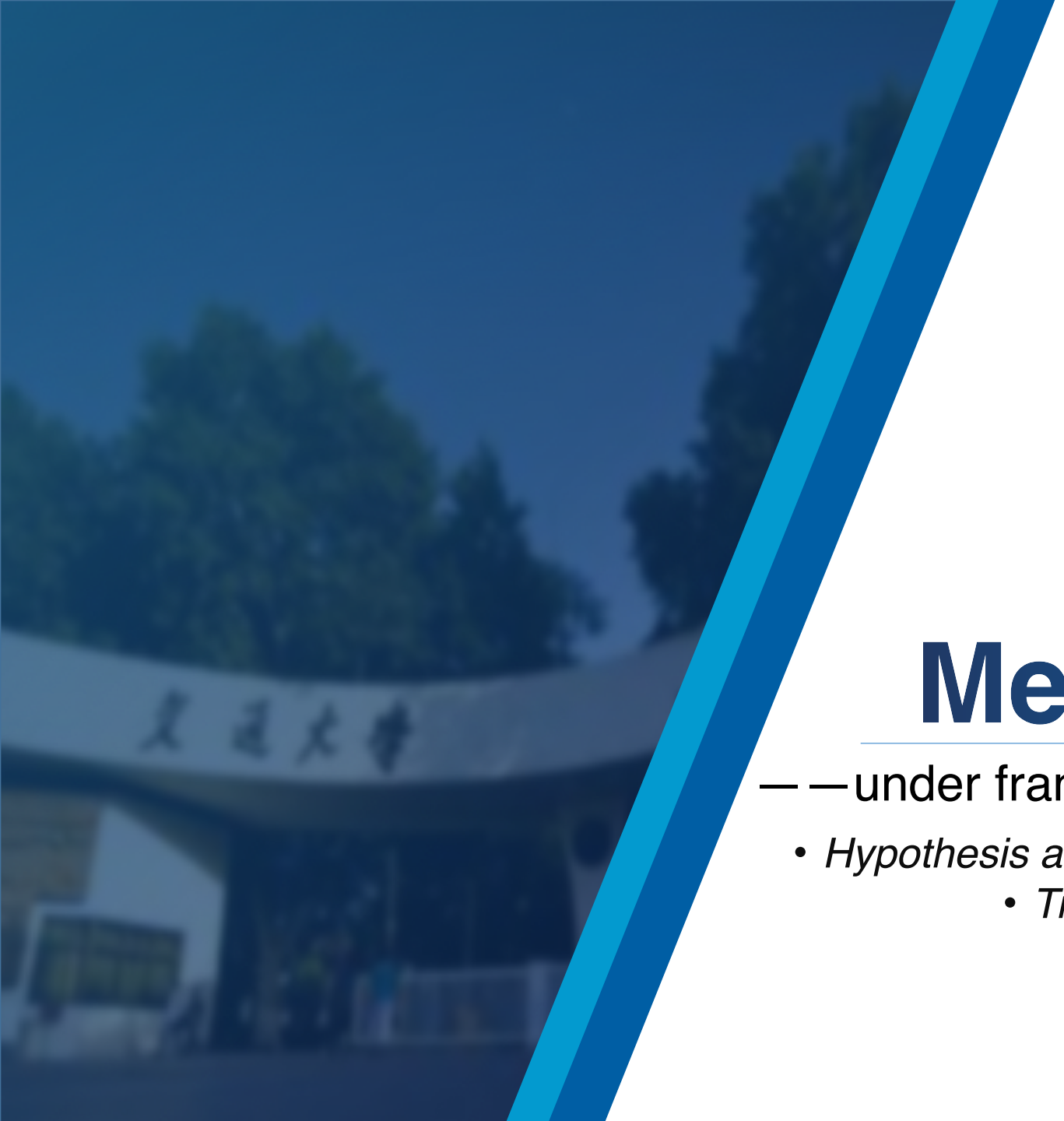
Comparison with general auction:
General auction: one seller faces many buyers
Bilateral auction: both buyers and sellers compete

Comparison with public quotation market:
Publicly quoted market: the seller determines the prices, which cannot be changed within a trading period, and the buyer can only decide whether to accept the publicly quoted price
Price: the public quotation market is often higher than the bilateral auction market
Quantity: the public quotation market is often lower than the bilateral auction market
Possible cause: Collusion

Double auction mechanism is generally considered as the most efficient market mechanism.

Factors influences





02

Methodology

——under framework of experimental asset market

- *Hypothesis and Variables*
- *Transaction Mechanism*
- *Experiment Procedures*
- *Asset Pricing*

Experimental Hypothesis and Experimental Variables

Fluctuations

- Increase the difficulty of price equilibrium
- Provide more arbitrage opportunities
- Markov Process
- Transition Rate

Price Limitation

- Short term: signal action
- Long term:Evaluation of deviation from basic value
- $(F_t - F_{t-1})/F_{t-1} \in (-10\%, +10\%)$

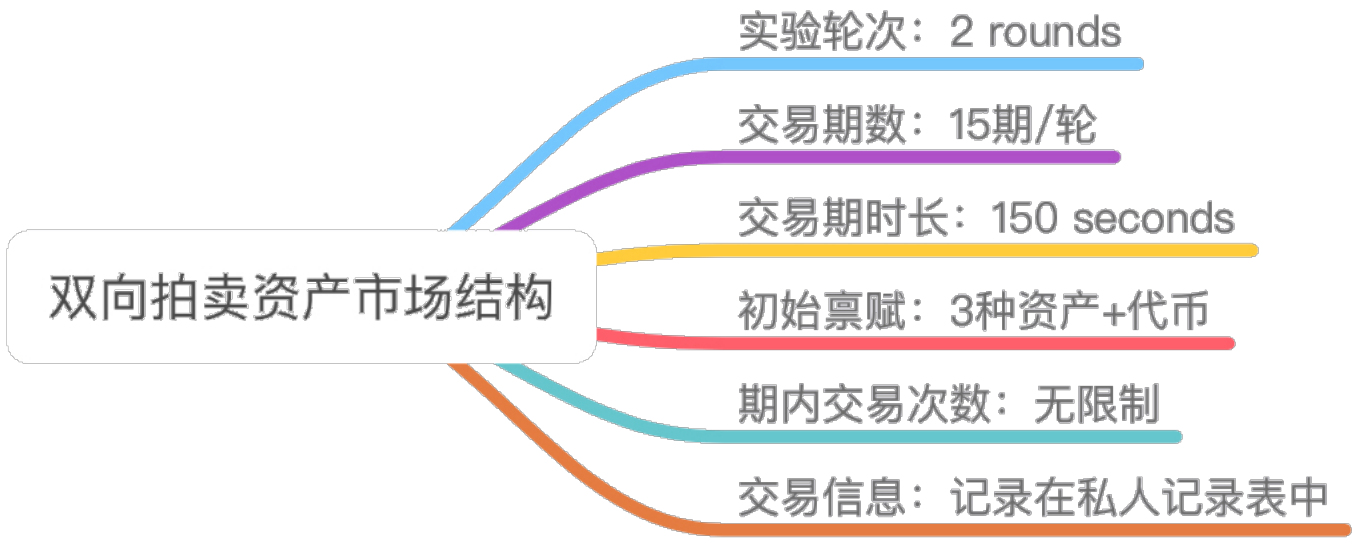
Circuit Breaker

- Short term: signal action
- Long term: affect liquidity
- $k = (\overline{F_t} - \overline{F_{t-1}})/\overline{F_{t-1}}$

Learning Ability

- Speed of mastering market information
- arbitrage opportunity

Market Structure



Transaction Mechanism

1. Price formation method and transaction process:
   continuous trading mode and bidding market

2. Traders' endowment trading requirements:
Asset: transaction volume is required to be an integer
Tokens: The transaction volume is required to be accurate to 2 decimal places

3. Price restriction mechanism:
Price limit and circuit breaker

4. Information disclosure

5. Transaction payment mechanism:
No margin system, short selling is not allowed
Only token transactions are allowed

Ask Diagram of Sellers
(Listed from low to high)

资产A	资产B	资产C
3.2	5.8	9.1
3.3	5.8	9.1
3.3	6.2	9.2
3.5		9.6
3.7		

Bid Diagram of Buyers
(Listed from high to low)

资产A	资产B	资产C
3.2	5.2	9.0
3.0	5.1	9.0
3.0	5.1	9.0
3.0	4.9	8.7

Procedures

Experiment I

Control group:
No price limit
experience group:
Single asset price limit
10%
Single asset price limit
30%

Experiment II

Control group:
No price limit
experience group:
Single asset price limit
10%
The circuit breaker
mechanism was suddenly
added in the seventh
trading cycle

Questionnaire

Cognitive ability test

Research on relevant
background information

Psychology related
tests

Asset Pricing

Asset Pricing

Different assets: different dividend distribution policies

Initial price of each asset:

Total discounted present value of all dividends

Embodiment of economic cycle:

High dividend distribution policy: economic prosperity

Low dividend distribution policy: economic depression

Three assets -- different risks

Different mobility rates --

different levels of economic volatility

Markov Process

DCF Model

Discrete time Markov process -- A simple model

First, let's assume that:
(1) The economic cycle is of equal length, which is converted at equal intervals
(2) Markov characteristic: the next economic cycle only depends on the state of the previous cycle, and has nothing to do with the previous state
(3) Time homogeneity: the transition probability from one cycle to the next is the same

Later, we will relax the assumptions

According to the assumptions, the model and parameters are as follows:

Transition Matrix

Markov with transition rate of 0.5: $\begin{bmatrix} 0.5 & 0.5 \\ 0.5 & 0.5 \end{bmatrix}$

Markov with transition rate of 0.7: $\begin{bmatrix} 0.7 & 0.3 \\ 0.3 & 0.7 \end{bmatrix}$

Assume that the first state is G

Transition rate of 0.5:

['G', 'G', 'B', 'B', 'B', 'B', 'B', 'G', 'B', 'G', 'B', 'B', 'G', 'G', 'B']

FV_A: 6.06110228549967

FV_N: 5.761558003539772

FV_Z:5.462013721579871

Transition rate of 0.7:

['G', 'G', 'G', 'G', 'G', 'G', 'B', 'B', 'B', 'B', 'G', 'G', 'G', 'G', 'G']

FV_A:8.975472766761706

FV_N: 7.21874324417079

FV_Z:5.462013721579871

```python
import numpy

#状态空间
states=["G","B"]
#可能的时间序列
transitionName=[["GG","GB"],
                ["BG","BB"]]
#概率矩阵
transitionMatrix=[[0.5,0.5],
                  [0.5,0.5]]

def RandomProcess():
    i=1
    Seq=[]
    START="G"
    Seq.append(START)
    while i<15:
        if START=="G":
            change=numpy.random.choice(transitionName[0],p=transitionMatrix[0])
            if change=="GG":
                START="G"
                Seq.append(START)
            elif change=="GB":
                START="B"
                Seq.append(START)
        elif START=="B":
            change=numpy.random.choice(transitionName[1],p=transitionMatrix[1])
            if change=="BG":
                START="G"
                Seq.append(START)
            elif change=="BB":
                START="B"
                Seq.append(START)
        i+=1
    print(Seq)
RandomProcess()
```

Dividend for three assets

Aggressive Asset: 1.2 at good state/0.3 at bad state

Normal Asset: 0.9 at good state/0.45 at bad state

Zero-risk Asset: 0.6 at good state/0.6 at bad state

$$\mathrm{F}V_{Asset} = \sum_{i=1}^{15} w_i d_i \qquad w_i = 1/(1+r)^{i-1}$$

$\mathrm{F}V_{Asset}$: Fundamental Value

w_i: weight of period i

d_i: dividend of period i

Transition rate=0.5

FV_{A}: 6.06

FV_{N}: 5.76

FV_Z: 5.46

Transition rate=0.7

FV_{A}: 8.98

FV_{N}: 7.22

FV_Z: 5.46

Transition rate=1.0

FV_{A}: 10.92

FV_{N}: 8.19

FV_Z: 5.46

Three kinds of endowment

Transition rate=0.5
Give the person 3 unit of each asset at first: (n_A, n_N, n_Z, n_C)=(3,3,3,178.16)
Give the person 6 units of each asset at first: (n_A, n_N, n_Z, n_C)=(6,6,6,126.32)
Give the person 9 units of each asset at first: (n_A, n_N, n_Z, n_C)=(9,9,9,74.48)

Transition rate=0.7
Give the person 3 unit of each asset at first: (n_A, n_N, n_Z, n_C)=(3,3,3,165.02)
Give the person 6 units of each asset at first: (n_A, n_N, n_Z, n_C)=(6,6,6,100.04)
Give the person 9 units of each asset at first: (n_A, n_N, n_Z, n_C)=(9,9,9,35.06)

Transition rate=1.0
Give the person 3 unit of each asset at first: (n_A, n_N, n_Z, n_C)=(3,3,3,156.29)
Give the person 6 units of each asset at first: (n_A, n_N, n_Z, n_C)=(6,6,6,82.58)
Give the person 9 units of each asset at first: (n_A, n_N, n_Z, n_C)=(9,9,9,9.13)

All the expected initial endowment of each person is 230 SC.

Continuous Time Markov Process -- Relaxation of the First Hypothesis

Economic cycles do not convert at fixed intervals of equal time, and their conversion is accidental. Therefore, we introduce continuous time Markov process.

The model is divided into two parts: jumping time and dwelling time. The jump time refers to the time when the economy changes, and its transfer probability can still follow the discrete time Markov process. Dwelling time refers to the time that the economy stays in boom/recession: the dwelling time between two "jumps" follows an exponential distribution. Therefore, according to the nature of continuous time Markov, the number of conversion times in a short time follows the Poisson distribution:

$$\mathbb{P}(N(t+h) = n+m \,|\, N(t) = n) = \begin{cases} 1 - \lambda h + o(h) & \text{if } m = 0 \\ \lambda h + o(h) & \text{if } m = 1 \\ o(h) & \text{if } m > 1 \end{cases}$$

The parameter Lambda is the parameter of exponential distribution of dwelling time, which can simulate the speed of economic transformation process according to the size of the parameter

Relaxation of the second hypothesis:

Markov characteristic: the next economic cycle only depends on the state of the previous cycle, and has nothing to do with the previous state.

Because whether the economy is prosperous or not depends not only on the previous period, but also on the economic prosperity of previous periods. That is to say, the actual process does not completely follow Markov characteristics. Therefore, we will introduce its weighting parameters with the previous two periods to determine the status of the current period.

The parameters can refer to the regression model of the economic climate index and its previous two indexes. However, because experimental economics is different from practice, the application of actual parameters in the experimental economics environment may not be effective, so the parameters need to be adjusted later.

Relaxation of the third hypothesis:

Randomize the transition probability: suppose that the transition probability follows a normal distribution with a certain mean and standard deviation, and it is generated randomly according to the experiment, which has certain feasibility. However, this model is too complex and quite accidental in the limited time of the experimental asset market. Therefore, it is of little practical significance to release the third assumption of the model.

03

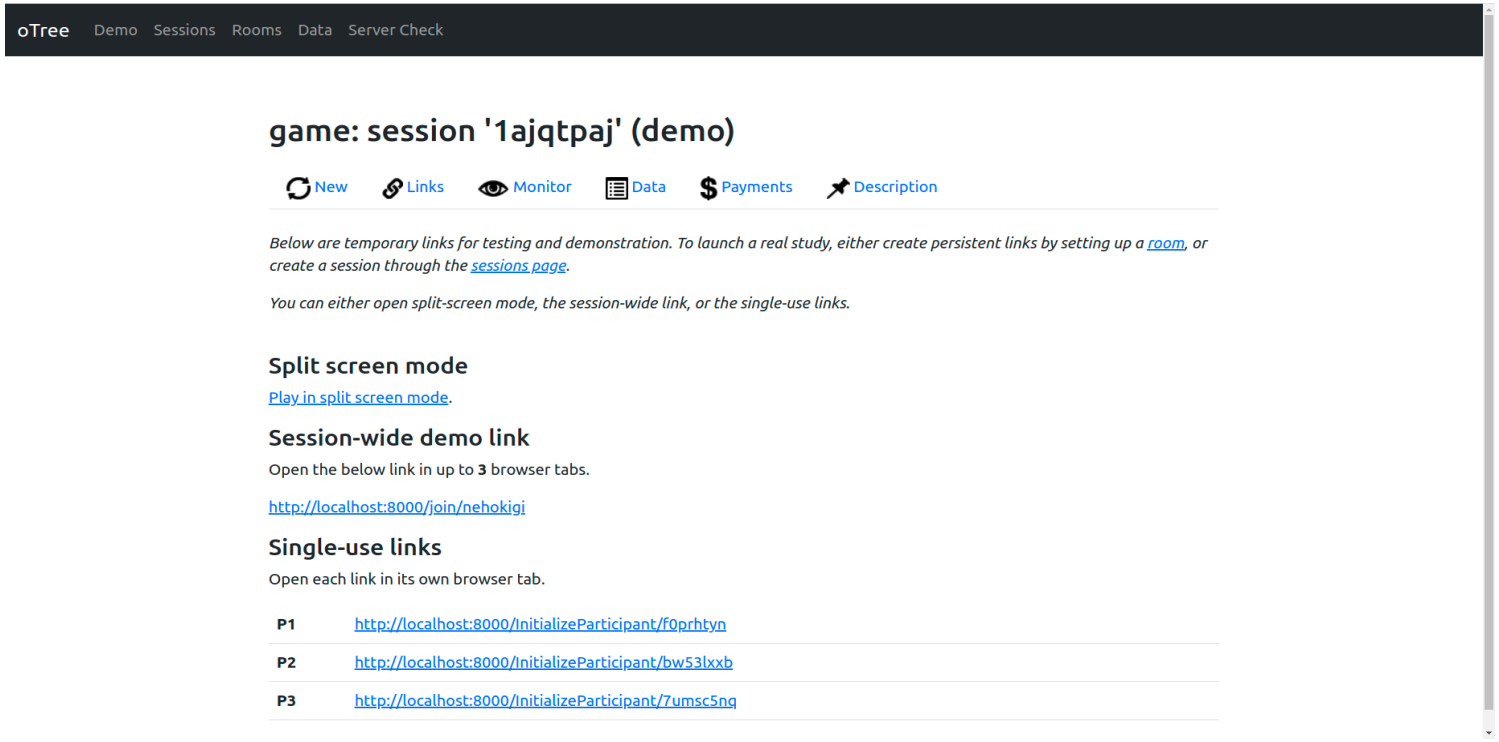
Experiment Design Based on OTree

- *Intro of oTree*
- *Codes*
- *Experiment Simulations*

OTree Experiment Design

OTree is a python based framework that allows you to build:

1. Multi player strategy games, such as prisoner's dilemma, public goods game, auction
2. Controlled behavior experiments in economics, psychology and other related fields
3. Questionnaire and test



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Conclusion

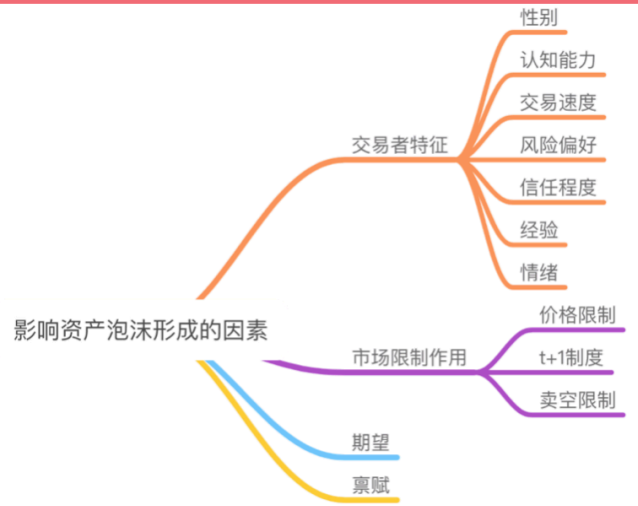
Research findings:

Optimize the simulation framework of the experimental asset market:
In the traditional literature, it only discretizes the time and conducts experiments in 15/30 equal periods of time, which is insufficient for the simulation of the actual asset market. This project will relax the discretization assumption of asset market time in the traditional literature, simulate the contingency of emergencies in the actual asset market, and consider from the two dimensions of state transition parameters and time parameters, which has certain significance for promoting the experimental simulation of the experimental asset market.

In the traditional literature, only discrete Markov process is used, assuming that the transfer probability is only related to the previous period, this project will extend it to more conform to the economic fluctuation state of the actual asset market.

资金使用情况	款项名	费用
1	书籍、资料费	506.8
2	耗材（打印资料等）	200
3	软件使用	600

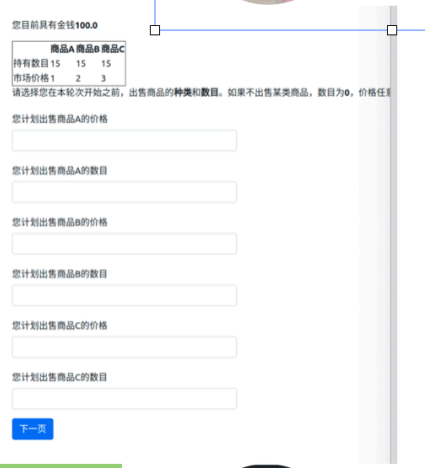
经济波动对资产市场中个人投资行为的影响——基于双向拍卖机制



代码实现参数确定

模型推演

在传统文献中其仅仅将时间离散化，在15/30个等长的时间内进行实验，对于实际资产市场的模拟不足。本项目将传统文献中资产市场时间的离散化假设进行放宽，将实际资产市场中突发事件的偶然性进行模拟，从状态转换参数、时间参数两个维度进行考量，对与因此对于实验性资产市场的实验模拟具有一定推进意义。



基于OTree平台的实验设计

oTree是一个基于python的框架，能够让你构建：

1. 多人策略游戏，如囚徒困境，公共品博弈，拍卖
2. 经济学，心理学等相关领域的受控行为实验

1 离散时间模型

相等经济周期，马尔科夫特性，时间同质性

2 连续时间模型

非相等经济周期，马尔可夫性，时间同质性

3 多期影响模型

非相等经济周期，非马尔科夫行，时间同质性

实验界面成果展示

西安交通大學
XI'AN JIAOTONG UNIVERSITY

Thanks

May, 2022

金禾经济研究中心