Course EE-LECO

Experimental Economics

Asset markets

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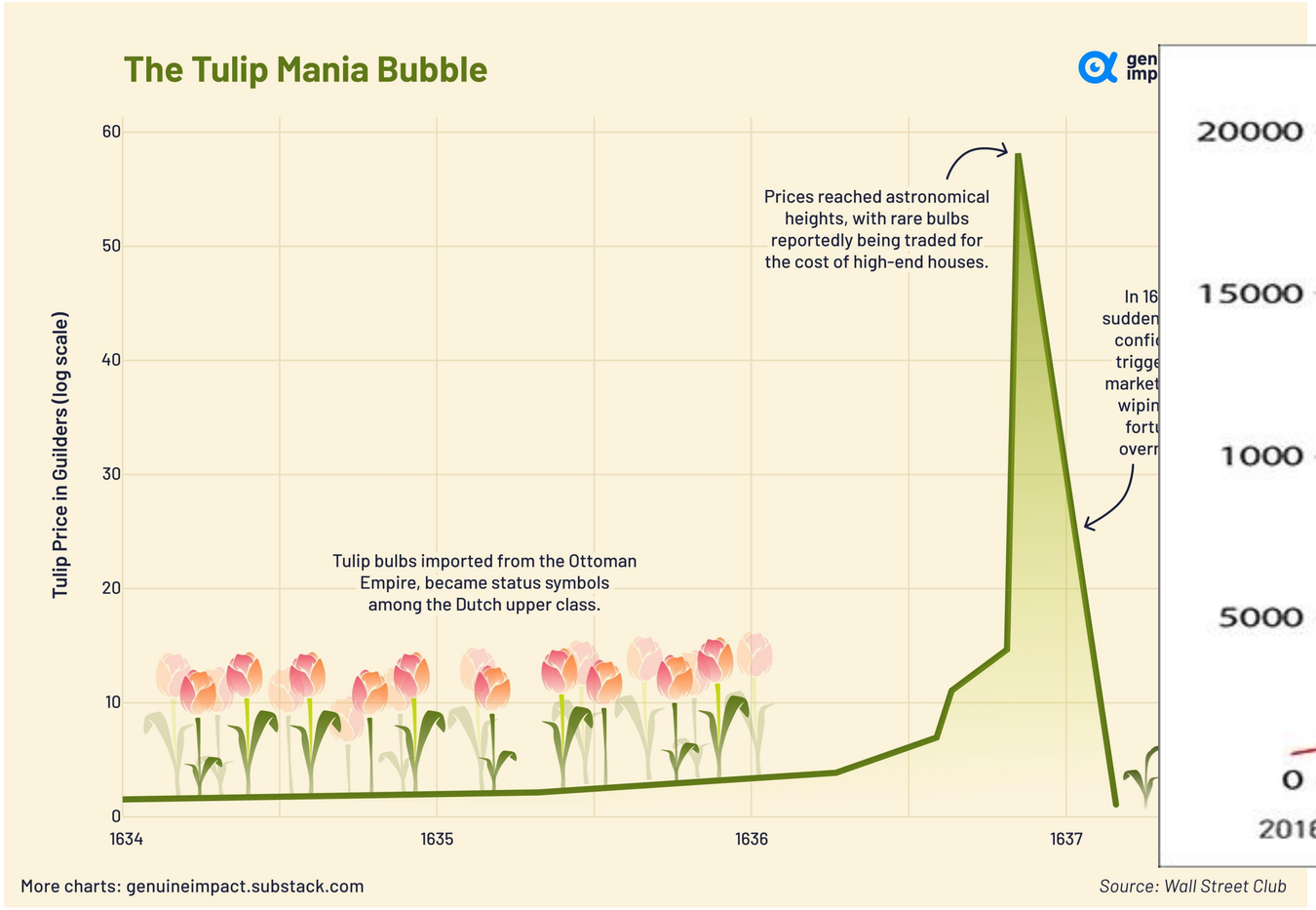
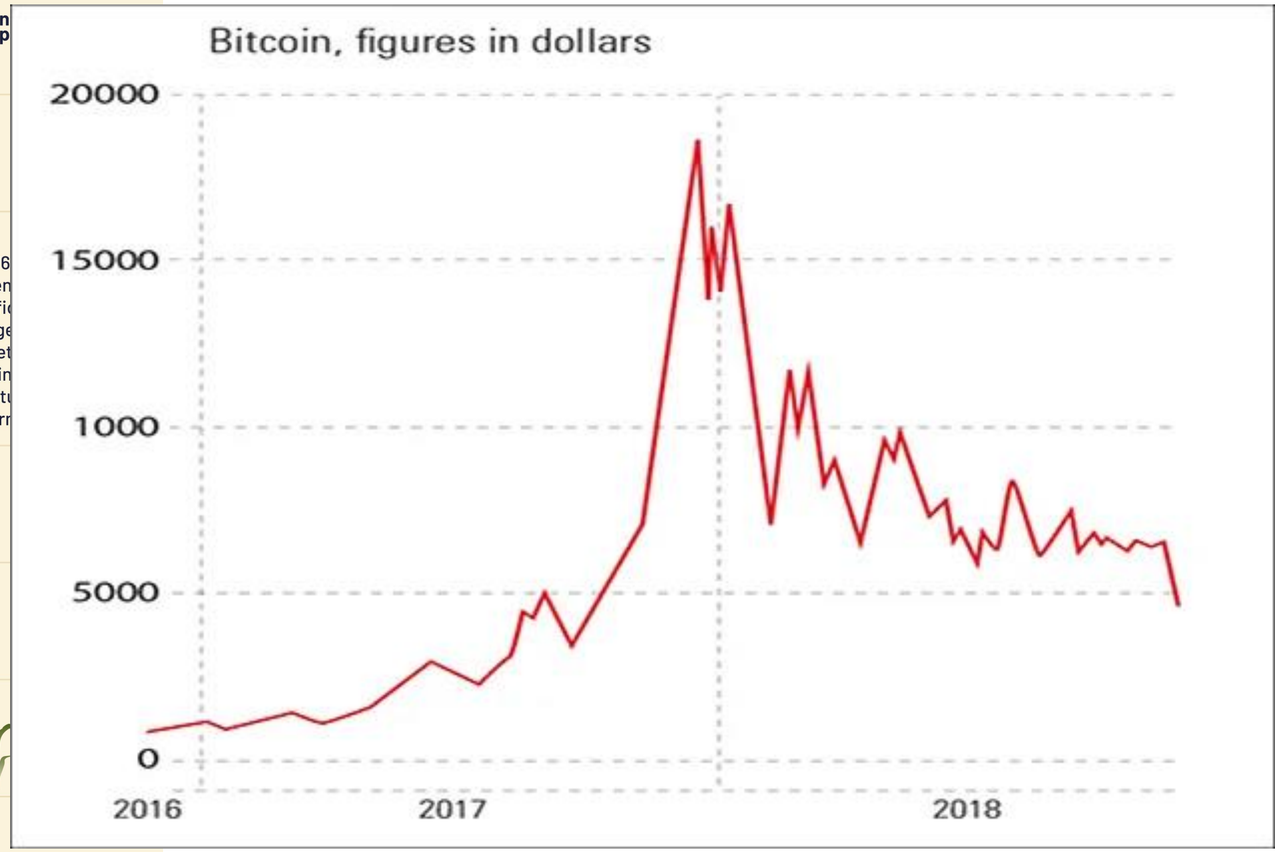
Outline for today

- What is a call market?
- What is the fundamental value of an asset?
- What is the behavior in an asset market experiment?
- How do you explain that behavior?

The 17th century Dutch *Tulip mania*





➢ [How a Random Flower Became the Bitcoin of the 1600s - YouTube]

Price bubbles and fundamental values

- How and why do price bubbles form and burst?
- How to distinguish bubbles from other financial market phenomena?
- What are fundamental values?
- What happens when, in a context of uncertainty, fundamental values are replaced by future expectations over fundamental values and there is a mutual dependence between prices and future expectations?

Fundamental value

Fundamental value (e.g., of a stock) = expected net present value of future dividends

$E(D_t)$ is the **expected dividend** in a given time period t with p_{tn} being the probability to be paid dividend outcome R_{tn}

$$E(D_t) = pt_1 R_{t1} + pt_2 R_{t2} + \cdots + p_{tN} R_{tN}$$

Assuming that expected dividends are constant over time $E(D_t) = D$

➢ Present value of future payment of a dividend with no “end”:

$$FV = \frac{D}{(1+r)} + \frac{D}{(1+r)^2} + \cdots + \frac{D}{(1+r)^t} = \frac{D}{r}$$

Efficient markets

- Market price (e.g., of a stock) = fundamental value (FV)

- The price of an asset must take into account all the information available at the time

Actual markets

Actual price of a stock: $\boldsymbol{P_t = FV_t + B_t}$

$\boldsymbol{B_t} > 0$: Bubble (overvaluation)

$\boldsymbol{B_t} < 0$: Periods of undervaluation

Is any deviation a bubble?

- Fundamental value may change. Given that new information is coming in → prices may fluctuate

Fundamentalists vs. Trend-followers

- **Fundamentalists/Rational traders:** Traders that buy if the market price is below the fundamental value and sell if it is above. Thereby, fundamentalist traders push the market price back to its fundamental value (i.e., stabilizing force).
- **Trend-following/Trend-extrapolating traders:** Traders that still buy if prices are above the FV because they believe that a “greater fool” would buy the asset at an even higher price in the future (i.e., destabilizing force).

Computer simulations

- Bubbles and crashes can be simulated
- Combine fundamentalists and trend-followers
- Price increases can be simulated with *positive shocks*
- **Bubble**: trend-extrapolating traders buy because they expect price increases to continue and demand pressure causes prices to rise and fundamentalists have no way to fix the problem.
- **Crash**: trend-extrapolating traders sell because they expect price reductions to continue and supply pressure causes prices to go down and fundamentals-based traders have no way to fix the problem.
- Simulations are useful, but limited in informing us how human traders will behave. → **Solution?**

Laboratory experiments

- But how do you pay the shares you hold when the experiment ends?

➢ Fix a redemption value

- Also not all assets have decreasing, predictable values (as in our experiment) …

➢ Create an “infinite horizon” with a constant FV in the lab

- How? → Two simple tricks…

Quasi-infinite horizon with constant FV

1. Use a *fixed terminal probability* p for the experiment to end after every period → e.g., $p = \frac{1}{2}$ → redemption value $= \frac{D}{2r+1}$

$$\sum_{t=1}^{\infty} \left(\frac{1}{2}\right)^t \cdot \frac{D}{(1+r)^t} = D \cdot \sum_{t=1}^{\infty} \left(\frac{1}{2(1+r)}\right)^t = \frac{D}{2r+1}$$

2. For all set number of periods, choose final redemption value = $\frac{D}{r}$ being the present value if asset was to live *forever*

The limit-order/call market experiment

- Asset pricing model with two types of assets:
  - risky asset pays $\boldsymbol{High}$ or $\boldsymbol{Low}$ with 50% probability every period
  - safe asset pays an interest rate r per period

- **Treatment**: $H = \$1.60$, $L = \$1.20$, and $r = 0.10$

- Present value of an **infinite-period asset**: $\frac{\$1.40}{0.1} = \$14.00$

Review of asset market experiments

The role of experience

- Do subjects learn after losing money in a market crash?
- ➢ They do learn, but not sufficiently
- Bubbles are rarer if subjects have participated in two previous asset markets in the **same group.**
- How to “bring experience” to the lab?
  - Invite students with previous experience in double auctions experiments
  - Invite students with previous experience in asset market experiments
  - Invite business people/real traders
  - Invite subjects with (no) experience of prior bubbles

Review of asset market experiments

The role of institutions

- **Short selling**: trader sell assets they do not own
- **Buying on margin**: trader buy assets by borrowing the balance from a bank or broker
- **Futures trading**: traders trade assets ahead of schedule, i.e., buying or selling assets at a set future date for a set price

➢ Bubbles can dampen but do not cease to exist

- For other factors see "**A Review of Bubbles and Crashes in Experimental Asset Markets**" in *Journal of Economic Surveys* by Palan (2013)

Behavioral Finance

- Instead of assuming *rational expectations*, BF explains price fluctuations with the regularities and *psychological* patterns of investor behavior.
- Non-rational investors are in fact following typical behavioral patterns, so their decisions are not entirely irrational but rather quasi-rational (Thaler, 2000), as the sources of guiding patterns can be identified.
- A large number of empirical research found anomalies weakening the practical validity of the *Efficient Markets Hypothesis* which assumes
  - No transaction costs
  - Information is costless
  - Investors have homogenous expectations and are rational

Behavioral Finance

An empirical fact: The equity premium puzzle

- The *Equity Premium Puzzle* refers to the fact that stocks have outperformed treasury bonds by an extraordinarily high margin over the last century (about 5% per year) – a margin so high that it is very difficult to explain regardless of how thoroughly the situation is analyzed.

- The equity premium puzzle is one of the many widely researched mysteries in the world of finance and investment.

Your experiment

The limited order market experiment

- **Call market**: traders submit limit orders to buy or sell
- Orders used to generate a single, market-clearing price when the market is called.
- Asset shares:
  - traded at the same price
  - purchased by those who submitted buy orders with a maximum willingness to pay (limit) above
  - sold by those who submitted sell orders with a minimum willingness to accept (limit) below

Lab report

Q1&2

How much would a rational trader pay per share in period 1 assuming all other traders are also rational?

$$FV_t = (13 - t) \times \left(\frac{\$1.60 + \$1.20}{2} \right) + \text{Redemption value}$$

$$FV_1 = \$16.80 + \$14 = \$30.80$$

Was the FV increasing, decreasing or constant over the 12 periods?

$$\frac{dFV_t}{dt} = -\$1.40$$

Lab report

Q3

Without changing the shares' dividends, how to get a constant or increasing FV?

- Introduce an interest rate r on cash holdings

$$\text{for } t = 12 \rightarrow FV = \frac{D}{(1+r)} + \frac{D}{(1+r)^2} + \cdots + \frac{D}{(1+r)^{12}} + \frac{\text{Redemption value } (RV)}{(1+r)^{12}}$$

$$RV = \frac{D}{r} \quad \rightarrow \frac{dFV_t}{dt} = 0$$

$$RV > \frac{D}{r} \quad \rightarrow \frac{dFV_t}{dt} > 0$$

$$RV < \frac{D}{r} \quad \rightarrow \frac{dFV_t}{dt} < 0$$

Lab report

Q3

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$$\text{for } t = 12 \rightarrow FV = \frac{D}{(1+r)} + \frac{D}{(1+r)^2} + \cdots + \frac{D}{(1+r)^{12}} + \frac{\text{Redemption value } (RV)}{(1+r)^{12}}$$

$$\text{if } r = 0$$

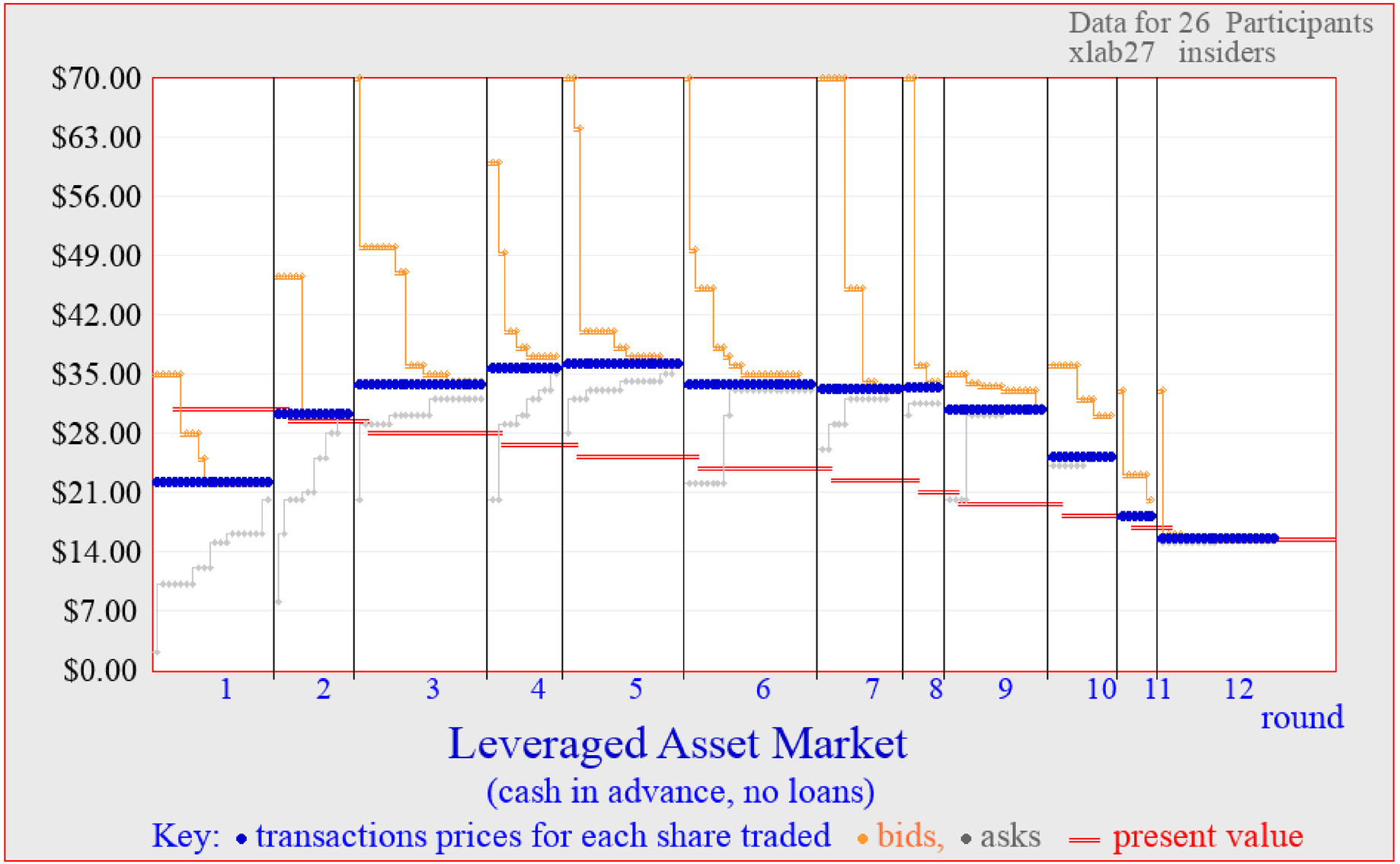
$$\text{and } D > 0 \quad \rightarrow \frac{dFV_t}{dt} < 0$$

$$\text{and } D = 0 \quad \rightarrow \frac{dFV_t}{dt} = 0$$

$$\text{and } D < 0 \quad \rightarrow \frac{dFV_t}{dt} > 0$$

Lab report

Q4&5



Lab report

Q4&5

A. Positive Bubble: $Market\ price > 1.05 \times FV$

B. No bubble: $1.05 \times FV \geq Market\ price \geq 0.95 \times FV$

C. Negative bubble: $Market\ price < 0.95 \times FV$

Period	Market price	Fundamental value	Bubble category
1	22	30.8	C
2	30	29.4	B
3	33.5	28	A
4	35.5	26.6	A
5	36	25.2	A
6	33.5	23.8	A
7	33	22.4	A
8	33.25	21	A
9	30.5	19.6	A
10	25	18.2	A
11	18	16.8	A
12	15.4	15.4	B

Lab report

Q6: Why is quantity of shares of not predictive power?

Since quantity of shares remains constant → correlation between any variable and a constant is always zero

Period	Mispricing $\lvert Market\ Price - FV \rvert$	Quantity of shares in the market	Variance of shares held by traders	Quantity of shares traded by all traders
1	8.8	156	6.48	20
2	0.6	156	9.84	13
3	5.5	156	19.84	22
4	8.9	156	22.96	12
5	10.8	156	29.28	20
6	9.7	156	31.92	22
7	10.6	156	33.36	14
8	12.25	156	36.56	6
9	10.9	156	36.72	17
10	6.8	156	39.44	11
11	1.2	156	42.8	6
12	0	156	53.92	20

```
. corr mispricing share_variance
(obs=12)

             | mispri~g share_~e
-------------+------------------
  mispricing |   1.0000
share_vari~e |  -0.1228   1.0000
```

```
. corr mispricing quantity_traded
(obs=12)

             | mispri~g quanti~d
-------------+------------------
  mispricing |   1.0000
quantity_t~d |   0.0645   1.0000
```