THE LUCAS MODEL OF ASSET PRICING: EXPERIMENTS

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  - focus on parametric variations (preferences, consumption, dividends...) of "stochastic Euler equations"
  - weak empirical support
  - experiments can inform us about where the the model works and where it potentially fails

(Stochastic Euler Equations)

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- Take historical price and consumption data
- Fit equations for a choice of utility and information

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- *Why* is the model wrong in the field?
- Models are idealizations; the laboratory is an opportunity to test them in an idealized environment.

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- Important message from our work:

$$\textit{individual} \not\leftrightarrow \textit{market}$$

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- Contrast economic thinking/social choice thinking

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  - Individuals hardly behave as predicted in the theory
- ... without having to invoke design elements that are claimed to be the reason for these phenomena in the field
  - Institutions (intermediaries, governments,...), Stochastics (ambiguity, rare events,...), Constraints (incomplete markets, collateral, indivisibilities, ...)

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- Subject price forecasts are “almost” fulfilled

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  - For empiricists: Euler equations might be misguided (because they assume prices are functions of fundamentals only)
  - For policy: excess volatility does not stand in the way of significant Pareto improvements

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  - maybe use dynamic completeness and induce a Radner equilibrium? (Duffie-Huang [1985])

Setting

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  - *tree*: pays \$0 (bad state) \$1 (good state) each period
    probability $p = 0.5$ (i.i.d.)
  - *bond*: pays \$0.50 each period

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- (may restrict shortsales)

How Will Prices Be Formed? Trade Through Continuous Electronic Open Book...

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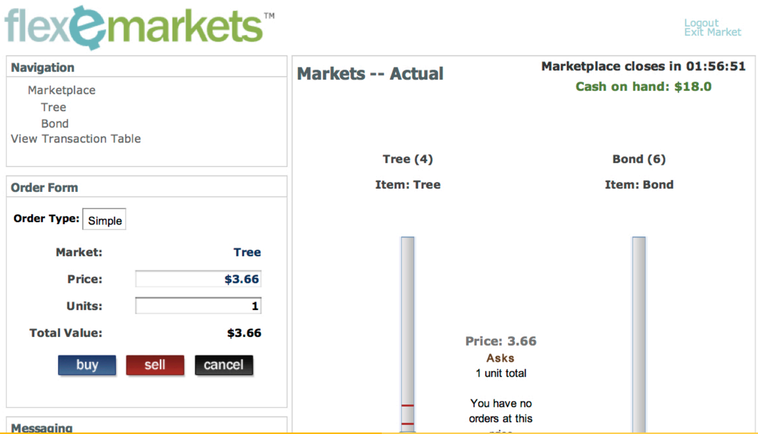

(Graphical Display Of Book Of Orders)

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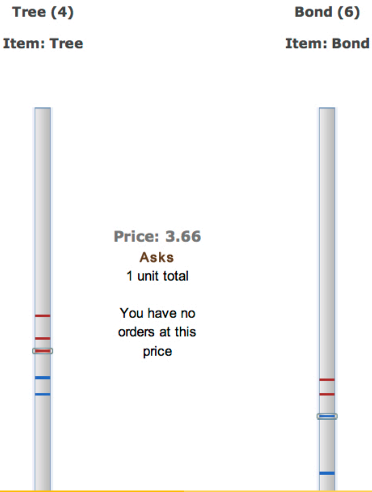

Experimental timeline

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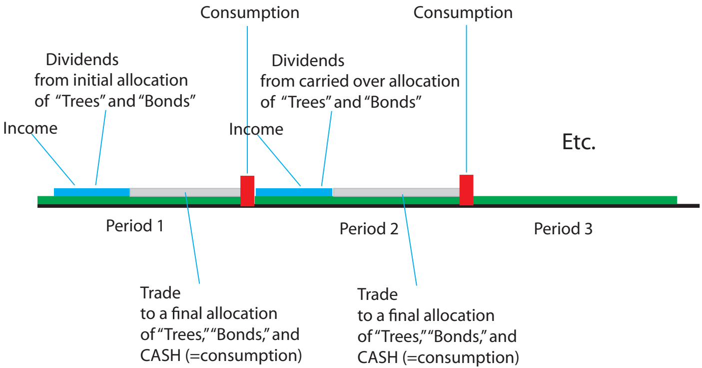

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- pay subjects only cash of last period (intermediate payoffs are forfeited)
- termination rule: at -10 minutes: reduce to 2-periods

  ending probabilities $= 1/6,\ 5/6$

  (exploits separability, iid dividends)

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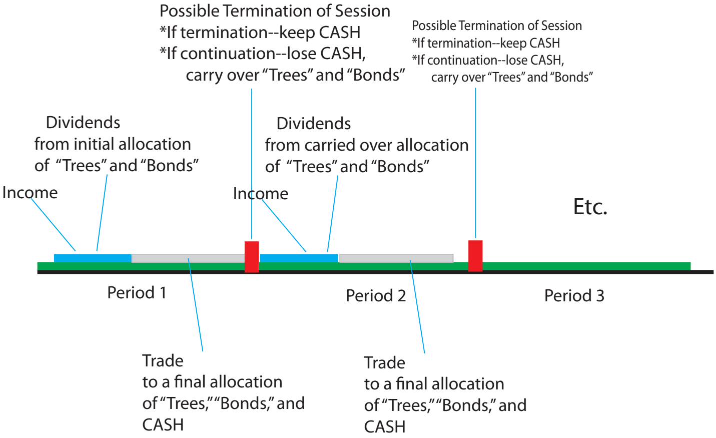

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- *Equilibrium assumes perfect/correct forecasts!*

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- cross-sectional and intertemporal predictions reinforce each other
- (countercyclical equity premium, or cyclical discount of Tree price relative to Bond price)

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  - (price risk is hedged)

Homogeneous Log Utility, $\beta = 5/6$

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- Prices and returns – Tree cheaper; Both assets cheaper in Low state; Countercyclical equity premium and pro-cyclical discount

State	Tree		Bond		Price	Equity
	Price	Return	Price	Return	Discount	Premium
High (H)	\$2.50	3.4%	\$3.12	-0.5%	\$0.62	3.9%
Low (L)	\$1.67	55%	\$2.09	49%	\$0.42	6%

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- Holdings and trading: Type I (receives income in Even periods and buys Trees to hedge price risk)

Period	Tree	Bond	(Total)
Odd	7.57	0.62	(8.19)
Even	2.03	7.78	(9.81)
(Trade in Odd)	(+5.54)	(-7.16)	(-1.62)

Sessions/Replications

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Session	Place	Replication Number	Periods (Total, Min, Max)	Subject Count
1	Caltech*	4	(14, 1, 7)	16
2	Caltech	2	(13, 4, 9)	12
3	UCLA*	3	(12, 3, 6)	30
4	UCLA*	2	(14, 6, 8)	24
5	Caltech*	2	(12, 2, 10)	20
6	Utah*	2	(15, 6, 9)	24
(Overall)		15	(80, 1, 10)	

(Starred sessions ended with prematurely halted replication)

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Data	Tree Price	Bond Price	Discount (Bond - Tree)
Mean	2.75	3.25	0.50
St. Dev.	0.41	0.49	0.40
High (State)	2.91	3.34	0.43
Low (State)	2.66	3.20	0.54
Difference across states	0.24	0.14	-0.11

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- Correlation is between the average (per replication) difference between bond and tree price, and the average (per replication) difference of prices (of a security) between high and low states.

	Tree	Bond
Correlation	0.80	0.52
(St. Err.)	(0.40)	(0.40)

Prices move with fundamentals – but noisily

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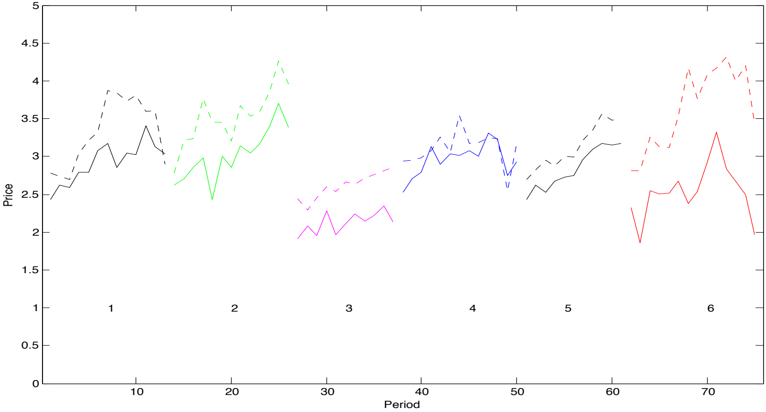

Apparent trend is not significant once allowing for influence of state (change)

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Table 10: OLS regression of changes in period-average transaction prices. (* = significant at $p = 0.05$.)

Explanatory Variables	Tree Price Change Estim.	Tree Price Change (95% Conf. Int.)	Bond Price Change Estim.	Bond Price Change (95% Conf. Int.)
Change in State Dummy (None=0; High-to-Low=-1, Low-to-High=+1)	0.19*	(0.08, 0.29)	0.10	(-0.03, 0.23)
R^2		0.18		0.04
Autocor. (s.e.=0.13)		0.18		-0.19

Results in Returns

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Table 7: Average returns across securities and states (High or Low aggregate dividend).

State	Tree	Bond	Equity Premium
High	12.8 (%)	15.9	-3.1
Low	17.8	16.1	1.7
Difference	-5.0	-0.2	-4.8
Average	16.1	16.0	0.1

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	States		Periods	
	High	Low	Odd	Even
Type I	14.93 (19.75)	7.64 (4.69)	7.69 (2.41)	13.91 (20.65)
Type II	15.07 (10.25)	12.36 (15.31)	14.72 (20)	11.74 (5)
ANOVA *p*:				
Factors	0.09		0.27	
Interaction	0.23			

(Autarky cash holdings in parentheses)

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- (Significant correlation between prices and fundamentals cannot easily be detected in 10-15 rounds)
- If agents do not expect prices to move with fundamentals, the resulting equilibrium is VERY different from Lucas model!
- ... but very much like in our experiments (stochastic drift, etc.)

Prices when agents do not expect prices to move with fundamentals

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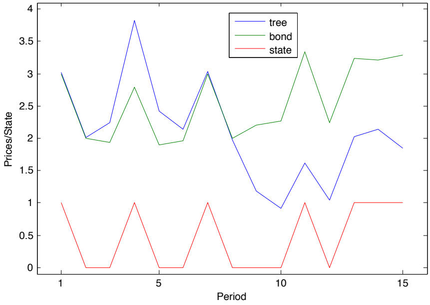

(Consumption share of Type I agent fluctuates between 39 and 44%.)

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- But Adam, Marcet and Nicolini (2012) do not point out that *equilibrium allocations could still be pretty much the same as in the Lucas equilibrium* – and close to optimal!
- ... because our agents trade consistent with their expectations, and their expectations are almost self-fulfilling?

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Table 12: End-Of-Period Asset Holdings Of Three Type I Subjects. Initial allocations: 10 Trees, 0 Bonds. Data from one replication in the first Caltech session.

Subject	1	2	3	4	5	6
Trees:						
3	4	4	3	4	3	4
5	1	1	0	1	1	3
7	7	10	13	15	19	20
Bonds:						
3	3	5	3	5	3	4
5	8	15	14	15	16	17
7	2	3	0	4	0	4

(So, individuals are not "representative" of what happens at the market level!)

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- find significant risk aversion

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Table 15: GMM Estimation And Testing Results For Three Different Sets Of Instruments.

Instruments	β (p value for $\beta = 5/6$)	γ (p value for $\gamma = 0$)	χ^2 test (p value)
constant 1, lagged consumption growth, lagged asset returns	0.86 (0.003)	-0.01 (0.917)	7.124 (0.310)
constant 1, lagged consumption growth	0.86 (0.029)	-0.18 (0.162)	0.731 (0.694)
high state dummy, low state dummy, lagged consumption growth	0.86 (0.002)	0.16 (0.001)	14.349 (0.006)

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- The intertemporal variation (predictability) in asset prices is far less than predicted (given cross-sectional difference). Prices exhibit excessive volatility.
- Subjects seem to have anticipated this and therefore reduce their demands to hedge against price risk; still, these anticipations are inconsistent in equilibrium (prices will – and do – depend on tree dividends even if this is not anticipated...)
- Nevertheless, the risk sharing properties of the Lucas equilibrium emerge: *allocations are OK even if prices are excessively volatile.*

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  - Introducing redundant securities such as options
  - Replacing consol bond with shorter-maturity options (optimal maturity of fixed-income securities?)

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