April 12

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Lars Hansen "asset pricing is all about covariances"

Theories of asset prices:

asset - claim at t on a stream of payments

$d_{t+1}, d_{t+2}, \ldots$ ex dividend

$d_t, d_{t+1}, d_{t+2}, \ldots$ cum dividend

Basic asset pricing model

cum-dividend claim on $\{d_{t+j}\}_{j=0}^{\infty}$

$\beta = \frac{1}{1+\rho}$, ρ = discount rate ≥ 0

β - discount factor

$\{d_{t+j}\}_{j=0}^{\infty}$ is a random process

at t, d_t is known

$\left.\begin{array}{l} d_{t+1} \\ d_{t+2}, \ldots \end{array}\right\}$ random variables described by a Markov process

<u>Markov chain:</u>

n states, $P_{n \times n}$, π_0

dividend in state i is $\bar{d}_i$

$\bar{d}_1, \bar{d}_2, \ldots, \bar{d}_n$ possible values of the dividend

s_t is the state $\in [1, 2, \ldots, n]$

$d_t = d(s_t)$, $\bar{d}$ an n-dimensional vector

example: $S = \{1, 2\}$, $P = \begin{bmatrix} .95 & .05 \\ 0 & 1 \end{bmatrix}$

$$\pi_0 = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \leftarrow$$

$$\bar{d} = \cancel{\begin{bmatrix} 0 \\ 0 \end{bmatrix}}, \quad \bar{d} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

Asset pricing model: Simplest

p_t = price of the asset cum dividend

risk-neutral -

↳ only E_t future stuff matters

- model 101 - asset prices is all about expectations (means)
- Lars Hansen - asset prices are all about

covariances (of what with what?)

Stanzin – "in asset pricing, there is never a dull moment"

Robert Barro at Harvard –

"I like Stanzin" // "disaster risk"

$$p_t = d_t + \beta E_t d_{t+1} + \beta^2 E_t d_{t+2} + \ldots$$

(*) $\boxed{p_t = \sum_{j=0}^{\infty} \beta^j E_t d_{t+j} + \cancel{c_t \beta^{-t}}}$ ← answer

(**) $p_t = d_t + \beta E_t p_{t+1}$

$$p_{t+1} = \sum_{j=0}^{\infty} \beta^j E_{t+1} d_{t+j+1}$$

(*) is a solution of (**)

Is it it the solution or are there are others?

there are others –

let $d_t = 0 \ \forall t$

$p_t = 0 + \beta E_t p_{t+1}$ –

Suppose $P_t = c\,\beta^{-t}$ for some $c > 0$.

$$\beta = \frac{1}{1+\rho} < 1 \quad \beta^{-1} = (1+\rho)$$

$$\beta^{-t} \nearrow = (1+\rho)^t c$$

$$P_t = 0 + \beta\, P_{t+1}$$

$$c\,\beta^{-t} = \beta\, c\,\beta^{-(t+1)} = c\,\beta^{-t} \checkmark$$

rational bubble.

$$P_t = c_t\,\beta^{-t}$$

$$E_t c_{t+1} = c_t$$

Olivier Blanchard
Mark Watson

$$P_t = \beta E_t [d_{t+1} + P_{t+1}]$$

ex dividend asset

(asset pricing all about means expectations)

$$P_t = E_t [\beta (d_{t+1} + P_{t+1})]$$

Lars Hansen "covariances"

$$P_t = E_t \left[\beta_{t+1} \left(d_{t+1} + P_{t+1} \right) \right]$$

β_{t+1} ~ stochastic ~ random variable

↪ David Kreps.

$\cdots \Longrightarrow$

$$P_t = E_t \beta_{t+1} \, E_t \left(d_{t+1} + P_{t+1} \right)$$

$$+ \, cov_t \left(\beta_{t+1}, d_{t+1} \right) + cov_t \left(\beta_{t+1}, P_{t+1} \right)$$