$$c_{t+p} - c_t = \alpha + \beta s_t + \epsilon_{t+p}$$

Extra credit

$$y_{t+2} = a y_{t+1} + b x_{t+1} + \epsilon_{yt+2}$$
$$x_{t+2} = c y_{t+1} + d x_{t+1} + \epsilon_{xt+2}$$

$$\begin{aligned}
E_t\left(y_{t+2}\right) &= E_t\left(a y_{t+1} + b x_{t+1} + \epsilon_{yt+2}\right) \\
&= a E_t\left(y_{t+1}\right) + b E_t\left(x_{t+1}\right) + 0 \\
&= a\left(a y_t + b x_t\right) + b\left(c y_t + d x_t\right) \\
E_t\left(y_{t+1}\right) &= E_t\left(a y_t + b x_t + \epsilon_{yt+1}\right) = a y_t + b x_t \\
E_t\left(x_{t+1}\right) &= E_t\left(c y_t + d x_t + \epsilon_{xt+1}\right) = c y_t + d x_t
\end{aligned}$$

Announcement
Groups find a paper topic. Let me know what it is by 21 October.

Conditional and unconditional distributions
$0 < \rho < 1$, Stationary AR(1), ϵ_t iid $(0,\sigma^2)$

$$y_t = \rho y_{t-1} + \epsilon_t$$

Unconditional distribution of y_t is the same for all t. The unconditional mean

$$y_t = \epsilon_t + \rho \epsilon_{t-1} + \rho^2 \epsilon_{t-2} + ...$$
$$E\left(y_t\right) = E\left(\epsilon_t + \rho \epsilon_{t-1} + \rho^2 \epsilon_{t-2} + ...\right) = 0$$

But the conditional mean,

$$E_{t-1}\left(y_t\right) = E_{t-1}\left(\rho y_{t-1} + \epsilon_t\right) = \rho y_{t-1}$$

The conditional distribution is different for every different value of y_{t-1}.

Unconditional variance

$$Var\left(u_t\right) = E\left[u_t - E\left(u_t\right)\right]^2$$

Conditional variance definition

$E_{t-1}\left(u_t\right) = E\left(u_t | u_{t-1}, u_{t-2}, ...\right)$

$$\sigma_t^2 = E_t\left[u_t - E_{t-1}\left(u_t\right)\right]^2 = E\left(\left[u_t - E\left(u_t | u_{t-1}, u_{t-2}, ...\right)\right]^2 | u_{t-1}, u_{t-2}, ...\right)$$

ARCH(1) model

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2$$

ARCH(2) model

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 u_{t-2}^2$$

ARCH(p) model includes p lags of u_t^2