

Firm's costs are all from borrowing.

Firm's costs =  $\phi_t \cdot Y_t$ , so this product should be the debt  
↓  
marginal cost

measurement equation:  $\frac{X_t^D}{X_t}$  is trend adjustment to adjust gap between  
Data debt trend and  
model debt trend

$$\Delta \ln(\text{Debt})_t = \Delta \ln \left( \frac{X_t^D}{X_t} \cdot \phi_t \cdot Y_t \right)$$

↑  
observed data

$$= \Delta \ln(\phi_t \cdot Y_t \cdot X_t^D)$$

$$= \ln \phi_t - \ln \phi_{t-1} + \ln Y_t - \ln Y_{t-1} + \ln g_t^D$$

$$= \tilde{\phi}_t - \tilde{\phi}_{t-1} + \tilde{Y}_t - \tilde{Y}_{t-1} + \tilde{g}_t^D + \ln \bar{g}^D$$

where  $\tilde{g}_t^D = \rho \cdot \tilde{g}_{t-1}^D + \varepsilon_t^D$  only appears in measurement equation