

Discrete Population Model (Ricker, Harvesting)

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1 Model Framework

- Generic discrete population model subject to exploitation - used to model population dynamics of a variety of organisms (fisheries, insects, birds)- Ricker-type model.
- Model reads

$$N_{t+1} = N_t e^{(r_t(1-N_t/K) + \sigma_E \epsilon_{E,t})} - F \frac{N_t^2}{N_t^2 + h^2} \quad (1)$$

- N_t population biomass at time t
- $r_t = r_0 e^{\sigma_r \epsilon_{r,t}}$ intrinsic growth rate with demographic stochasticity (exponential filtering used)
- K carrying capacity of population - finite due to density dependent effects
- F maximum harvesting rate
- h half saturation of sigmoidal exploitation term
- $\epsilon_{r,t}, \epsilon_{E,t}$ Gaussian noise terms for demographic and environmental stochasticity with mean zero standard deviations σ_r and σ_E .

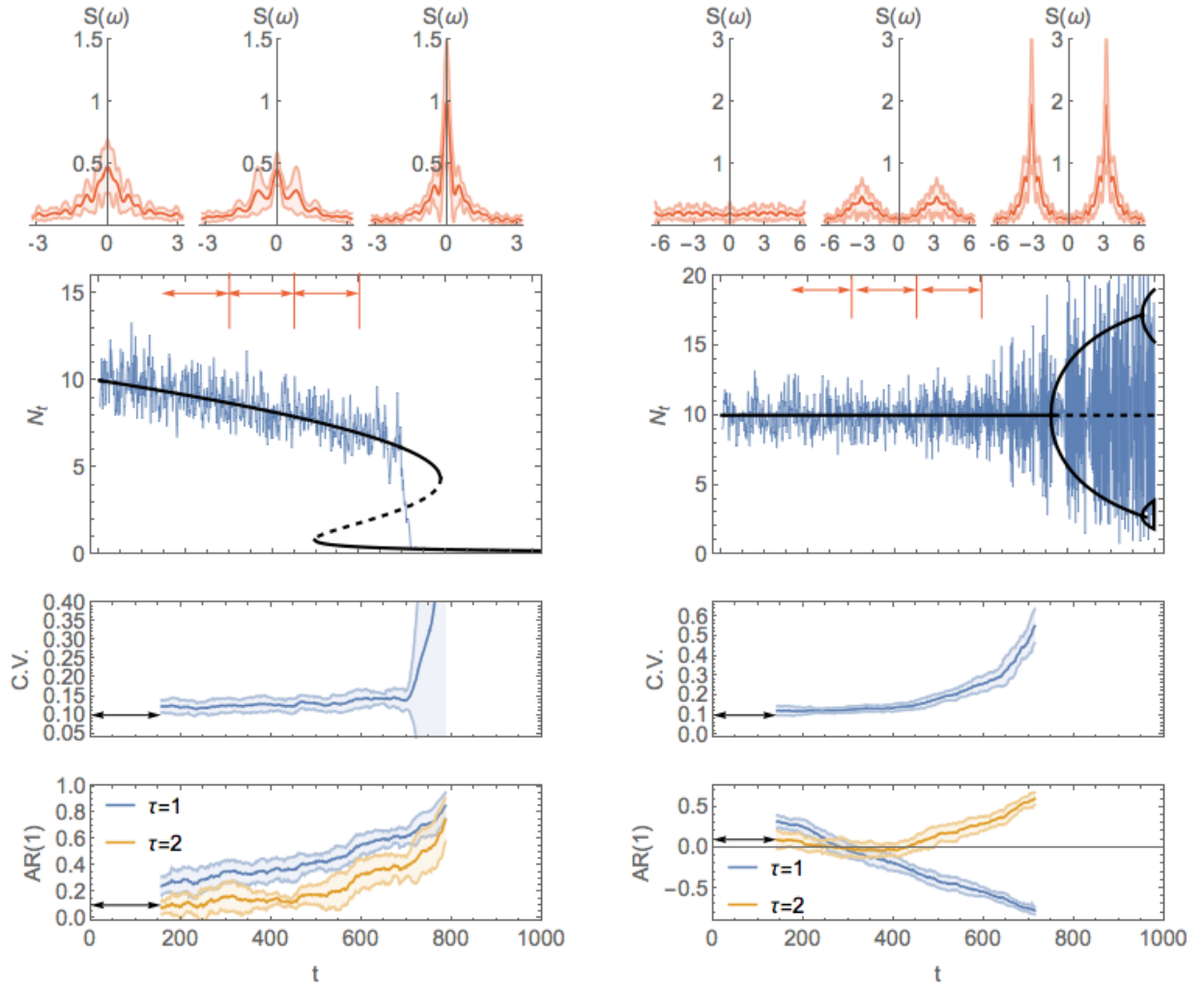


Figure 1: Early warning signals preceding the Fold and Hopf bifurcation

2 Data analysis