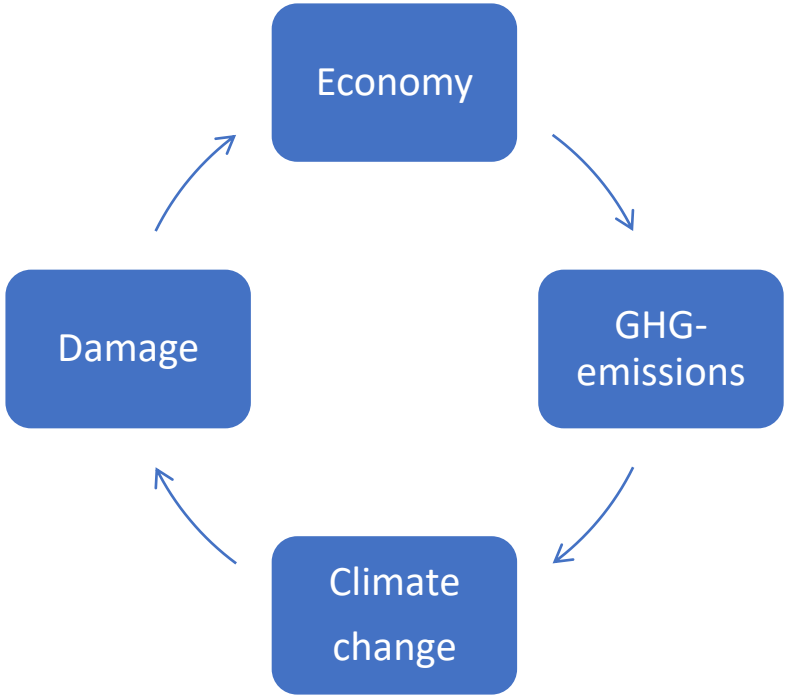
Integrated Assessment Models: Interaction Economy, GHGs, and Climate



- What does each component look like in an Integrated Assessment Model? (For example DICE)

Components of IAM

- Economy:
  - Utility function: CRRA over consumption
  - Production function: Cobb-Douglas with capital and labor
  - Capital Accumulation

- GHG emissions: usually linear in (brown) production

- Climate: GHG emissions affect global temperature
  - GHG emissions accumulate => GHG stocks => warming (through radiative forcing)
  - Carbon cycle quite complicated (in DICE: atmosphere, upper ocean, lower ocean)
  - Temperature in atmosphere is most important (DICE: temperature in atmosphere & deep oceans separately)
  - Economics: simplification 10 year delay between carbon stock and temperature (Dietz & Venmans, 2019, JEEM)

- Damage from climate: temperature => extreme weather => damage
  - Usually multiplicative: $Y^{net} = (1 - Damage)Y^{gross}$

Utility function (concave)

Options:

- CRRA: Constant Relative Risk Aversion: $u(c_t) = \frac{c_t^{1-\nu}-1}{1-\nu}$; $u_c = c_t^{-\nu}$
  - One parameter for risk aversion and intertemporal substitution: nu
  - In dynamic model: $U_t = \sum_{t=0}^{\infty} \beta^t u(c_t)$
  - Time preference (discounting): beta
- CARA
- Other option: Recursive utility
  - For example: $U_t = \left[(1-\beta)c_t^{\rho} + \beta[E_t(U_{t+1}^{\alpha})]^{\rho/\alpha}\right]^{1/\rho}$
    - Risk aversion parameter: alpha
    - Intertemporal Elasticity of Substitution: rho
    - Time preference: beta

Production

- Usually Cobb-Douglas production function:
  - $F(K, L) = AK^{\alpha}L^{1-\alpha}$

- Properties:
  - Constant return to scale
  - Decreasing returns to capital
  - Decreasing returns to labour

- Income shares are constant ($RK = \alpha Y; WL = (1 - \alpha)Y$)

Capital Accumulation

- Capital accumulation: $K_{t+1} = (1 - \delta)K_t + I_t$

- Consumption vs. savings
  - Saving more now increases capital, production & consumption in future

- Solow Model: savings rate exogenous
- Ramsey Model: savings rate set to maximize discounted utility
  - Intertemporal optimality (more on this in next classes)

Abatement: reducing GHG emissions

- Option 1: Final good to reduce emissions (as in DICE):
  - Emissions: $E = \gamma(1 - a)Y$
  - Total costs (convex): $\Gamma(a) \cdot Y$

- Options 2: change in capital stock
  - Replace “brown” capital with “green capital”
  - Many variants of these: need some sectoral structure