MADIAMS 2.0:

How an economic system can shift from climate-adverse to climate-friendly physical capital

An insight into the dynamic structure of the model

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MADIAMS 2.0 features

- 2 types of physical capital

(fossil fuel driven/ renewable energy based)

- Non-equilibrium approach

to goods and services production/consumption

(stocks of goods, supply $\neq$ demand)

Scale invariance

$L(t)$ • **available labor force**

$\lambda_L(t) = \frac{\dot{L}}{L}$ • **effective depreciation rate in dynamic equations**

$$\dot{A} = F \quad \Rightarrow \quad \begin{cases} a = \frac{A}{L} \\ f = \frac{F}{L} \end{cases} \quad \Rightarrow \quad \dot{a} = f - \lambda_L a$$

$$\lambda_L = \text{const} \quad \Rightarrow \quad L(t) = L_0 \exp(\lambda_L t)$$

Firm – control strategy – output partitioning (1/2)

- y — total annual production
- τ — carbon tax
- $y' = y - \tau$ — to be partitioned between:
- y_{kf} — investments in k_f - fossil-fuel driven physial capital
- y_{kr} — investments in k_r - renewable energy-based physial capital
- y_h — investments in - human capital h (including R&D, education, social capital etc.)
- y_g — production of - consumer goods and services g

Firm – control strategy – output partitioning (2/2)

- y_{ckf} f_{ckf} – investments in carbon efficiency (only fossil-fuel driven physial capital)
- y_{ekf} f_{ekf} – investments in energy efficiency (fossil-fuel driven physial capital)
- y_{ekr} f_{ekr} – investments in energy efficiency (renewable energy-based physial capital

Government – control strategy – carbon tax partitioning

$$\tau = (\sigma_{kf} + \sigma_{kr} + \sigma_{h} + \sigma_{g} + \sigma_{ckf} + \sigma_{ekf} + \sigma_{ekr})\tau$$

Physical capital

Fossil fuel-driven physical capital

$$\dot{k}_f = y_{kf} + \sigma_{kf}\tau - (\lambda_k + \lambda_L)k_f$$

Renewable energy-based physical capital

$$\dot{k}_r = y_{kr} + \sigma_{kr}\tau - (\lambda_k + \lambda_L)k_r$$

Auxiliary state variables – to account for learning-by-doing effect – no depreciation

$$\dot{k}_f^* = y_{kf} + \sigma_{kf}\tau$$

$$\dot{k}_r^* = y_{kr} + \sigma_{kr}\tau$$

Human capital

Human capital

$$\dot{h} = y_h + \sigma_h \tau - (\lambda_h + \lambda_L) h$$

Net human capital (including learning-by-doing effect)

$$h_0 = h + \alpha_{LD}(k_f^* + k_r^*)$$

Goods on stocks

Goods on stocks g

$$\dot{g} = y_g - \lambda_L g - c$$

(c - consumption)

NB: non-equilibrium approach, supply ≠ demand

Wage rate evolution

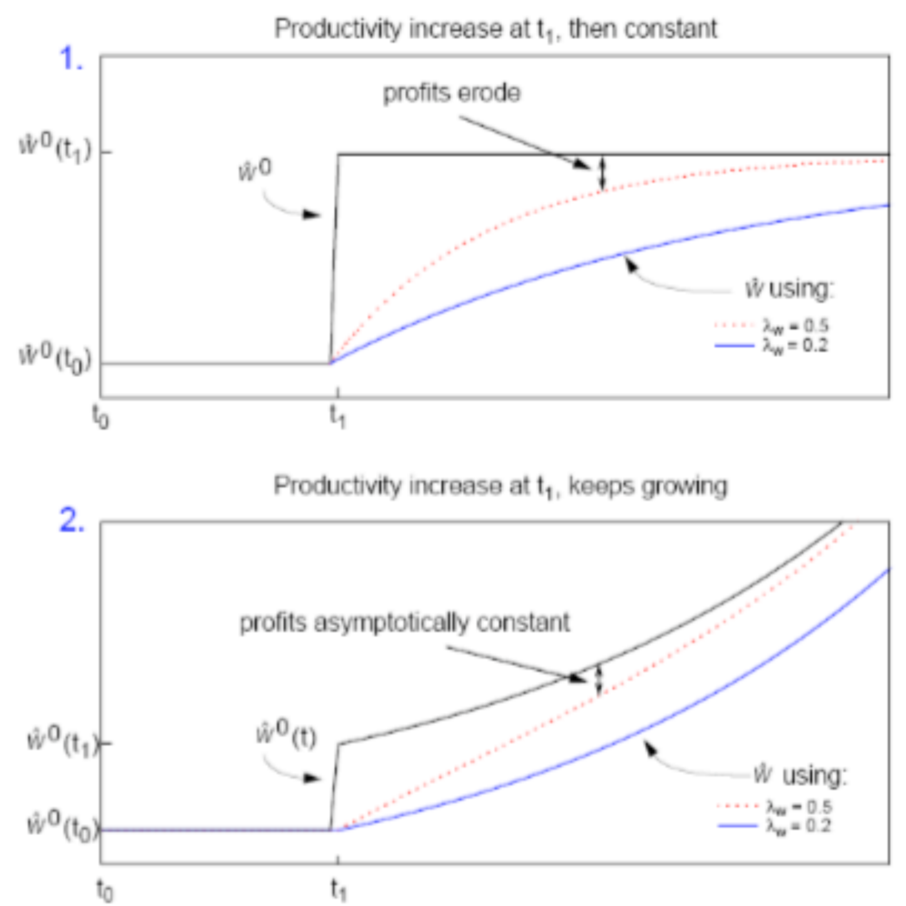
Wage rate w

$$\dot{w} = \lambda_w (w_0 - w)$$

- λ_w rate of wage adaptation

- w_0 target wage rate

(variant: $w_0 = \alpha_w p y_g$)



Savings

Household savings

$$\dot{s}_h = \beta_{sh} q w + i_h$$

$\beta_{sh} = const$ - fraction of income saved

q - employment rate

i_h - interest - $i_h = z s_h$

Firm's debt

$$\dot{s}_f = -\kappa_f$$

κ_f - credit uptake (variant: $\kappa_f = f_k y p$)

Carbon and energy efficiency (1/2)

$$e_{kf} = \frac{E_{kf}}{f_{ckf}}$$

- e_{kf} • **emissions**
- E_{kf} • **energy**
- f_{ckf} • **carbon efficiency**

$$E_{kf} = \frac{y_{kf}}{f_{ekf}} \qquad E_{kr} = \frac{y_{kr}}{f_{ekr}}$$

- E_{kf} E_{kr} • **energy**
- y_{kf} y_{kr} • **production**
- f_{ekf} f_{ekr} • **energy efficiency**

Carbon and energy efficiency (2/2)

Carbon efficiency

$$\overset{\square}{f}_{ckf} = \mu_c (y_{ckf} + \sigma_{ckf} \tau) + \lambda_c f_{ckf}$$

Energy efficiency

$$\overset{\square}{f}_{ekf} = \mu_e (y_{ekf} + \sigma_{ekf} \tau) + \lambda_e f_{ekf}$$

$$\overset{\square}{f}_{ekf} = \mu_e (y_{ekr} + \sigma_{ekr} \tau) + \lambda_e f_{ekr}$$

Thank you for your attention!