Online Appendix

A Additional model details

A.1 Energy producer

The corresponding first-order conditions for the energy producer Equation (19) are given by:

$$[\theta_t]: \quad \left[\frac{\partial \hat{X}_t}{\partial \theta_t}\frac{\theta_t}{\hat{X}_t} + \psi_E\right](1-\varphi_t) - \frac{1-\varphi_t}{1+\left(\theta_t \frac{I_t^g}{I_t^b}\right)^{\frac{\rho_E-1}{\rho_E}}}$$
$$- \varphi_t' \frac{\theta_t}{\theta_{t-1}} + \frac{1}{1+r_t}\frac{p_{t+1}^E Y_{t+1}^E}{p_t^E Y_t^E}\varphi_{t+1}' \frac{\theta_{t+1}}{\theta_t} = 0 \tag{1}$$

$$[I_t^b]: \quad \frac{p_t^E Y_t^E}{I_t^b}\frac{1-\varphi_t}{1+\left(\theta_t \frac{I_t^g}{I_t^b}\right)^{\frac{\rho_E-1}{\rho_E}}} = (1+\tau_t^b) \tag{2}$$

$$[I_t^g]: \quad \frac{p_t^E Y_t^E}{I_t^g}\frac{1-\varphi_t}{1+\left(\theta_t \frac{I_t^g}{I_t^b}\right)^{\frac{1-\rho_E}{\rho_E}}} = (1+\tau_t^g). \tag{3}$$

where $\frac{\partial \hat{X}_t}{\partial \theta_t}\frac{\theta_t}{\hat{X}_t} = (1-\psi_E) - \left[\left(\frac{\psi_E}{1-\psi_E}\right)^{\zeta}\theta_t^{\mathcal{R}\zeta} + 1\right]^{-1}$ and zero in the case of $\mathcal{R} = 0$.

A.2 Output-good-producing firm

The first order conditions for cost minimization of the output-good-producing firm are given by:

$$r_t^k = mc_t Y_t^{\frac{1}{\rho}}(1-\psi)\left(K_t^\alpha L_t^{1-\alpha}\right)^{\frac{-1}{\rho}}\alpha\left(\frac{L_t}{K_t}\right)^{1-\alpha} \tag{4}$$

$$w_t = mc_t Y_t^{\frac{1}{\rho}}(1-\psi)\left(K_t^\alpha L_t^{1-\alpha}\right)^{\frac{-1}{\rho}}(1-\alpha)\left(\frac{K_t}{L_t}\right)^{\alpha} \tag{5}$$

$$p_t^E = mc_t Y_t^{\frac{1}{\rho}}\psi A_E^{\frac{\rho-1}{\rho}} E_t^{\frac{-1}{\rho}}. \tag{6}$$

B The social planner's problem

The social planner maximizes the utility of the five agents:

$$\max_{\{c_{i,t}^C, c_{i,t}^E, l_{i,t}, K_t, I_t^b, I_t^g\}_{i,t}} \quad \sum_i \frac{1}{5}\sum_{t=0}^{\infty}\beta^t\left[v(e_{i,t},\tilde{p}_t^E) - g(l_{i,t})\right], \tag{7}$$

where the indirect utility function and the disutility of labour are given by:

$$v(e_{i,t}, \tilde{p}_t^E) = \frac{1}{\varepsilon}\left[e_{i,t}^{\varepsilon} - 1\right] - \frac{\nu}{\gamma}\left[\left(\tilde{p}_t^E\right)^{\gamma} - 1\right] \quad \text{and} \quad g(l_{i,t}) = \mu\frac{l_{i,t}^{1+\phi}}{1+\phi}, \tag{8}$$

subject to the initial condition $K_0 = \bar{K}$ and a series of constraints:

1. the definition of expenditures for the agents (consequence of the indirect utility function):

$$e_{i,t} = c_{i,t}^C + p_t^E c_{i,t}^E \tag{9}$$

2. aggregation of their labour supply and consumption:

$$L_t = \frac{1}{5}\sum \xi_i l_{i,t}, \qquad c_t^C = \frac{1}{5}\sum c_{i,t}^C, \qquad c_t^E = \frac{1}{5}\sum c_{i,t}^E. \tag{10}$$

3. the aggregate production function:

$$Y_t = \left[(1-\psi)\left(K_t^{\alpha}L_t^{1-\alpha}\right)^{\frac{\rho-1}{\rho}} + \psi\left(A_E E_t\right)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}} \tag{11}$$

4. the production function for producing energy services:

$$Y_t^E = \hat{X}_t\left[\left(\theta_t^{\psi_E-1}I_t^b\right)^{\frac{\rho_E-1}{\rho_E}} + \left(\theta_t^{\psi_E}I_t^g\right)^{\frac{\rho_E-1}{\rho_E}}\right]^{\frac{\rho_E}{\rho_E-1}} \tag{12}$$

together with the definition of $\hat{X}_t$:

$$\hat{X}_t = \begin{cases} X_t\theta_t^{1-\psi_E}\left[\psi_E^{\zeta} + (1-\psi_E)^{\zeta}\theta_t^{-\mathcal{R}\zeta}\right]^{\frac{1}{\mathcal{R}\zeta}} & \text{if } \mathcal{R} \neq 0 \\ X_t\left(\psi_E^{\psi_E}(1-\psi_E)^{(1-\psi_E)}\right)^{\frac{\rho_E}{\rho_E-1}} & \text{if } \mathcal{R} = 0. \end{cases} \tag{13}$$

5. the resource constraint for the output good:

$$c_t^C + K_{t+1} - (1-\delta)K_t + I_t^b + I_t^g = Y_t \tag{14}$$

6. the resource constraint for the energy services:

$$Y_t^E = \frac{c_t^E + E_t}{1-\varphi_t} \tag{15}$$

and the constraint of permanently reducing GHG emissions by 85% in 25 years and beyond, i.e. $I_t^b/\bar{I}^b \leq 0.15 \ \forall\ t \geq 100$ (quarterly calibration), where $\bar{I}^b$ is the steady-state value in a world without any ambition to become climate neutral.

C Additional figures

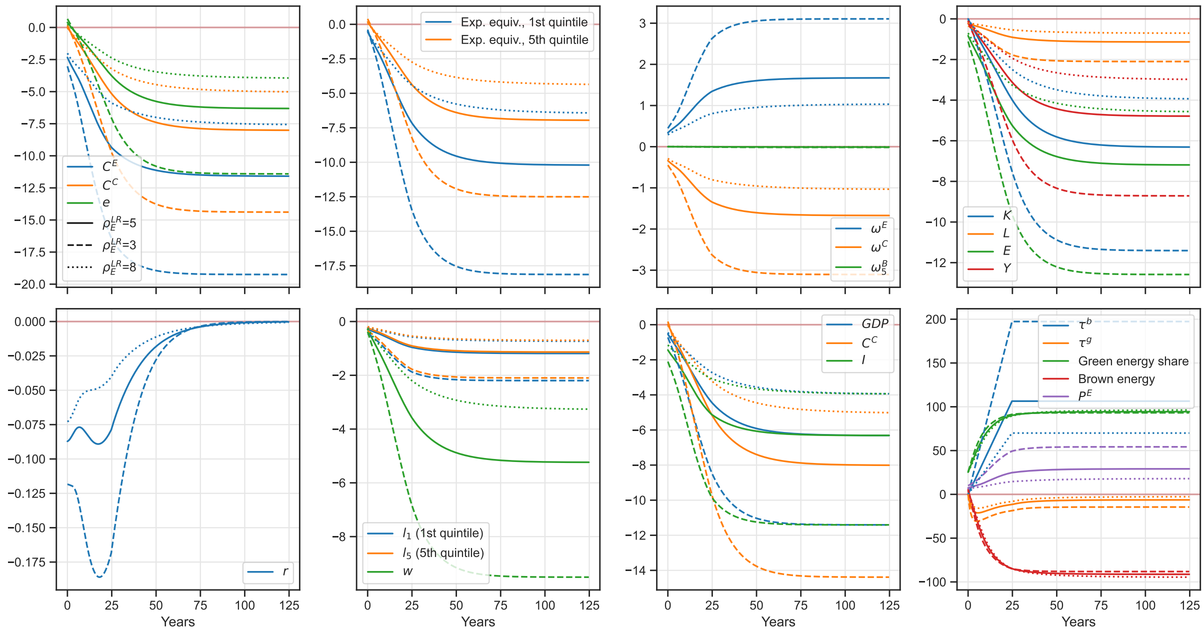

Figure 1: Sensitivity to the long-run elasticity of substitution between the brown and green technology ρ_E^{LR}.

Notes. The figure shows the percent deviations of the respective variables from their initial steady state. The deviations for the real interest rate is schown in annualized percentage point deviations.

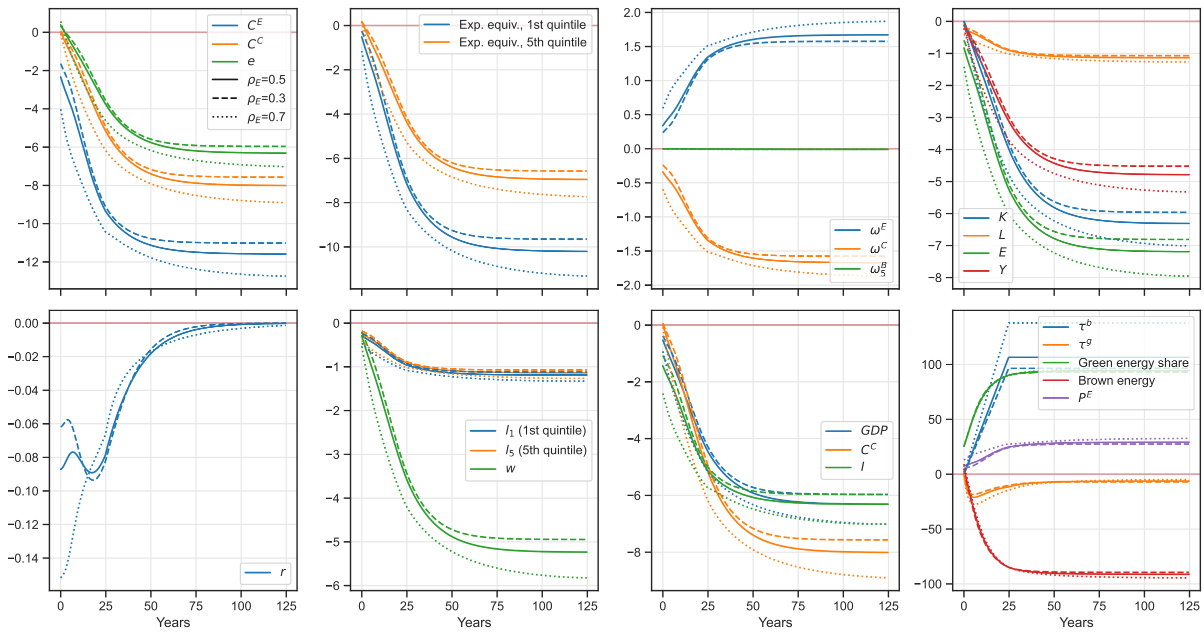

Figure 2: Sensitivity to the short-run elasticity of substitution between the brown and green technology ρ_E.

Notes. The figure shows the percent deviations of the respective variables from their initial steady state. The deviations for the real interest rate is schown in annualized percentage point deviations.

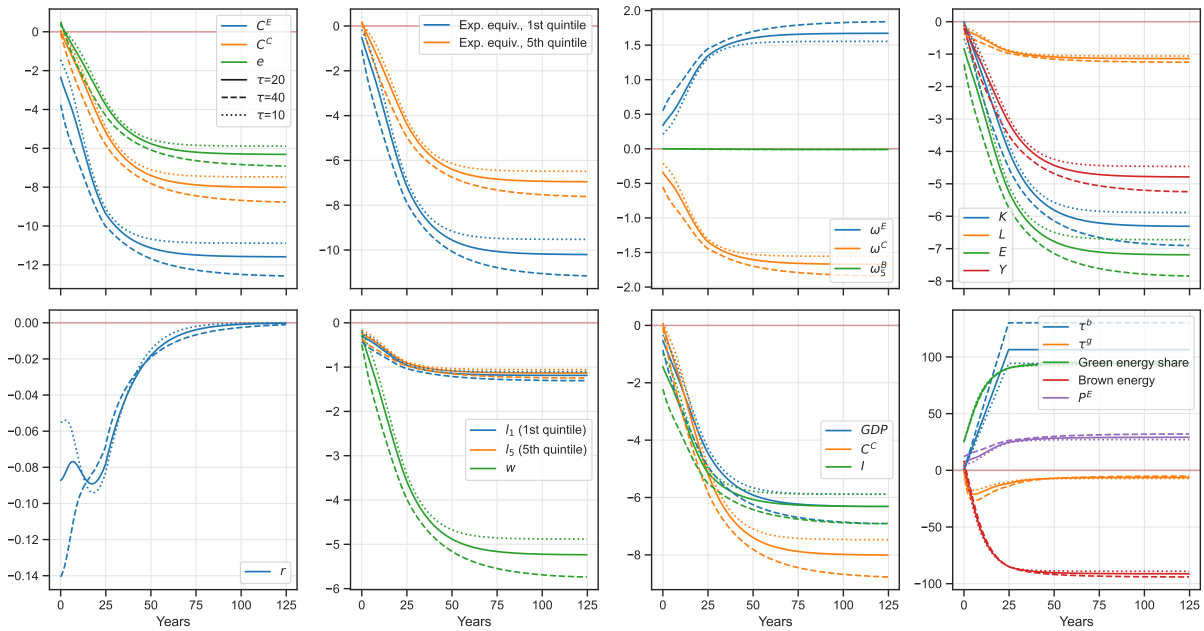

Figure 3: Sensitivity to the adjustment costs of the relative technology terms for energy producers τ.

Notes. The figure shows the percent deviations of the respective variables from their initial steady state. The deviations for the real interest rate is schown in annualized percentage point deviations.

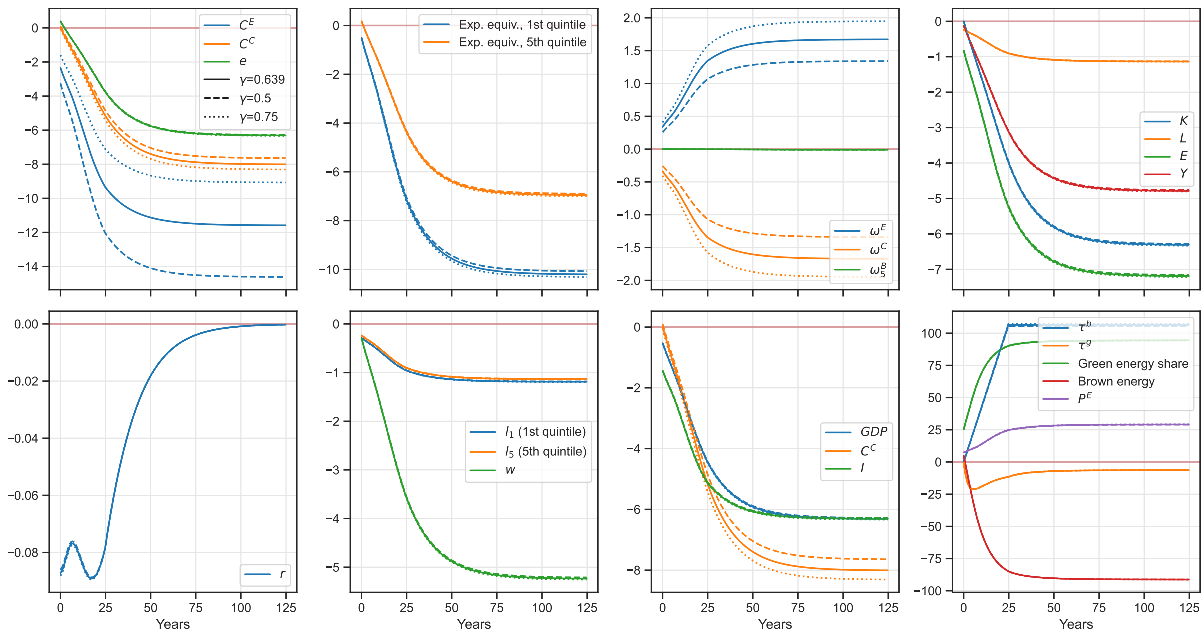

Figure 4: Sensitivity to the preference parameter γ.

Notes. The figure shows the percent deviations of the respective variables from their initial steady state. The deviations for the real interest rate is schown in annualized percentage point deviations.

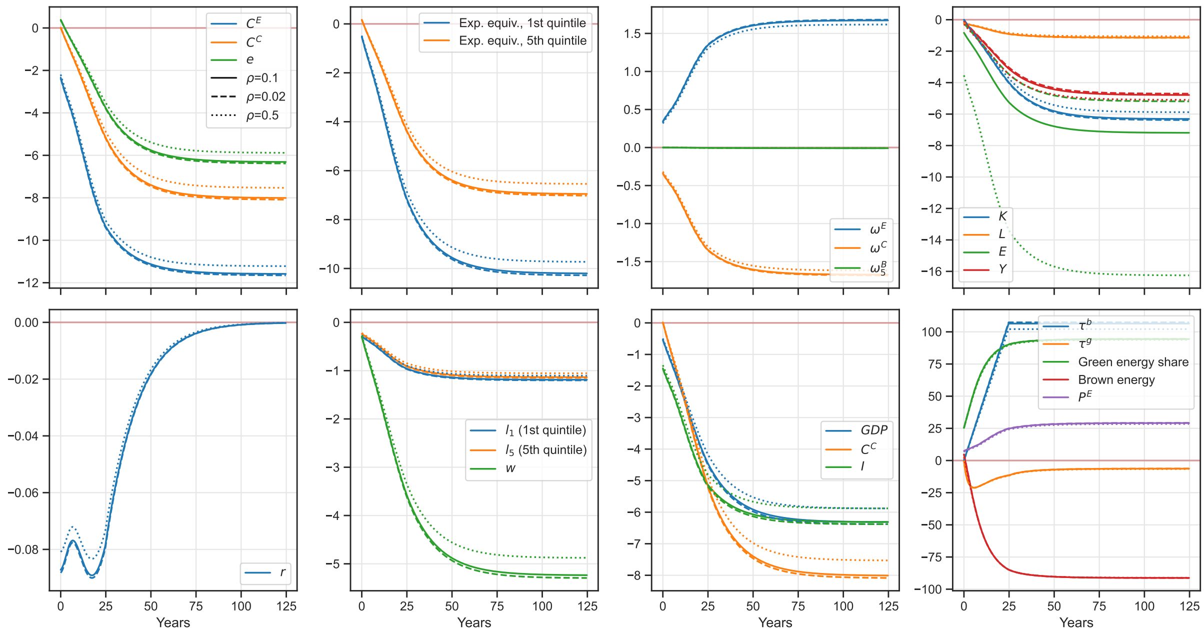

Figure 5: Sensitivity to the elasticity of substitution between the capital-labour aggregate and energy services ρ.

Notes. The figure shows the percent deviations of the respective variables from their initial steady state. The deviations for the real interest rate is schown in annualized percentage point deviations.