Climate Policies, Investments, and the Role of Elections

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- Capital goods in the energy sector characterized by long service life
  - Power plants
  - Mines
- Investments are made under political uncertainty
  - Political uncertainty caused by election (Trump vs. Biden)
  - Use of capital goods subject to changing climate policy
  - Capital goods may end as stranded assets
- Climate policy may depend on existing capital stock
  - Politicians concerned about rent distribution
  - Composition of capital stock affects intensity of climate problem
- We study the interaction of elections, climate policy and investments by using an OLG-model

Literature

- Besley and Persson (2024) study the relationship of energy transition, elections and green preferences
- Karp and Rezai (2014) analyze distributional effects of taxing an open-access resource in an OLG
- Altruism in an OLG is studied by Goussebaïle (2024)
- Fuest and Meier (2023) discuss the impact of divergent political goals on climate policy
- Kalkuhl et al. (2020): No commitment possible, time consistent policies are extreme
- Political implications of asset stranding rarely discussed Literature overview: Dulong et al. (2023)
- Uncertainty with respect to climate policy changes exogenous van der Ploeg and Rezai (2020), Diluiso et al. (2021), Bretschger and Soretz (2022)

General assumptions

- Overlapping generation model in discrete time
  - Young generation y
  - Old generation o
- Every generation lives two periods
- Generation size normalized to unity
- All individuals j of generation i are identical with the exception of ideological preferences
- Utility depends on consumption of black energy b_t^{ij}, green energy g_t^{ij} and numéraire good c_t^{ij}, and emission stock E_t:

$$V(b_t^{ij}, g_t^{ij}, c_t^{ij}, E_t, \Psi^{ij}) = \beta \left[b_t^{ij} + g_t^{ij} \right] - \frac{\gamma}{2} \left[b_t^{ij} + g_t^{ij} \right]^2 + c_t^{ij} - hE_t$$

Energy generation

- Energy generation requires capacities
  - Green capacity $Q_t \geq g_t^s$
  - Black capacity $Z_t \geq b_t^s$
- Capacities in $t+1$ depend on investments in t

$$Q_{t+1} = q_t$$
$$Z_{t+1} = z_t$$

- Investments made by young generation
  - Black investment costs z_t
  - Green investment costs αq_t
- No variable costs in case of green energy
- Flow dependent extraction costs $M(b_t^{sj}) = \frac{m}{2}(b_t^{sj})^2$
- Emissions stock evolution

$$E_t = \sum_i \sum_j b_t^{ij} + \delta E_{t-1}$$

Young generation

- Young individuals endowed with exogenous income L
- Income used for capacity investments, and consumption of numéraire good and energy
- Budget constraint

$$L + \frac{T}{2} = c_t^{yj} + z_t^j + [\alpha - \sigma_t]\, q_t^j + p_b b_t^{yj} + p_g g_t^{yj}$$

- T denotes governmental transfer, p_b black energy price, p_g green energy price and $\sigma_t \in [0, \alpha - 1)$ is green investment subsidy

Old generation

- Old generation owns capacities
- Revenue from energy sales determines income
- Income used for consumption of numéraire good and energy
- Budget constraint

$$p_b b_t^{sj} - M(b_t^{sj}) - \theta_t b_t^{sj} + p_g g_t^{sj} + \frac{T}{2} = c_t^{oj} + p_b b_t^{oj} + p_g g_t^{oj}$$

- Carbon tax θ_t

Government and Elections

- Government
  - Sets carbon tax and investment subsidy
  - No debt
  - Budget constraint

$$T = \theta_t b_t^s - \sigma_t q_t$$

- Two parties (partisan politicians)
  - Party O represents old generation
  - Party Y represents young generation
  - Ψ^{ij} denotes ideological bias in favor of party Y
    - Uniformly distributed around mean 0
    - Density $\xi^i = \xi$
  - χ denotes general popularity of party Y
    - Uniformly distributed around mean 0
    - Density υ

Government and Elections

- Elections held at beginning of every period
- Each party $i = O, Y$ implements policy (θ_t^i, σ_t^i) that maximizes welfare W_t^i of its generation
- Individual j of generation i votes for party Y if

$$W_t^{iY} + \Psi^{ij} + \chi \geq W_t^{iO}$$

- Probability of party O to win elections

$$\pi_t = \frac{\upsilon}{2}\left\{\left[W_t^{oO} - W_t^{oY}\right] + \left[W_t^{yO} - W_t^{yY}\right]\right\} + \frac{1}{2}$$

Timing

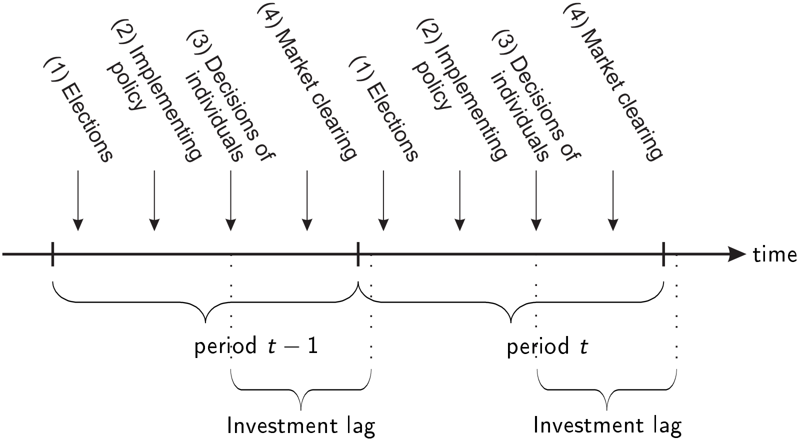

Figure: Timing

Timing

- Backward induction to solve model

  Elections: Government of period $t-1$

  1. Investment subsidy rate σ_{t-1}
  2. Investments q_{t-1} and z_{t-1}

  Elections: Government of period t

  3. Carbon tax θ_t
  4. Energy demand, supply and market equilibrium at t

- Individuals make investment decisions under uncertainty

Maximization Problem of Old Individual

- Representative individual maximizes its welfare given the budget constraint and the limited capacities
- Energy demand

$$D^o(p_t) = \frac{\beta - p_t}{\gamma}$$

- Black energy supply

$$p_t = mb_t^s + \theta_t + \lambda_b,$$
$$\lambda_b \geq 0, \quad \lambda_b[Z_t - b_t^s] = 0$$

- Green energy supply

$$p_t = \lambda_g$$
$$\lambda_g \geq 0, \quad \lambda_g[Q_t - g_t^s] = 0$$

Maximization Problem of Young Individual

- Representative individual maximizes its intertemporal welfare, with ρ as discount factor, given its budget constraint
- Energy demand

$$D^y(p_t) = \frac{\beta - p_t}{\gamma}$$

- Aggregated energy demand

$$D(p_t) = 2\frac{\beta - p_t}{\gamma}$$

Equilibrium

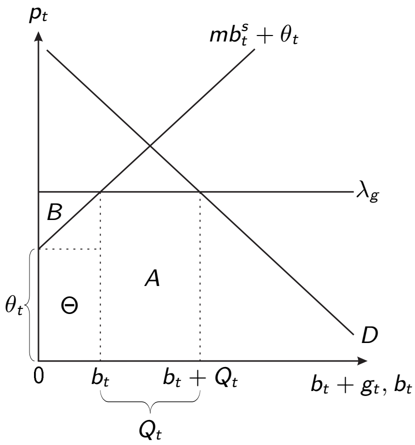

Figure: Equilibrium on the energy market with $b_t^s < Z_t$ (left-hand side) and $b_t^s = Z_t$ (right-hand side)

Preferred carbon tax

- Party $i = O, Y$ maximizes welfare $W^i(\theta_t^i)$ of generation $i = o, y$
- Parties take into account
  - Evolution of the emission stock
  - Governmental budget constraint
  - Binding green capacity constraint
  - $b_t^y(\theta_t)$, $g_t^y(\theta_t)$ $b_t^o(\theta_t)$, $g_t^o(\theta_t)$, $p_t(\theta_t)$, $b_t^s(\theta_t)$

$$\theta_t^O = \begin{cases} \theta_t^{Ob} = \frac{4m+\gamma}{2} Q_t + \frac{4m+2\gamma}{\gamma} h - \frac{2m\beta}{\gamma}, & \text{if } b_t^s \leq Z_t, \\ \theta_t^{OZ} = 0, & \text{if } b_t^s = Z_t, \end{cases}$$

$$\theta_t^Y = \begin{cases} \theta_t^{Yb} = -\frac{\gamma}{2} Q_t + \frac{4m+2\gamma}{4m+\gamma} [1 + \rho\delta] h + \frac{2m\beta}{4m+\gamma}, & \text{if } b_t^s \leq Z_t, \\ \theta_t^{YZ} = -\frac{\gamma}{2} Q_t - \frac{2m+\gamma}{2} Z_t + \beta, & \text{if } b_t^s = Z_t. \end{cases}$$

Preferred carbon tax

- Non-binding capacity constraint
  - Social planner considers damages of $t, t+1, \ldots$
  - Old party considers damages in t
  - Young party considers damages in t and $t+1$
  - Neither θ_t^{Ob} nor θ_t^{Yb} is socially optimal
- Binding capacity constraint
  - Taxes only redistribute income
  - θ_t^{OZ} only optimal in knife-edge case
  - θ_t^{YZ} never optimal

Maximization Problem of Young Individual in $t-1$

- Representative young individual maximizes its intertemporal welfare given the budget constraint
- Uncertainty in $t-1$ with respect to expected energy price $E(p_t)$, expected fuel tax $E(\theta_t)$, expected black energy supply $E(b_t^s)$
- First-order conditions

$$\rho E(p_t) = \alpha - \sigma_{t-1}$$
$$\rho \left[E(p_t) - mE(b_t^s) - E(\theta_t)\right] = 1$$

- Perfect foresight
  No stranded assets

Imperfect Foresight

- Party O wins with probability π_t, party Y with probability $1 - \pi_t$
- Winning party sets either θ_t^{ib} or θ_t^{iZ}, $i = O, Y$
- Individuals' expectations given by

	θ_t^{Ob}	θ_t^{OZ}
θ_t^{Yb}	(I)	(II)
θ_t^{YZ}	(III)	(IV)

- Cases (I) and (III) can be ruled out
- Tax implement by old party $\theta^{OZ} = 0$
- Tax rate set by Y-government can lead to stranded assets

Imperfect Foresight

- Case (II)
  - No stranded assets if $\pi_t \to 0$
    - Individuals expect party Y to win with high probability
    - Investments oriented to θ_t^{Yb}
  - Stranded assets possible if $\pi_t \to 1$ and h high
    - Individuals expect party O to win with high probability
    - Investments oriented to $\theta_t^{OZ} = 0$
    - High tax rate θ_t^{Yb} implemented
- Case (IV)
  - No stranded assets by definition
- (II) or (IV)
  - Young party prefers case (II) policy
  - Case (II) policy only possible if $\sigma_{t-1} < \tilde{\sigma}_{t-1}$ holds

Exogenous π_t

- O-government in $t-1$
  - Old generation does not benefit from higher capacity in t
  - Old generation bears 50% of subsidy costs
  - O-government sets $\sigma_{t-1}^{O} = 0$
  - True for endogenous election probability
- Y-government faces several opposing effects
  - Lower energy price depresses profits from energy sales
  - (Possible) Reduction of fuel use reduces profits
  - More green energy use boosts profits
  - (Possible) Reduction of fuel use reduces climate damages
  - (Possible) Reduction of fuel tax boosts profits
  - (Possible) Reduction of fuel use reduces transfer

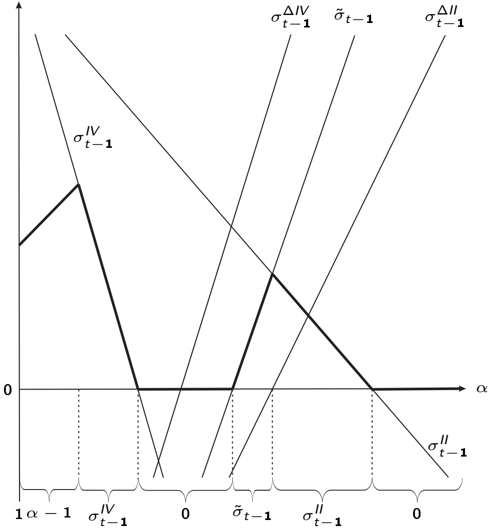

Figure: σ_{t-1} depending on α for small π_t and $\beta - 2[1+\rho\delta]h$

Exogenous π_t

- Y-government in period $t-1$ bind hands of successor for small α and small π_t
  - Low probability to win elections
  - High risks of stranded assets
  - Subsidy used to reduce assets at risk
- For high π_t, parameter spaces allowing for σ_{t-1}^{II} and σ_{t-1}^{IV} may overlap
- Y-governments uses σ_{t-1}^{IV} to bind hands of successor if $\alpha > \tilde{\alpha}$
  - Elections won with high probability
  - Low risk of stranded assets
  - Subsidy used in case of expensive green capacity investments to reduce assets at risk

Endogenous π_t

- No strategic effects for case (IV)
- No analytical solution for case (II)
- Numerical example
  - Endogenous π_t: Subsidy rate $\sigma^s_{t-1} = 2.55645$ and election probability $\pi^s_t = 0.595826$
  - O-government sets $\tilde{\sigma}^s_{t-1} = 0$ leading to $\tilde{\pi}^s_t = 0.573172$
  - Exogenous probability $\tilde{\pi}^s_t$: Y-government sets $\breve{\sigma}_{t-1} = 2.33646$
- Strategic effects
  - With endogenous probability, old generation has more to lose if elections are lost
  - With endogenous probability, young generation has more to win if elections are won
  - First effect dominates

- Overlapping generation model
  - Individuals invest in black and green capacity
  - Elections determine climate policy
- Climate policy used to internalize climate damages and redistribution between generations
- O-government abstains from climate policy to avoid redistribution to the young
- Y-government implements climate policy
- Carbon tax only affects climate damages in t if some black assets strand
  - Preferred policy of Y-government
  - Low subsidy rate in $t-1$ necessary
  - Low election probability

- Subsidy rate in $t-1$ can be used to bind hands of successor
  - Low reelection probability
    Use high subsidy rate in case of cheap green capacity
  - High reelection probability
    Use high subsidy rate in case of expensive green capacity
- Subsidy rate in $t-1$ can be used to increase reelection probability
  - Higher subsidy than with exogenous reelection probability
  - Potential losses of both generations higher
  - Effect stronger for old individuals