Climate Change Impacts of Renewable Energy Policies: The Roles of Capacity Constraints and Market Structure

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Motivation

- Impacts of biofuel on oil supply: mostly ignored
- Reason: small market share of biofuel in gas market
- Our story: in a dynamic model, renewable energies could have major impacts on the current supply of oil
  1. Conditions: capacity constraints, market power in oil
  2. mechanism: intertemporal allocation of a nonrenewable resource
- Relevance: LCA of biofuels, effects of renewable energy policies, “Green Paradox”
- Plan of the talk
  1. show intuition in simple model
  2. Numerically solve a more complicated model using market data
Next level of LCA: dynamic approach

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- Market power in oil sector
Premises of our approach (cont’d)

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2. GHG problem: carbon has been released \textit{too fast}, far exceeding rates of dissipation
3. GHG is a stock pollutant. Earlier emissions cause more NPV damage.
4. Optimal path: lower emission \textit{now}, implying higher emission in the future
Impacts on the *path of GHG emissions* from renewable energies

- Low cost biofuel, high cost biofuel and solar
What we do

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- linear production costs: constant MC of production/extraction
Behavior of an oil cartel

- Objective: raise price by reducing extraction/supply

But one barrel not extracted today will raise supply tomorrow: competing with its future self.

Crucial: elasticity of demand

1. Higher elasticity, harder to raise price: have to cut production by more

2. If different elasticities in different time periods, want to raise price in periods with lower elasticities

In a basic Hotelling model

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\dot{p} = r - \dot{\gamma}
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Empirical evidence: OPEC behaves like a cartel (with mistakes)
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Static effects of biofuel

- Biofuel is a competitive fringe
  Increasing the elasticity of demand
Static model: small effect
Solar

- backstop: infinite elasticity
Price path under perfect competition

Price path with backstop

\[ P_c(t) = C_c + \lambda_c e^\gamma \]
Price path under monopoly

Marginal revenue

Price path
Example: impacts of solar cost reduction

Price path with backstop