Discussion of Climate Change, Directed Innovation, and Energy Transition: The Long-run Consequences of the Shale Gas Revolution by Daron Acemoglu, Philippe Aghion, Lint Barrage, and David Hémous

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Federal Reserve Bank of Richmond Climate Workshop

Really Important Question: Everyone Wants The Answer!

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The Comanche Solar facility in Pueblo, Colo., in 2016. An Xcel Energy coal fired power plant is seen in the background. Rick Wilking/Reuters

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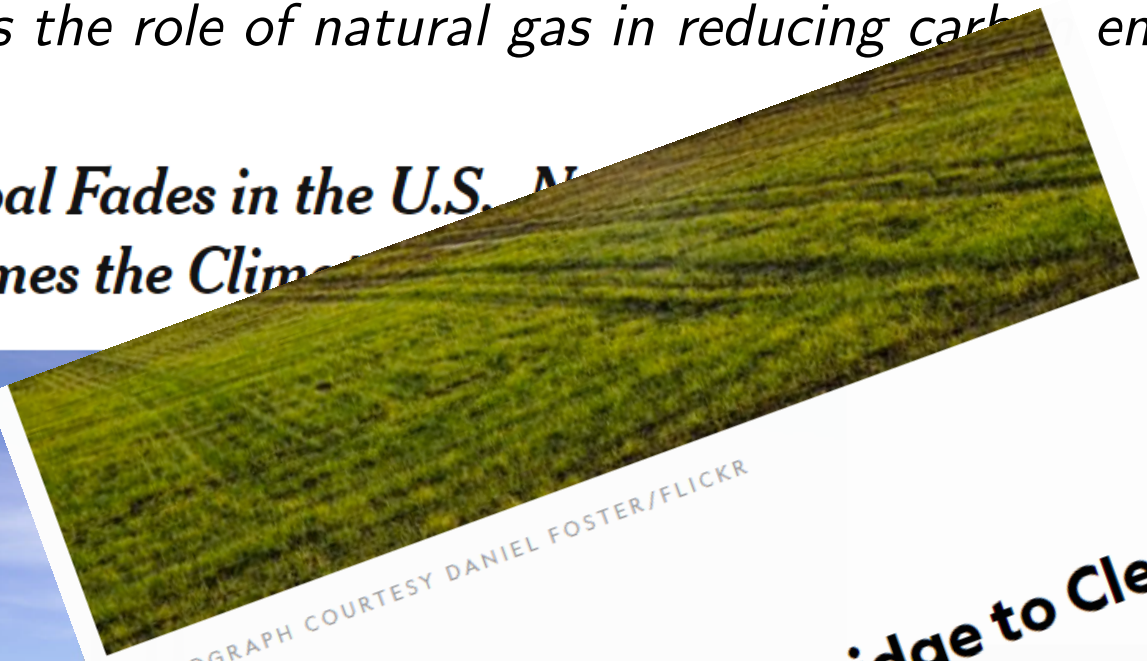

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ARTICLE

Can Natural Gas Be a Bridge to Clean Energy?

Join the debate over whether we should view natural gas as a transitional fuel that eventually gives way to renewables, or whether it is blocking the way forward.

Model

Final good

- Produced from electricity and non-electricity inputs

Electricity

- Produced from power plants and resources
- Three types of power plants: coal, natural gas, green
- Innovate in each type of power plant tech: A_c, A_s, A_g

Resource

- Costly to extract coal and natural gas
- Exogenous resource extraction tech: B_c and B_s
- Natural gas boom: one-time increase in B_s

Equilibrium Allocation of Innovation

$$\left(\frac{s_{gt}}{s_{ft}}\right)^{\psi} \approx \frac{\kappa^{\varepsilon} A_{gt-1}{}^{\varepsilon-1}}{\eta_f \left[\kappa_c^{\varepsilon}\left(\left(\frac{1}{A_{ct-1}}\right)^{\frac{\varepsilon-1}{\varepsilon}} + \frac{A_{ct-1}^{\frac{1}{\varepsilon}}}{B_{ct}}\right)^{-\varepsilon} + \kappa_s^{\varepsilon}\left(\left(\frac{1}{A_{st-1}}\right)^{\frac{\varepsilon-1}{\varepsilon}} + \frac{A_{st-1}^{\frac{1}{\varepsilon}}}{B_{st}}\right)^{-\varepsilon}\right]}$$

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- Coal tech is like gas tech

Effects of the Natural Gas Boom

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Long-Run Effect Depend on Growth Rates of B_s and B_c

Fast growth in extraction technologies

- Resource extraction costs small relative to power plant costs
- Shale gas boom can push economy to long-run equilibrium with only fossil innovation
- High emissions in long run!

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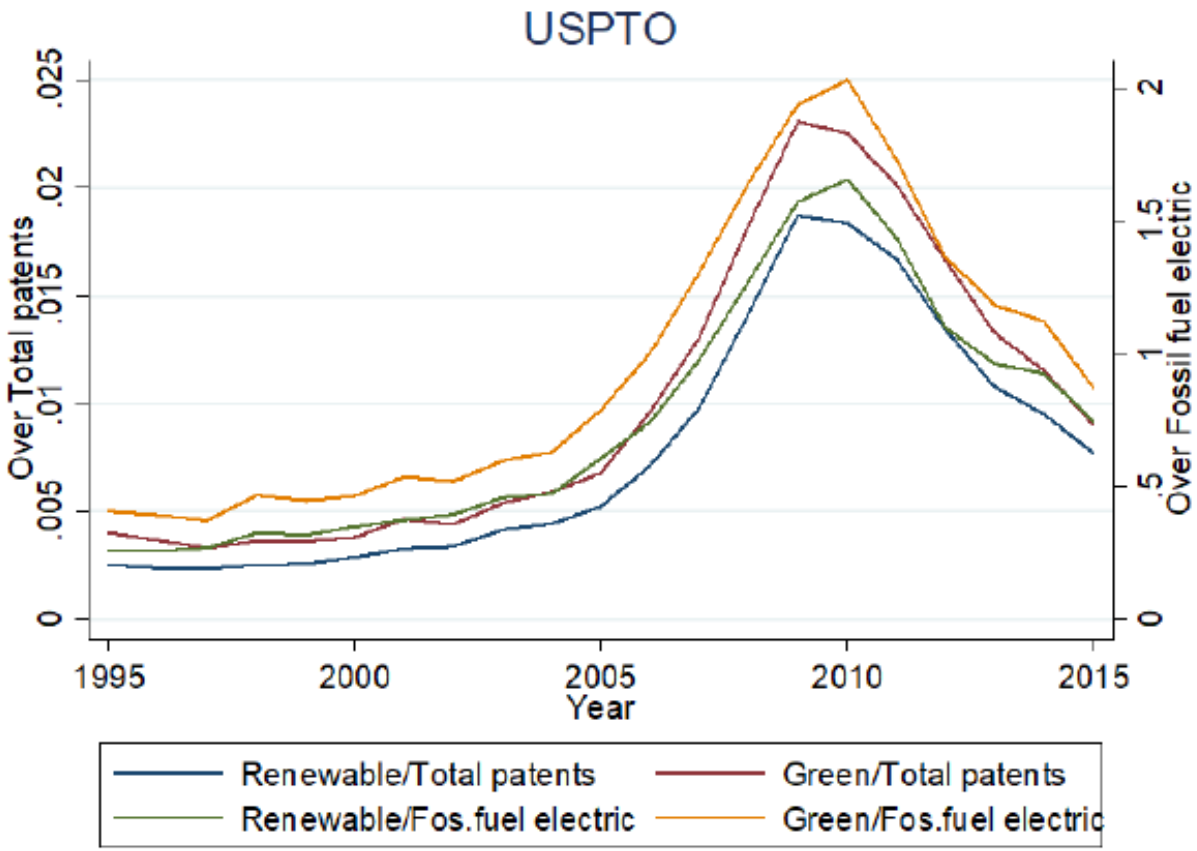
Zero growth in extraction technologies (constant)

- Resource extraction costs eventually become large relative to power plant costs
- Reduces benefit in power plant innovation over time
- Always go to long-run equilibrium with only green innovation
- BUT: shale gas boom slows down green transition

Endogenous Growth Rate of Extraction Tech?

- Shale gas boom increases B_s relative to B_c
- Path dependence $\Rightarrow$ more scientists innovate in B_s over time
- Could also draw scientists away from power plant tech

What About in The Data?



What does data look like for patents in extraction technologies?

What's Feasible?

Endogenize all the technologies?

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Aggregate more?

- Combine power plant and extraction sectors
- Natural gas boom $\Rightarrow \uparrow$ natural gas sector productivity
- Pro: incorporates effects of boom on extraction tech
- Con: lose distinction between resource extraction and demand

What About Final-Use Energy Efficiency Innovation?

$$Y_t = \left((1-\nu) Y_{pt}^{\frac{\lambda-1}{\lambda}} + \nu (\tilde{A}_{Et} E_t)^{\frac{\lambda-1}{\lambda}} \right)^{\frac{\lambda}{\lambda-1}}$$

- $\tilde{A}_{Et}$ matters for long-run trends in US carbon emissions (Casey 2019)
- Natural gas boom could affect incentives for innovation in energy efficiency
- Might matter for long-run impact of boom on emissions
- Sensitivity for different growth rates of energy efficiency tech?

In Sum: Nice Paper!

- Interesting and important question
- Impressive model with elegant and intuitive innovation dynamics
- Meaningful insights for our understanding of the role of natural gas in fighting climate change

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Thank you!