Natural Gas Combined Cycle Innovations in the US: The Impact of the Advanced Turbine System Program

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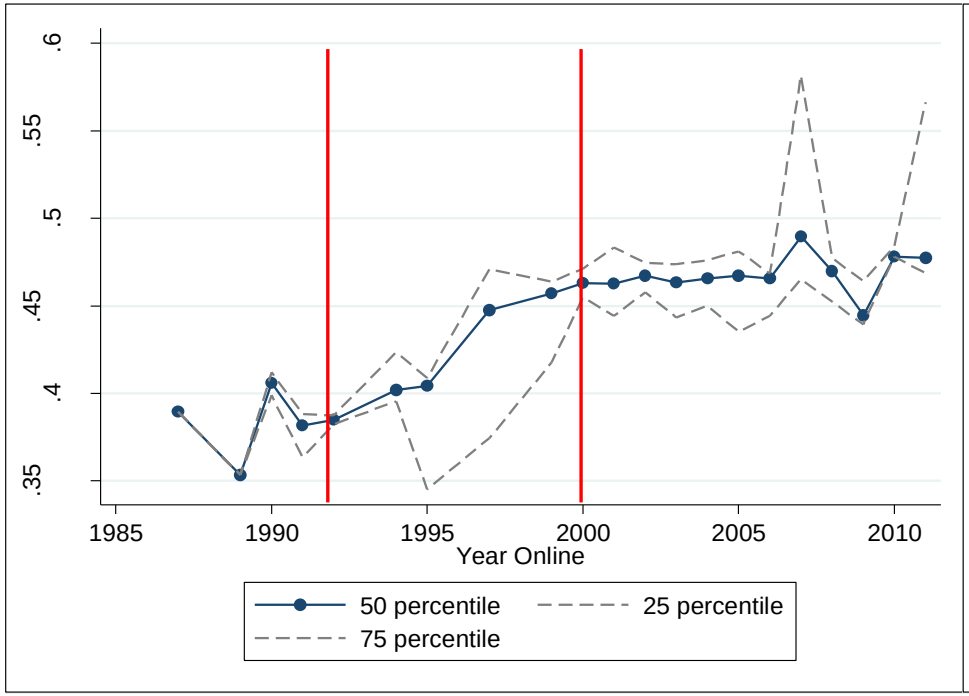
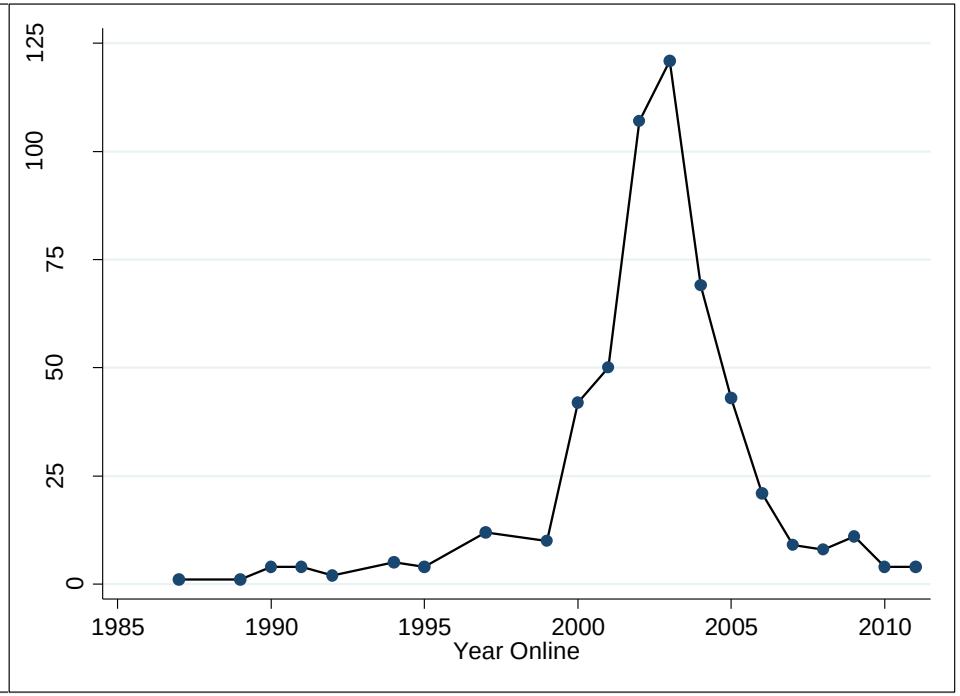
DOE's Advanced Turbine System Program (ATS)

- DOE Advanced Turbine System program (DOE-ATS), 1992-2000
- Cost sharing program with NGCC turbine manufacturers: General Electric (GE) and Siemens Westinghouse Power Corporation (SWPC)
  - DOE $315 million, private sector $155 million
- Goals of the program for NGCC:
  - Improved efficiency
  - Reduced electrical generation costs
  - Lower NOx emissions

NGCC Efficiency



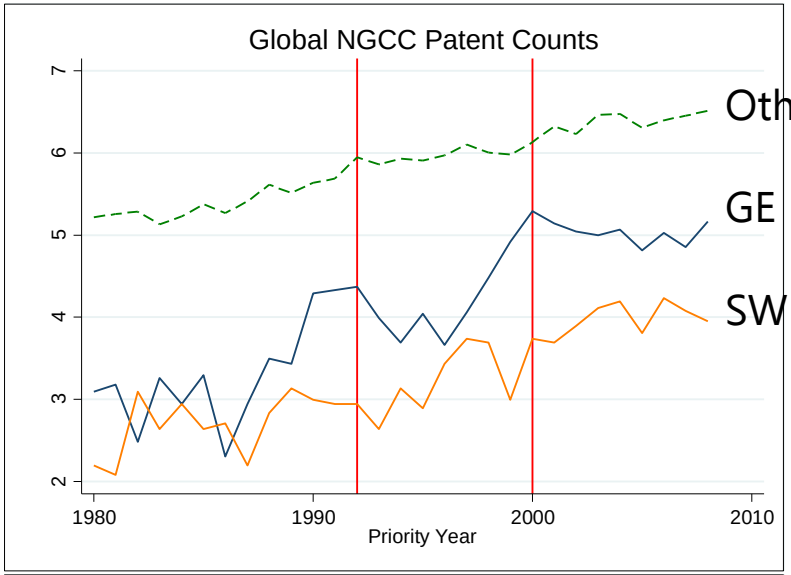


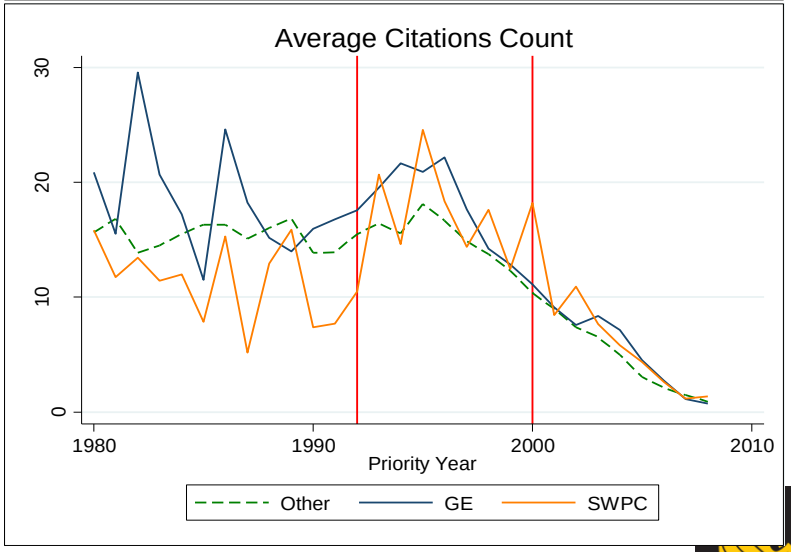
Method

Research Question: What was the impact of DOE-ATS on innovation?

Measure: Patent counts (volume) and patent citations (impact)

Method: Fixed-effects negative binomial model for program participants and 12 other companies





Data

- PATSTAT, patent database
  - Patent application eventually granted into patents, by application filing date, families (unique invention)
  - Forward patent citations excluding self-citations for US patents only
- Relevant technology fields
  - Curtis (2003): cycles, compressor, combustor, closed loop steam cooling, seals, removable inner turbine shell, single crystal
- Companies (including mergers)
  - GE, SWPC, Alstom/ABB, Hitachi, Honeywell, IHI Corp., Kawasaki, Mitsubishi, MTU, Rolls-Royce, SNECMA, Toshiba, United Technologies

Method

$$inventions_{jt} = \beta_1 + \delta_{jt}(year_t \cdot participant_j) + \alpha_t + \alpha_j + \epsilon$$

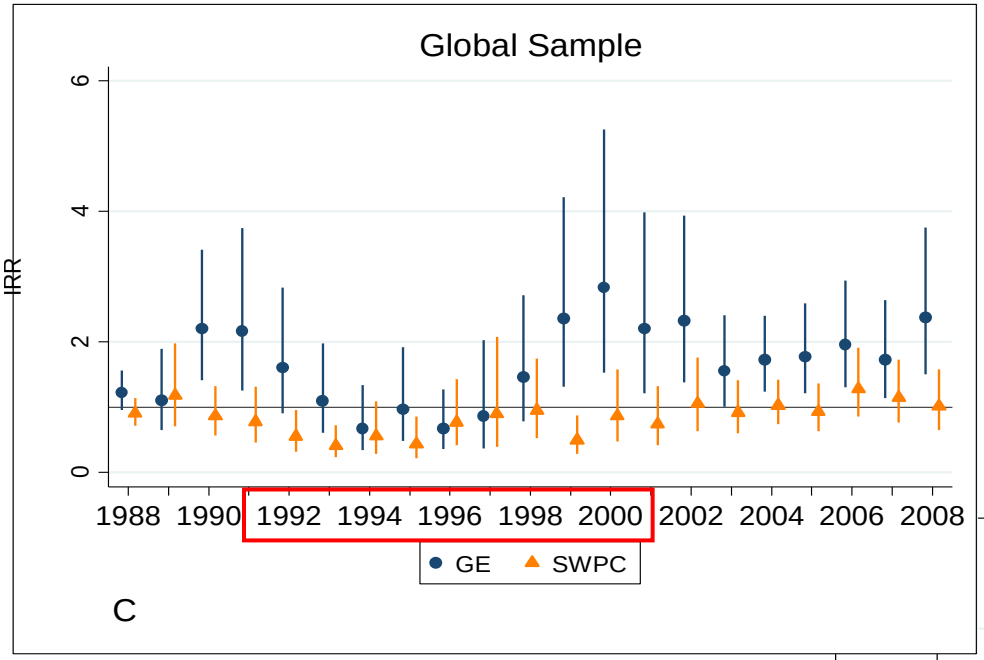
$$inventions_{jt} = \beta_1 + \delta_{kt}(year_t \cdot company_k) + \alpha_t + \alpha_j + \epsilon$$

$$citations_{it} = \beta_1 + \delta_{jt}(year_t \cdot participant_j) + \alpha_t + \alpha_j + \epsilon$$

$$citations_{it} = \beta_1 + \delta_{kt}(year_t \cdot company_k) + \alpha_t + \alpha_j + \epsilon$$

$$j = company$$
$$t = time\ (year)$$
$$k = participant\ company$$
$$participant\ (0, non - participant; 1, participant)$$
$$\alpha_j = company\ FE$$
$$\alpha_t = year\ FE$$
$$i = patent$$
$$\epsilon = error$$

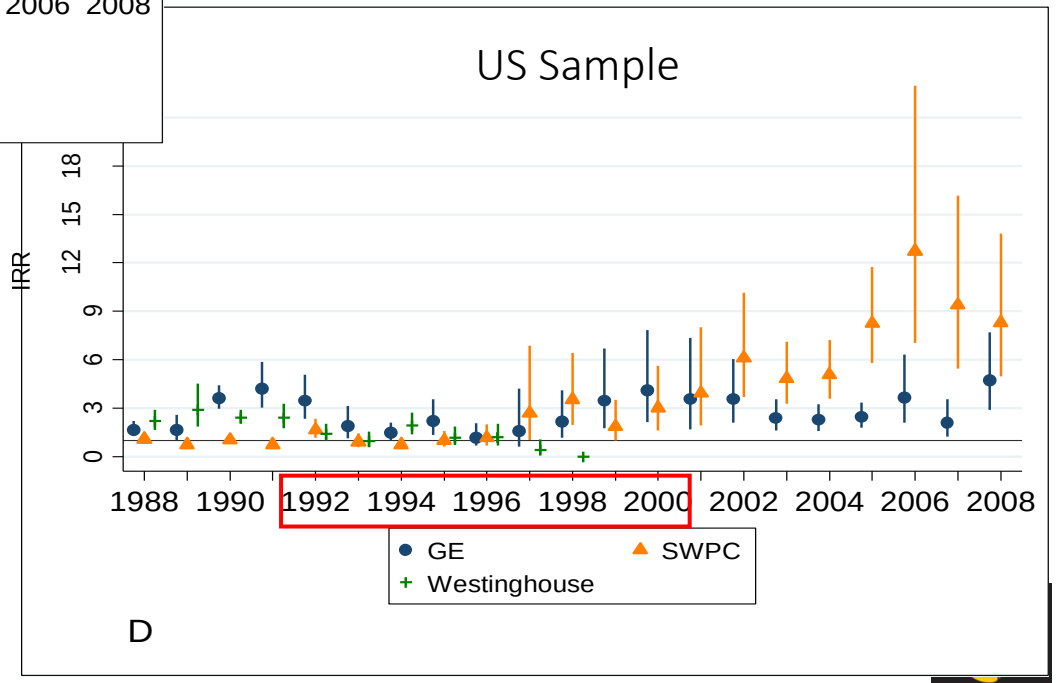
Count Results



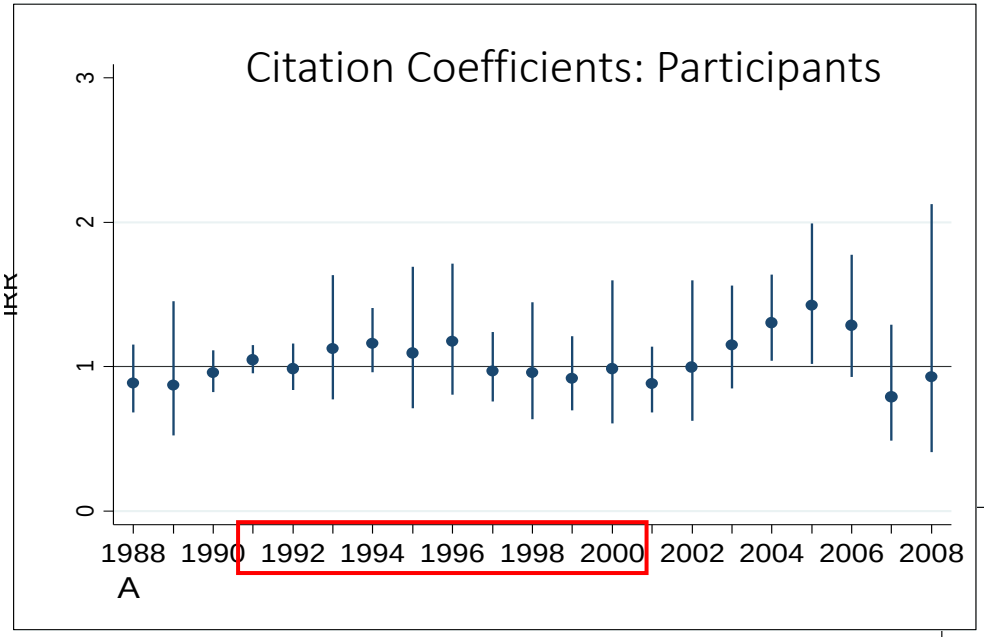
Upper CI 95%

Coefficient

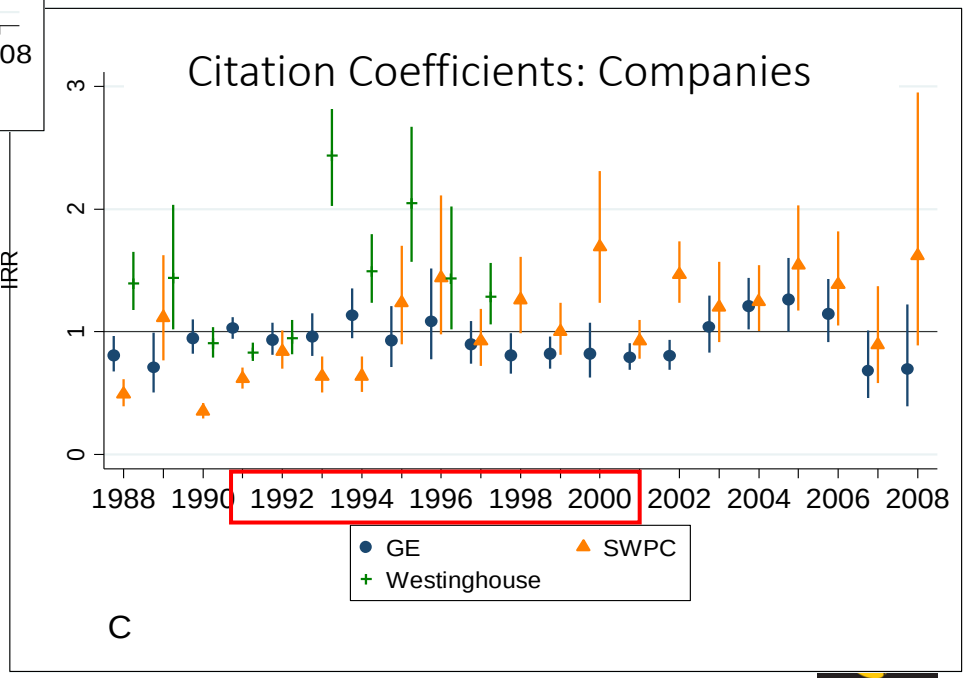
Lower CI 95%



Citation Results: US



GE: 7G, 7H, 9H 1995
7HA/9HA 2014
Westinghouse: 501G 1994
Siemens: V84.3A 1995
SWPC: H-series 2007



Findings & Future Work

- Not a uniform impact on participants
  - GE robust increase in patenting
  - Westinghouse higher impact patents
- Implication: Program design should account for company characteristics
- Difference in global vs. US patenting
- Qualitative work for further evaluation
- Future work: NGCC ramp speed for intermittent renewable technology

Thank you!

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