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

![Graph showing NGCC Efficiency over time]

- 50 percentile
- 25 percentile
- 75 percentile

Year Online

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

\[ \text{inventions}_{jt} = \beta_1 + \delta_{jt} (\text{year}_t \cdot \text{participant}_j) + \alpha_t + \alpha_j + \epsilon \]

\[ \text{inventions}_{jt} = \beta_1 + \delta_{kt} (\text{year}_t \cdot \text{company}_k) + \alpha_t + \alpha_j + \epsilon \]

\[ \text{citations}_{it} = \beta_1 + \delta_{jt} (\text{year}_t \cdot \text{participant}_j) + \alpha_t + \alpha_j + \epsilon \]

\[ \text{citations}_{it} = \beta_1 + \delta_{kt} (\text{year}_t \cdot \text{company}_k) + \alpha_t + \alpha_j + \epsilon \]

\[ j = \text{company} \]
\[ t = \text{time (year)} \]
\[ k = \text{participant company} \]
\[ \text{participant} (0, \text{non-participant}; 1, \text{participant}) \]
\[ \alpha_j = \text{company FE} \]
\[ \alpha_t = \text{year FE} \]
\[ i = \text{patent} \]
\[ \epsilon = \text{error} \]
Count Results

Global Sample

US Sample

Upper CI 95%
Coefficient
Lower CI 95%
Citation Results: US

Citation Coefficients: Participants

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

Citation Coefficients: Companies

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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