Gaining Steam:
Incumbent Lock-in and Entrant Leapfrogging

Richard Hornbeck, Shanon Hsuan-Ming Hsu, Anders Humlum, Martin Rotemberg

Discussant: Jane Olmstead-Rumsey, LSE

Adoption of Steam Power Was Slow

1. Is slow adoption a generic feature of new general purpose technologies?
2. Should we do anything about it?

1. Is Slow Adoption A Generic Feature of New GPTs?

- Paper's view: no. Depends on cost structure of new technology
  - Water: high marginal cost, low fixed cost
  - Steam: low marginal cost, high fixed cost
  - $\Rightarrow$ entrants enter with old technology even in 1880
  - Helps distinguish vintage capital vs. cost structure theories

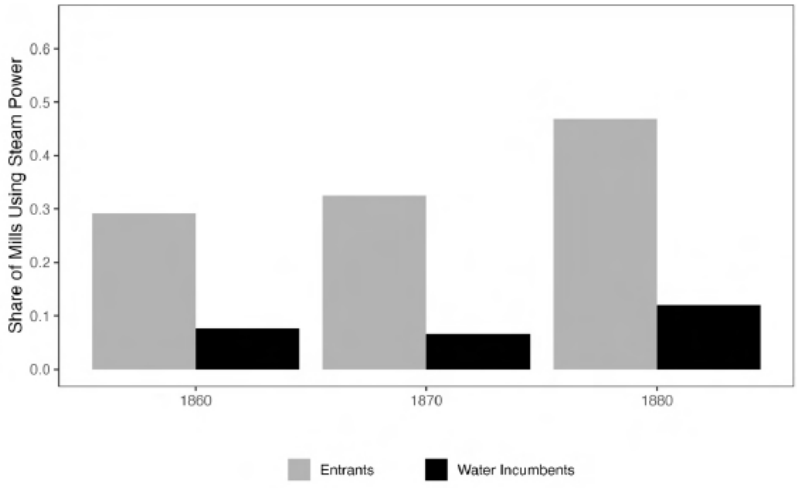
    David (1990); Atkeson & Kehoe (2007) vs. Melitz (2003); Reichardt (2024)

- My view: yes. Seems to be a generic feature
  - ICT revolution, green transition Brynjolfsson et al. (2021); Hsieh & Rossi-Hansberg (2023); De Ridder (2024); Acemoglu et al. (2012); Aghion et al. (2024); Kwon et al. (2023); ...
  - Low fixed cost technologies: electric motor, artificial intelligence diffuse slowly

2. Should We Do Something to Speed Up Adoption?

- Paper's view: yes in this case. Positive agglomeration effects $\Rightarrow$ role for policy
- My view: possibly. Need to understand agglomeration effects clearly
  - Estimated agglomeration forces are small and local

Entrants Do Not Always Embody New Technology

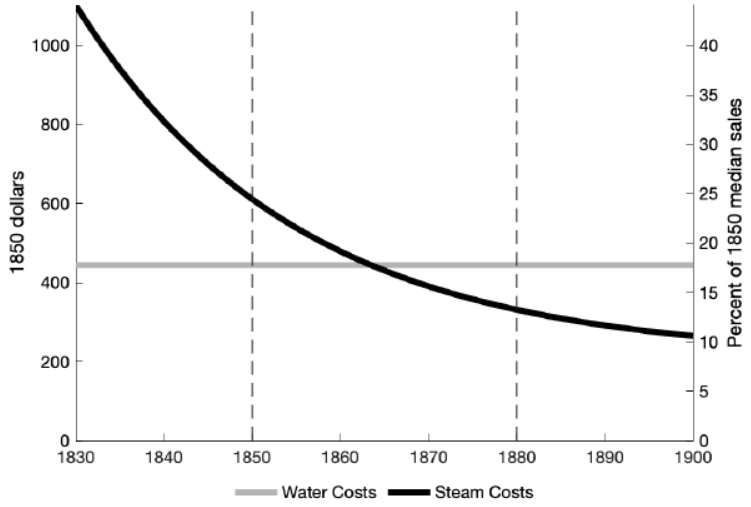


Water is Cheaper to Adopt and Operate

		%	Target
Water	**Adoption cost**	**18**	E vs. I size + hand vs. water capital
	Operating cost	**10**	Exit rate, water
	Switching cost to S	1.4	Incumbent vs. entrant water share
Steam	Adoption cost, 1850	42	Steam adoption rate 1850
	Adoption cost, 1880	**9**	Steam adoption rate 1880
	Operating cost	**30**	Exit rate, steam
	Switching cost to W	5.8	Incumbent vs. entrant steam share

Estimated costs as a percentage of median annual sales in 1850. Targets pool 1850-1880.

Adoption Cost of Steam Declines Slowly



Steam ↓ Marginal Cost: Direct + Agglomeration Effects

$$y_{jct} = exp(\varphi_{jct} + \mathbb{1}(R_{jct} = S)(\gamma + \alpha s_{ct}))x_{jct}$$

1. Direct: γ: 9% lower marginal cost
   - target: sales differential, water vs. steam, 1850-1880
2. Agglomeration: α from local share of adopters s_{ct}: 2.5% lower marginal cost
   - target: revenue growth 1850-1880 diff., high vs. low waterpower counties

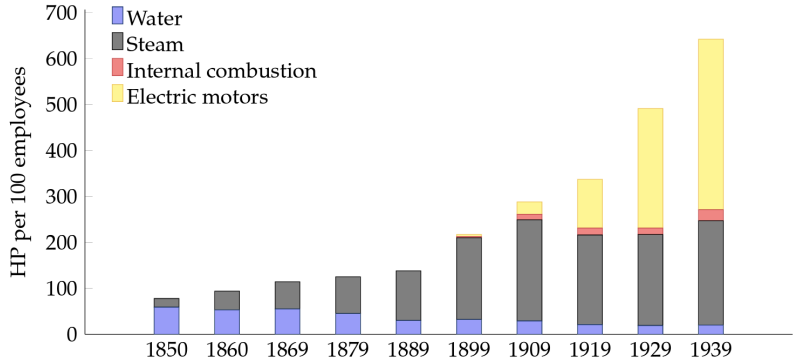
- α: residual differences in rev. growth by waterpower potential after controls:
  - county-industry FE, industry-year FE, water/coal/market access
- What if instead γ changes over time?

Should Policy Speed Up The Transition?

- Policy: buy sunk capital of water incumbents
  - **More** entrants enter with water (option value of switching)
  - Relies on measuring agglomeration effects right
- Alternative: where does fall in steam cost come from, why is it slow?
  Bresnahan and Trajtenberg (1995); Liu & Ma (2024)

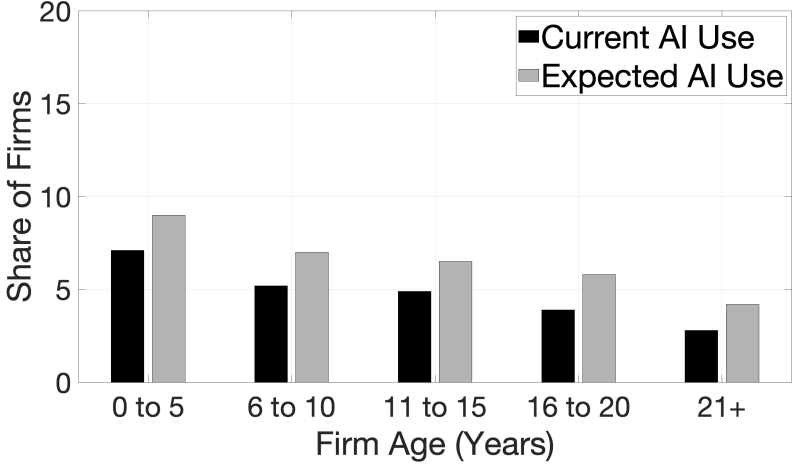
Electric Motors (Low Fixed Cost) Also Diffused Slowly

FIGURE 3: Capacity of primary power by type in horsepower per 100 employees in manufacturing in the United States



Source: Reichardt (2024).

AI (Low Fixed Cost?) Diffusing Slowly For All Firms



Source: Census Business Trends and Outlook Survey

Why is AI Diffusing Slowly? Not Applicable Yet

Reasons for Not Planning to Use AI	**Share resp. (%)**
AI is not applicable to this business	**80.9**
Lack of knowledge on the capabilities of AI	**7.3**
Concerns about privacy/security	**6.6**
AI is not a mature enough technology yet	**6.1**
Other	4.5
Too expensive	4.1
Lack of skilled workforce	2.9
Concerns about bias	2.8
Lack of required data	2.2
Laws and regulations prevent or restrict use of AI	1.2
Previous or current use of AI did not meet expectations	0.9

Source: Census Business Trends and Outlook Survey

Conclusion

- Interesting paper, immense data collection effort
- Spotlights key feature of slow adoption: entrants also slow to adopt
- Most GPTs diffuse slowly
- Open question: can/should policy speed up transition? If so, how?