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Government funding and support for energy RD&D: what do we know about outcomes?

Session 4: Regulation and innovation for smarter and cleaner energy markets & networks
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University of Cambridge

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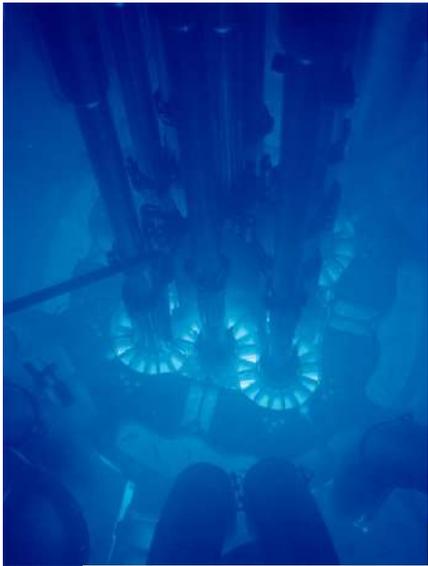
Overview

1. Motivation: government role in energy innovation
 - From how much to how?
2. Public energy R&D institutions in context
 - *US National Labs*
 - *Partnerships with cleantech startups and grants to SMEs*
 - *ARPA-E*
3. Key findings
4. Questions going forward

Government policy plays an important role

Calls for more funding for energy innovation since the mid-1990s

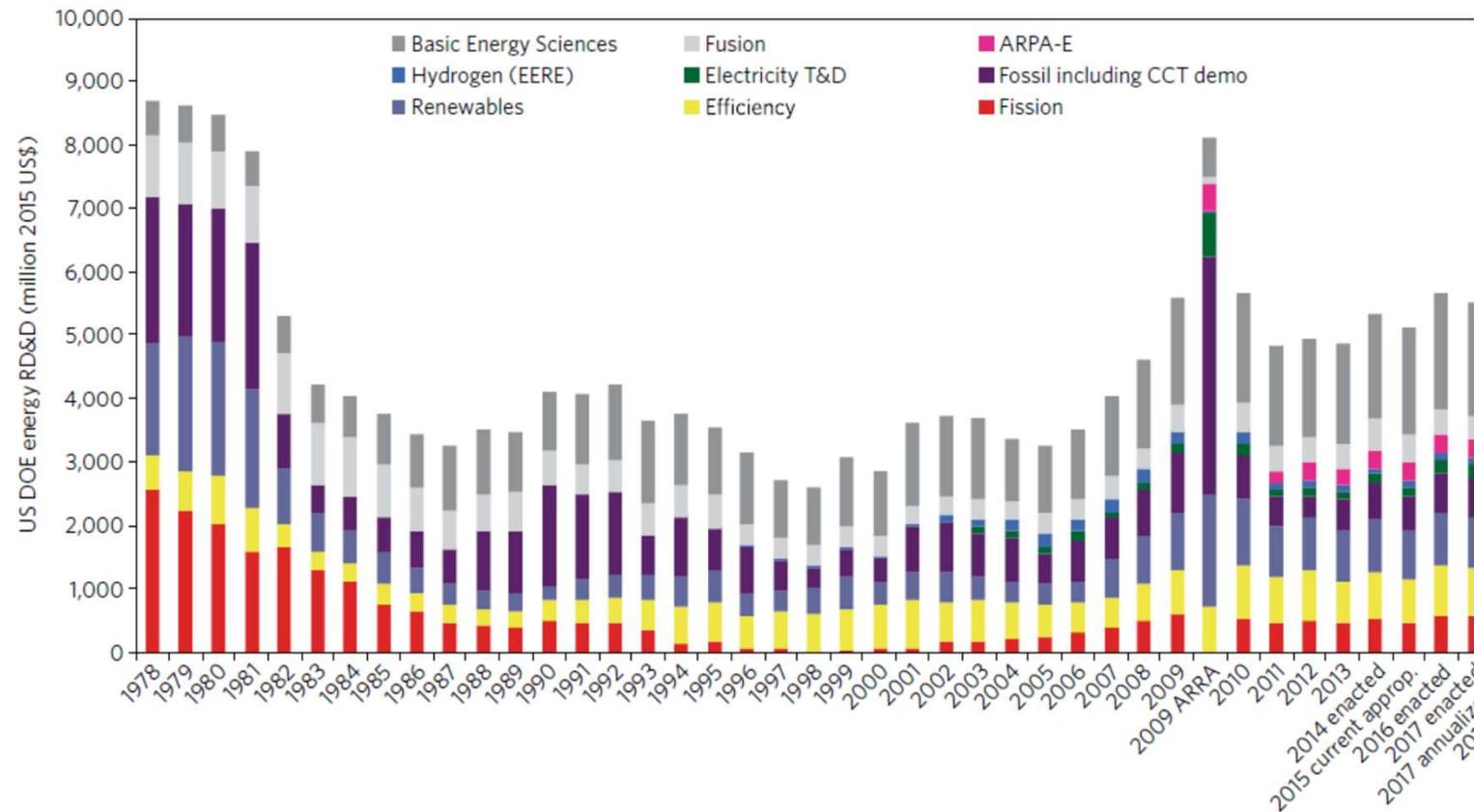
- Government R&D and its combination with other policies has played and continues to play a key role in energy



ASIDE: In spite of Trump's proposals, US Congress is not going long with energy R&D cuts]

Budget approved by Congress last month ignored President Trump's request

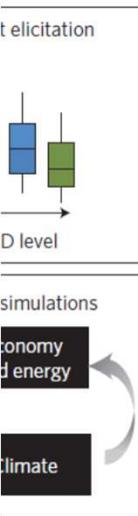
- Different sides of the aisle could get behind different pieces of evidence advancing different goals



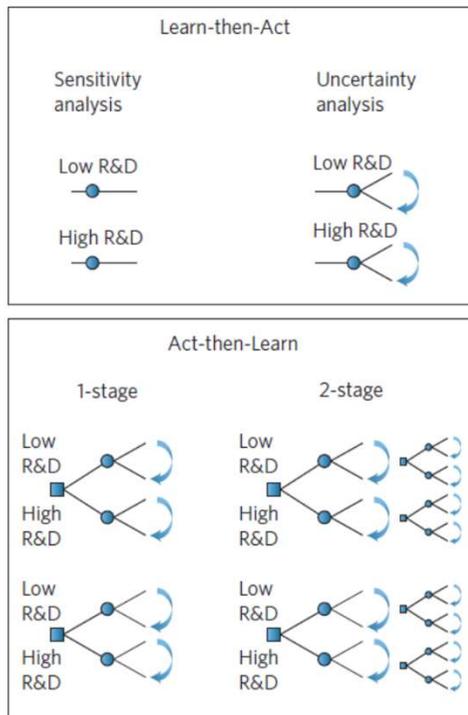
Work prioritizing R&D investments across technologies

Biggest returns on investments on storage and solar

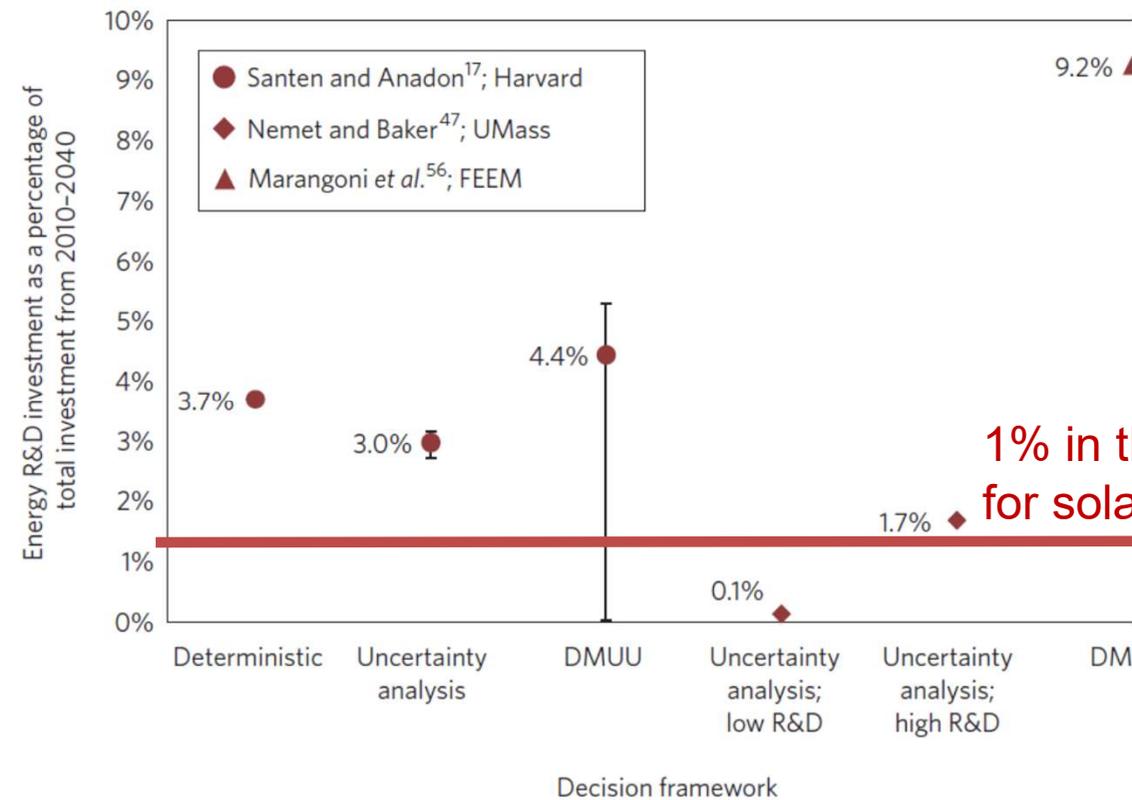
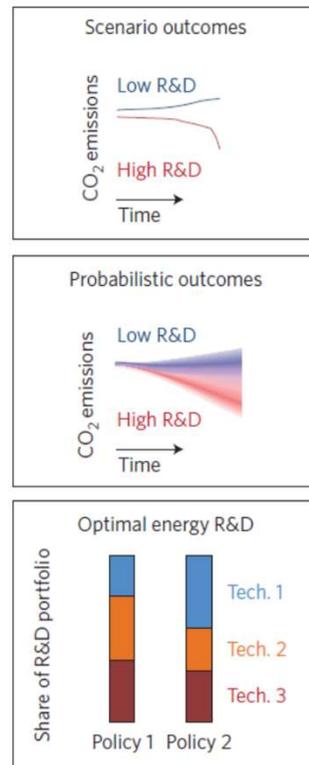
Components



b Decision frameworks

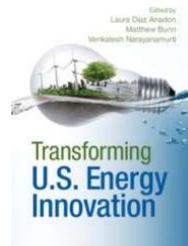
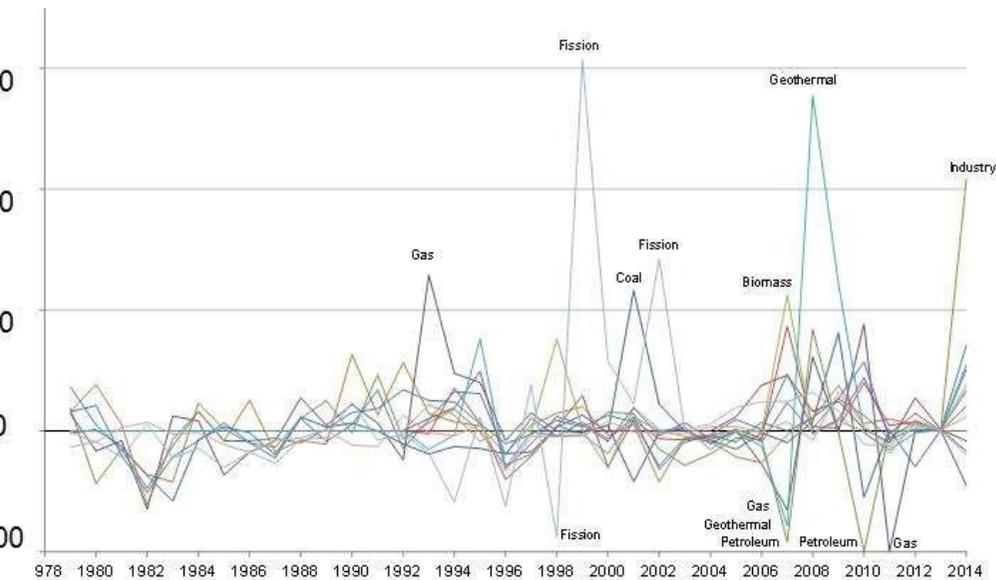


c Types of results



Anadon, Baker, Bosetti (2017), *Nature Energy*;
Santen & Anadon (2016) *Ren. & Sust. En. Rev.*

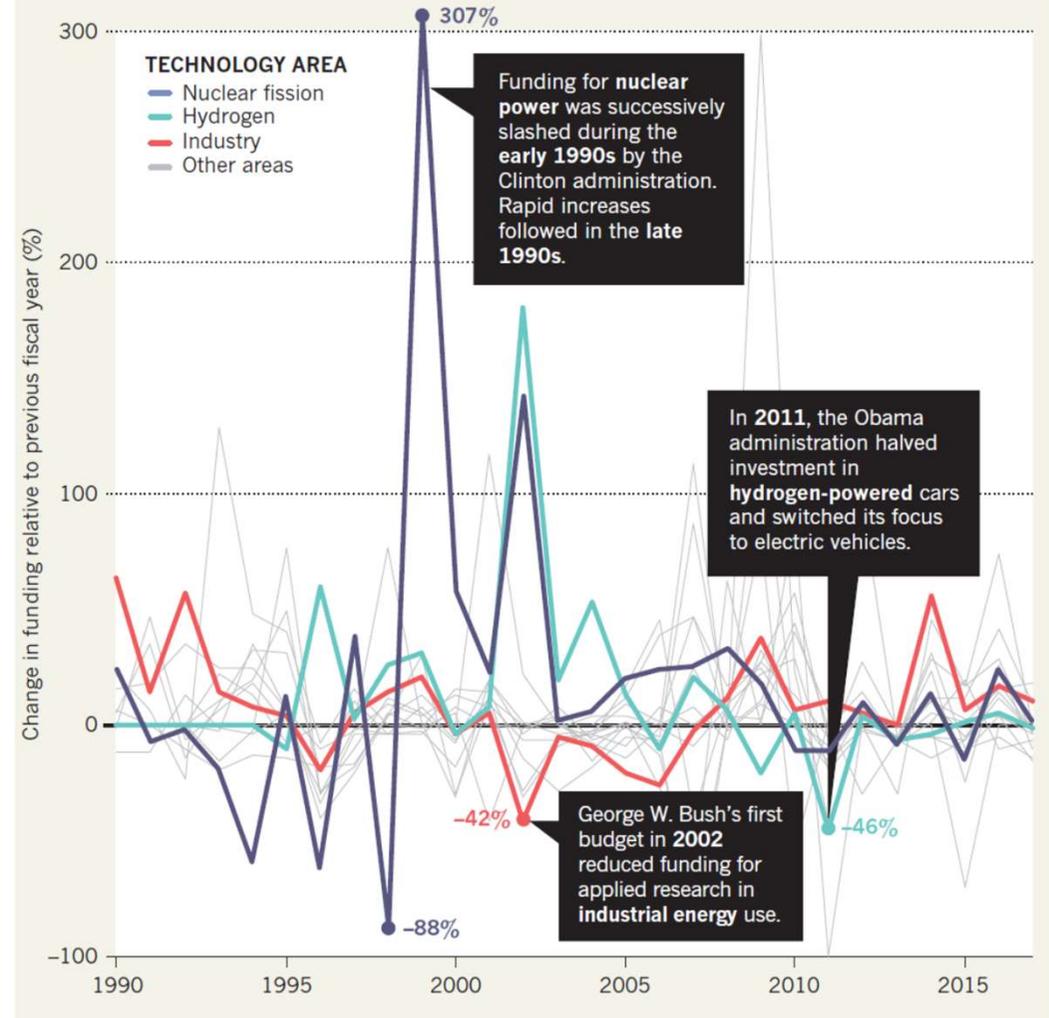
or some time we have pointed out the need for more funding stability



Anadon, Chan & Lee (2014), CUP

VOLATILE FUNDING

US Department of Energy budgets for the research, development and demonstration of different technologies fluctuate between years as government policies and priorities change. Unstable funding lowers the efficacy of such programmes.



Chan, Bin-Nun, Goldstein, Anadon, Narayanamurti (2017) *Nature*

2. Public energy innovation institutions

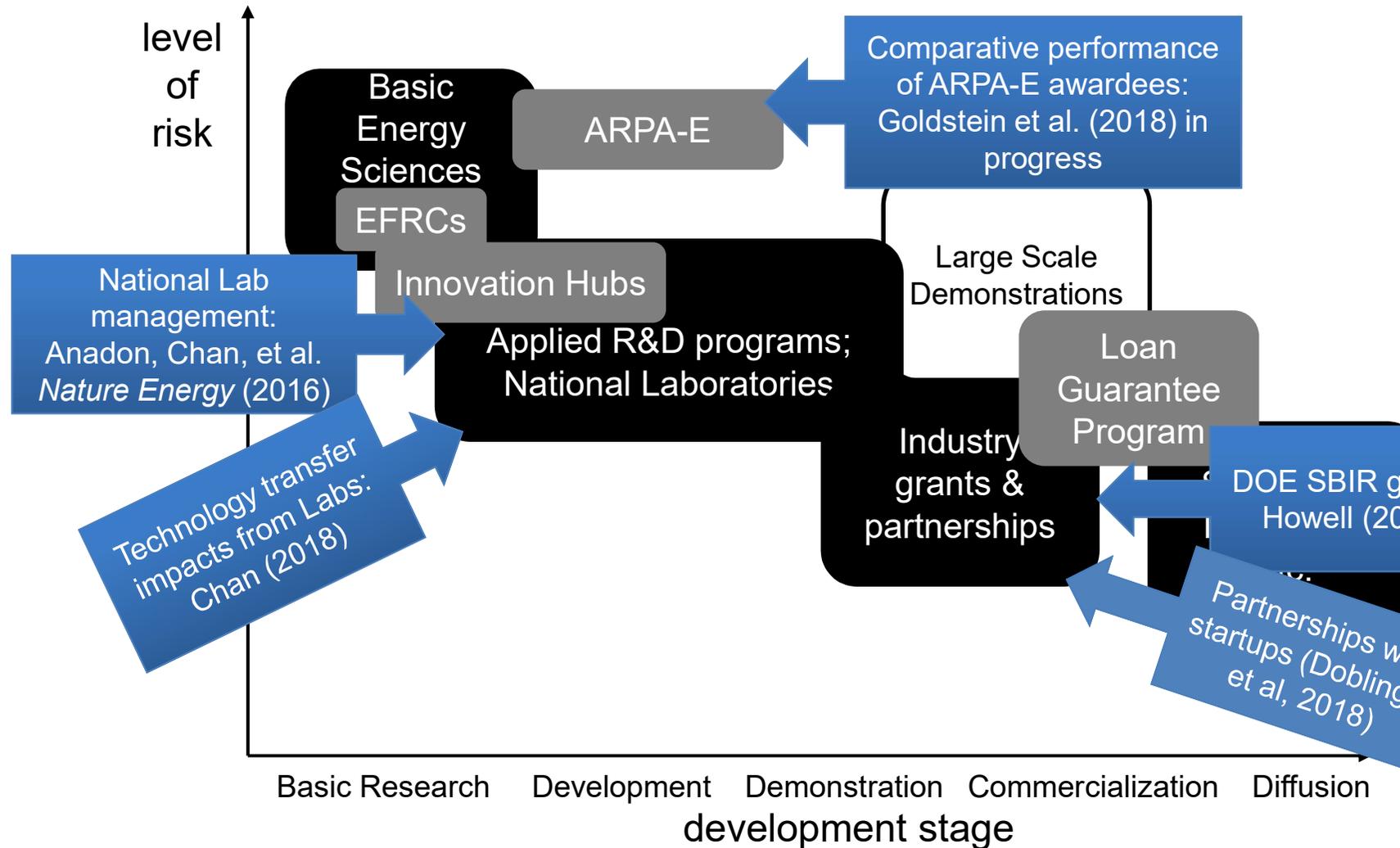
Recent institutional innovation in energy R&D

Updated and adapted from Anadon (2012) in *Research Policy* & Chanal. (2017) in *Nature*:
 - provision of funds
 - circles: direct private sector involvement in decision-making;
 - house: creation of new entity during the funding;
 - person: provision of expertise in the form of business or technical advice.

Country	Selection of new institutions funding and enabling energy innovation	Use-inspired basic research	Applied R&D	Demonstration	Market formation and deployment
United Kingdom	UK Carbon Trust (2001-)				\$
	UK Energy Research Center (2004-)	Non-technology, social science research			
	Energy Technologies Institute (2007-)			\$	
	Env. Transf. Fund/International Climate Fund (2008/2011-)				\$
	Technology Strategy Board/Innovate UK (2008/2014) ¹			\$	
	Catapults ² (2011-)	2017: Faraday Institute			\$
United States	Energy Frontier Research Centers (2008-)	\$			
	ARPA-E (2009-)		\$		
	Energy Innovation Hubs ³ (2009-)	\$			
	Cyclotron Road (2015-)		\$		

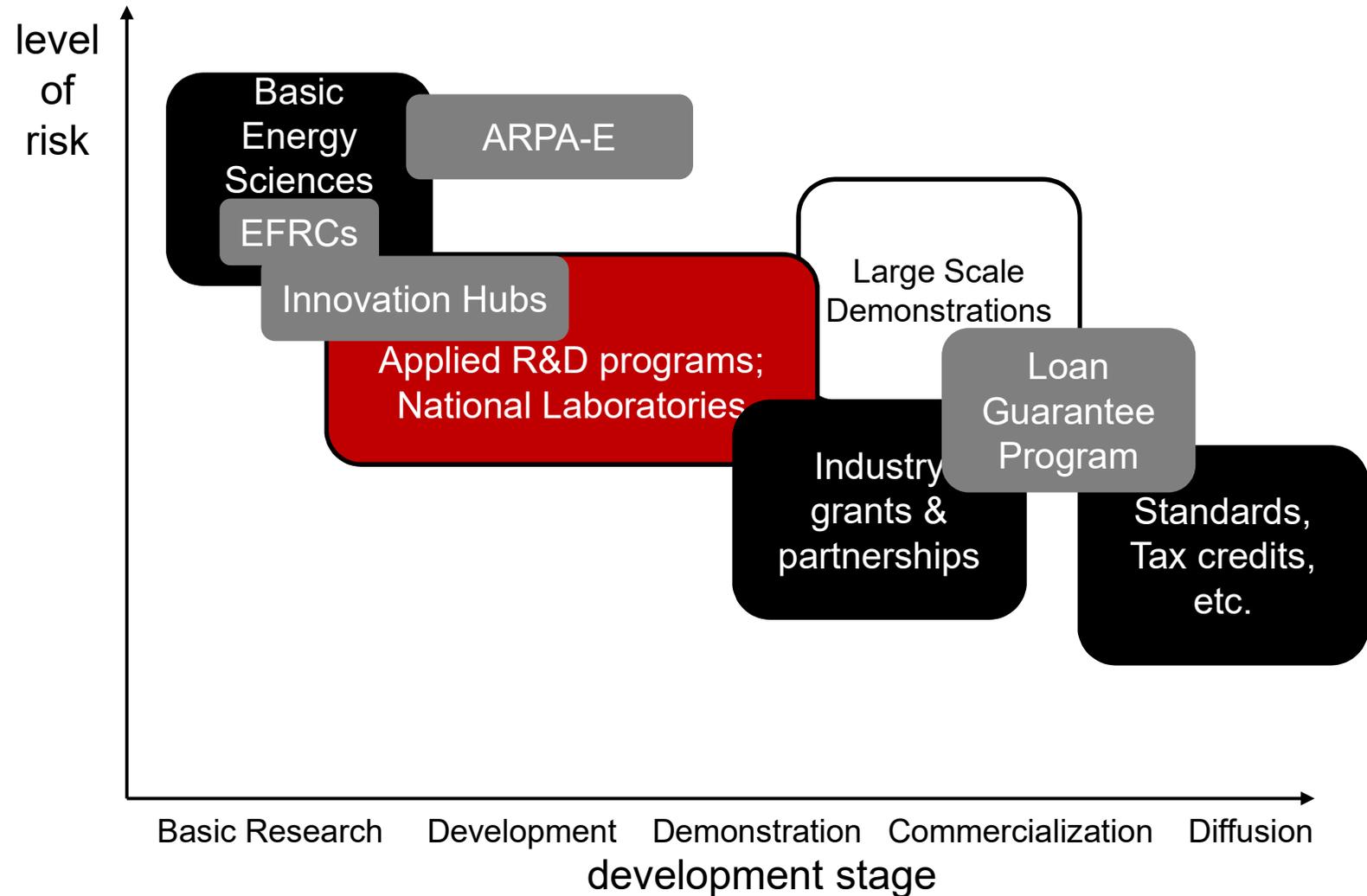
Growing evidence on the impact of different federal energy innovation institutions/policies in the US

Data is starting to become available to learn more about the impacts (short term) of different initiatives

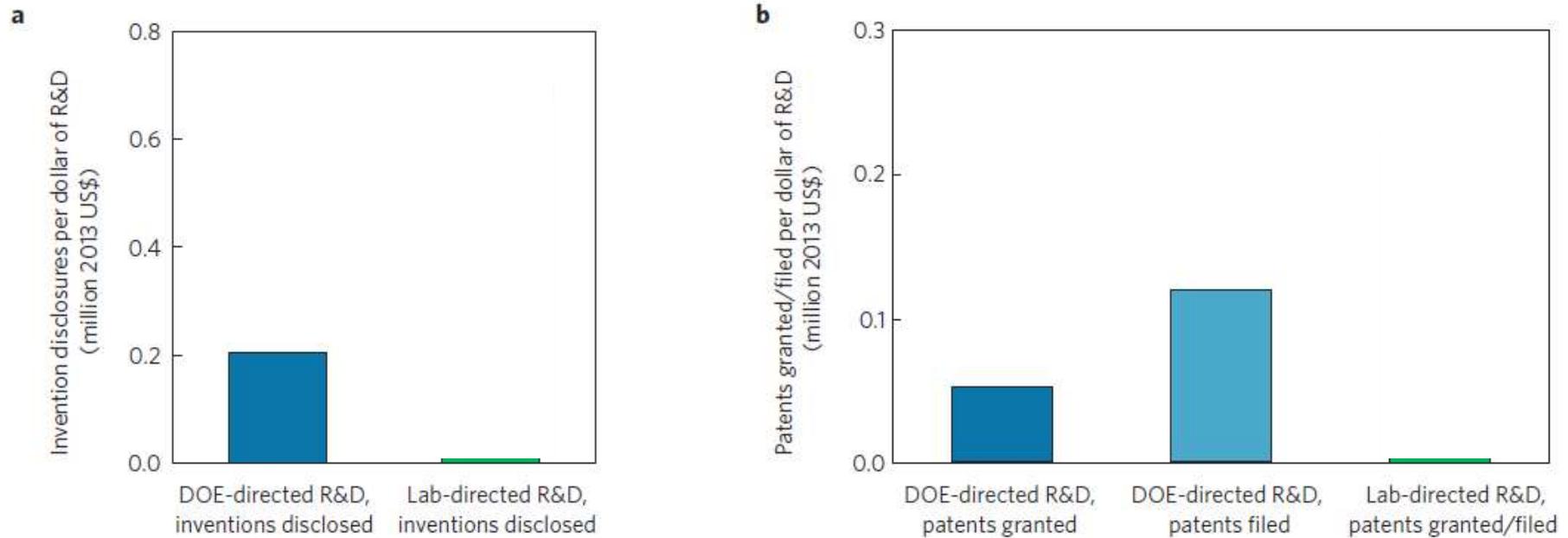


US National Labs

Particularly timely in the UK since labs were mostly privatized in the 1980s and the Faraday Institution is trying to create a 'virtual lab'

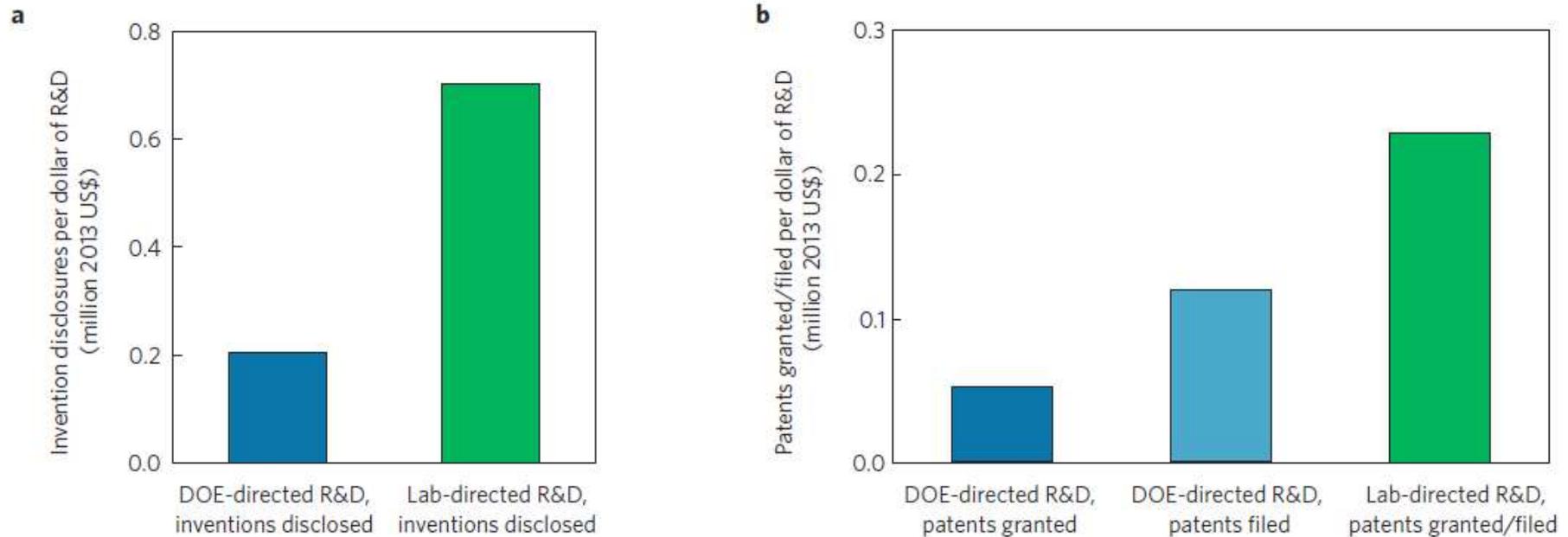


Lab- (as opposed to HQ-) controlled funds are more productive at the margin in tech transfer terms



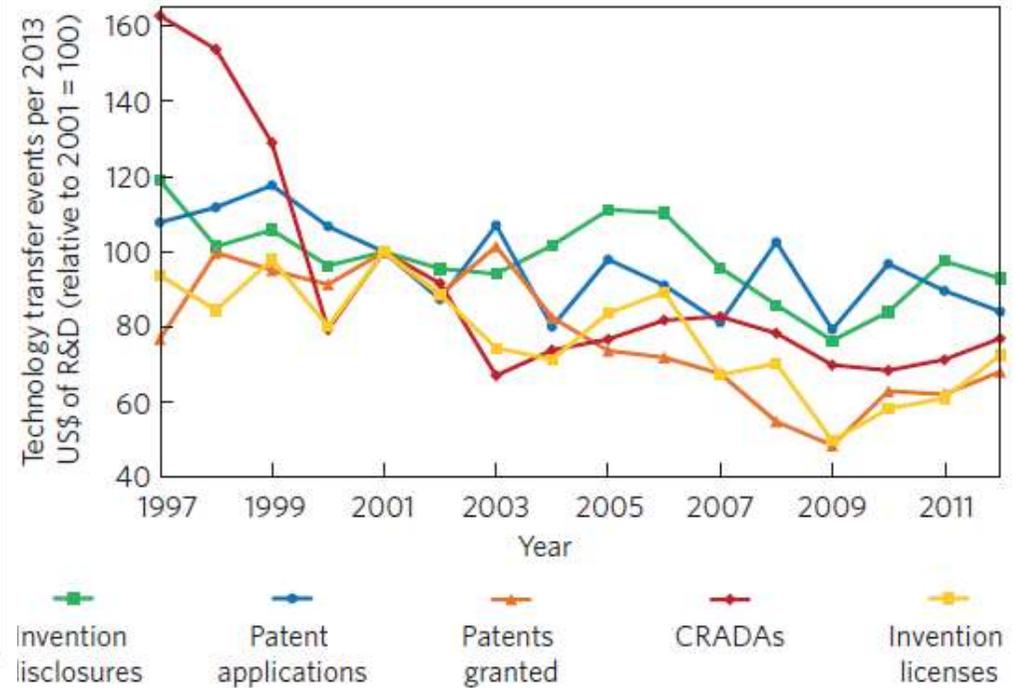
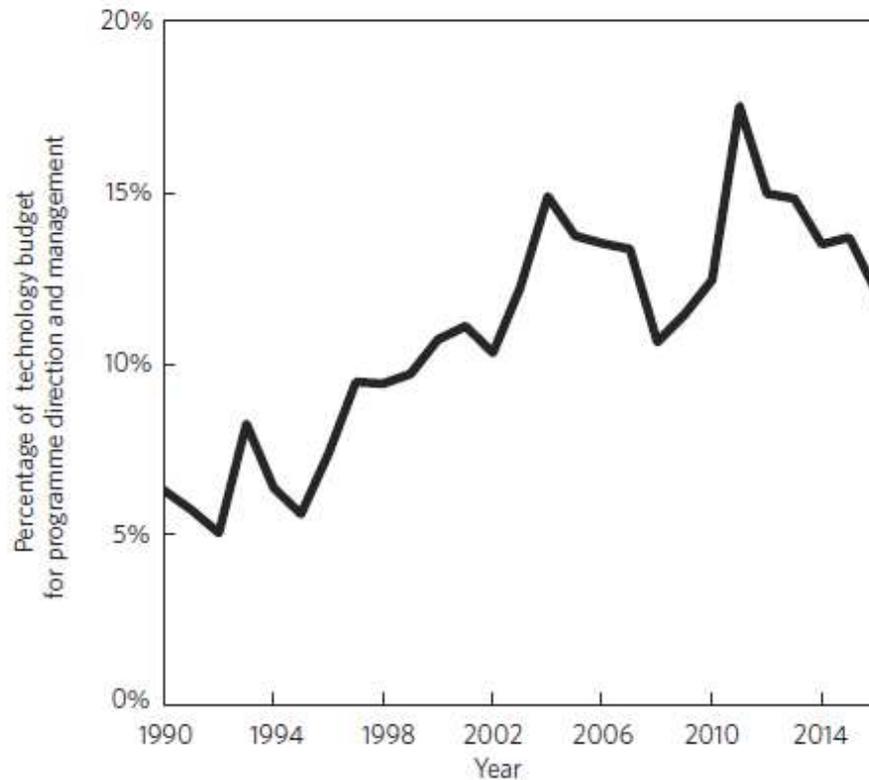
Anadon, Chan, Bin-Nun, Narayanamurti (2016), *Nature Energy*; See also Chan et al. (2017) *Nature* "Six guiding principles for energy innovation"

Lab- (as opposed to HQ-) controlled funds are more productive at the margin in tech transfer terms



- Lab directed funds have decreased twice recently but are the most productive → increase laboratory directed funds (LDRD) at the margin, further facilitate private sector interaction, and new contracting approaches

Increased demands for short term 'results' (less tolerance to uncertainty) can lead to a vicious circle

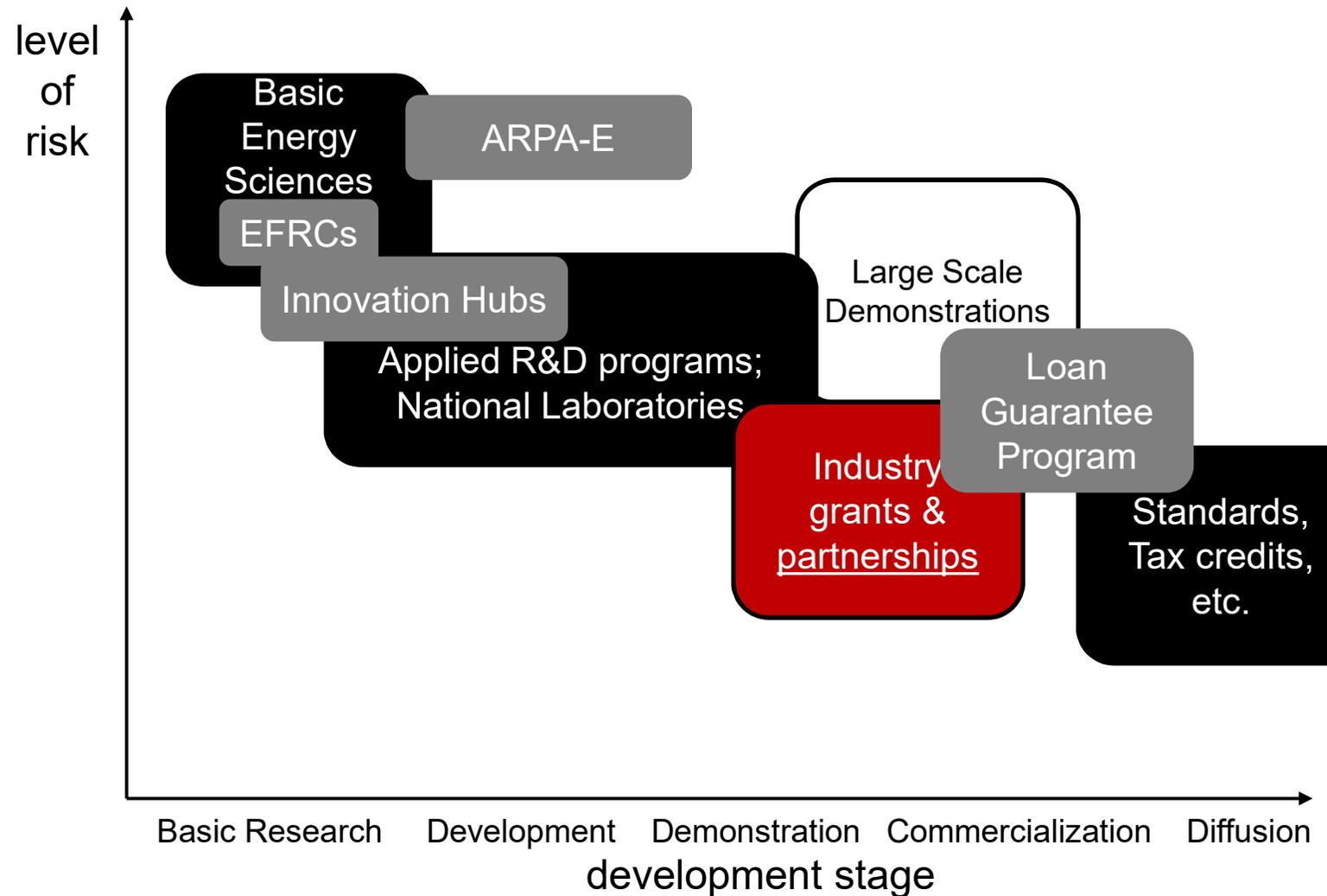


- From interviews and data analysis we found that there is a vicious circle of congressional demands for short-term results, increased admin, less risk taking, less results, which leads to more demands for results...

Alliances (joint development, licensing, procurement) between public institutions (e.g., labs) and cleantech startups

Recommendation from the (mainly qualitative) literature to collaborate as much with as many diverse partners as possible or “Don’t Go At It Alone” Baum et al., (2000, p. 267)

What if startups cannot collaborate with everyone: Who holds critical technological resources in cleantech innovation?



Results relevant for public-private partnership design

Patenting activity: increases with every additional governmental technology alliance when compared to those startups that did not engage in such alliances

- Different expertise, tacit knowledge, facilities, less risk of leakage

Private financing deals: increase for every additional license from a governmental agency (quality signals)

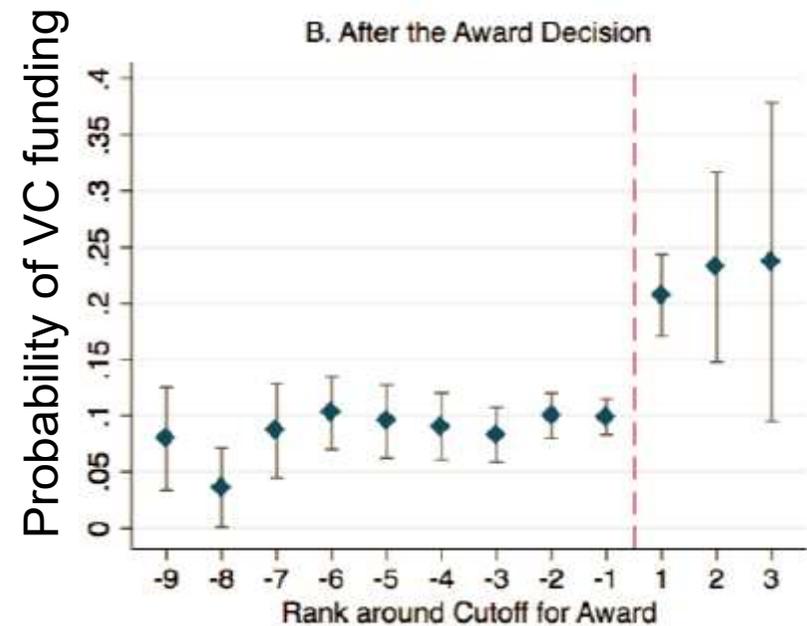
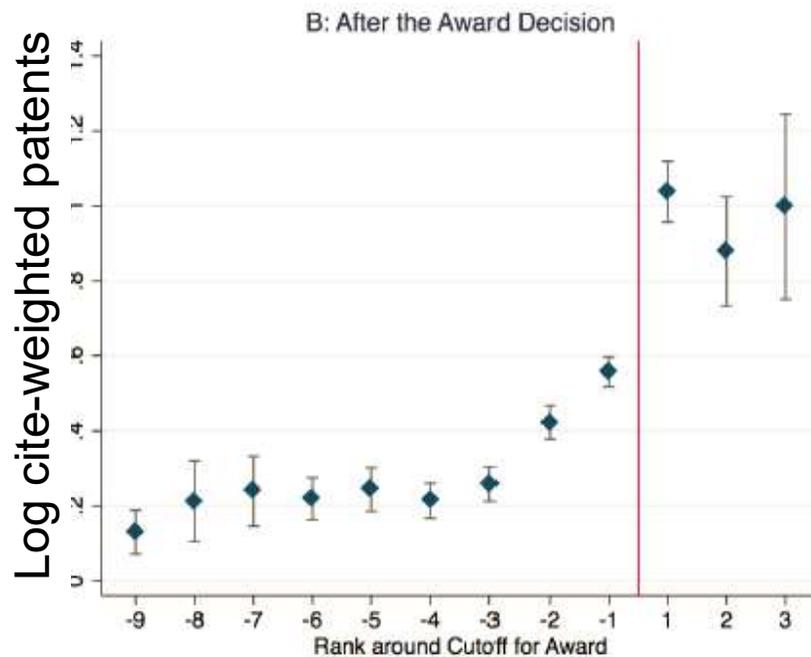
- Quality signals, information asymmetry, correlated with firm openness

Public procurement not associated with better startup outcomes

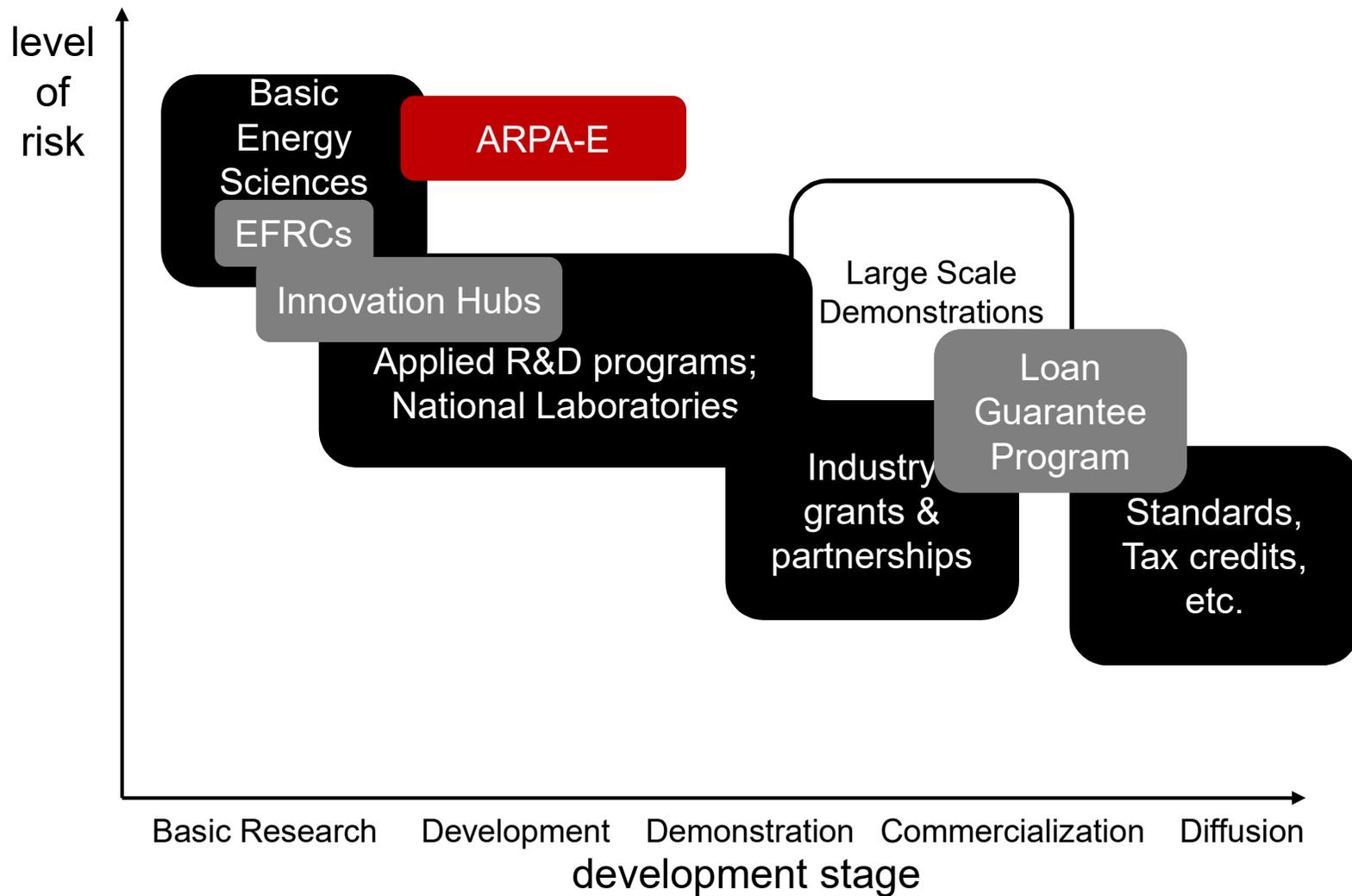
DOE R&D grants to small businesses

Regression discontinuity design on U.S. DOE Small Business Innovation Research (SBIR) grant recipients (over 20 years, thousands of awards):

- Award doubles probability that a firm receives subsequent VC and has large, positive impacts on patenting and commercialization



Actively managed R&D funding organizations



Ongoing work on ARPA-E and licenses

Over 400 projects, across 39 states, with over \$1 billion in funding

Over 20 focused programs and 3 open solicitations

Recipients:

- 32% led by small business
- 42% by universities
- 14% by large business
- 8% by FFRDCs
- 4% by non-profits

- ARPA-E awardees doing better than other awardees and other firms on follow on funding (Goldstein, Dobliger, Anadon 2018, ongoing)
- Compared to other similar awards from DOE ARPA-E has:
 - Excelled broadly in producing patents
 - Excelled in publications relative to EERE
 - Matched the output of publications from Office of Science (Goldstein & Narayanamurti, 2018, under review)
- Chan (2016) used matching on patents from national labs:
 - Licensing increases spillover benefits to firms (whether or not not-patenting would result in better outcomes is a longstanding question)

3. Key findings

Broad guiding principles from cross national experiences

- 1. Giving researchers and technical experts autonomy and influence over funding decisions (e.g., labs, ARPA-E)**
- 2. Incorporating technology transfer in research organizations (labs, transfer, joint development, and researcher mobility)**
- 3. Focusing demonstration projects on learning (decades of projects)**
- 4. Incentivizing international collaboration**
- 5. Adopting an adaptive learning strategy**
- 6. [Keep funding stable and predictable]**

4. Questions going forward

Important questions going forward

- How to think through the balance
 - Portfolio across actors, technologies, and stage of development?
 - Insights from TIS?
- How to measure success beyond patents, licenses, papers, spinoffs, follow-on funding?
 - Incentives to report failures, changes in direction (ARPA-E has revised milestones)
 - **GETTING DATA FROM PUBLIC ENTITIES**
- What gaps exist in the landscape to attract different actors and other needed types of innovation?
 - Demonstration
 - How to incentivize partnering while sharing learning
 - Use of facilities for actors not yet at a company stage?
 - Attracting large firms?
- How to translate the U.S. insights to other countries with different funding and risk taking environments?

Thank you for your attention!

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