INTEGRATING TECHNOLOGICAL INNOVATION IN ENVIRONMENTAL POLICYMAKING

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BETTER POLICIES FOR BETTER LIVES

Outline

1. Green innovation – definitions and implications
2. The “double externality” of green innovation
3. Environmental policy and green innovation – theory and evidence
4. Other drivers of green innovation
5. Low carbon innovation: Taking stock and policy priorities
6. Final Remarks

1. Green innovation: definitions and implications

"Products and processes which provide customers and business value, but significantly decrease environmental impacts."

Fussler and James 1996

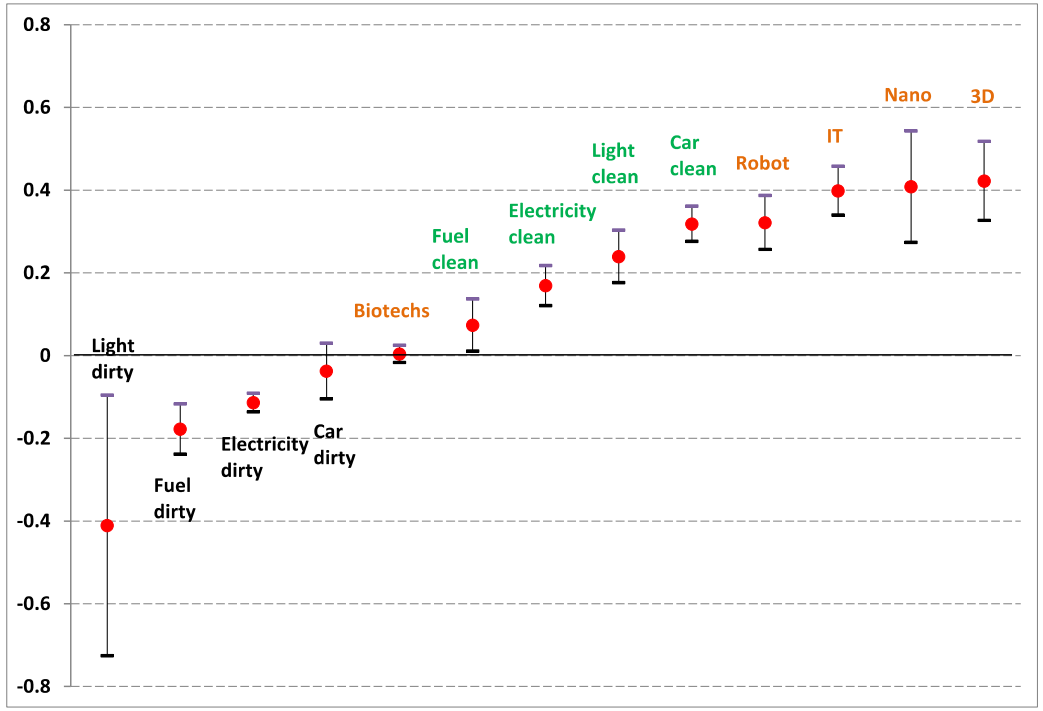
"Assimilation or exploitation of a product, production process, service or management method that is novel to the firm or user and which results, throughout its lifecycle in a reduction of environmental risk, pollution and other negative impacts of resources, compared to alternatives."

Kemp and Pearson 2007

2. Double externality in green innovation

1. Knowledge externalities (innovators are not rewarded for all the benefits of their inventions) at innovation stage

- True for all innovation, but spillovers in green might be higher



Dechezleprêtre et al. 2014

2. Double externality in green innovation (cont'd)

2. Pollution externality in the adoption and diffusion phases due to the positive impact of green innovation on the environment.

- The beneficial impact of green innovations makes diffusion socially desirable.

Private return in green innovation is less than its social return.

⇒ Under-investment by markets

⇒ Role for pro-innovation framework policies and environmental policies

3. Environmental policy and green innovation - theory

- Environmental policies will increase innovation as firms seek to reduce compliance costs (weak version of the Porter hypothesis)

- Three enabling conditions (Porter and van der Linde 1995):

    1. Let the industry decide on best approaches/technologies
    2. Policies should be designed to foster continuous improvement
    3. Limit policy uncertainty

- Generally, more stringent policy induces greater innovation.

3. Environmental policy and green innovation - toolkit

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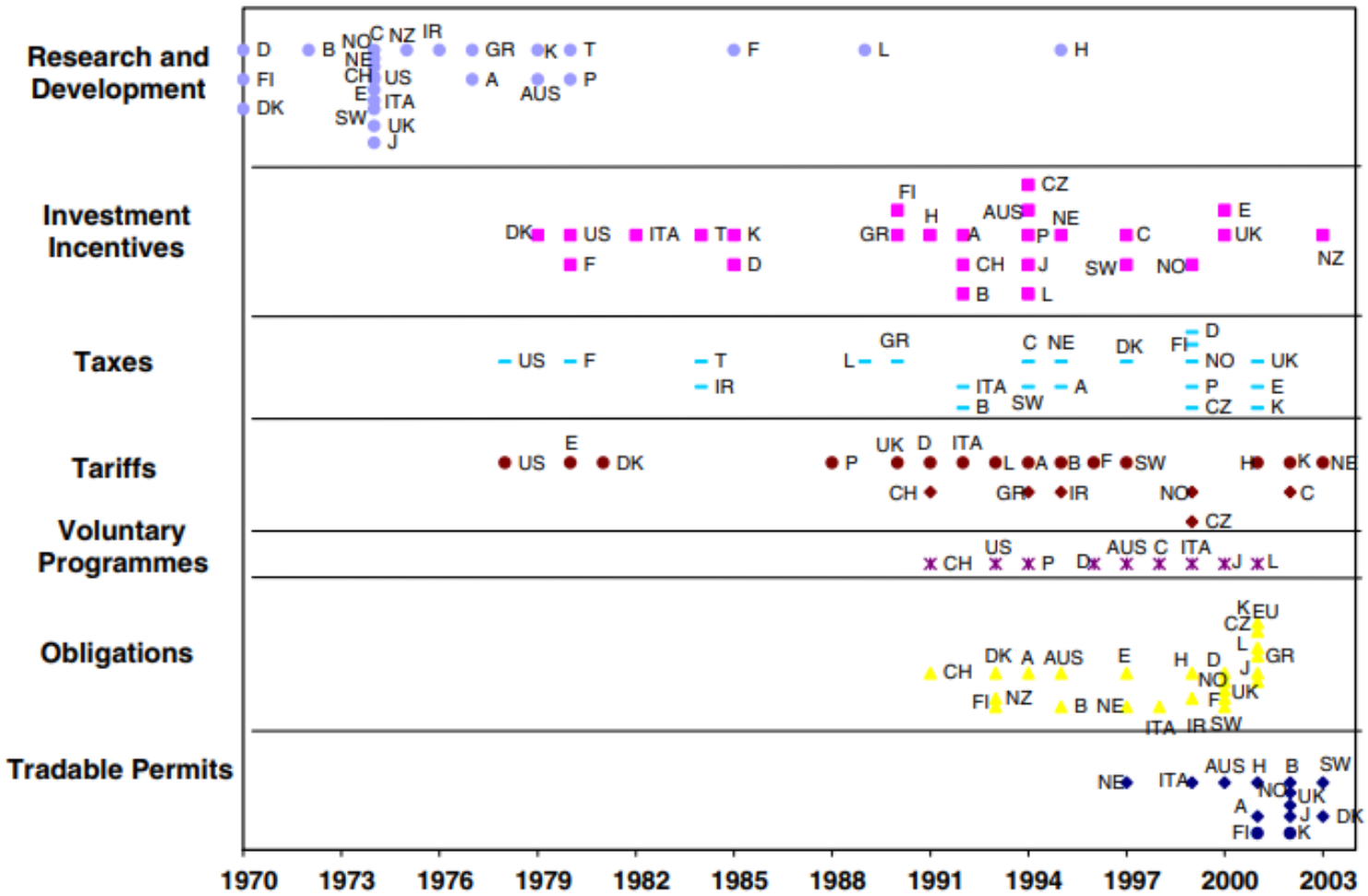
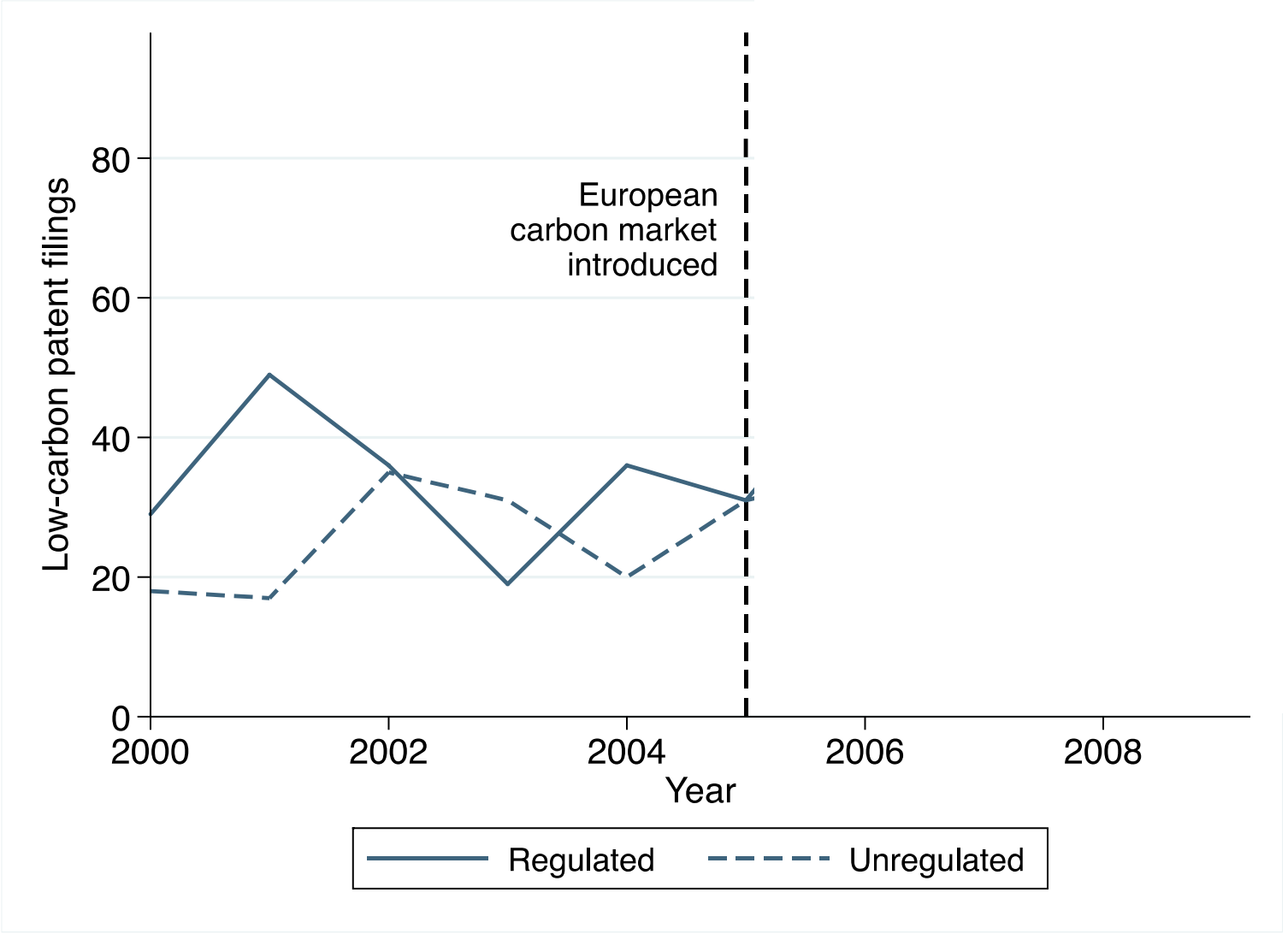


Johnstone et al. 2010

Impact of the ETS on green innovation



Calel & Dechezleprêtre, 2016.

3. Environmental policy and green innovation - Evidence

- ‘Mix’ of instruments makes individual policy effects difficult to isolate.

- Proxies of environmental policy stringency are imperfect:
  - Perception of stringency by business leaders
  - Abatement expenditures by firms in an industry

- Metrics for innovation are also imperfect:
  - R&D expenditure
  - Patent counts

- Empirical evidence is at best partial and not as straightforward.

3. Environmental policy and green innovation - Evidence

- Market-based instruments equalise industry marginal abatement costs and compliance is therefore less costly for firms than more prescriptive policies.
  - However, schemes such as emission trading where price is set based on aggregate emissions can result in volatile and/or low prices. This can run counter to the ambition of long-term certainty.

- Command-and-control policies can send clear signals to the market about desirable and undesirable properties of production processes. This can be effective in directly changing firm and investor behaviour.
  - There is evidence that that performance standards can lead to more innovation than technology standards.

- Building flexibility into environmental policy (including in regulations) induces greater innovation in clean technologies.
  - Command and control instruments can in some cases be flexible (e.g. performance standards) and market based instruments can in some cases be inflexible (differentiated value-added taxes based on technical criteria).

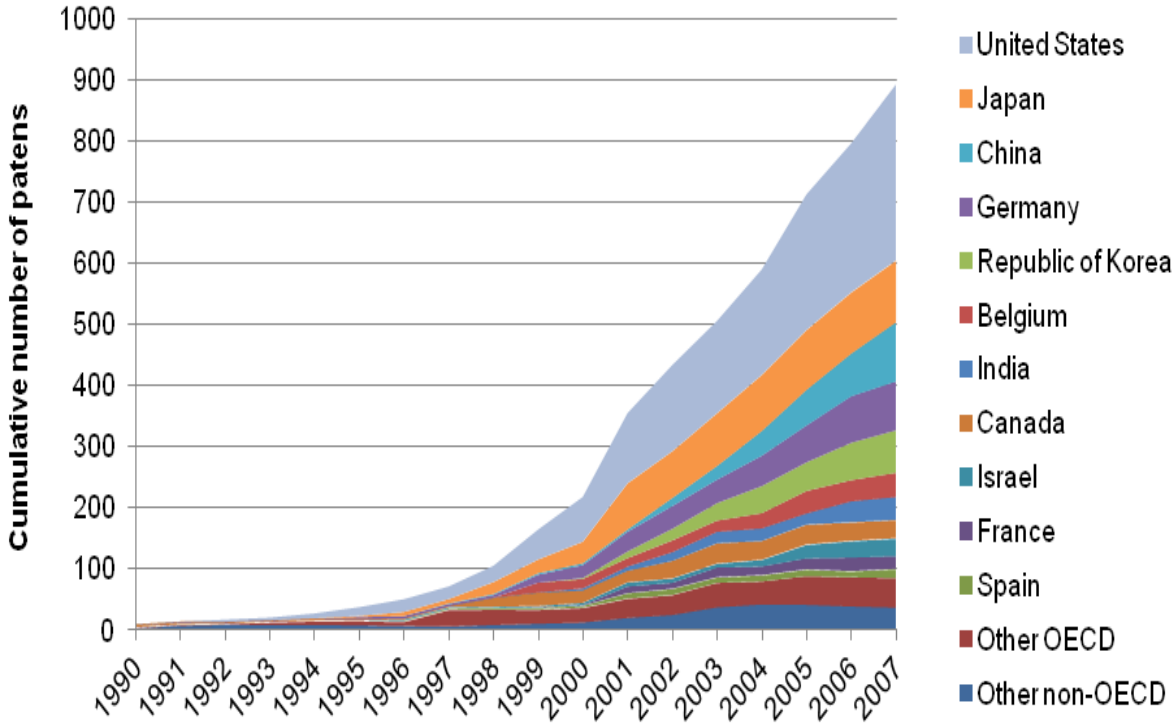
4. Other factors influencing green innovation

- Maturity and nature of technology can affect choice of optimal instrument.
  - Study of renewable energy sector finds that the effectiveness of particular policy instruments depends on the technology, which is being offered support (Johnstone et al. 2010).

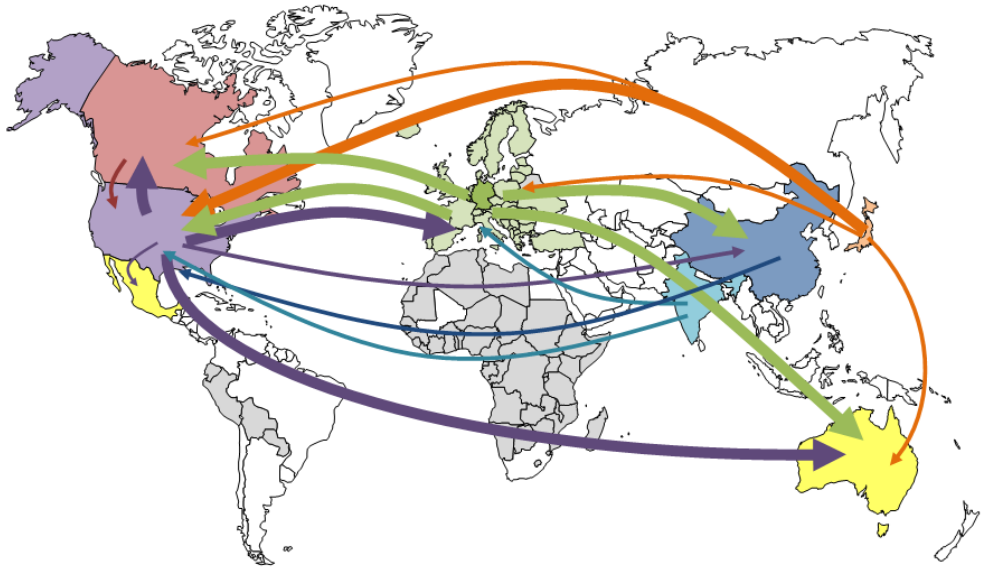
- The institutional setting matters.
  - Regulation directly impacting the prices of "dirty" inputs more effective than quality standards in settings where enforcement is weak.

- Foreign institutional settings affect incentives for individual countries to subsidise R&D.

4. Other factors influencing green innovation



Growth of climate adaptation related biotech patents



Agrawala et al. 2012

4. Other factors influencing green innovation

Necessity is the mother of invention

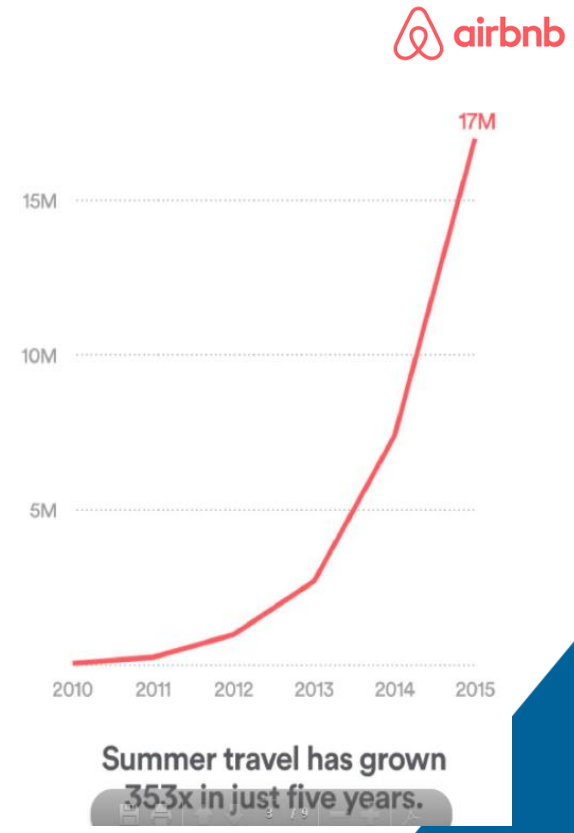
Our empirical analysis, using a panel of up to 28 countries covering a period of 25 years, reveals a consistent stimulating effect of natural disasters on patents of risk-mitigating technologies. For all technologies included in this study, we provide strong evidence that risk-mitigating innovation in a country increases with the severity of its recent natural disasters.

Miao and Popp 2014

4. Other factors influencing green innovation

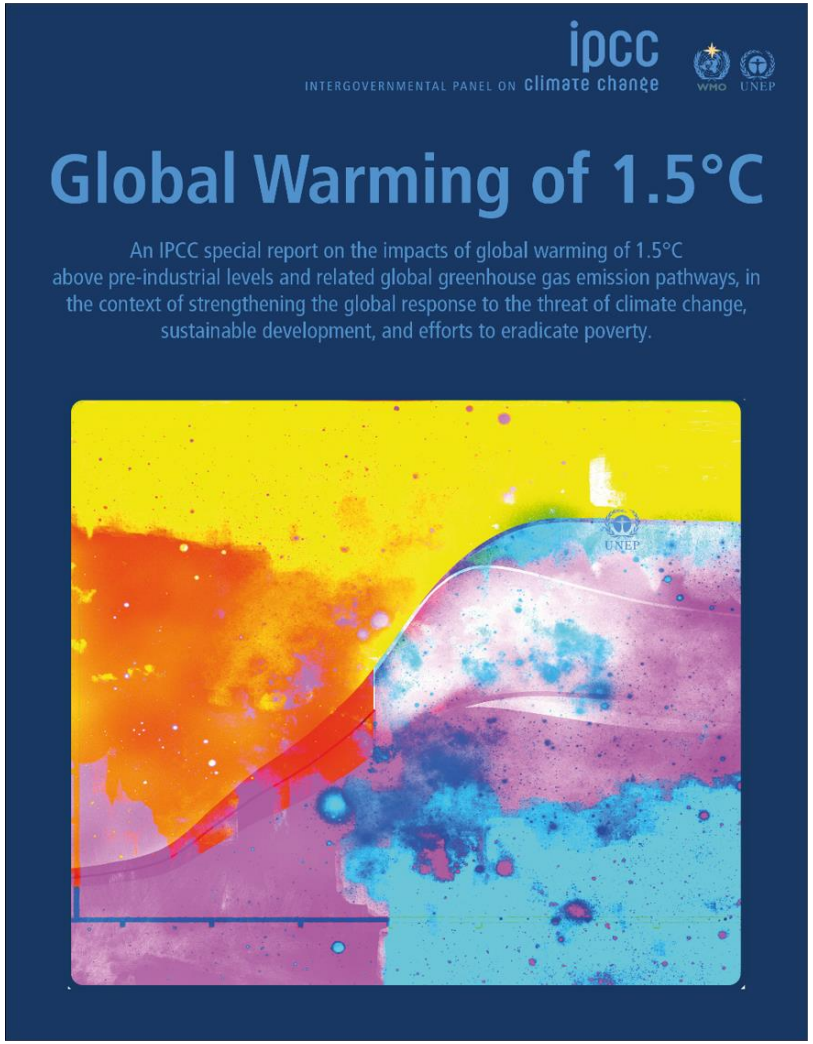
Technological transformations as drivers for Circular Business Models

- Waste Value Creation
- Circular Supplies
- Product Life Models
- Idle Capacity
- Product-Service-Systems



OECD 2018

4. Low Carbon Innovation



The New York Times

New U.N. Climate Report Says Put a High Price on Carbon

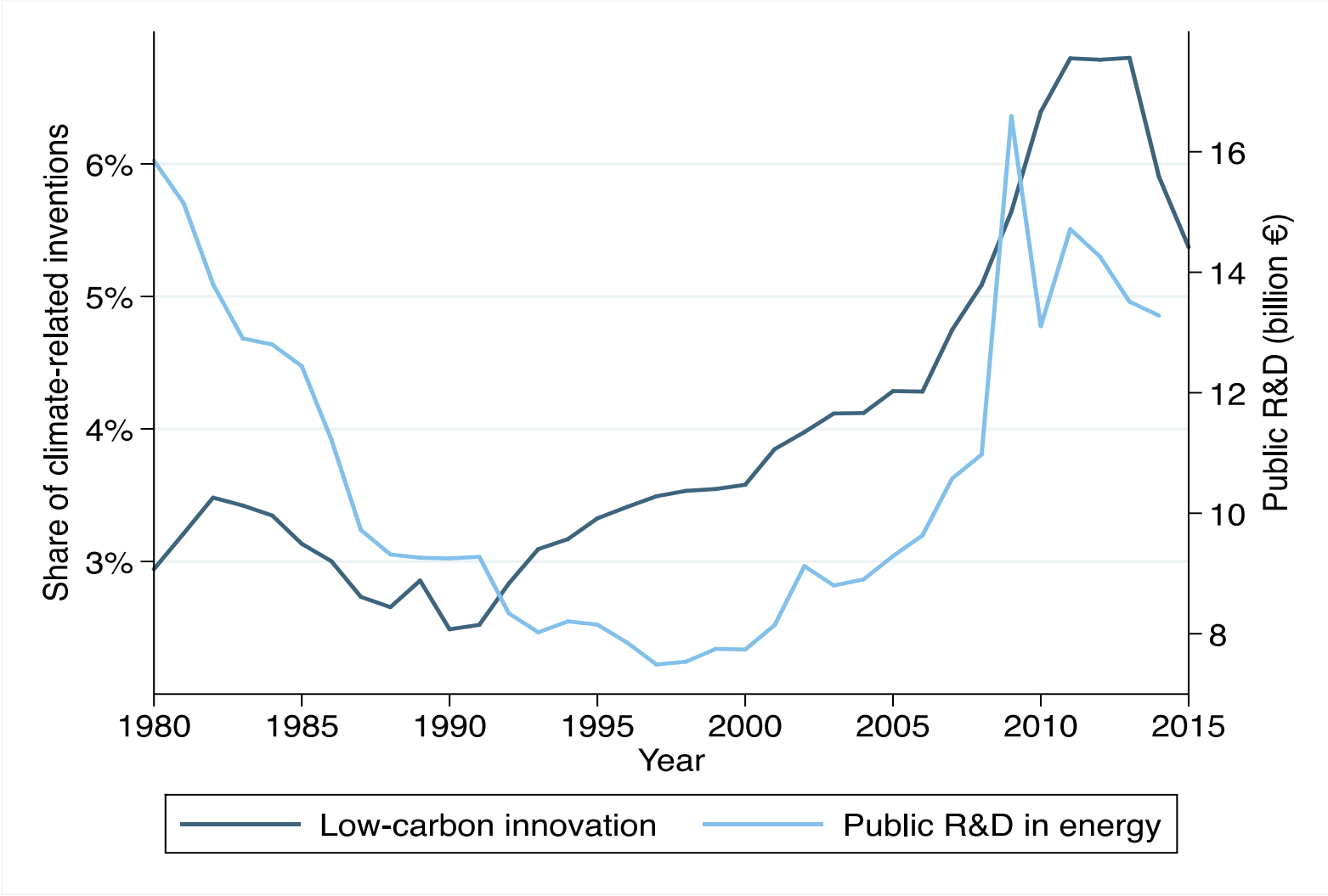
"the United Nations report estimated that governments would need to impose effective carbon prices of **$135 to $5,500 per ton of carbon dioxide pollution by 2030** to keep overall global warming below 1.5 degrees Celsius, or 2.7 degrees Fahrenheit."

FINANCIAL TIMES

Economics Nobel recognises work on climate change and innovation

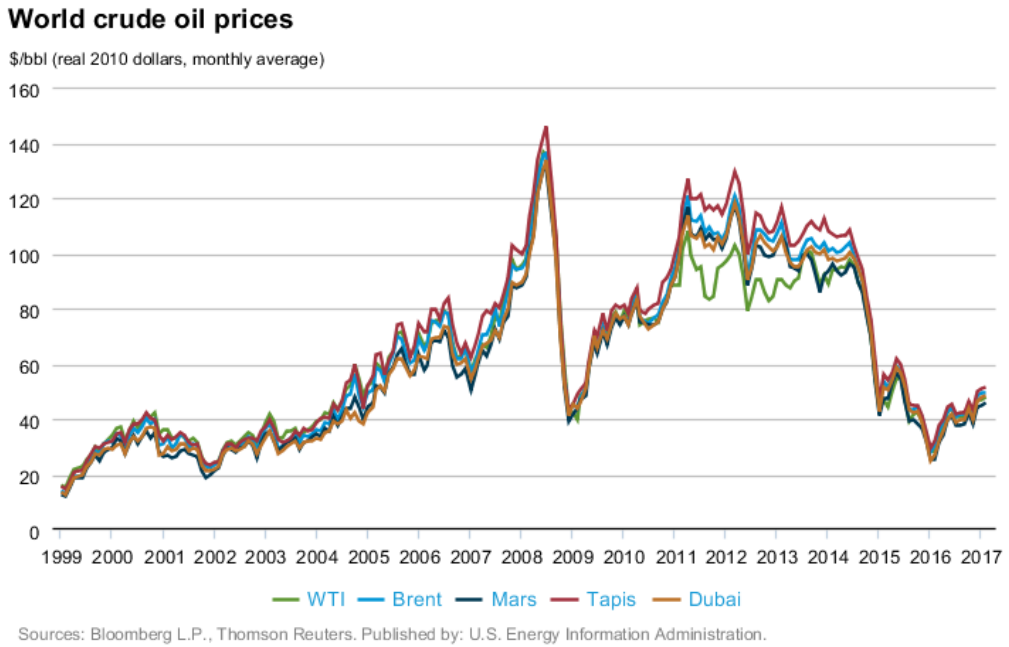
"Mr Nordhaus was **an early advocate of carbon taxes**, but the committee noted that the models he developed also allowed policymakers to calculate quantitative paths for the best tax, showing how they would depend on assumptions about climate sensitivity to carbon emissions, or the extent of damage caused by climate change."

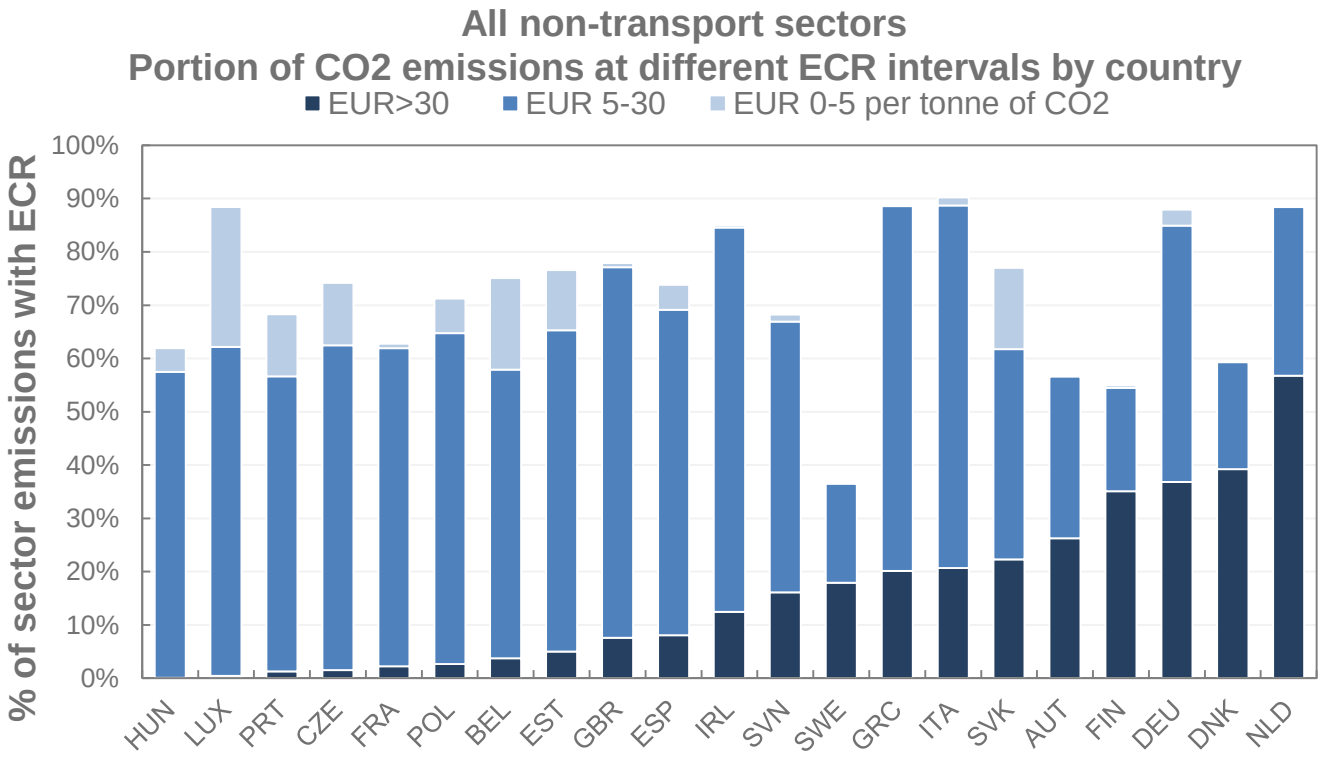
4.1 Global low-carbon innovation is *decreasing* when we need it the most



Dechezleprêtre (2017) from EPO's PATSTAT database; IEA

4.2 Key culprits: Low energy prices and Low Carbon Rates





OECD 2016

4.3 Restarting the low-carbon innovation machine

- **A three pronged policy approach**
  1. Carbon pricing
  2. Public support to R&D (subsidies, tax credits..)
  3. Potentially using revenues from carbon taxes/permits to finance low carbon R&D

- **Carbon prices, while slowly rising still remain too low**. The gap between actual carbon prices and real climate costs is estimated to be 76% across OECD and G20 countries. (OECD 2018)

4.3 Restarting the low-carbon innovation machine - 2

- Direct support for new low-carbon technologies is a necessary complement to a high carbon price.

- How much? IEA recommends 5-fold increase in public R&D spending across OECD countries.

- At what level? Multinational
  - Example: Benefits from subsidized R&D much higher for Europe as a whole than for individual countries

4.3 Restarting the low-carbon innovation machine - 3

- Recycling carbon tax/permit revenues for low carbon R&D could be politically attractive and has large revenue potential
- Commitments to fund R&D should be long term and funding needs to be stable (sudden spikes not useful)
- R&D subsidies need to be combined with high carbon price (or a price floor)

5. Final Remarks

- Environmental policies in general have had an impact on at least the direction of technological change, by increasing the (implicit) price of pollution on firms.
- Very little is proven, however, about the downstream/general equilibrium environmental consequences of this technical change.
- Higher emission prices have impacts on invention.
- Conversely, the muted impact of some market based instruments may be more due to low effective prices, rather than the choice of the instrument.

5. Final Remarks (cont'd)

- Proxies for all three key variables – "green", "environmental policy stringency", and "innovation" are imperfect, which can confound generalisability of results.

- A lot of green innovations are by existing firms, often chipping at the edges, as opposed to Schumpeterian, driven by new entrants.

- In fact, many aspects of environmental policies (such as vintage differentiation and grandfathering) *inhibit* firm entry and exhibit.

- An excessive focus on the supply of technologies can obscure concomitant changes in consumption demand patterns, which could (partially) offset final environmental outcomes.

Thank you for your attention