INTERNATIONAL COMPETITION IN THE RACE TO CLEAN TECHNOLOGY

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CONCEPTUAL MOTIVATION

- International climate agreements, though well-intentioned, often are not implemented or enforced
- Consider two major policy levels in these efforts
  - **Carbon Tax**: Does not get around the classical public goods problem
  - **Clean Research Subsidy**: Potential strategic complementarities between various actors

GOAL OF THIS PROJECT

- Assess the state of clean technology in the US and China using patent data
- Construct a two country, two sector model of the incentives for private firm innovation
- Determine implications for effect of policy on clean transition speed
- Make positive predictions about policy outcomes in a multilateral setting

EXISTING LITERATURE

- Popp (2006): energy patent classification methods
- Aghion et al (2016): fuel prices and path dependence in clean/dirty innovation
- Acemoglu et al (2016): optimal time-varying carbon tax and clean research subsidy policy
- Hemous (2015): model of trade and directed technical change

DATA CONSTRUCTION

- Hand classify 1000 patents as clean/dirty/neither in both US and China
- Clean/dirty means with respect to CO2, local pollution effects not considered
- Train multi-layer neural network classifiers on the abstract text (~250 words)
- Extrapolate to set of all patents in each country

PATENT CLASSIFICATION

CN102235631A

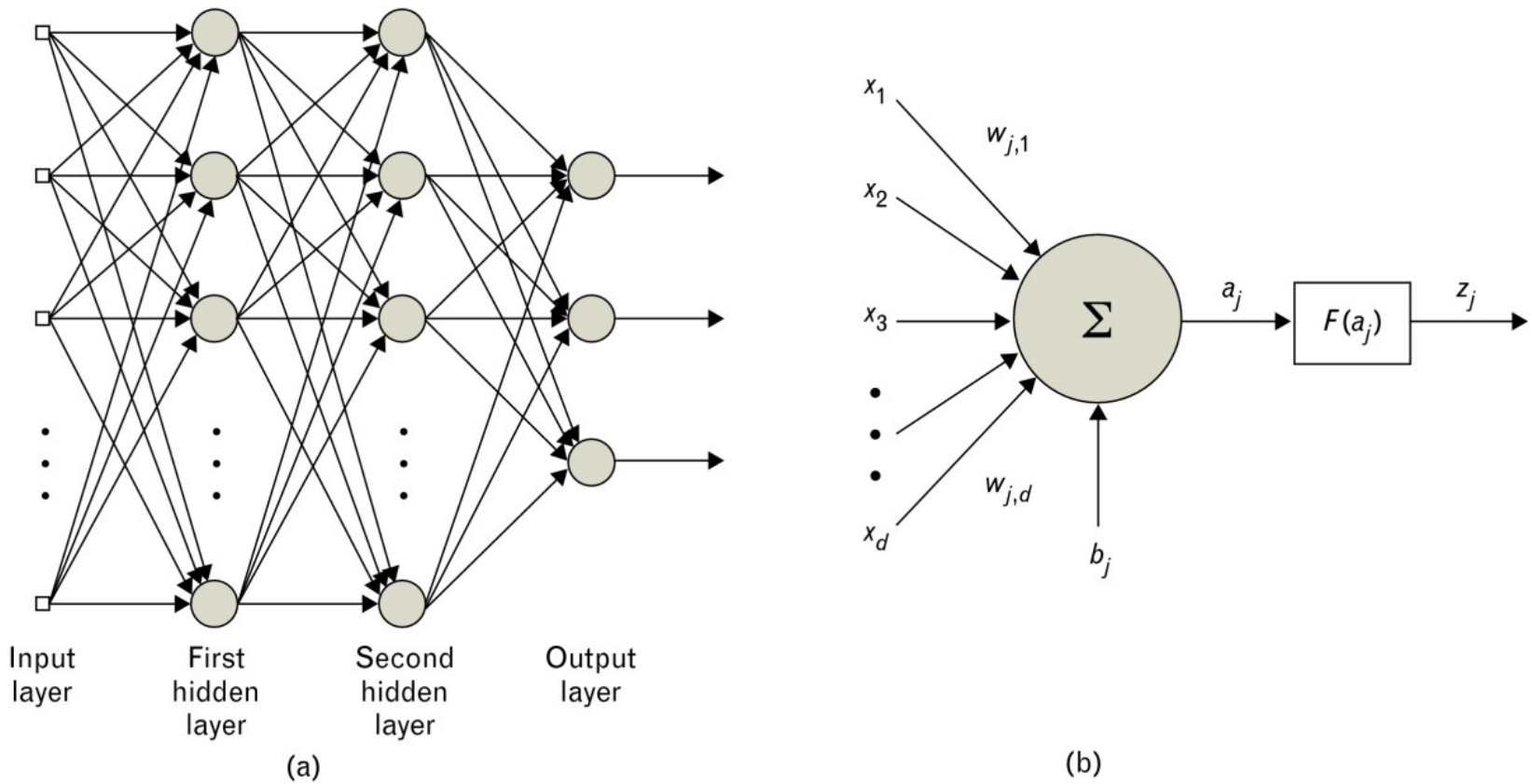
风光互补路灯

苏州晶雷光电照明科技有限公司, 2011

本发明涉及LED照明灯领域，尤其涉及一种风光互补路灯，包括底座、灯杆、路灯，其特征是：还包括位于灯杆上的风能发电机和太阳能电池组件、位于底座内的蓄电池和控制器；所述的风能发电机和太阳能电池组件分别与控制器的输入端电连接，路灯与控制器的输出端电连接，控制器与蓄电池电连接；控制器包括蓄电池过充电保护电路、蓄电池过放电保护电路、控制路灯工作的光控电路。本发明的有益效果：将风能和光能储存于蓄电池并为路灯提供电源，节能环保。

TRAINING NEURAL NETWORK

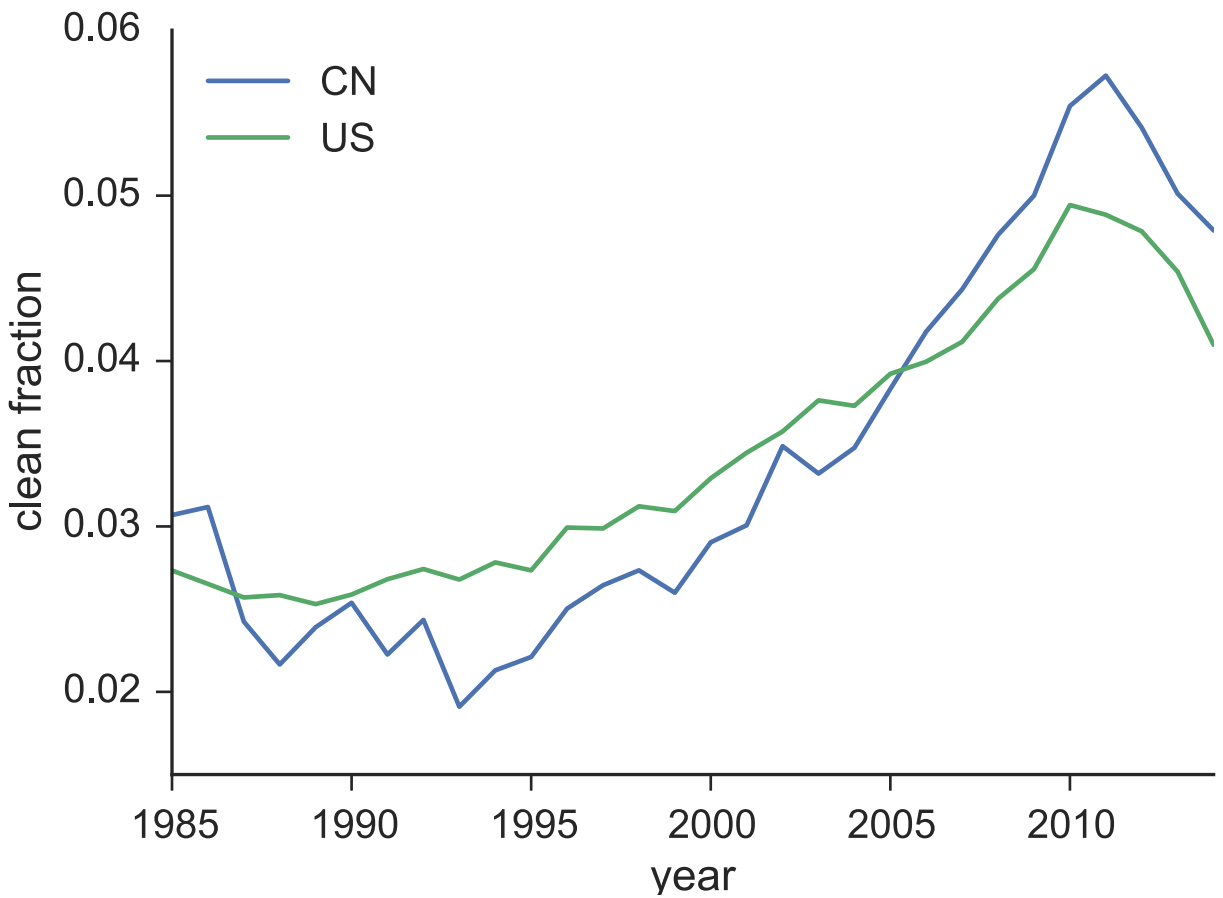
Maps from word vectors to {clean,dirty,neither}



Source: Blackwell (2012)

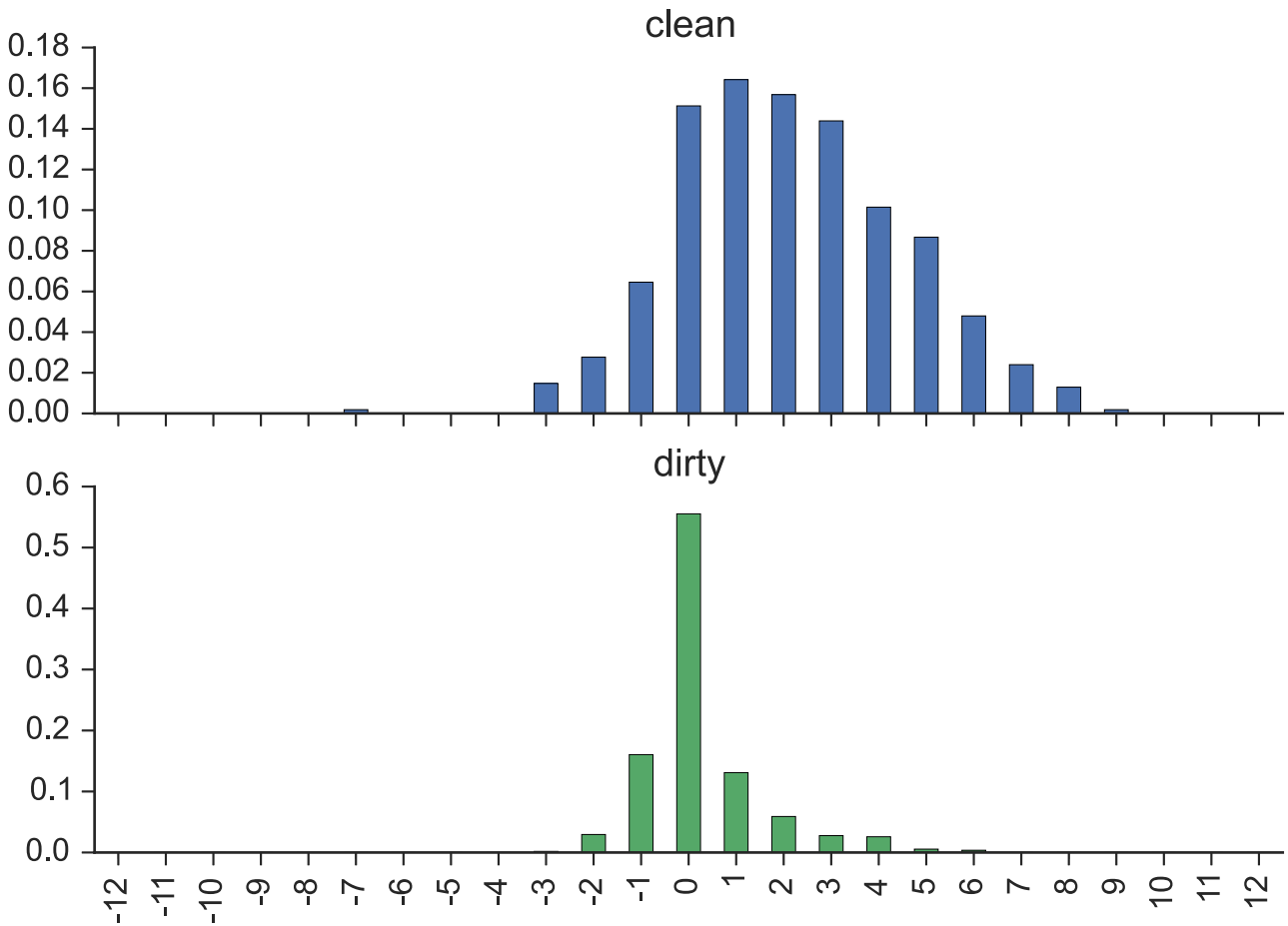
HISTORY OF TECHNOLOGY

The fraction of clean patents has been rising over time



STATE OF TECHNOLOGY

Below are the step distributions for clean and dirty tech



PRODUCTION ENVIRONMENT

- Final output comes from either clean or dirty sources

$$Y_i = \left[C_i^{\frac{\varepsilon-1}{\varepsilon}} + D_i^{\frac{\varepsilon}{\varepsilon-1}} \right]^{\frac{\varepsilon-1}{\varepsilon}}$$

- Each is in turn made from a continuum of intermediates

$$\log(X_i) = \int_0^1 \log(x_{i,j})\, dj \quad \text{for} \quad X \in \{C, D\}$$

- Production of intermediates is linear: $x_{i,j} = q_{x,i,j} \ell_{x,i,j}$

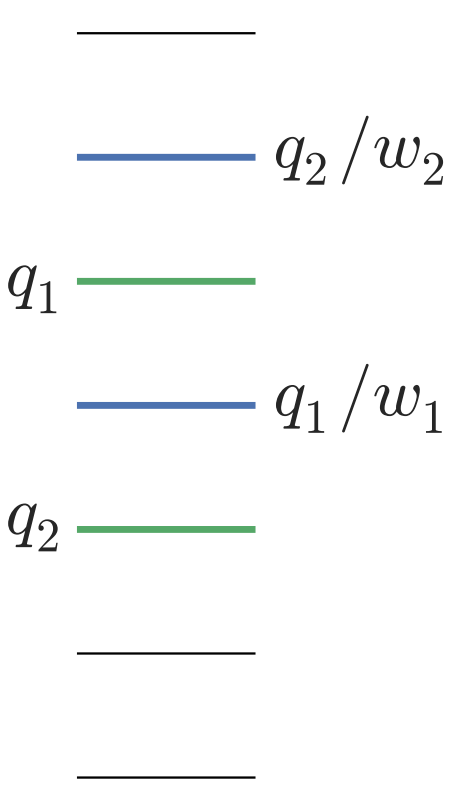
INTERNATIONAL TRADE

Wage ratio between countries (w_1/w_2) a key equil variable

$\lambda^n = q_1/q_2$

$\lambda^{\overline{n}} = w_1/w_2$

$n > \overline{n}$?



INCENTIVES FOR INNOVATION

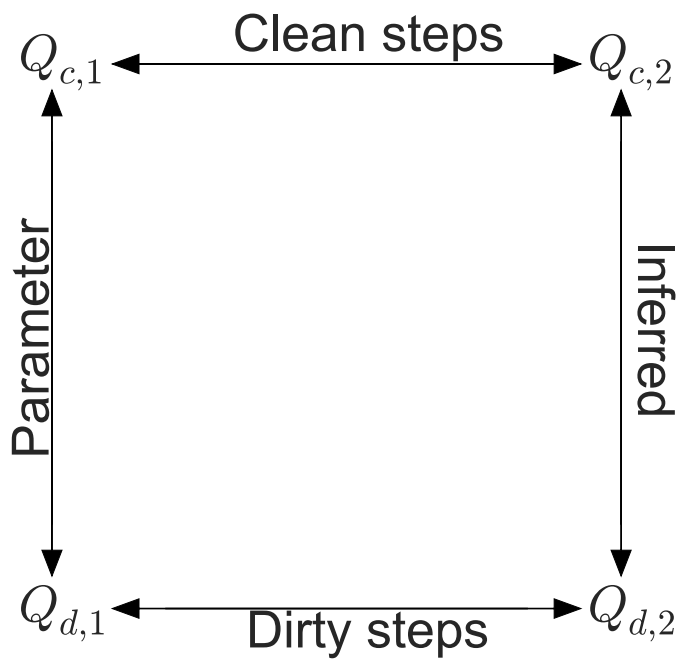
- The unit cost leader (w/q) will be the sole producer with

$$\tilde{\pi}_x = (1 - \lambda^{-1})\tilde{X}^{\frac{\varepsilon-1}{\varepsilon}}$$

  where $\sim$ denotes normalization by output Y_i
- When $\varepsilon \geq 1$, as transition progresses ($\tilde{C} \uparrow$), incentives for clean innovation go up ($\tilde{\pi}_c \uparrow$)
- Innovation incentives also higher in country that is technological leader

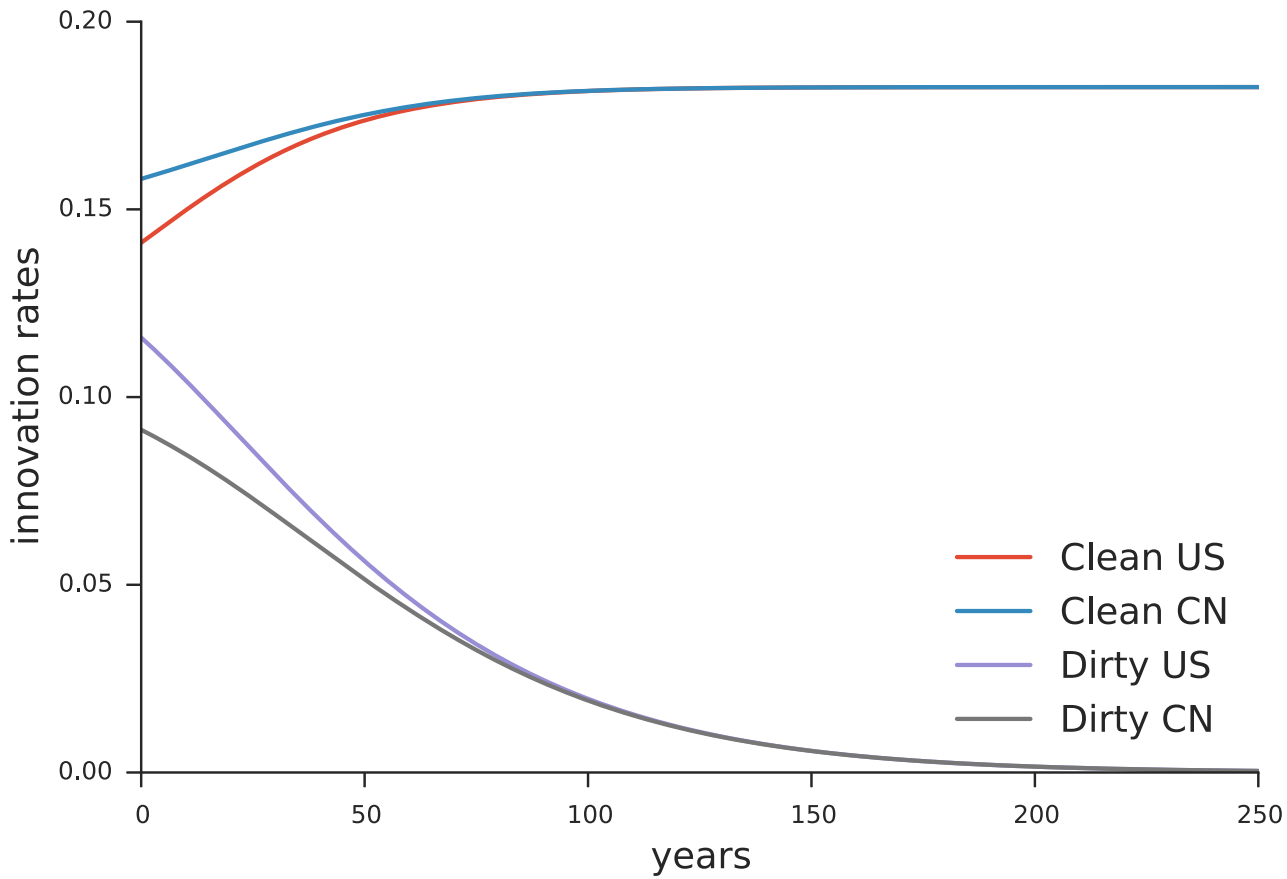
CALIBRATING PARAMETERS

Clean/dirty productivity ratio $Q_{c,1}/Q_{d,1}$ and substitution ε determine relative aggregated productivity values



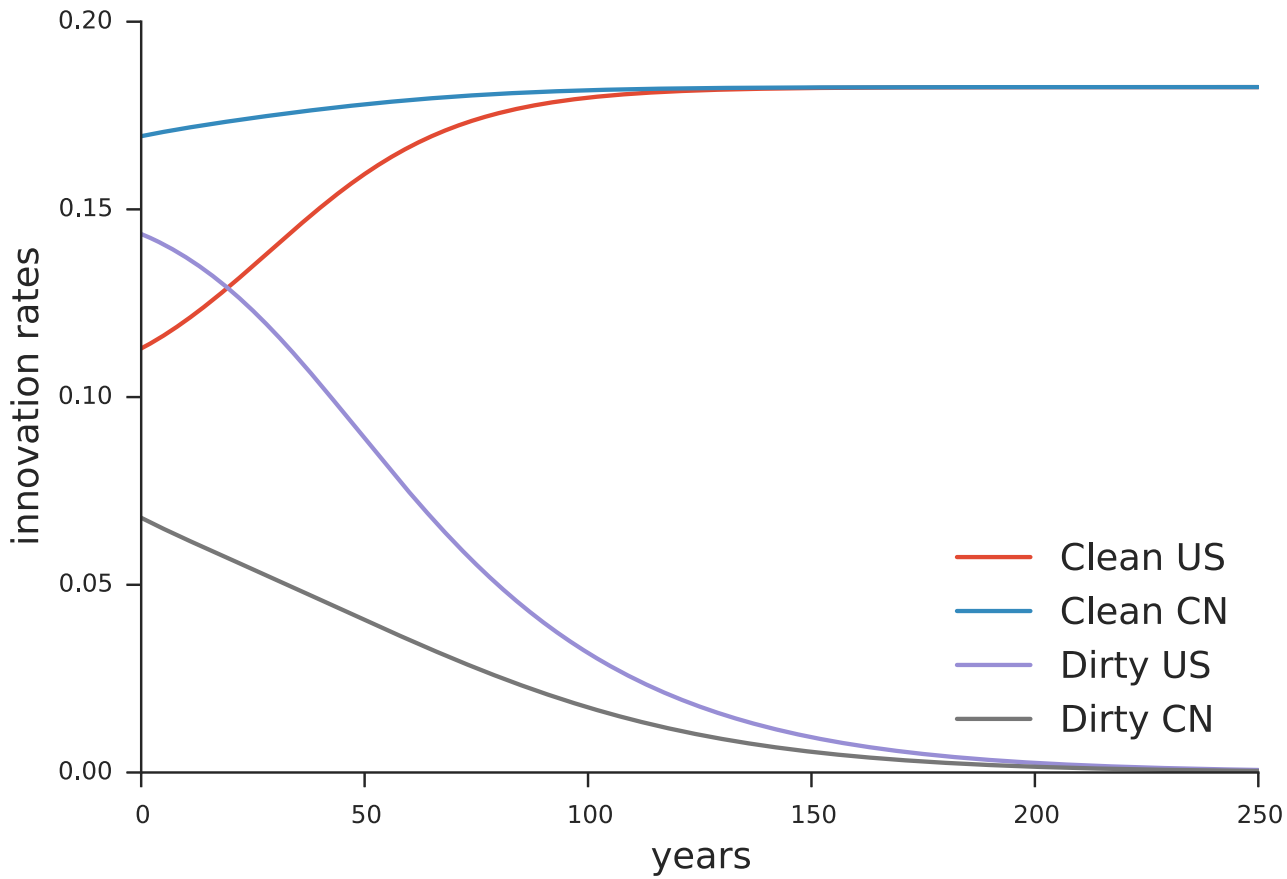
MAKING THE TRANSITION

Clean research subsidy >55% induces a clean transition



ASYMMETRIC POLICY

Case of US subsidy = 40% and CN subsidy = 60%



FUTURE WORK

- Determine optimal and equilibrium values for clean research subsidy policy (looks like US 60%, CN 65%)
- Extend analysis to multiple countries, rather than just US/CN (both theory and data work)
- Establish a stronger link between model and climate outcomes (emissions, climate damage, leakage)
- Think about time-varying policies and the possibility of delay as a deviation