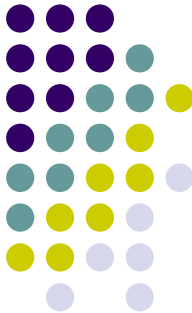


# Invention and Transfer of Climate Change Mitigation Technologies on a Global Scale: a Study Drawing on Patent Data

CERNA (Mines ParisTech) and OECD



## Research team



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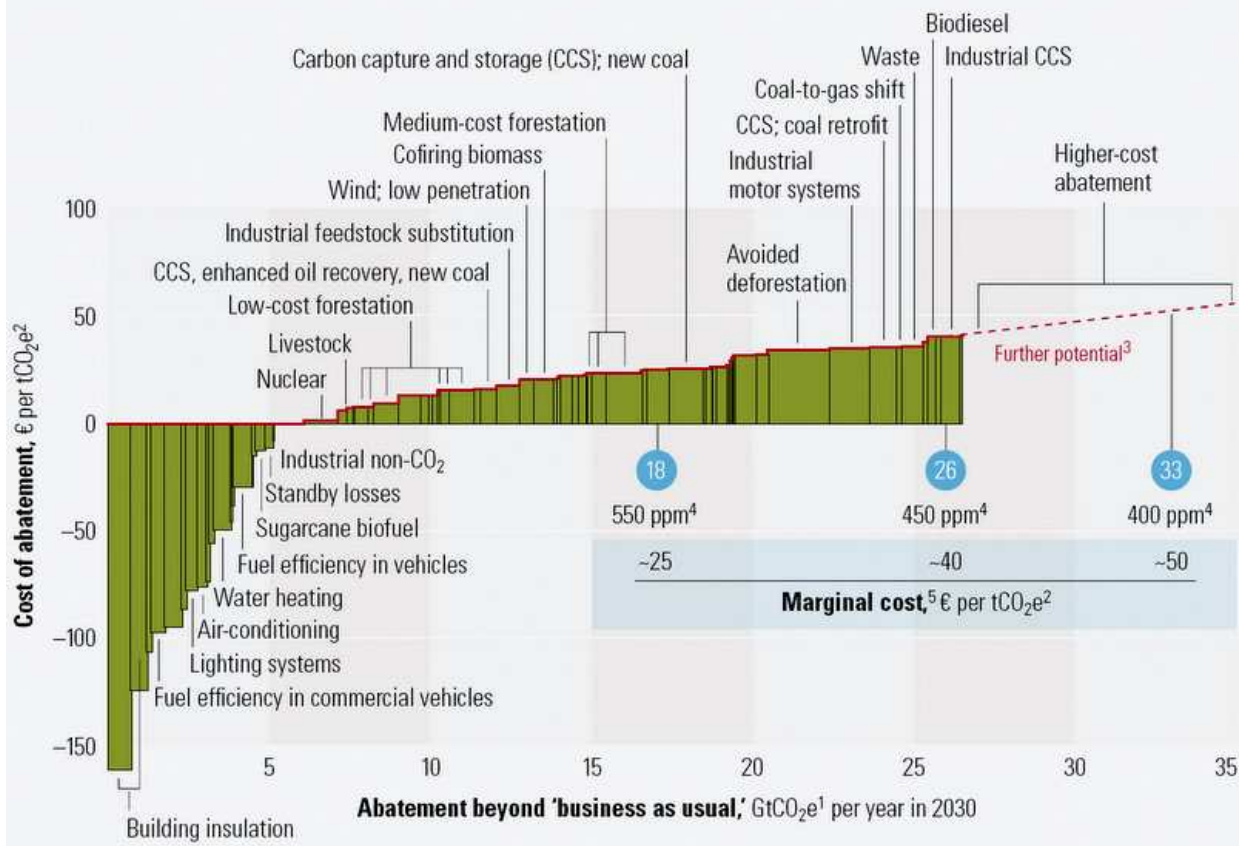


## Project objective

- Describing *quantitatively* innovation & international technology transfer of climate change mitigation technologies
- Scope:
  - Across 80 countries, including emerging economies
  - Over time: 1978 – 2003
  - 13 technology classes

▶ The first quantitative study with this extensive coverage

● Approximate abatement required beyond 'business as usual,' 2030



## The use of patent counts

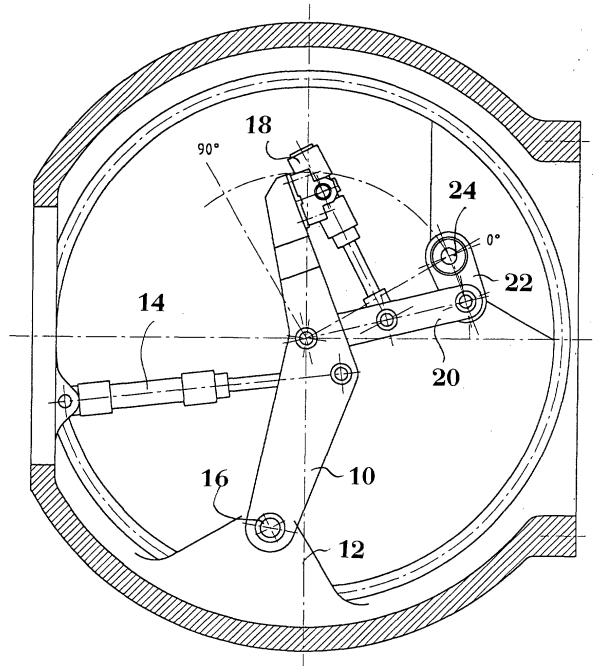


- An indicator of innovation
  - # of inventions
- An indicator of international diffusion
  - # of countries in which the invention is patented
- We use the OECD/EPO World Patent Statistical database PATSTAT that includes about 270,000 patents in climate-related technologies
  - Only recently available



## Ex: Patent # DE 19948997A1

- A system of individual blade adjustment for wind turbines
- PATSTAT tells us that:
  - The inventor is located in Germany
  - The application date is 11 october 1999
  - It was first filed in Germany, then in 6 other countries



# Diffusion of # DE 19948997A1



# Pros and cons of patent data



- Advantages
  - The only quantitative indicator available today at a disaggregate level on a global scale
  - Covers both emerging and mature technologies
- Drawbacks
  - Not all inventions are patented
    - Other means of protection: secrecy, lead time
    - Tacit knowledge and know-how is not patentable
  - Patented inventions have heterogeneous economic value
  - The propensity to patent varies across sectors and countries (patent breadth)

▶ A good proxy for innovation

## Dealing with patent breadth



- The number of patents that is granted for a given innovation varies significantly across countries
  - Examining international patent families in PATSTAT, we find that one EPO patent is equivalent on average to 1.4 Japanese patent
  - We divide the number of Japanese patents by 1.4
- We apply the same methodology for all patent offices and set the weight of applications at the EPO to unity

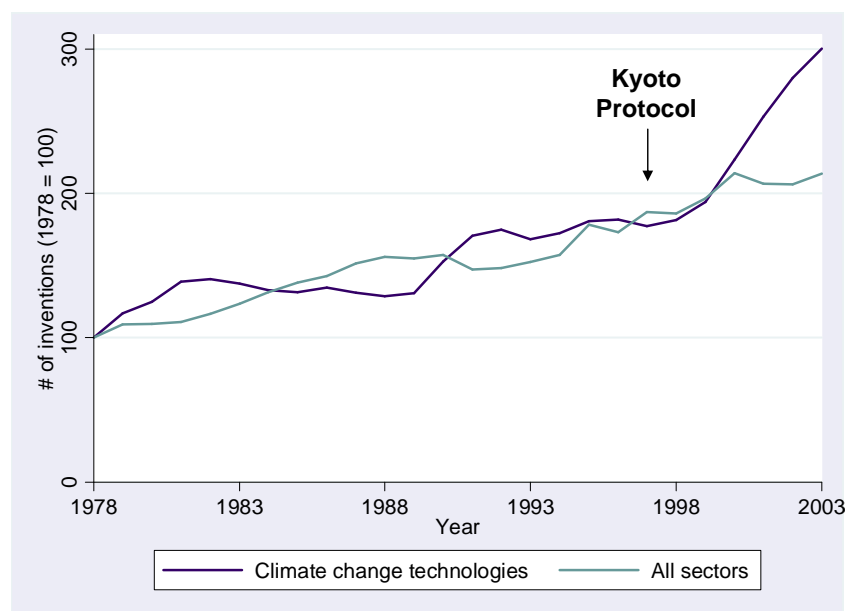
# Outline



1. Innovation

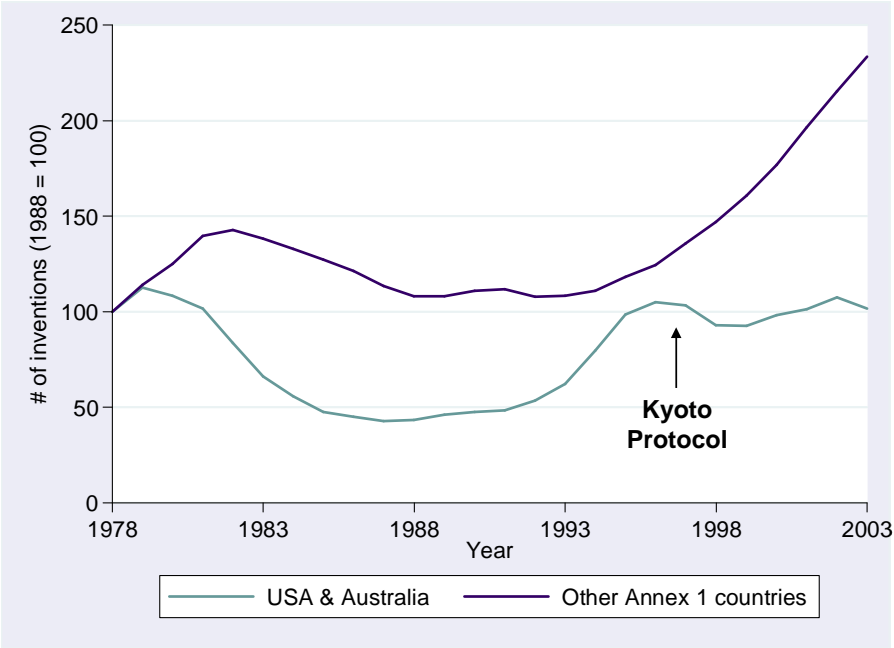
2. International technology diffusion

# Innovation trend 1978-2003

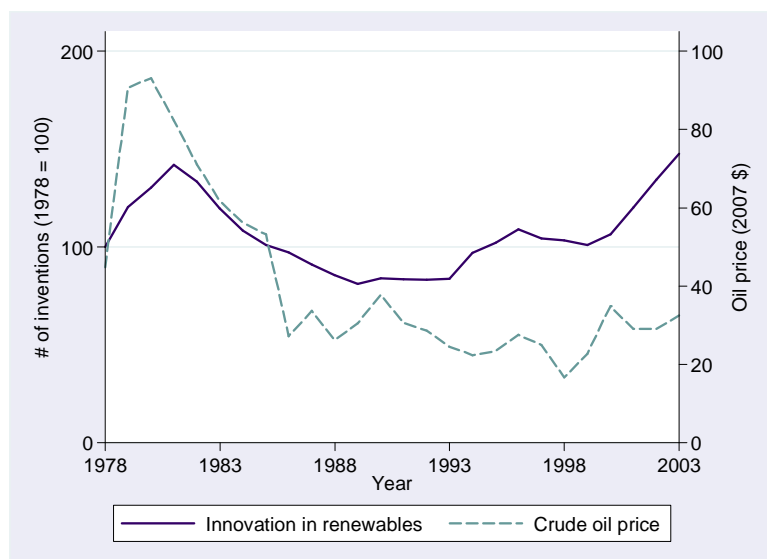


► The Kyoto Protocol has seemingly induced more innovation

# USA & Australia vs other Annex 1 countries

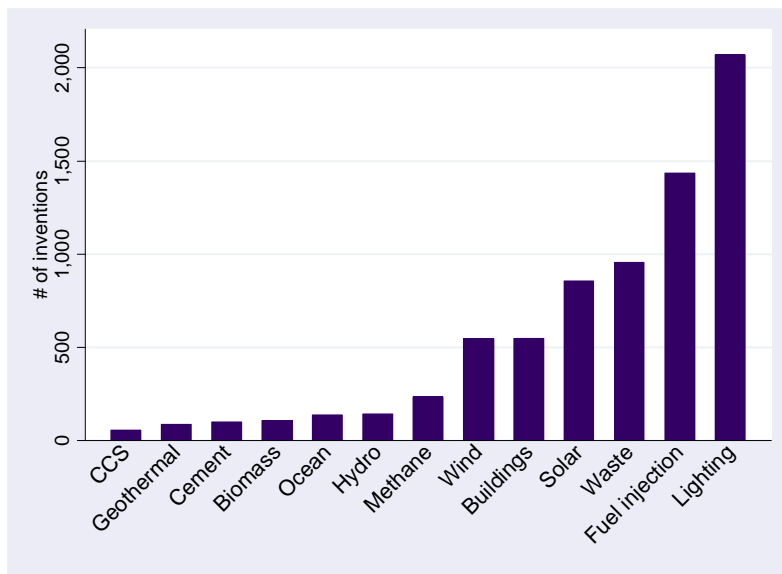


# A specific trend: Renewable energy tech.



- Very correlated with oil prices
- The level of innovation in 2003 just equals the early 1980s record high

# Innovation by technology



- A few innovations in
- Emerging tech:
  - CCS
- Mature tech:
  - cement, biomass, hydro

Average annual number of inventions 1998-2003

## Top 10 inventor countries 98-03



Country	Rank	Average % of world inventions
Japan	1	40.8 %
USA	2	12.8 %
Germany	3	12.7 %
China	4	5.8 %
South Korea	5	4.6 %
Russia	6	4.2 %
France	7	2.4 %
UK	8	1.9 %
Canada	9	1.5 %
Brazil	10	1.1 %

- Japan is the world leader
  - 40% of total inventions!
- Japan + Germany + the USA account for 66% of total innovation
- The contribution of China, South Korea and Russia is not negligible
  - Cement, geothermal, lighting

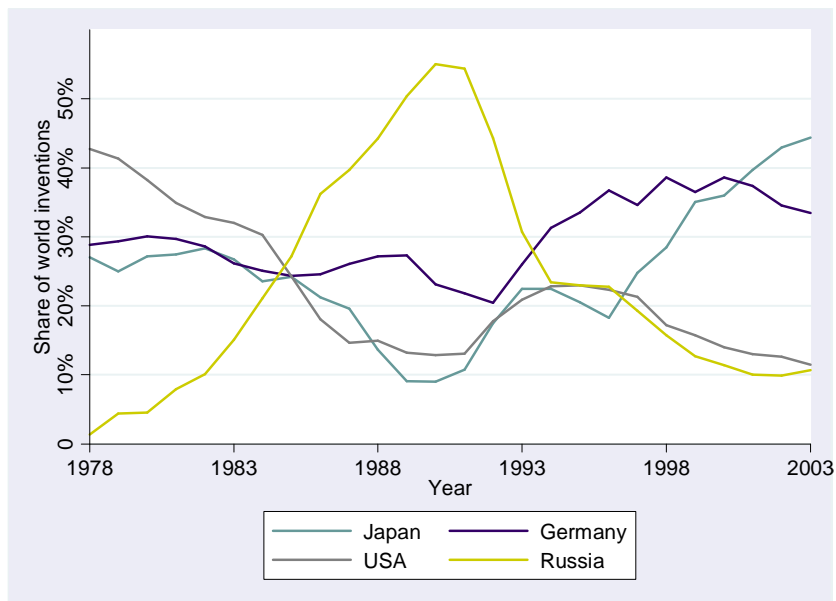
## A focus on emerging economies



Country	Average % by technology class	World rank	Most important technology classes (decreasing order)
China	5.8 %	4	Cement, geothermal, solar, hydro
South Korea	4.6 %	5	Lighting, ocean, hydro, biomass
Russia	4.2 %	6	Geothermal, cement, hydro, CCS
Brazil	1.3 %	10	Ocean, building
Taiwan	0.7 %	17	Ocean, lighting
India	0.2 %	>20	Cement
Mexico	0.1%	>20	Ocean
South Africa	0.03%	>20	

► Some emerging economies are already major innovators

# Country performances may change rapidly



**Evolution of countries' innovation share in wind tech 1978-2003**

# Outline



1. Innovation

2. International technology diffusion

## Origin and destination of technologies

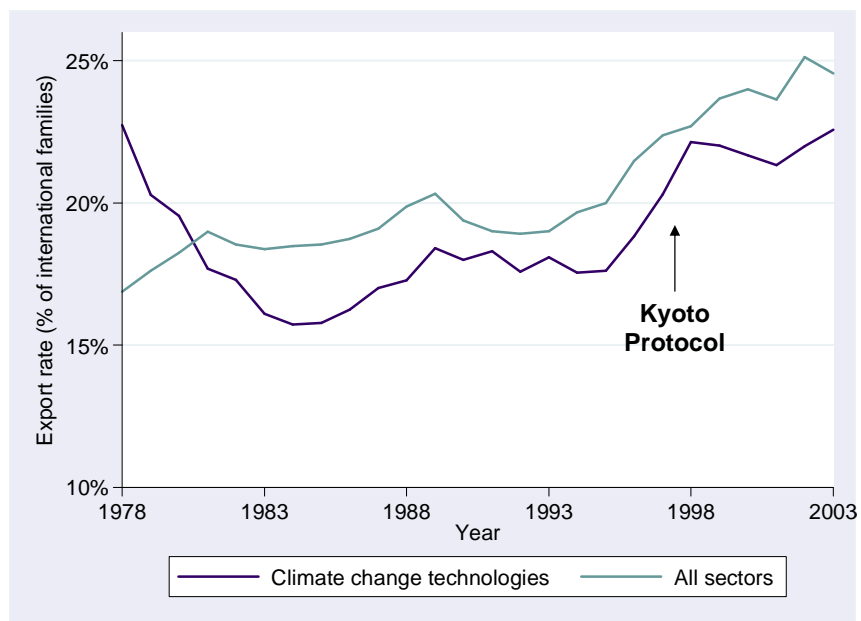


<b>Origin \ Destination</b>	<b>Developed countries</b>	<b>Emerging economies</b>
<b>Developed</b>	75.9 %	17.8 %
<b>Emerging</b>	4.9 %	1.5 %

% of exported inventions from 1998 to 2003

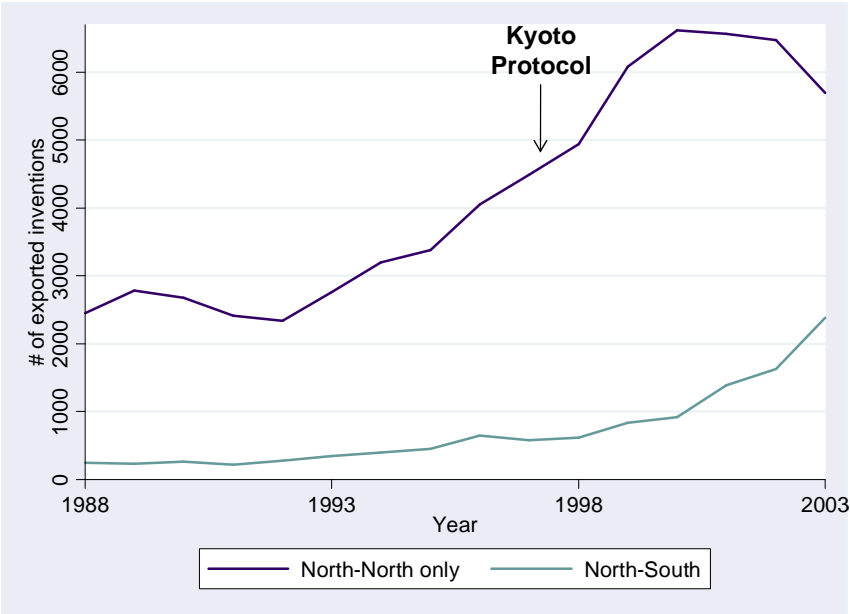
► Technology transfer mostly concerns industrialized countries

# Technology transfer



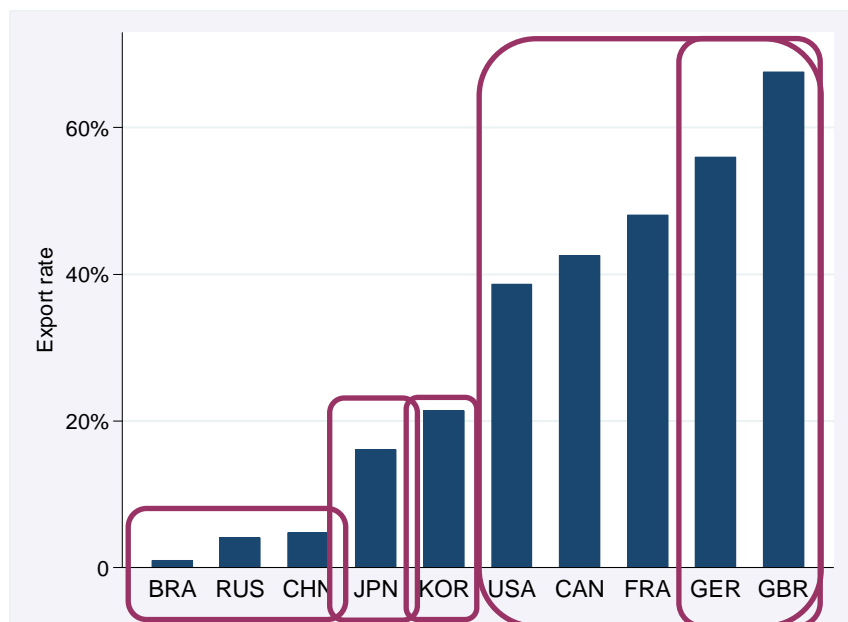
► The Kyoto Protocol has had no immediate impact on the intensity of technology transfer

# North-North transfer vs North South transfer



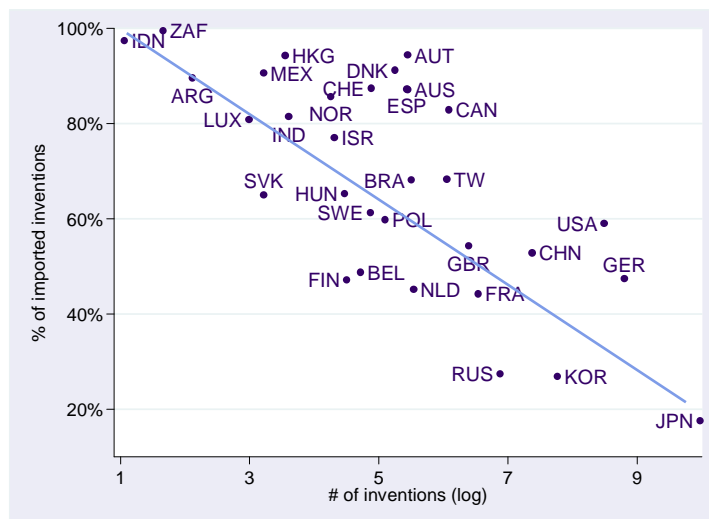
► The composition of technology transfer has changed in the recent period

# Export performance of inventor countries



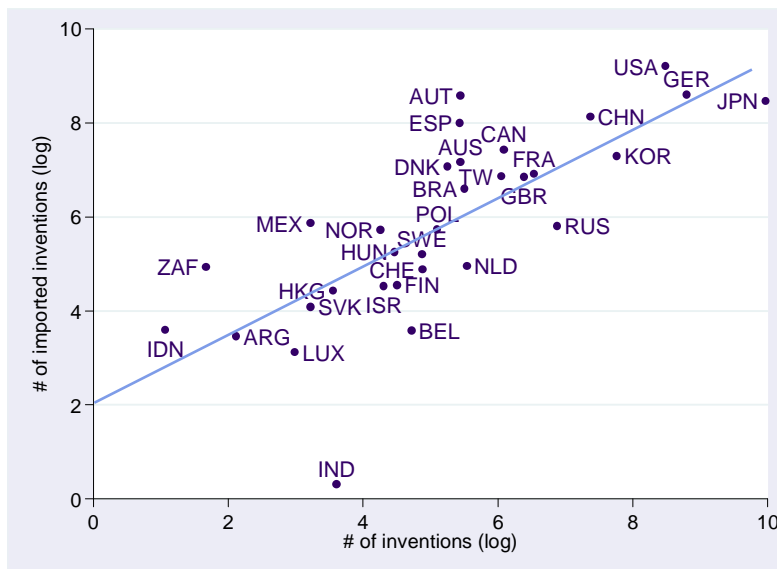
► Emerging countries tend to produce innovation for domestic use

# Importing or innovating locally?



► Foreign and domestic innovation are substitutes

# Local innovation and imports



- Innovators are also importers

► The demand for technology boosts both imports and local innovation

## What drives technology transfer?



- For instance, why do 75% of transfers occur between developed countries?
  - Higher technology absorptive capacities?
  - A stricter patent system?
  - Lower barriers to international trade or to Foreign Direct Investments?

► Econometric analysis

## How?



$$\begin{aligned} P_{i,j,t} = & \alpha_0 + \alpha_1(Patent\_Stocks_{j,t}) + \alpha_2(Local\_Patents_{j,t}) \\ & + \alpha_3(Log\_Dist_{i,j}) + \alpha_4(Com\_Lang_{i,j}) \\ & + \alpha_5(IPR\_strictness_{j,t}) + \alpha_6(Tariff\_rate_{j,t}) \\ & + \alpha_7(Same\_bloc_{i,j,t}) + \alpha_8(Capital\_control_{j,t}) \\ & + \alpha_9(Log\_Population_{j,t}) + \alpha_{10}(GDP\_growth_{j,t}) \\ & + \alpha_{11}(Education_{j,t}) + \alpha_{12}(GDP\_percapita_{j,t}) \\ & + \alpha_{13}(Kyoto_{j,t}) + \alpha_{14}(specific\_demand_{j,t}) \\ & + \alpha_n(Year\_dummies_{i,j}) + \varepsilon_{i,j,t} \end{aligned}$$

► See the paper

## Results (1)



- Technology absorptive capacities of the recipient country are important
  - The accumulation of technology-specific knowledge, as opposed to generic skills, is particularly critical
- In most sectors, IPR strictness has a significant positive effect on patent flows
  - Note: we deal with *patented* technologies

## Results (2)



- Barriers to international trade – e.g., high tariff rates – significantly hinder technology transfer
  - Suggests CC techs are frequently embodied in capital equipment goods
- Paradoxically restrictions on foreign direct investment seem to promote technology transfer
  - Regulations requiring technology transfer in FDI?
  - Restrictions shift tech transfer to other diffusion channels (exports, licensing)?

## Results (3)



- Domestic and imported technologies are substitutes in 2 tech fields and complements in 5
  - Domestic and foreign inventions may crowd each other, depending on the technology
    - => Sector specificities
- Kyoto participation increases transfers in 6 technology fields

## Conclusion (1)



- The Kyoto Protocol has induced:
  - more innovation in climate-friendly technologies
  - more technology transfer in some areas
- Main inventor countries
  - Japan, USA and Germany represent two thirds of world innovation
  - However China, South Korea and Russia rank 4, 5 and 6, respectively

## Conclusion (2)



- About 75% of technology transfer occur between industrialized countries
  - A huge potential for the development of North-South transfer
  - North-South transfer is already increasing
- Although China, South Korea, and Russia are major innovators, they do not export much
  - A huge potential for the development of South-South transfer

## Conclusion (3)



- Low barriers to international trade and strict IPR promote technology transfer
  - Constraints on FDI: a policy lever?



More information on  
[www.cerna.mines-paristech.fr](http://www.cerna.mines-paristech.fr)

Thank you