Intellectual property rights protection and international transfer of low-carbon technologies through trade and foreign direct investments

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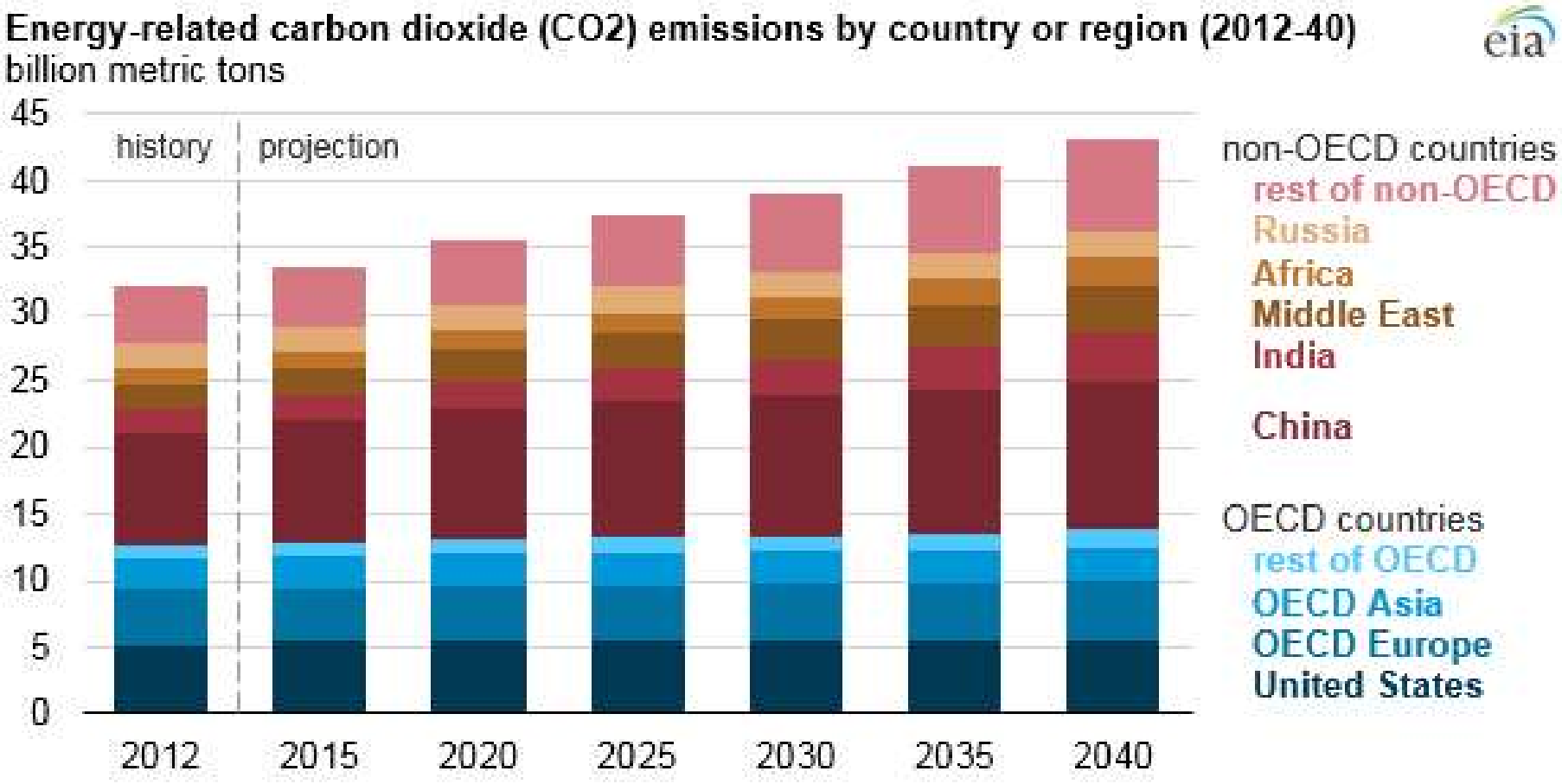
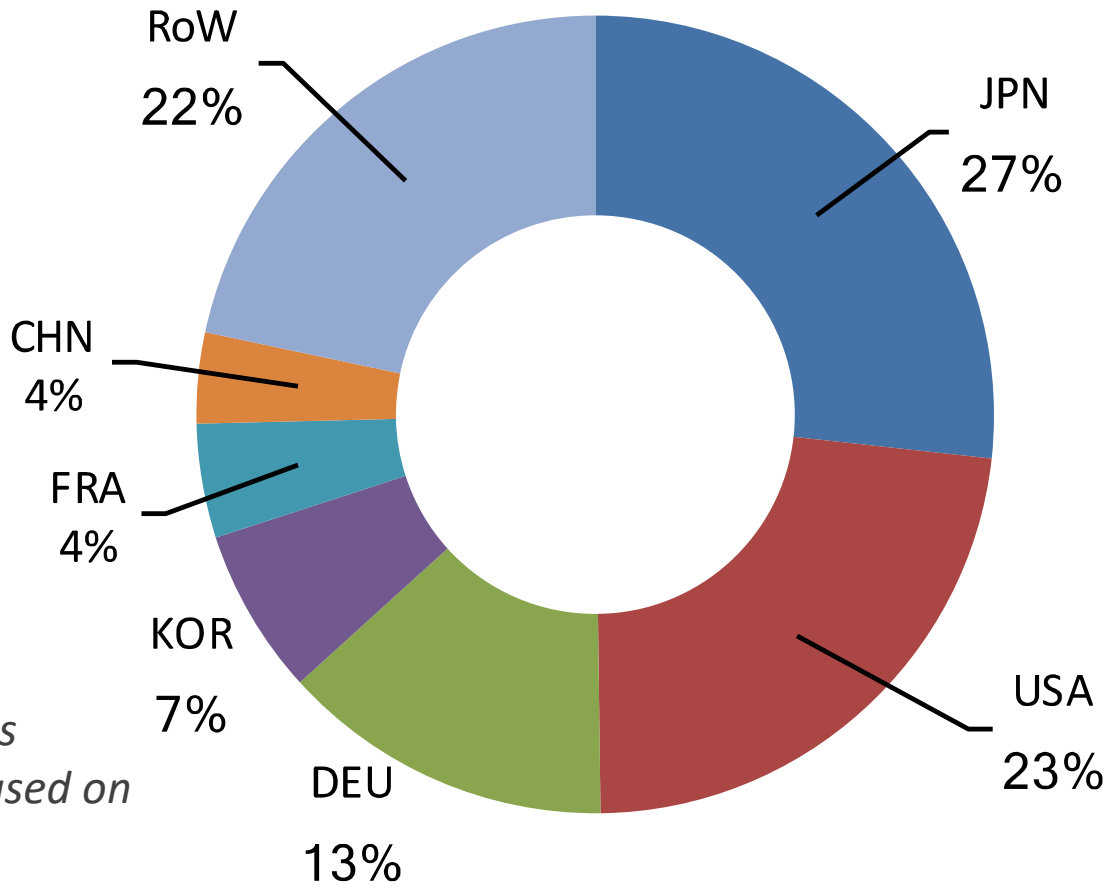
Emissions will increase in developing countries



Source: International Energy Outlook 2016

But clean innovation is concentrated in the North

Share of patented low-carbon inventions 2005-2015



Source: authors calculations based on PATSTAT

Climate mitigation & tech transfer

- Accelerated international transfer of low-carbon technologies crucial for emissions reductions
  - Key to understand its drivers

- Many drivers of ITT
  - Local environmental policies
  - Local absorptive capacities
  - Trade policies
  - FDI policies
  - Development policies
  - **Intellectual property rights**

IPR in climate negotiations

- International transfer of low-carbon technologies should increase => crucial to understand its determinants
- IPR potentially an important one is contentious within international climate negotiation
  - *Proponents*: IPR protection necessary condition for transfer to happen
  - *Opponents*: IPR generates market power that decreases technology access at affordable price
- Not a new debate viewed as a **blocking point** of the climate negotiation => no action mentioned in the COP21 Paris Agreement

Channels of International Technology Transfers (ITT)

- **Transfers** can be mediated by the **market**

1. **International trade in capital goods**
2. **Foreign direct investment**
3. Licensing of patented technologies

Transfer channel	Knowledge location	Spillover mechanisms in the recipient country	Knowledge intensity and imitation threat
Export of intermediate goods	Source country	Reverse engineering Business relationships	+
Foreign direct investment	Recipient country	Reverse engineering Business relationships Labor circulation	++

- **Or not** mediated by the market, **spillovers**
  - Reverse engineering, skilled labour circulation, published patent examination

The role of IP rights

- Patents and other IP rights

  1. Grant exclusivity for technology use to inventor for a determined period of time (typically 20 years)

  2. Disclose information that generate knowledge spillovers

- Their primary function is to increase incentives to innovate

- Their impact on technological diffusion is ambiguous. Maskus (2000) opposes:

  - a positive ***market expansion effect:*** stronger IPR create a market for firms whose intellectual assets are secured

  - and a negative ***market power effect***: stronger IPR lead to higher prices

  ➔ The net effect of IPR is an empirical question

One size patent system and heterogeneous technologies

- Technologies vary in several dimensions
  - Development stage, maturity, tradability, demand size
  - And IP sensitivity: possibility to be codified and exposure to imitation
- IPR likely to have differentiated effects depending on the technology

➔ Necessary to perform the analysis for each technology **separately**

Absorptive capacities

- Key parameter is **absorptive capacities** = capital and people allocated to research, past innovation achievements
- Many developing countries have small capacities (in relative terms) (Lall, 1992)
  - Domestic firms less able to imitate imported technologies ➔ Strengthening IPR is less important for innovators
- Under low capacities, IPR likely impact more FDI than trade
  - FDI brings knowledge and soft skills necessary to produce the technology locally ➔ need protection from imitation
  - Trade can deliver knowledge to protect through reverse engineering but only when there are local capacities

Contribution

- We conduct 2 ***panel data*** analysis :
  - trade in low-carbon equipment goods between countries
  - FDI in low-carbon technologies between countries
- Using country-pair level datasets at the technology level
- 28 OECD countries and up to 80 non-OECD countries for 2006-2015
- **8 low-carbon technologies** in renewables, cleaner transportation, and energy efficiency
- Specific results for **non-OECD countries**
- No other study has performed such a test on the ***channels*** of international transfer
  - Dechezleprêtre et al. (2013) estimate the effect of IPR on **international patent filing** of low-carbon technologies

Technological scope

Sector	Technology class
Power generation	Hydro Solar photovoltaic Solar thermal Wind
Transport	Cleaner vehicles: hybrid and electric vehicles
Buildings	Heating Insulation Lighting

EMPIRICAL STRATEGY

Bilateral trade in low-carbon equipment

$$TRADE_{ijt} = \exp\left(\alpha_0 + \alpha_1 IPR_{jt} + \beta X_{ijt} + \delta_{ij} + \gamma_t + v_{ijt}\right)$$

- $TRADE_{ijt}$ shipment value from exporter *i* to importer *j*
- IPR_{jt} index of IPR protection in the importing country
  - Lagged one year to mitigate endogeneity
- δ_{ij} include every time invariant country-pair factors (distance, contiguity, etc.) and importer characteristics (institution, regulations, etc.)
- γ_t are year dummies
- X_{ijt} include importer and exporter size and bilateral trade costs
- Estimated via PPML (Silva and Tenreyro, 2006)

FDI in low-carbon technologies

$$FDI_{ijt} = \exp\left(\varphi_0 + \varphi_1 IPR_{jt} + \theta X_{ijt} + p_{ij} + \eta_t + u_{ijt}\right)$$

- FDI_{ij} : number of low-carbon FDI deals between owners in country *i* and their subsidiaries in country *j*
- Similar approach but X_{ijt} differs

Time-varying regressors

Regressors	Trade	FDI
Importer IP protection	X	X
Importer Absorptive capacities	X	X
Importer Log (GDP)	X	X
Importer Log (per capita GDP)	X	X
Importer Environmental Regulations	X	X
Importer Effectively Applied Tariff	X	
Importer Nr. of Non-Tariff Measures	X	
Importer business regulations quality		X
Importer labor market regulations quality		X
Importer controls of capital and people movement		X
Country pair in Trade Agreement (0/1)	X	X
Exporter Log (GDP)	X	X
Exporter Log (per capita GDP)	X	X
Exporter IP protection	X	X
Exporter Environmental Regulations	X	X

DATA

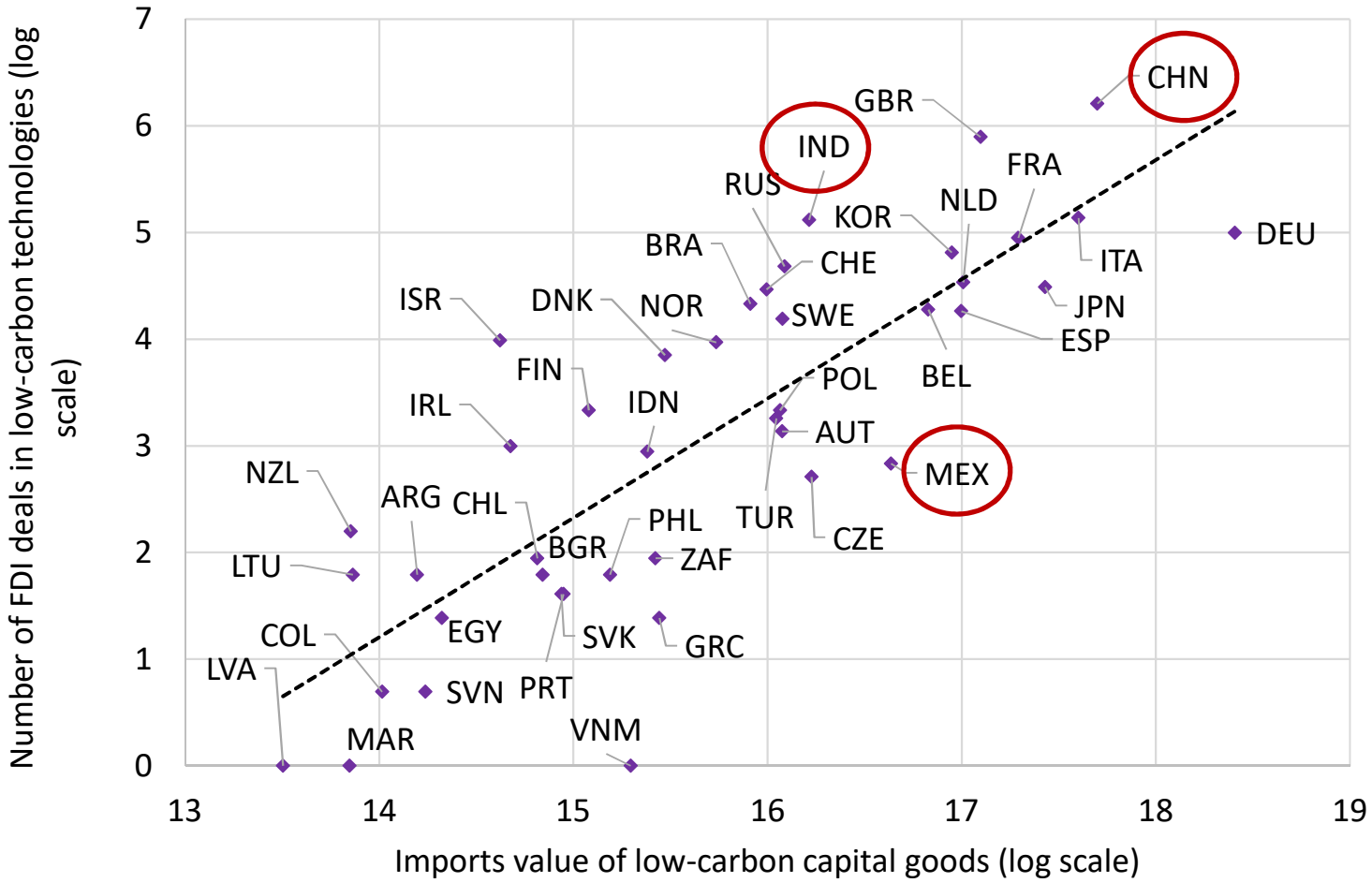
Trade in low-carbon capital goods (source)

- Data from BACI which is an augmented version of UN Comtrade (Gaulier and Zignago, 2010)
- Trade flows at the country-pair level for 2006-2015 for 6-digits products (HS)
- Low-carbon technologies identified based on the HS nomenclature description and checked based on existing environmental goods nomenclature (APEC, CLEG, FRIENDS, etc.)
  - Examples: 854140 “photosensitive semiconductors” or 850231 “wind-powered electric generating sets”
- Our final sample accounts for around 88% of global trade in the selected technologies.

FDI in low-carbon technologies (source)

- **FDI data rarely available** at the industry level scarcer at technology level
- We combine data on FDI deals (Zephyr) and data on patent filing (Patstat) to compute a proxy of country pair FDI by technology
- For each low-carbon technology, we keep FDI deals in which
  - The investing firm successfully filed a patent in this technology
  - The target firm operates in an industry in which the technology is useful
- On this sample, we compute the number of deals for each country-pair and each technology
- Climate mitigation patents are identified using the “Y02” IPC category developed by the EPO
- 71 recipient countries for 2006 – 2015

IMPORT VS inward FDI : average over 2006-2015



Note: author calculation based on BACI, Zephyr, and Patstat. Values are summed over the technologies and over 2006-2015.

Intellectual Property Rights protection measure

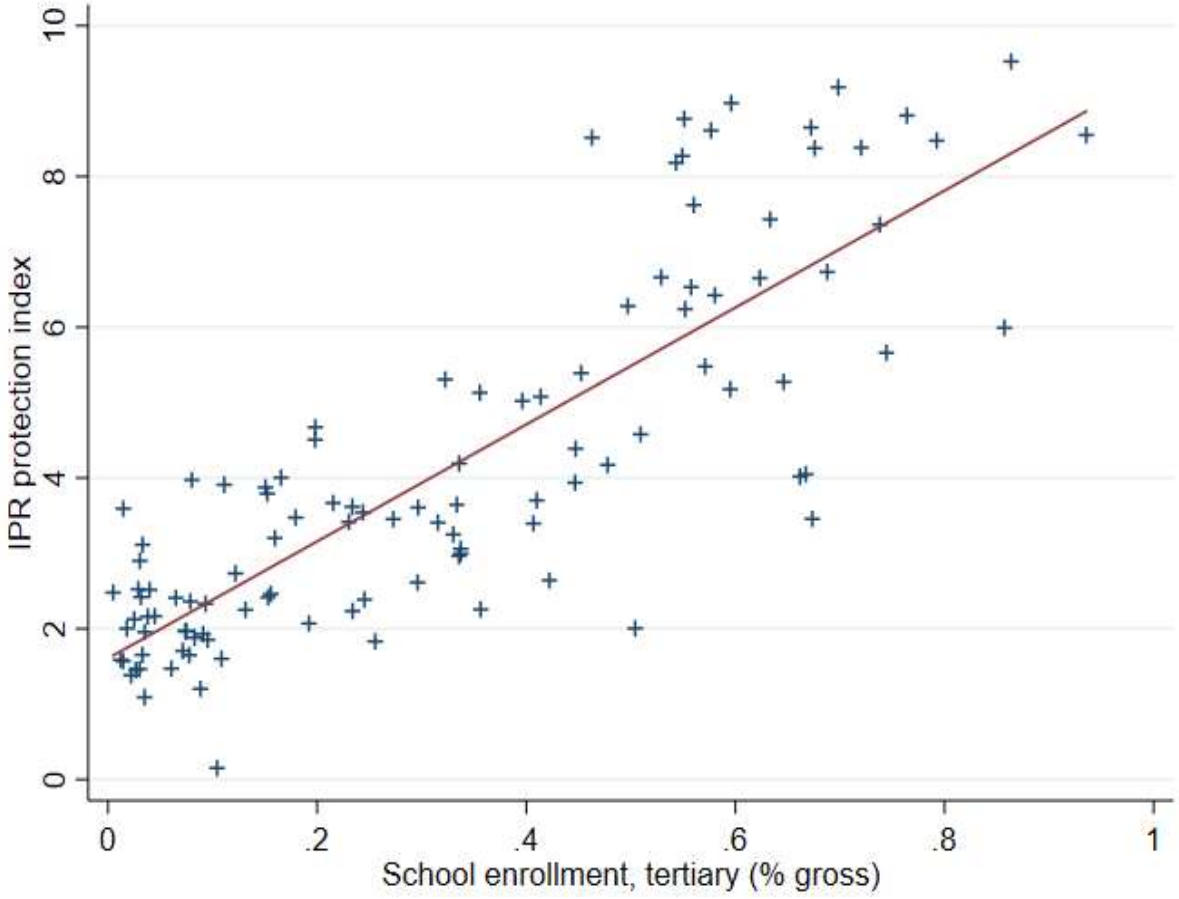
- **Our IPR index = IPR x legal system**
- Inspired from Maskus and Yang (2013): strong IPR on paper are de-facto weak under a weak legal system
- IPR comes from the Executive Opinion Survey (EOS) produced by the World Economic Forum (WEF)
- Legal system index composite index based on legal enforcement of contracts, judicial independence, impartial courts, police reliability, etc.

IPR protection: *within* country variation

	Mean	Within-country Std. Dev.	% of mean (C.V.)
All countries	3.84	0.40	10%
OECD countries	6.45	0.48	7%
Non-OECD countries	2.90	0.37	13%

Absorptive Capacities and IPR protection

Proxy for capacities = Enrolment in tertiary education (World Bank)



RESULTS

Base model - Trade

	Shipment value of low-carbon equipment							
	Hydro	Solar PV	Solar Thermal	Wind power	Heating	Insulation	Lighting	Cleaner vehicles
Importer IPR	-0.009	0.440**	0.101*	0.432**	0.086**	-0.01	-0.062	-0.146
	(0.117)	(0.215)	(0.052)	(0.173)	(0.035)	(0.038)	(0.087)	(0.141)
Year FE	X	X	X	X	X	X	X	X
Country-pair FE	X	X	X	X	X	X	X	X
Nr. Observations	15,423	25,301	16,132	9,410	27,033	20,824	19,535	13,231
Nr. Country-pairs	1,872	3,102	1,946	1,093	3,328	2,526	2,393	1,651

Net effect never negative and positive for 4 technologies

Large differences: 1 unit (more than twice the within-country standard deviation) is predicted to increase imports of solar PV by 44%, solar thermal by 10%, wind power by 43%, and heating by 9%.

Base model - FDI

	Number of FDI deals in low-carbon technologies							
	Hydro	PV	Solar thermal	Wind	Heating	Insulation	Lighting	Cleaner vehicles
Recipient IPR	0.078	0.176	0.230*	0.132	0.289	-0.049	0.342**	0.257**
	(0.107)	(0.124)	(0.139)	(0.125)	(0.199)	(0.213)	(0.167)	(0.114)
Year FE	X	X	X	X	X	X	X	X
Country-pair FE	X	X	X	X	X	X	X	X
Nr. Observations	23,055	24,037	23,583	25,666	22,469	17,839	18,679	23,791
Nr. Country-pairs	2,812	3,040	2,964	3,192	2,736	2,128	2,356	2,812

All columns estimated via Pseudo Poisson Maximum Likelihood. All regressors are one year lagged. Standard errors in parentheses clustered at the country-pair level. * p<0.10, ** p<0.05, *** p<0.01. Regressors include recipient's GDP, GDP per capita, IPR protection, Capacities, Stringency of Labour and Business regulations, Controls of movement of capital and people, Investor's IPR protection, GDP, and GDP per capita.

Net effect never negative and positive for 2 technologies

Low-capacity countries (tertiary enrolment rate < median)

	Hydro	Solar PV	Solar Thermal	Wind	Heating	Insulation	Lighting	Cleaner vehicles
Trade	0.024	-0.45	0.142	-1.221	0.207***	0.253***	-0.071	0.106
	(0.200)	(0.286)	(0.111)	(0.924)	(0.077)	(0.074)	(0.288)	(0.260)
FDI	0,116	0.309**	0.268*	0.277*	0.587**	-0,16	0.571***	0.324**
	(0.129)	(0.132)	(0.151)	(0.149)	(0.283)	(0.243)	(0.198)	(0.131)

Impact on FDI stronger than for high-capacity countries

FDI : countries go to the median IPR = 4.2 (~ China)

Country		India	Brazil	Indonesia
CO2 emissions (Mt in 2014)		2,238	530	464
Change in IPR protection		**4%**	**33%**	**22%**
% change in FDI deals	Hydro	4%	28%	20%
	Solar PV	6%	45%	31%
	Solar Thermal	5%	36%	25%
	Heating	9%	84%	56%
	Lighting	12%	118%	77%
	Cleaner vehicles	5%	44%	30%
	Average	**7%**	**59%**	**40%**

Conclusion

- Stronger IPR positively correlated with higher transfer of several low-carbon technologies
- However, heterogeneous effect because technologies vary in:
  - Patent intensity
  - Complexity
  - Degree of competition
- Impact of IPR on FDI almost always positive for countries weaker capabilities
- Caveats : no obvious IV available

Policy implications for developing countries

- Relaxing IRR does not seem to be a good idea
- Small improvement in IPR may generate significant transfer in major emitting countries (India, Brazil, Indonesia)
- High heterogeneity between technologies

➔ case-by-case approach recommended

THANK YOU