
DO GREEN FOREIGN DIRECT INVESTMENTS INCREASE THE INNOVATIVE CAPABILITY OF MNE SUBSIDIARIES?

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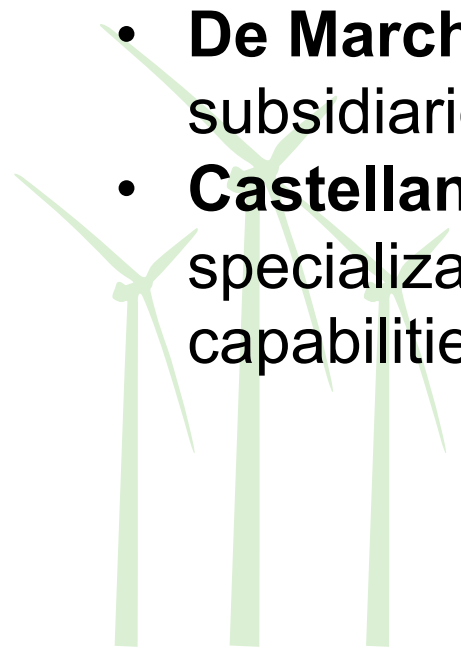


- The diffusion of green knowledge and technologies is key to fast-track the green transition.
- Multinational Enterprises (MNEs) are an important channel of knowledge transfer and they can possibly drive the diffusion of green technologies, overcoming the lack of knowledge, often reported as a key barrier to achieving the green energy transition, especially in less developed countries.

This paper explores how MNEs subsidiaries can positively spur the development of green innovation in countries at different levels of development, kickstarting their green transition.

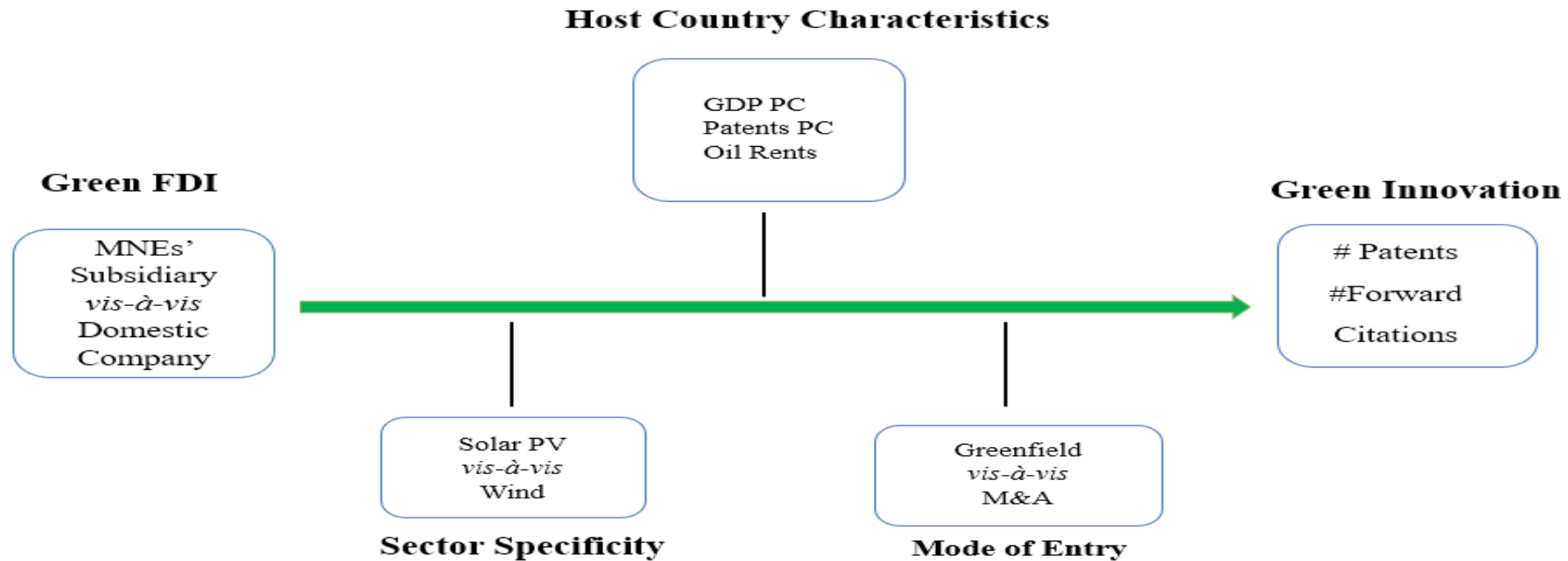


- **Knowledge transfer in the MNE-subsidary relationship** is widely investigated but there is limited evidence on green technologies.
 - **Noailly and Ryfisch (2015)** investigate the internationalization of green R&D by studying the patenting activity of 1,200 MNEs and finding that around 18% of the patents are developed by their affiliates.
 - **De Marchi et al (2022)** based on CIS in 14 European countries suggest that subsidiaries have an advantage in green innovation with respect to domestic firms.
 - **Castellani et al. (2022)** show that greenfield FDIs in Europe contribute to regional specialization in environmental technologies, especially in industries with previous capabilities in specific green technologies.



RESEARCH QUESTIONS

To what extent are MNEs contributing to increase the green innovative capabilities of their subsidiaries vis-à-vis domestic companies?



DATA



- **Green FDI**s are investments undertaken by MNEs with at least one patent in **renewable energy technologies** (subset of Y20E: **geothermal, hydro, marine, solar thermal, solar PV, solar thermal-PV hybrid, wind, biofuels, fuel from waste**).
- Subsidiaries' main business activities focus on production/distribution of renewable energy.
- # GREEN FDI's 1,055 (73% GREENFIELD INVESTMENTS and 27% M&As)
- Patents are attributed to subsidiaries if at least one inventor is from the same country of the subsidiary (Stiebale, 2016): **1,410 SUBSIDIARIES' PATENTS IN RE**
- **Counter sample:** 6,276 DOMESTIC COMPANIES (in the same sectors/countries of the subsidiaries)
- Period of the analysis: 2003-2015

EHDDGG



- **Negative binomial model** (Piperopoulos et. al., 2018)
- **Output variables**
 - # of green patents (DOCDB families) up to 5 years after the investment
 - # forward citations (average) to green patents up to 5 years after the investment
- **Main independent variable:** Dummy 1= MNE subsidiary 0 = domestic company
- **Moderating factors:** Host country-specific characteristics (GDP per capita; # of patents per capita in the country; oil rents %GDP)
- **Controls:** SIZE, AGE, PRE-DEAL KNOWLEDGE BASE
- **F** ACE 2-
- **Subsamples**
 - Wind & Solar (vs. domestic companies)
 - Greenfield investments & M&As (vs. domestic companies)

	OUTPUT: # green patents						OUTPUT: # forward citations to green patents					
	t (1)	t+1 (2)	t+2 (3)	t+3 (4)	t+4 (5)	t+5 (6)	t (7)	t+1 (8)	t+2 (9)	t+3 (10)	t+4 (11)	t+5 (12)
FDI SUBSIDIARY	-0.859***	-0.049	0.188	0.377	0.705***	0.552**	1.167***	1.154***	1.202***	1.510***	2.115***	2.187***
PATENT PORTFOLIO STOCK LAG 1 (LN)	-0.690**	-0.614***	-0.626***	-0.145	-0.518**	-0.172	-1.029***	-1.056***	-1.099***	-1.049***	-1.026***	-0.666***
AGE (LN)	-0.314***	-0.249***	-0.189***	-0.244***	-0.087	-0.156*	-0.072	-0.414***	-0.281***	-0.226**	-0.125	-0.003
MIDDLE_SIZE	0.093	0.173	0.066	0.138	0.105	0.934***	-0.127	-0.150	0.021	-0.040	0.015	0.815***
BIG_SIZE	0.350*	0.088	0.308	0.398**	0.405**	1.064***	-0.313	0.067	-0.487**	-0.154	0.507**	0.741**
COUNTRY GDP PC (LN)	0.106	0.010	0.029	0.150*	-0.004	-0.081	0.250***	0.305***	0.255***	0.458***	0.360***	0.228**
COUNTRY PATENT PC (LN)	0.131	0.466***	0.265	0.422**	0.764***	1.062***	0.384*	-0.032	0.242	-0.165	0.353	0.921***
OIL RENTS (%GDP)	-0.049	-0.061	-0.082*	-0.063	-0.023	0.011	-0.145***	-0.074*	-0.156***	-0.012	-0.064	0.192
INDUSTRY F.E.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
DEAL YEAR F.E.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
# Obs.	7331	7331	7331	7331	7331	7331	7331	7331	7331	7331	7331	7331

E-FAE



Subsidiaries **outperform comparable domestic companies** with respect to # of green patents & # of forward citations.

→ Subsidiaries have a green innovative advantage with respect to domestic companies





- **GDP per capita**

- Relative to domestic companies **the subsidiaries of multinationals are more innovative** when the GDP per capita is lower.

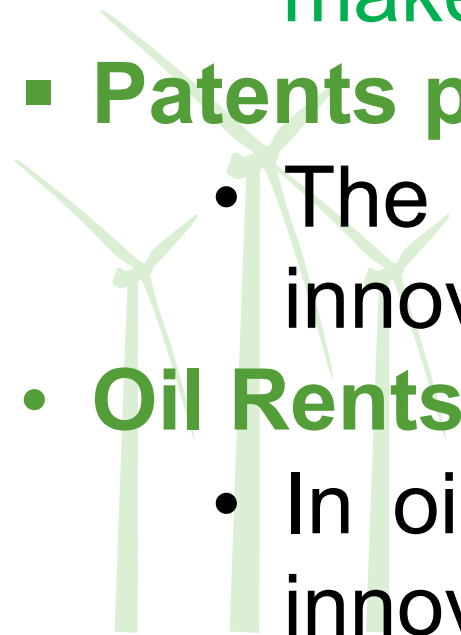
→ In less developed countries being a subsidiary it really makes a difference!

- **Patents per capita**

- The advantage of being a subsidiary is larger in more innovative countries → **better absorptive capacity**

- **Oil Rents (% GDP)**

- In oil-reliant countries, subsidiaries engage less in green innovative activity → **the resource curse hypothesis.**



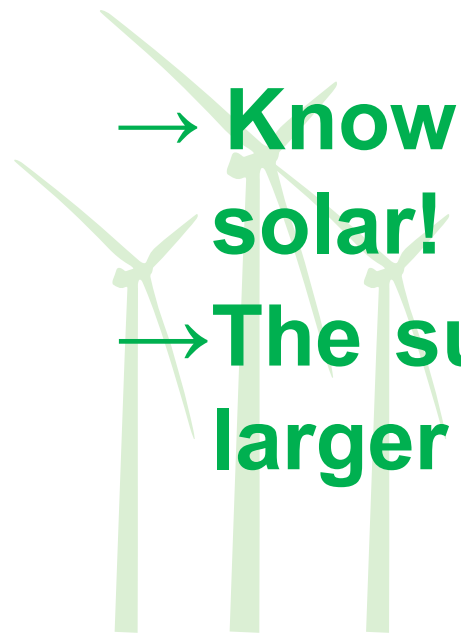
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- **Wind** subsidiaries outperform domestic companies in both outputs;
- **Solar** subsidiaries outperform domestic companies only in forward citations;

→ **Knowledge is more tacit in wind and more codified in solar!**

→ **The subsidiaries' advantage in terms of patent quality is larger in wind than in solar PV.**



MODE OF ENTRY



- **Greenfield investments** outperform domestic companies in terms of forward citations, but not in terms of # of patents.
- **M&A** perform better in terms of both output variables, i.e., the amount and quality of innovation.

→ **G** [Bar chart showing a long horizontal bar with many small segments, representing a high value for Greenfield investments in terms of forward citations.]

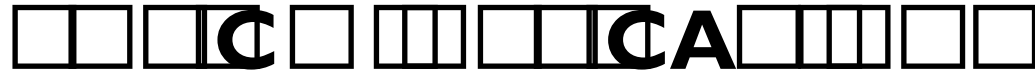
→ **A** [Bar chart showing a long horizontal bar with many small segments, representing a high value for M&A in terms of forward citations.]
[Bar chart showing a shorter horizontal bar with fewer segments, representing a lower value for M&A in terms of patents.]

→ **The gap between subsidiaries and domestic companies in terms of innovative capability is larger in case of acquisitions than in greenfield investments.**

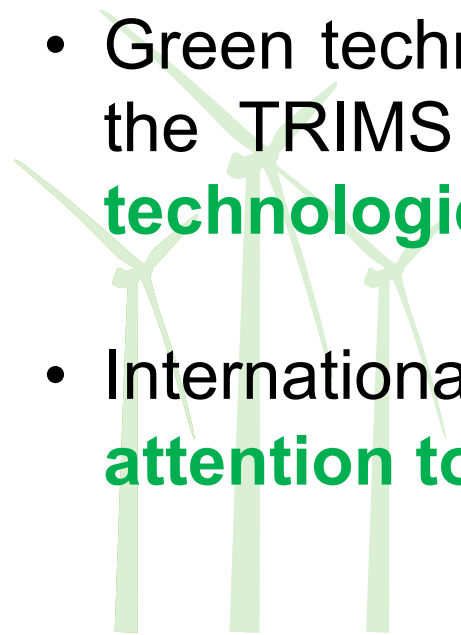
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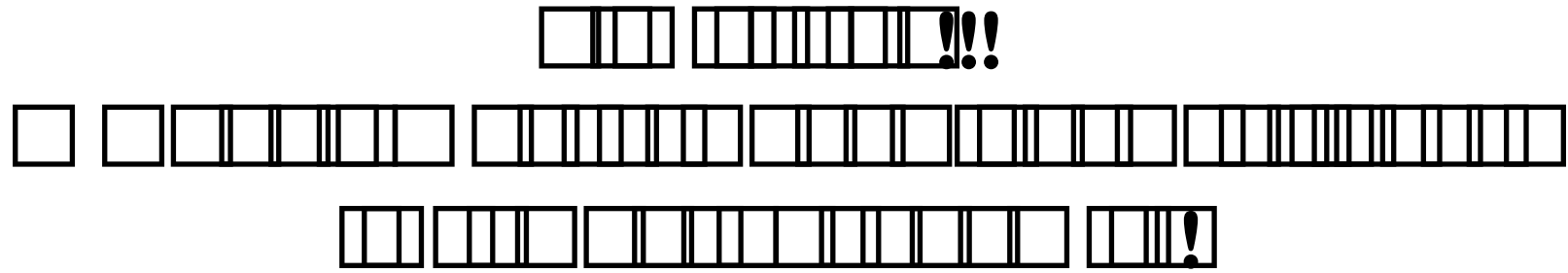


1. Subsidiaries of green MNEs are more innovative than domestic firms with similar characteristics.
2. The green innovative advantage is larger in less developed countries, in particular when they already possess high levels of relevant domestic innovative capacity, as exemplified by the cases of China and India.
3. Firm-level and sectoral characteristics also matter.
 - Green FDI is more effective when technologies are characterized by low tradability and uncodified knowledge, as in wind compared to solar PV industries.
 - Cross-border acquisitions are more efficient at establishing green innovative capabilities than newly established greenfield subsidiaries.

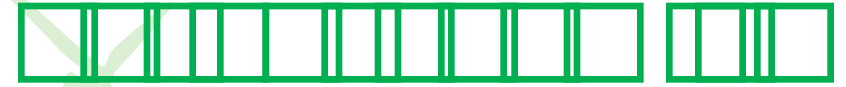
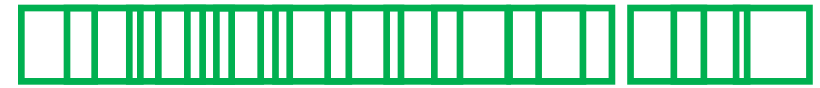
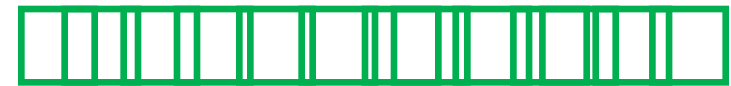


- **Attracting green FDI** countries can enhance their green innovative capacities.
- Policies attracting green FDI should go hand in hand with measures **encouraging knowledge spillovers from MNE subsidiaries to domestic companies**, such as policies including local content requirements and training of the local workforce.
- Green technology transfer should take a more central role in the WTO around the TRIMS agreement, accounting for the **public goods nature of green technologies**, to support their global diffusion through FDI.
- International organizations, such as the UNFCCC, should direct **more attention to FDI as a key channel for green technology transfer**.





G  **FD** 

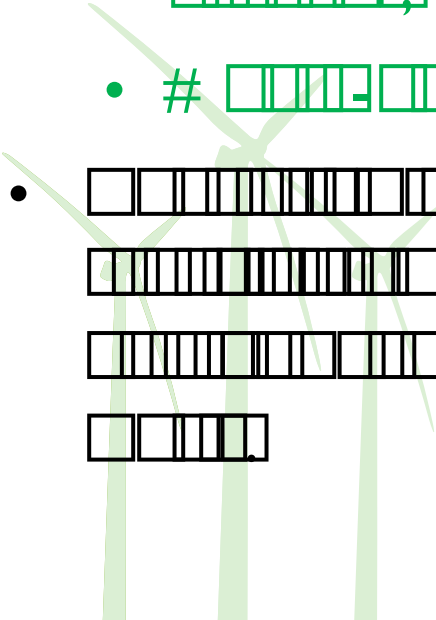


Vito Amendolagine,
Roberta Rabelotti & Dalila Ribaudò





- B (2006) FDI A
[Redacted text]
- E B (2006), (A [Redacted text], 2023; B, 2006; [Redacted text], 2019)
 - # [Redacted text];
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- FDI ([Redacted text]); [Redacted text]
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Thank You!



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