

Green FDI and Technological Spillovers in Host Economies

Vito Amendolagine (The University of Foggia) - Italy,

Roberta Rabelotti (University of Pavia) - Italy,

Dalila Ribaud (Aston Business School) - United Kingdom

Motivation

The paper aims to extend the evidence on the role of green foreign direct investment (FDI) in renewable energy (RE) technologies to spread innovation in the host economies. It is based on two previous articles aimed at exploring the impact of green FDI on the development of green technologies by investors (Amendolagine et al., 2021) and by their foreign subsidiaries (Amendolagine et al., 2023). Here we aim at investigating the relevance of green FDI to trigger technological spillovers in the host economies, by transferring green knowledge to local companies.

The increasing diffusion of RE technologies, such as wind and solar photovoltaic (PV), is key to achieve low-carbon global transition in the energy sector (IRENA, 2019). While countries in Europe have previously been the lead markets, the development and diffusion of RE technologies are increasingly taking place at a global scale, including in several latecomer countries (IEA, 2018b; IRENA, 2020; UNCTAD, 2023).

The international diffusion of RE technologies is key for mitigating climate change (Iyer et al., 2015; Rempel & Gupta, 2021) and multinational enterprises (MNEs) can play an important role in spreading these technologies across borders. Noailly and Refish (2015) show that a large share of green patents worldwide relies on MNEs' cross-border R&D activities. With respect to non-globalized firms, MNEs are in a privileged position to develop green capabilities since they have direct access to relevant pools of green knowledge in the global economy (Maksimov et al., 2019). However, it remains unexplored whether MNEs spread green technologies not only across country-borders but also across firms, going beyond MNEs' boundaries.

Theoretical Background

In general, the literature on FDI spillovers is quite extensive highlighting that FDI can have a positive impact on the productivity and innovation of local firms. One pioneering contribution is provided by Blomström and Kokko (1998), who undertake a comprehensive survey on the literature about MNEs and spillovers. They highlight the potential for knowledge transfer and positive externalities generated by the presence of MNEs in host countries. Their analysis emphasizes the importance of factors such as backward linkages and technology gaps in determining the extent and nature of spillovers. In another key contribution on the topic, Javorcik (2004) focuses on the productivity effects of FDI through backward linkages. Using firm-level data for Lithuanian companies, the study finds evidence of positive spillovers from foreign affiliates to domestic firms., but not in wholly owned foreign investments. Also, the proximity of domestic firms to foreign affiliates enhances their productivity levels, supporting the notion that knowledge diffusion occurs through supply chain relationships. This is confirmed by Gong et al. (2023), who explore the impact of US FDI in China on the productivity of domestic companies. They find that innovation introduced by US MNEs enhances the productivity of local companies co-located in the same provinces as the MNEs' subsidiaries.

With a focus on innovation in FDI host economies, Branstetter (2006) finds that Japanese firms' FDIs in the United States increase the likelihood to license MNEs technology to local firms, and the licensing leads to an increase in the innovative activity of local firms. The author also finds that the impact of FDI on knowledge spillovers is stronger for firms that are more technologically advanced. This is because more technologically advanced firms are more likely to have the absorptive capacity to use and adapt the knowledge transferred by MNEs. More recently, Tan et al (2022) examine the effect of FDI technological spillover on the innovation quality of local enterprises in China. Based on a firm level analysis with patent data, their findings suggest that FDI has a positive impact on the innovation quality of local enterprises, indicating the presence of knowledge spillovers from FDI in the Chinese context.

In the context of environmental technologies, Grafstrom (2018) investigates knowledge spillovers in the wind power industry within the European Union. The paper explores the transfer of knowledge and technology across countries and its impact on the wind power sector. The findings suggest the existence of international knowledge spillovers, highlighting the importance of FDI in facilitating knowledge diffusion in the renewable energy sector.

With a focus on green FDI, Amendolagine et al (2023), show that (i) foreign ownership positively impacts on the companies' innovative capabilities – measured by the quality and quantity of green patents; (ii) this green advantage vis-à-vis domestic companies is larger in less developed countries; (iii) green FDIs are more effective when technologies are characterized by low tradability and a large component of Doing-Using-Interacting (DUI) in knowledge production. Moreover, their analysis shows that that over time, bi-directional knowledge flows based on continuous interactions and learning process may be established (see also Amendolagine et al 2021).

Methodology

In this paper, the empirical analysis is based on an updated version of the green FDI dataset used in Amendolagine et al. (2021) and Amendolagine et al. (2023). Green FDIs are defined as foreign direct investments undertaken by firms with at least one climate change-related technology patent in the following RE technologies: geothermal; hydro; marine; solar (including thermal, solar photovoltaic; solar thermal-PV hybrid); wind; biofuels; and fuel from waste. The database includes 1,261 green FDIs in the period from 1997 to 2020: 69 % greenfield investments and 31 % mergers and acquisitions (M&A).

This paper aims at extending Branstetter (2006) to estimate the impact of green FDIs on two different outputs: (i) the number of citations to foreign investors' green patents by green patents invented in the host economy (as a measure of forward spillover); (ii) the number of citations to green patents invented in the host economy by foreign investors' green patents (as a measure of backward spillover).

The impact is measured at both extensive and intensive margin. The intensive margin is captured through a variable counting the number of green FDI directed to each of the countries where backward/forward citations' foreign first inventors are based, within the time span 1997-2020. The extensive margin is instead measured through a dummy variable taking on value 1 at the year of the first investment (in any country) and 0 otherwise. We estimate this effect excluding self-citations, that is, citing/cited patents are applied for by companies that do not belong to foreign investors' group (i.e. headquarter and its subsidiaries)¹.

¹ Self-citations represent ~5% of the total sample. When do include these in the estimates, results do not significantly vary.

Tests are undertaken both on the full sample and on two sub-samples specific to wind and solar technologies, respectively. Furthermore, the specific role of greenfield-type FDI and cross-border acquisitions is also investigated. Finally, two different macro-level moderating factors are considered: (i) the economic development level of the host economy (measured by GDP per capita); (ii) the stringency of host economies' environmental policies (measured by the OECD Environmental Policy Stringency Index).

Given the count nature of the output variables, the impact of green FDI of technological spillovers in host economies is measured by a negative binomial estimator (Amendolagine et al., 2023; Branstetter, 2006; Piperopoulos et al., 2019).

Preliminary results

Overall, we find evidence that green FDIs increase forward technological spillovers in the host countries, enhancing green innovative activities. Their impact is stronger in case of cross-border acquisitions rather than in greenfield investments and in the wind industry with respect to the solar sector. Furthermore, their impact is more evident in developing economies and in countries with stricter environmental policy. However, there is no evidence of backward spillovers from green FDI.

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