Weekly Summary

Economics of Climate Change

March 1, 2024

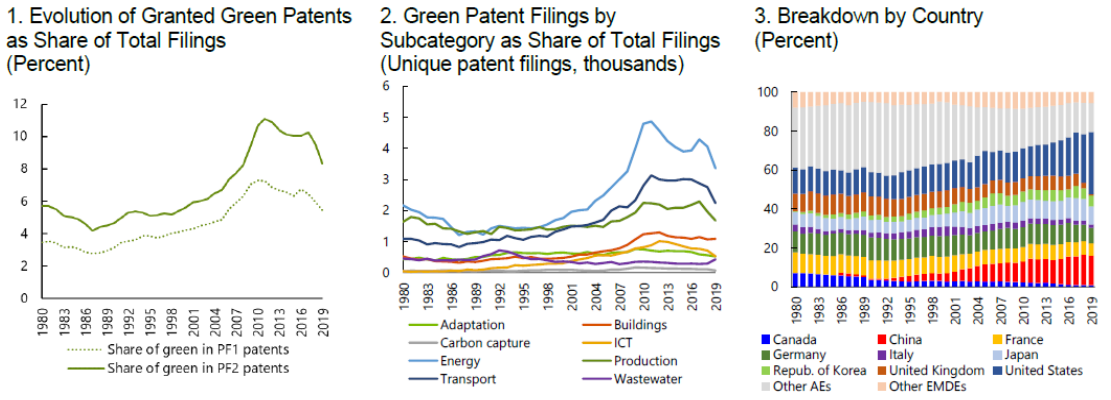
Green Innovation to boost activity and cut emissions

Countries that expand their climate policy portfolio exhibit higher climate change mitigation patent filings, low carbon technology trade flows, and green foreign direct investment flows. The coordination and cooperation of international policies is also very relevant, showcasing evidence of potential climate policy spillovers.

Innovation in low carbon technologies (LCTs), which is essential in the fight against climate change has slowed in recent years. According to an IMF Staff's paper, a global climate policy strategy can bolster innovation in, and deployment of, LCTs.

The trend of green patent filings has shown a consistent rise since the early 1980s, leveling off in recent years. Although the overall volume of patent applications has maintained a steady growth, the proportion of green patents reached a peak in 2010, followed by a slight decline thereafter. Green patents represent on average 6.6% of total filings, and if only those with "family size 2" [1] are considered, they reach 10% of the total, a share between 1.5 and 2 times higher than in 1980 (see **Figure 1.1**).

Figure 1. **TRENDS AND COMPOSITION OF GREEN PATENTS**



Sources: European Patent Office Worldwide Patent Statistical Database (PATSTAT); and Hasna and others (forthcoming).
Note: AE = advanced economy; EMDE = emerging market and developing economy; ICT = information and communications technologies; PF = patent family.

Source: BBVA Research from IMF Staff Discussion Note.

1: Patents filed and granted in at least two application authorities are labeled as "family size 2," which are generally higher quality patents than those of "family size 1", filed and granted in only one application authority.

Most green patents are filed in a few technological subfields and in advanced economies. Among the eight green patent categories analyzed (not mutually exclusive), energy stands out, accounting for 35% of the total, followed by transport and production (see **Figure 1.2**). By country, over 90% of overall green patents were filed in advanced economies during 1980-2000, with more than 60% concentrated in nine countries (Group of Seven, China and Korea). **However, since the 2000s, emerging markets have been gaining momentum** (see **Figure 1.3**).

The deceleration in green patents raises concerns about meeting climate goals. It becomes imperative to accelerate green innovation. The surge in hydraulic fracking, lowering oil prices and diverting focus from renewable energies, alongside the technological maturity in sectors like solar PV, have contributed to this slowdown. Despite the potential of existing technologies to achieve over 80% of required emissions reductions by 2030, a broad innovation slowdown persists. With critical technologies for a net-zero future still undeveloped on early-stages, the urgency to drive green innovation in this decade is crucial.

Green innovation is also essential for economic activity, mitigating the potential costs derived from the compliance with climate policies. An acceleration in green innovation would have a positive impact on economic activity in the short and medium term, buffering direct adverse impacts of climate policies. It also has a positive impact on firm revenues (see **Box 1**).

Box 1. The Economic Impact of Green Innovation

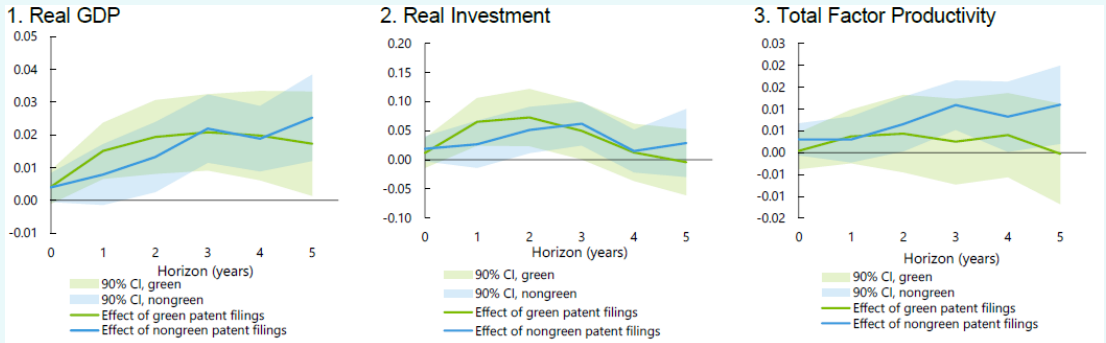
Green innovation can boost medium-term economic growth. An econometric[2] analysis based on patent applications in OECD and BRICS countries for the period 1990-2019, shows that **a 7% increase in climate change mitigation patents leads to a 0.14% rise in GDP** after five years compared to the baseline scenario, achieving its maximum impact after three years.

This pro-growth effect is comparable to that of non green patents and of technological breakthroughs, but **the channels through which they affect growth are different** -green patents work initially mostly through higher investment, whereas non green patents also have a positive short-term impact on productivity (see **Figure 2**).[3] **Green patent filings do not have a significant effect on TFP** over the horizon considered, contrary to what one might expect. This is attributed to *path dependency*[4], since the incorporation of new technologies may initially disrupt existing production processes, thus reducing the potential benefits on TFP in the short and medium term.

In any case, the heterogeneity of countries could be biasing aggregate impacts. It should be noted that the analysis has been carried out at an aggregate level for a set of very heterogeneous countries, both in green innovation and in economic development and policies. This could lead to biases, limiting the meaningfulness of the results. Thus, it would be advisable to **group countries according to energy dependence, income level**,... and estimate in each group the impact of green and non-green innovation on economic and business activity.

2: Details on econometric specifications and additional results are found in online Annexes II and III, respectively.
3: These estimates represent a lower bound, as they double when controlling for climate policies and quadruple when instrumenting national patent applications to control for the possible opposite effect.
4: Arguments raised by Acemoglu and others (2020) and Aghion and others (2014).

Figure 2. **IMPACT OF GREEN AND NONGREEN PATENTS ON ECONOMIC ACTIVITY (%)**

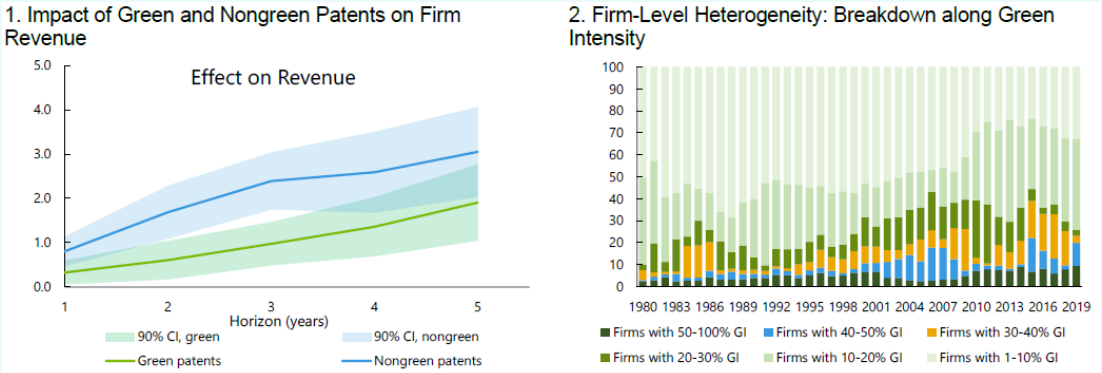


Sources: European Patent Office Worldwide Patent Statistical Database (PATSTAT); and Hasna and others (forthcoming, a).
Note: The analysis is based on a local projection framework in which the dependent variable is the log difference in real GDP over the horizon considered and the independent variable is the logarithm of green patent filings. For more details on the econometric specification and additional controls see Online Annex II. CI = confidence interval.

Source: BBVA Research from IMF Staff Discussion Note

At the firm level, green patents boost revenue but not as much as non green patents, **which may also reflect path dependency** (see **Figure 3.1**).[5] Indeed, most firms introducing green patents exhibit a low green intensity, defined as a firm's ratio of green patents to total patents (see **Figure 3.2**). This suggests that most firms still rely on non green technology, and that the productivity benefits of emerging green technologies may require time to fully materialize, as production processes adjust progressively.

Figure 3. **GREEN PATENTS AT THE FIRM LEVEL: IMPACT AND GREEN INTENSITY (%)**



Sources: Compustat; Hasna and others (forthcoming, b); and US Patent Trademark Office.
Note: In panel 1, the analyis is based on firm-level local projections in which the dependent variable is the log difference in firm revenue and the independent variables of interest are the the citation-adjusted firm-level patent flows divided by the firm's book value. For more details on the econometric specification and additional controls in each panel, see Online Annex II. CI = confidence interval; GI = green intensity.

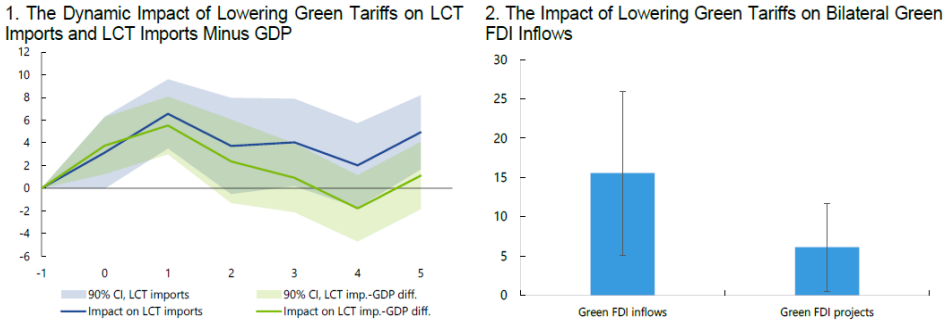
Source: BBVA Research from IMF Staff Discussion Note.

5: The analysis is based on US public firms. A one standard deviation increase in the quality-adjusted measure of patents held by firms yields a 2% increase in revenue after five years.

Domestic and international climate policies significantly bolster green innovation, with a notable increase in green patent filings following enhancements in such policies. The impact of global climate policies and international agreements, like the Kyoto Protocol and Paris Agreement, is even more pronounced than domestic measures, underscoring the importance of policy certainty, global market scale, and technological spillovers in driving innovation.

Furthermore, the implementation of climate policies catalyzes the deployment of low-carbon technologies (LCTs) through enhanced trade and foreign direct investment (FDI), particularly benefiting emerging markets and developing economies without dampening overall FDI. However, the landscape is complicated by protectionist measures that might hinder LCT diffusion amid rising geopolitical fragmentation (see **Figure 4**).

Figure 4. **THE IMPACT OF TRADE POLICIES ON LCT TRADE AND GREEN FDI** (%)



Source: Climate Policy Database; IMF climate policy dashboard; United Nations Conference on Trade and Development (UNCTAD) Trade Analysis Information System (TRAINS) database; and IMF staff calculations.
Note: Panel 1 plots the estimated impact of a one standard deviation change in tariffs from two local projections: one of the log difference of real LCT imports at different horizon and its pre-shock level and one of the log difference of LCT imports and GDP. Panel 2 shows the impact of a one standard deviation change in tariffs on bilateral green FDI (values and projects) from gravity estimations. Additional details are in Online Annex II. CI = confidence interval; diff. = difference; imp. = imports; LCT = low-carbon technology.

Source: BBVA Research from IMF Staff Discussion Note

International coordination and cooperation are also crucial to accelerate innovation. International coordination amplifies the positive impacts of innovation, with advanced economies' climate policies fostering LCT deployment globally, albeit with nuanced effects due to green subsidies potentially conflicting with global climate goals. These dynamics underscore the **balance required in policy formulation to mitigate negative externalities, avoid protectionist pitfalls, and harmonize domestic initiatives with international standards**, ensuring that the pursuit of green innovation and LCT diffusion does not exacerbate global inequalities or stymie technological transfer to less developed nations.

In summary, innovation can boost medium-term economic growth, stimulating investment and productivity. A more granular analysis by groups of countries would be advisable, since the high heterogeneity between them could be biasing the quantitative aggregate results. Green innovation and LCT deployment require more climate policy and lower trade costs, at the same time that international coordination will be crucial to accelerate innovation, showcasing evidence of potential cross-border spillovers.

Highlights of the Week

- **Global | The Frontiers of Knowledge Award goes to Partha Dasgupta for defining the field of environmental economics by incorporating and quantifying the social value of nature.** The BBVA Foundation Frontiers of Knowledge Awards in Economics, Finance and Management has gone in this sixteenth edition to Partha Dasgupta (University of Cambridge) for laying the foundations of environmental economics, through his pioneering work "on the interaction between economic life and the natural environment, including biodiversity," said the committee in its citation.
- **Global | Major growth of clean energy limited the rise in global emissions in 2023 - News - IEA.** Global energy-related CO2 emissions increased as exceptional droughts hit hydropower, but rise was lower than in 2022 thanks to expansion of technologies such as solar, wind & EVs
- **US | Climate tax policy reform options in 2025 | Brookings.** The combination of scheduled expirations of lower tax rates, fiscal pressures, and unmet climate targets suggests that a range of climate policy options could be under consideration.
- **Europe | Unity in power, power in unity: why the EU needs more integrated electricity markets.** Electricity market integration has substantial benefits that will improve the resilience and enable the transition of Europe's energy system.

DISCLAIMER

The present document does not constitute an “Investment Recommendation”, as defined in Regulation (EU) No 596/2014 of the European Parliament and of the Council of 16 April 2014 on market abuse (“MAR”). In particular, this document does not constitute “Investment Research” nor “Marketing Material”, for the purposes of article 36 of the Regulation (EU) 2017/565 of 25 April 2016 supplementing Directive 2014/65/EU of the European Parliament and of the Council as regards organisational requirements and operating conditions for investment firms and defined terms for the purposes of that Directive (MIFID II).

Readers should be aware that under no circumstances should they base their investment decisions on the information contained in this document. Those persons or entities offering investment products to these potential investors are legally required to provide the information needed for them to take an appropriate investment decision.

This document has been prepared by BBVA Research Department. It is provided for information purposes only and expresses data or opinions regarding the date of issue of the report, prepared by BBVA or obtained from or based on sources we consider to be reliable, and have not been independently verified by BBVA. Therefore, BBVA offers no warranty, either express or implicit, regarding its accuracy, integrity or correctness.

This document and its contents are subject to changes without prior notice depending on variables such as the economic context or market fluctuations. BBVA is not responsible for updating these contents or for giving notice of such changes.

BBVA accepts no liability for any loss, direct or indirect, that may result from the use of this document or its contents.

This document and its contents do not constitute an offer, invitation or solicitation to purchase, divest or enter into any interest in financial assets or instruments. Neither shall this document nor its contents form the basis of any contract, commitment or decision of any kind.

The content of this document is protected by intellectual property laws. Reproduction, transformation, distribution, public communication, making available, extraction, reuse, forwarding or use of any nature by any means or process is prohibited, except in cases where it is legally permitted or expressly authorised by BBVA on its website www.bbvaresearch.com.

ENQUIRIES TO:
BBVA Research: Azul Street, 4. La Vela Building – 4th and 5th floor. 28050 Madrid (Spain).
Tel. +34 91 374 60 00 y +34 91 537 70 00 / Fax (+34) 91 374 25
www.bbvaresearch.com