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The political extremes and innovation: How support for extreme parties shapes overall and green scientific research and technological innovation in Europe

Andrés Rodríguez-Pose [a,*], Zhuoying You [b], Peter Teirlinck [c]

[a] Cañada Blanch Centre and Department of Geography and Environment, London School of Economics, London, UK
[b] School of Digital Economy and Management, Fuyao University of Science and Technology, Fuzhou, China
[c] Department of Management, Strategy, and Innovation, KU Leuven, Leuven, Belgium

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ABSTRACT

This paper explores the relationship between support for extreme political parties and research and innovation across regions in the European Union (EU). Extreme parties often exhibit deep scepticism towards expertise and science, with extreme right-wing parties, in particular, challenging the legitimacy of climate change; an attitude that may weaken green research and innovation. We draw on data from 1137 EU regions —including scientific publication and patent records— and apply Tobit regression models to find that stronger support for extreme parties is associated with lower levels of scientific research and technological innovation, both overall and in their green forms. While this pattern is visible across the political spectrum, important differences emerge. Support for extreme right-wing parties is consistently tied to reduced research output and innovation performance, particularly in green technological sectors. By contrast, the relationship with extreme left-wing support is more variable, depending on the degree of radicalism, and shows no consistent negative connection with green innovation.

1. Introduction

Radicalism is resurgent in Europe. Since the Brexit referendum and the 2016 U.S. presidential election, the political fringes have been steadily encroaching on the mainstream. In the last two electoral cycles —2013-2018 and 2018–2022— the vote share for extreme parties[1] in national legislative elections climbed from 19 % to 22 % across the EU (Fig. 1). For the most radical elements, support jumped from 9 % to 12 %. Parties once dismissed as marginal —i.e., *Fratelli d'Italia* and *Lega Nord* in Italy, *Rassemblement National* in France, the Sweden Democrats, *Alternative für Deutschland*— have gained ground on the right. On the left, movements like *La France Insoumise* or *Bündnis Sahra Wagenknecht* have also expanded. Some have crossed from insurgency into incumbency: *Fidesz* in Hungary, *Syriza* in Greece, *Fratelli d'Italia*, or the Party for Freedom in the Netherlands.

The political rise of the extremes —many cloaked in populist rhetoric— has drawn ample scholarly attention (Mudde, 2004; Norris and Ronald, 2019; Hopkin, 2020; Berman, 2021). But what this ideological drift means for science, research, and innovation remains curiously underexplored (Rodríguez-Pose, 2020; Rodríguez-Pose et al., 2023). As these parties alter the policy environment, their influence is felt not only in legislative chambers but also in the laboratories, research centres, and tech ecosystems across Europe. Their presence shapes R&D investment, disturbs the climate in which scientists operate, and may ultimately hinder progress in both conventional and green technological domains (Wang et al., 2019).

Extreme parties —whether left or right— share a familiar script: anti-establishment, anti-elite, and fiercely illiberal (Cutts and Goodwin,

* Corresponding author.
E-mail addresses: a.rodriguez-pose@lse.ac.uk (A. Rodríguez-Pose), zhyingyou@gmail.com (Z. You), peter.teirlinck@kuleuven.be (P. Teirlinck).

[1] To measure extreme voting, this article draws on data from the Chapel Hill Expert Survey (CHES) (Jolly et al., 2022), widely regarded as the leading source on European political party positions. The CHES provides detailed assessments of parties' ideological placements, including left–right positioning and the salience of anti-elite rhetoric, alongside stances on key economic, social, and policy issues. For details on how these data are operationalised, and which parties are classified as extreme or more-radical extreme, see the methodology section. But it is worth noting that the degree of extremeness of political parties have changed over time. A full list of parties included in the analysis is provided in Table B1 in the Appendix.

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2014; Hopkin, 2020). Populist flair often accompanies a deep distrust of experts. Donald Trump, already in his 2016 campaign, gave the game away: "The experts are terrible… Look at the mess we're in with all these experts" (Politico, 2016). Marine Le Pen quipped during the 2022 French presidential campaign that she intended to consult "the only expert Emmanuel Macron has never consulted: the people" (BFMTV, 2022).

This suspicion bleeds into attitudes towards science and technology. Right-wing extremists, in particular, tend to see scientific institutions not as engines of progress but as outposts of elite conspiracy. The result? A corrosive effect on the research environment. Jair Bolsonaro, as Brazil's president, dismissed Covid-19 risks, derided protective measures, and undermined the science behind vaccination (Farias et al., 2022). During his first term in office, Donald Trump floated the idea of injecting disinfectant to combat the virus (BBC, 2020). Left-wing extremes are often no less suspicious of scientific authority —especially in domains like health and biotechnology— but tend to stop short of offering bleach as policy (National Academies of Sciences, 2017).

The consequence has been a re-politicisation of science. Once safely technocratic, discussions of innovation are now battlefield terrain (Mudde, 2004; Hopkin, 2020; Schwarzenegger, 2021). Scientific knowledge is framed not as truth, but as just another "way of knowing" (Holt, 2018; National Academies of Sciences, 2017). Innovation itself is questioned: who benefits, who profits, and who decides? (Nature, 2017a; Borins, 2018). In regions where extreme parties gain traction, governments come under pressure to reallocate public spending away from R&D and towards culture wars, immigration crackdowns, or anti-globalisation crusades. The results are research budgets trimmed, the social standing of scientists eroded, promising minds diverted, and the broader value of innovation questioned (Nature Microbiology, 2017; Vihma et al., 2021).

Extreme parties may share a set of political traits but their ideologies diverge sharply when it comes to climate change. Extreme right-wing parties have made climate scepticism something of a calling card (Funk and Kennedy, 2016), a stance that may carry serious implications for the scientific and technological effort needed to combat global warming.

The urgency of this effort has never been clearer. Climate change is steaming ahead and, in response, the European Commission has pledged to achieve net-zero greenhouse gas emissions by 2050 (European Commission, 2019). Yet the reforms needed to deliver on this ambition have provoked backlash. Extreme right-wing parties across the continent have increasingly positioned themselves as opponents of climate initiatives (Huber, 2020; Rodríguez-Pose and Bartalucci, 2024).

While their flavour of climate scepticism varies —from outright denialism (as in the Sweden Democrats) to a more conservative or nationalist variant (seen in the Danish People's Party and the Finns Party)— these parties consistently exhibit far less enthusiasm than their mainstream counterparts for action on climate change (Mudde, 2004; Forchtner et al., 2018; Vihma et al., 2021). Some take their cue from conspiracy theories, branding global warming as a hoax foisted on the public by liberal elites. The Sweden Democrats and the Dutch Party for Freedom, for instance, have both questioned the reality of climate change outright (Vihma et al., 2021).

This rift was visible in France's 2022 presidential contest. While President Emmanuel Macron championed a "complete renewal" of the green agenda, Marine Le Pen decried the European Green Deal as excessively restrictive (Euronews, 2022; Reuters, 2022). As such polarised narratives proliferate, the scientific consensus on climate change becomes politicised, and policy becomes more difficult to sustain.

More broadly, the discourse of extreme parties poses a fundamental challenge to any type of scientific research (Böhmelt et al., 2016; Cann and Raymond, 2018; Forchtner et al., 2018; Vihma et al., 2021; Fiorino, 2022). Their rise is symptomatic of a broader ideological shift. One that can distort R&D priorities, drain funding, and undercut innovation capacity (Wang et al., 2019). And while it is increasingly evident that such movements affect the climate for science and technology, concrete evidence of their implications remains scarce.

To date, there has been no systematic scholarly investigation into how support for extreme parties —particularly those peddling science-

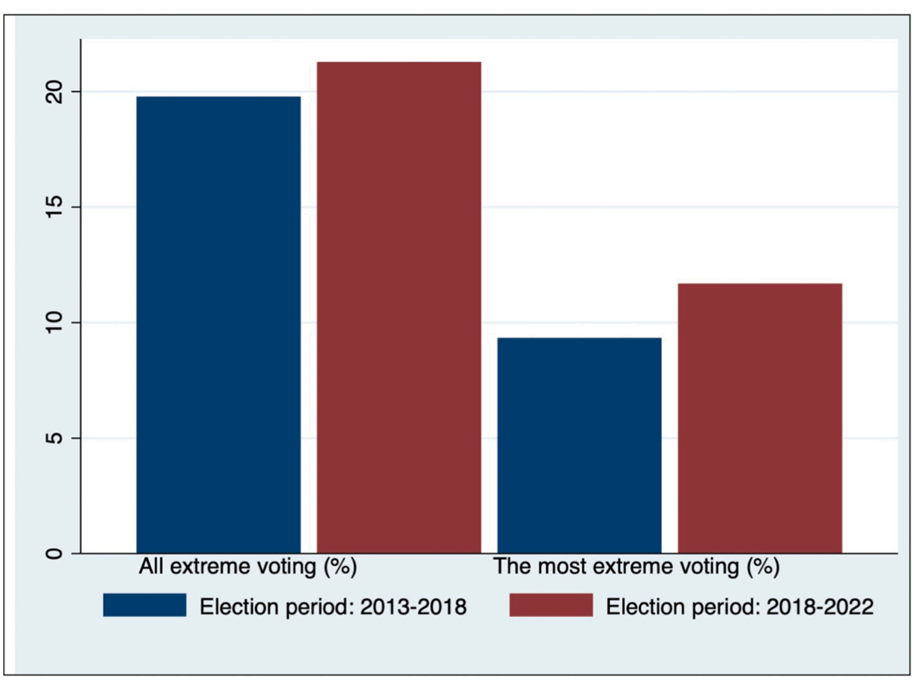

Fig. 1. The rise of extreme voting in Europe over election periods.
Notes: The scale of 1 to 10 represents the extent of support for certain political movements, measured as the percentage of supporters relative to the total population within specific regions. When the scale falls below 1 or rises above 9, it is classified as support for parties at the extremes of the political spectrum (Carter, 2013). If the scale decreases to a less extreme range —below 2 and above 8— this is considered a broader measure of such political support, encompassing all extreme left-leaning and right-leaning parties.

or climate-sceptical rhetoric— relates to research and innovation. This paper aims to help close that gap. It asks: Is rising support for extreme parties negatively associated with scientific research and technological innovation, especially in their green variants? And is this relationship more strongly negative in the case of climate-sceptical, extreme right-wing parties than for their left-wing counterparts?

To answer these questions, we draw on a newly constructed dataset encompassing 1137 regions (NUTS3) across the European Union (EU). We combine voting data with indicators of scientific research and technological innovation, including their green variants, and estimate Tobit and OLS models. Our findings point to a consistent pattern: extreme voting is negatively associated with both scientific research and green research, as well as with technological and green technological innovation. However, the strength and consistency of these associations vary by political orientation. Support for extreme right-wing parties —whether radical or more moderate— is generally linked to reduced scientific and technological output. The evidence for extreme left-wing parties is present but less conclusive. In particular, support for extreme right-wing parties correlates strongly with lower levels of green research and innovation. The effects of left-wing extremism are more heterogeneous, depending on the degree of radicalism involved.

This paper makes three contributions. First, it examines the under-explored relationship between political extremism and regional research and innovation, distinguishing clearly between left- and right-wing parties. Second, it brings fresh empirical insight to the politics of regional science and technology. Third, it addresses the political obstacles to the EU's green transition, offering early but policy-relevant implications.

The paper proceeds as follows: Section 2 reviews the literature on extreme voting in Europe and sets out the theoretical mechanisms underpinning our hypotheses. Section 3 details our methodology. Section 4 presents the empirical results. Section 5 offers conclusions and discusses the wider implications.

2. Extreme voting, research and innovation

2.1. The rise of the extremes across regions in Europe

Extreme parties sit at the far ends of the political spectrum, often tracing their ideological lineage to moments of instability and authoritarian temptation. Historically, their emergence has been linked to totalitarian movements —most infamously, the rise of Nazism in Germany— rooted in deep distrust of government and intent on dismantling the existing political order (Powell Jr, 1986; Brustein, 1997). But today's extremes are not simple replicas of the past. Rather than reviving fascism wholesale, they represent a "new" branch of radical politics: nationalist, authoritarian, and populist, but generally stripped of overt fascist associations (Ignazi, 1992; Mudde, 1996).

Much of the existing literature distinguishes extreme parties by comparing them to more familiar political actors: mainstream or centrist formations (see Table A1.1). Unlike their mainstream counterparts, extreme parties prioritise issues such as immigration, national identity, and institutional trust. They pair this with populist rhetoric, rejection of liberal values, and resistance to the current economic and political order, albeit to varying degrees (Aichholzer et al., 2014; Enders and Uscinski, 2021; Carvalho, 2023). While populists may rage against elites, extreme parties go further, often adopting more radical tactics (Wagner, 2012; Charron et al., 2023). Their appeal is also coloured by historical grievance: resentment fuelled by collective memory and perceived neglect (Fontana et al., 2023).

That said, their exact positions are far from uniform. National context matters. Party strategies are shaped by local welfare regimes, electoral rules, and exposure to international finance (Cutts and Goodwin, 2014). But despite such variation, extreme left- and right-wing parties share key traits.[2] Both reject globalisation, spurn liberalism, and blame social and economic dysfunction on external or internal "others", including migrants, institutions, or imagined elites (Rodríguez-Pose, 2020).

For the purposes of this paper —and in line with definitions used by Ramiro (2016) and Rooduijn et al. (2017)— we classify extreme parties as those that are anti-establishment, anti-elite, and anti-liberal, especially on matters of law, order, and authority. Many also harbour nationalist impulses, regardless of their left-right positioning.

According to the Chapel Hill Expert Survey (CHES), the ideological platforms of extreme left and right parties often show surprising overlap (Jolly et al., 2022; see Section 3.1.2 and Tables C2 and C3). Both ends of the spectrum are typically led by populist figures who cast themselves as champions of the "real people" in a struggle against corrupt elites (Carvalho, 2023). Their political narratives are couched in binary terms —"us" versus "them"— a framing that mirrors the classic populist playbook (Ignazi, 1992; Mudde, 2004).

At an ideological level, extreme parties tend to be sceptical of global trade, critical of economic liberalism, and staunchly opposed to the pro-market consensus that underpins most mainstream platforms (Hopkin, 2020).

Their rise, too, follows a familiar pattern. It is tightly correlated with economic insecurity, long-term industrial decline, and the sense of being "left behind" (Dijkstra et al., 2020). Supporters tend to be older, lower-income, and working-class —many of them men— who feel that their interests have been ignored by a political establishment more concerned with liberal reforms than local grievances (Goodwin and Heath, 2016; Hopkin, 2020). Economic downturns and high unemployment have only deepened this discontent, fuelling support for parties that promise rupture rather than reform (Rodríguez-Pose et al., 2021a).

In this climate of uncertainty, extreme rhetoric finds fertile ground. Disinformation spreads easily, and suspicion of experts —especially in science and policy— becomes a political asset rather than a liability (Wagner, 2012; Enders and Uscinski, 2021). The result is a volatile mix of populism and antiscientific sentiment, which helps drive both the rise and the radicalisation of the extremes.

Yet for all their shared traits, extreme parties diverge sharply across the ideological spectrum. The extreme right —to a greater extent than its left-wing counterparts— is defined by an explicit and often exclusive rejection of democratic norms. This rejection is usually framed through a blend of nativism, anti-system sentiment, and populist rhetoric. These features clearly distinguish these parties from the more measured conservatism of mainstream right-wing actors (Ignazi, 1992; Mudde, 1996; Carter, 2018; Arzheimer and Berning, 2019).

Extreme right-wing parties typically adopt strong anti-immigration platforms and appeal to narrowly defined segments of the electorate: those with perceived cultural, economic, or national grievances (Cutts and Goodwin, 2014; Guglielmi, 2022). They reject permissive immigration policies, champion traditional values over progressive causes,

[2] We conceptualise extreme parties by focusing on key social issues, recognising that capturing every aspect of their ideology across all domains is impractical. According to the CHES codebook, these parties typically prioritise immigration, social and cultural values, anti-establishment sentiment, and environmental policy (see Section 3.1.2 and Tables C2 and C3 in Appendix C). These priorities form the backbone of their political agendas and provide a basis for identifying shared characteristics across ideologically diverse parties.

While distinctions between left- and right-wing extremes can be nuanced —particularly given occasional overlaps in issue positions— this paper highlights their commonalities in order to examine their broader impact. Specifically, we consider how these ideological orientations relate to research and innovation, influencing policies tied to scientific progress and technological development. Recent studies have illustrated these dynamics across a variety of party cases (see Table A1.2). By identifying shared ideological traits, we aim to shed light on how the rise of extreme parties shapes the political context within which research and innovation agendas are formed.

and often weave nationalism tightly into their discourse. This ideological package is visible in parties such as France's *Rassemblement National*, Portugal's *Chega*, and Germany's *Alternative für Deutschland* (Mudde, 2004; Carvalho, 2023).

In contrast, extreme left-wing parties tend to focus their firepower on economic liberalism. They champion strong state intervention and target economic inequality as a core issue (Hopkin, 2020). Distinct from mainstream centre-left parties, these groups often integrate environmental concerns, gender equality, and anti-globalisation sentiment into their platforms. Greece's Coalition of the Left and Progress (*Syriza*) offers a case in point, alongside others like *La France Insoumise* or *Bloco de Esquerda* (March and Mudde, 2005; Ramiro, 2016; Norris and Ronald, 2019).

Territorial inequality also plays a role in shaping electoral outcomes. Extreme parties often find fertile ground not in dynamic urban centres, but in 'left behind' regions marked by economic decline and diminished opportunity (Guiso et al., 2017; Hopkin, 2020; Rodríguez-Pose, 2020; Rodríguez-Pose et al., 2023). Fig. 2a and b map this trend. Between 2013 and 2018, support for extreme parties exceeded 50 % in some areas, reaching peaks of 60 % (Fig. 2a). Hotspots included France, Hungary, East Germany, and southern Portugal. At the other end of the spectrum, more radical extreme parties attracted less than 5 % support in countries such as Bulgaria, Croatia, Ireland, Estonia, Lithuania, and Spain (Fig. 2b).

Fig. 3a and b focus on extreme left-wing parties. *La France Insoumise* achieved more than 20 % in several French regions (Fig. 3a). In southern Portugal, both *Bloco de Esquerda* and the Portuguese Communist Party drew notable support, while *Die Linke* retained a significant base in the former East Germany.

Support for extreme right-wing parties shows a striking concentration in central Europe (Fig. 4a and b). In Hungary, *Fidesz* regularly polled above 30 % in national legislative elections, while the more extreme *Jobbik* also attracted a considerable share of the vote. Similar levels of backing were evident in eastern France for *Rassemblement National*, in East Germany for *Alternative für Deutschland*, and in the Netherlands for the Party for Freedom.

2.2. The rise of extreme voting, research and innovation

2.2.1. How the rise of extreme voting can undermine overall scientific research and technological innovation

How is the rise in support for extreme parties associated with perceptions of science and technology-related policies across the EU? In this section, we explore the connection between political support for the extremes and overall scientific research and technological innovation. Anti-intellectual sentiment runs deep in many extreme ideologies (Borins, 2018). A defining characteristic of these movements is scepticism —often hostility— towards the value and contribution of established scientific research and technological development. This attitude can have damaging effects, particularly in sensitive fields such as genetically modified organisms, vaccination, and climate change, where scientific consensus clashes with political ideology (Farias et al., 2022).

Such disdain for science may erode research and innovation in two ways. First, when extreme parties come to power, they frequently enact policies that directly undermine scientific institutions. These include slashing funding, curbing academic independence, and impeding cross-border collaboration (Wang et al., 2019). Second, even without holding office, these parties contribute to a broader erosion of trust in expertise. Their rhetoric often questions the legitimacy of scientific progress, presenting it as self-serving rather than socially beneficial (Enders and Uscinski, 2021).

In this narrative, publications and patents become suspect, dismissed as products of "so-called" science, which in their view is publicly or privately funded in order to line the pockets of elites, not to serve the common good (Baker, 2016). The damage is not hypothetical. In the U. S., the first Trump administration systematically dismantled environmental and public-health regulations and destabilised scientific institutions, creating long-lasting harm (Tollefson, 2020). The second Trump administration is going considerably further, threatening not only funding but also the very principle of freedom. Similar patterns have emerged elsewhere. In Mexico, President López Obrador repeatedly cast scientists as elitist and corrupt, demoralising the scientific community and discouraging public support for their work (Gutiérrez Jaber, 2021).

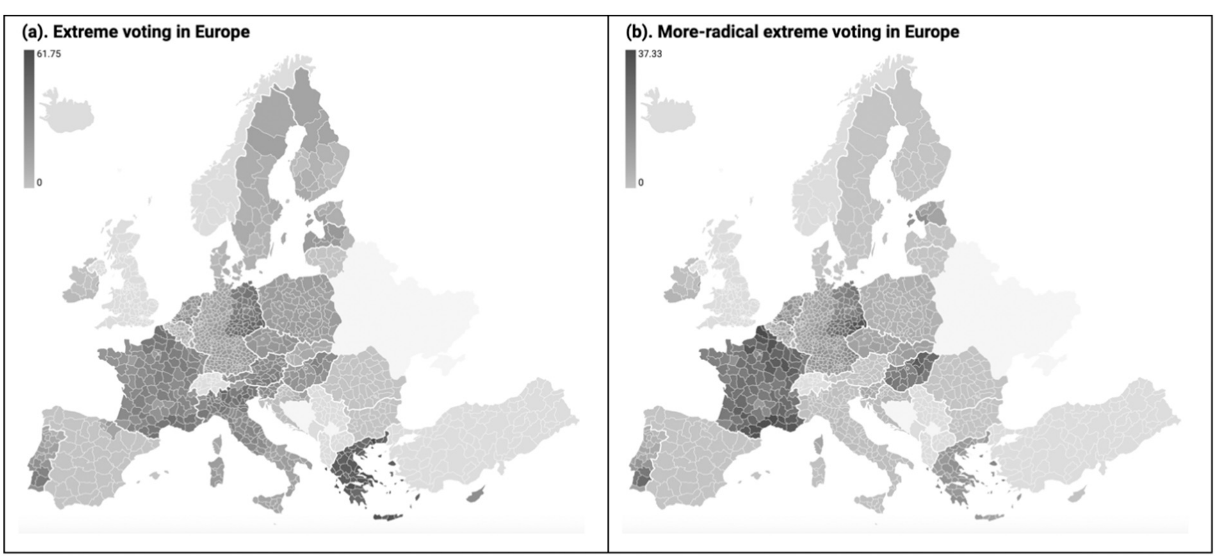

Fig. 2. Geographical distribution of extreme party voting (%) in EU regions (2013–2018).

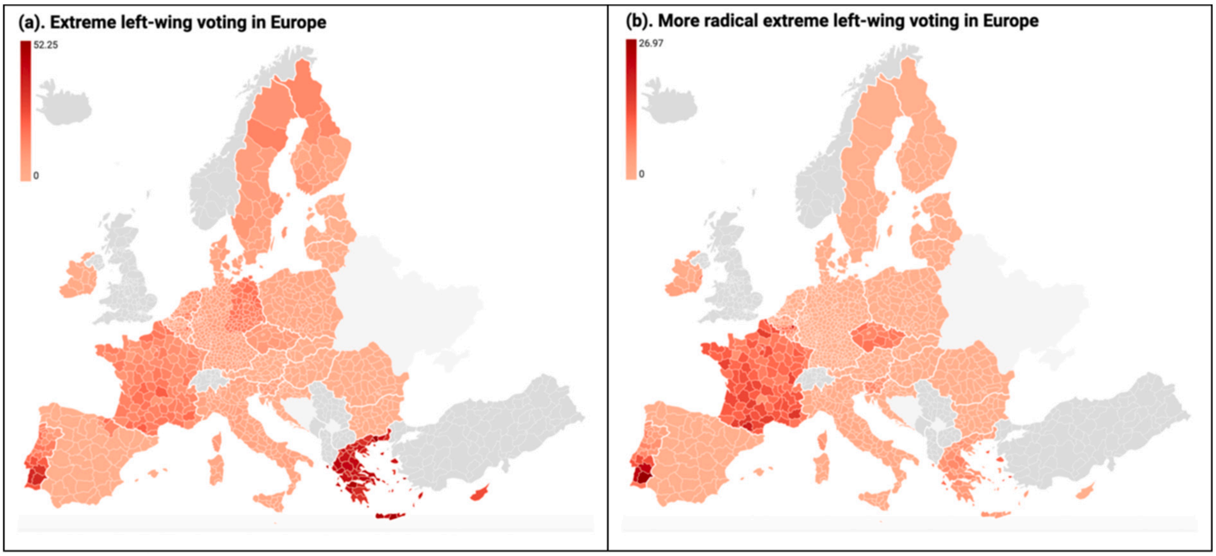

Fig. 3. Geographical distribution of extreme left-wing voting (%) in EU regions (2013–2018).

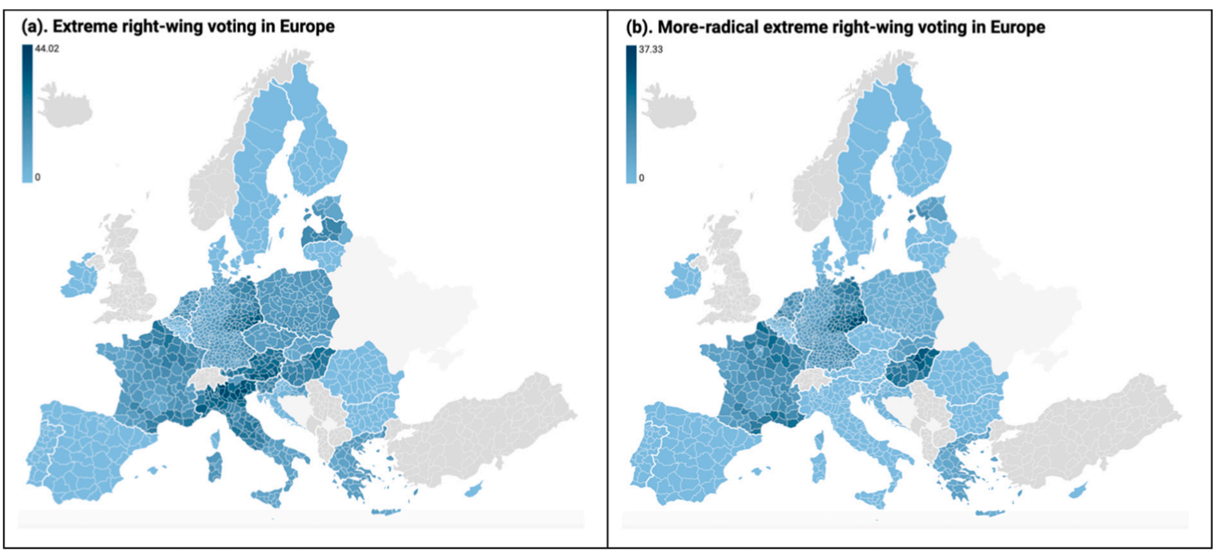

Fig. 4. Geographical distribution of extreme right-wing voting (%) in EU regions (2013–2018).

In Argentina, President Javier Milei has enacted sweeping budget cuts that directly threaten the financial sustainability of scientific research (Orfila, 2023). Where extreme parties govern, the consequences for science tend to be immediate and far-reaching. Research independence is frequently compromised. Under the first Trump presidency, political interference in federal research became commonplace, bending or ignoring scientific knowledge to suit political aims (Nature Methods, 2020: 949). Such actions not only disrupt scientific discovery but corrode public confidence in the results it yields.

Mobility and international collaboration are also vulnerable (Henn & Hannemann, 2023). The Trump administration's restrictive visa policies and travel and enrolment bans for foreign researchers and students are widely detrimental to science. They undermine a system that, as noted in Nature Methods (2020: 949), "critically depends on an influx of foreign-born scientists." Similar consequences were observed in Switzerland, where tighter immigration rules, adopted via referendum, posed obstacles to research cooperation (Nature, 2014).

Importantly, these effects are not limited to governments in power. Even outside office, extreme parties shape the scientific landscape by altering public discourse. As Nature (2017b: 149) noted of Dutch populist Geert Wilders, his party had "not needed to govern to have an impact on science." His campaign alone was enough to steer the national agenda towards populist priorities and foster scepticism towards expertise.

By spreading suspicion of research and expertise, and casting doubt on the very value of scientific knowledge, extreme parties contribute to a steady decline in public trust. This may be their most potent weapon. Enders and Uscinski (2021) and Guglielmi (2022) argue that delegitimising scientific institutions is a central, if subtle, mechanism through which extreme ideologies reshape the research environment.

Donald Trump's first presidency remains a case study in this strategy. As *Nature* (2017a: 435) observed, "rejecting mainstream science has become a theme for Trump." The consequences were profound. Disdain for science became a badge of authenticity, a signal that the speaker represented ordinary people against an allegedly out-of-touch scientific elite. Extreme parties frequently cast themselves in this role, increasing public mistrust and marginalising the institutions best positioned to advance innovation and address complex societal challenges (Nature, 2017b: 150).

When placed under the public spotlight, this persistent distrust of science, scientists, universities, and research institutions by extreme parties not only undermines confidence in research but also leads to undercutting funding and institutional support. While such trends are becoming well-documented in the U.S., they are also increasingly visible in Europe.

In the Netherlands, the rise of right-wing populism has brought Dutch universities and research institutions under growing scrutiny. International programmes and policies have faced public challenge as political hostility towards globalisation gains ground (Nature, 2017b: 150). In France, the ascent of the extreme right has provoked alarm in the scientific community. As one commentator warned, "French science … would not survive a withdrawal behind our frontiers and restrictions to the circulation of brains and ideas" (Pain, 2017). This concern is especially pronounced in regions such as Pas-de-Calais, where support for the extreme right and campaigns against globalisation have contributed to rejection of EU research frameworks, isolating local innovation systems. In Italy, the Meloni government has stoked similar fears. As Guglielmi (2022: 245) notes, "some researchers now worry that under the new [Meloni] government, funding for public research will be slashed further." In northern regions like Veneto and Lombardy, strong nationalist currents have combined with protectionist sentiment to curtail international researcher mobility and deepen academic isolation.

The digital age has further accelerated the spread of anti-scientific views. Extreme parties and their supporters have turned social media into a potent tool for waging culture wars, circulating scientific disinformation, and stoking public agitation (Kahan et al., 2011; Holt, 2018; Schwarzenegger, 2021; Yazar and Haarstad, 2023). Dubious claims about scientific "truths" —often emotionally charged and ideologically framed— are widely circulated, casting doubt on research integrity and weakening support for technological development.

Extreme parties also frequently target radical technologies backed by tech giants, branding them "elitist" or out of touch. The rapid diffusion of robotics and artificial intelligence (AI), for example, has displaced human labour and fed narratives of economic alienation, especially among middle- and lower-income voters. In this context, extreme parties often challenge the value of patent commercialisation, arguing that research institutions and private enterprises exploit patent systems to enrich elites at the public's expense (Borins, 2018).

Concerns over restricted access, the private appropriation of publicly funded innovations, and the concentration of commercial benefits are central to their critique. This rhetoric, in turn, discourages inventors, depresses patenting activity, and suppresses innovation more broadly (Engelberg et al., 2023). The US Bayh-Dole Act of 1980 —which enabled private entities to commercialise publicly funded research— has become a particular target. Extreme parties point to it as emblematic of a patent system tilted towards private interest, damaging public trust in innovation's value (Rai and Eisenberg, 2003; Sampat, 2006).

International collaboration also suffers. Nationalist and protectionist agendas routinely challenge multilateral frameworks such as WIPO agreements and harmonised patent laws, which are portrayed as threats to national sovereignty (Colantone and Stanig, 2019). While this rhetoric may offer short-term political returns by championing domestic inventors, it often repels foreign investment and restricts the funding base for high-end technology development.

Both extreme right- and left-wing parties have voiced scepticism about new technologies that appear to threaten their ideological positions or political bases (Bjørnskov and Potrafke, 2013). Arguments warning of the existential risks of AI and robotics, often framed in populist terms, are gaining traction (Guiso et al., 2017). Among extreme right-wing parties —such as *Jobbik* in Hungary— such critiques are typically couched in nationalist terms, casting disruptive innovation as a threat to traditional life and national sovereignty (Ignazi, 1992; Rooduijn et al., 2017; Kulin et al., 2021). On the extreme left, parties such as the Communist Party of Greece or *Die Linke* in Germany highlight the inequalities generated by innovation. They argue that monopolistic practices and high technology costs create barriers for working-class citizens (Ramiro, 2016; Rooduijn et al., 2017; Salmela and von Scheve, 2018). Further examples are presented in Table A1.2.

Perhaps the most insidious consequence, however, lies in the demoralisation of researchers and inventors. The continuous threat to funding, job stability, and regulatory clarity creates a climate of anxiety within the scientific community. As Tollefson (2019: 317) puts it in the context of the U.S., "what has damaged researchers' morale is the endless uncertainty about all aspects of their work, and the thinly veiled hostility from the administration. It's the onslaught of media stories about budget cuts, staff lay-offs and efforts to weaken environmental and health regulations." This atmosphere of fear and insecurity stalls progress and saps the ambition needed to drive scientific discovery.

Taken together, these arguments suggest that rising support for extreme parties —whether on the right or the left— is associated with declining institutional support for scientific research and technological innovation. From disinformation and distrust to nationalism and funding cuts, the cumulative link is clear: less encouragement, weaker systems, and diminished outcomes, leading to the following hypotheses.

Hypothesis 1. *(a):* The overall rise of extreme (including more-radical extreme) voting is negatively associated with research and innovation.

Hypothesis 1. (b)*:* The rise of extreme (including more-radical extreme) right-wing voting is negatively associated with research and innovation.

Hypothesis 1. *(c):* The rise of extreme (including more-radical extreme) left-wing voting is negatively associated with research and innovation.

2.2.2. *The rise of extreme voting, green scientific research and technological innovation*

If there is one domain of science and technology where the stakes are especially high, it is that of climate and environmental research. Europe has committed to a bold green transition (European Commission, 2019). At the heart of this transition is green research and innovation: environment-oriented scientific projects and climate-related technological development.

Yet, political support for this effort —despite overwhelming scientific consensus— seems to be on the wane. Across Europe, political parties are sharply divided. Green and mainstream parties have largely championed climate action. Extreme right-wing parties, by contrast, have elevated climate change and the green transition on their agendas not to advance it, but to challenge it (Funk and Kennedy, 2016; Forchtner et al., 2018). These parties routinely campaign on manifestos hostile to green objectives. Many remain unconvinced by the evidence on climate change and show scepticism —if not outright hostility— towards promoting green research (Mudde, 2004; Forchtner et al., 2018).

Their climate positions tend to fall into three categories: denialism, conservatism, and nationalism (Vihma et al., 2021). Climate denialism questions the reality or severity of global warming (Forchtner et al., 2018). Climate nationalism frames climate action as a threat to national sovereignty or interests, undermining multilateral efforts (Cann and Raymond, 2018). Climate conservatism expresses reservations about the cost, scale, or speed of climate policy, even if not rejecting its aims outright (Vihma et al., 2021).

As early as 2010, Nature (2010: 133) warned that "denialism over global warming has become a scientific *cause célèbre* within the [extreme] movement." That warning has since been borne out. In his first term, President Trump's administration aggressively —as is also being the case during his second term— curtailed climate research. Nature Methods (2020: 949) reported that "environmental science and climate change research have been particularly targeted... In the very first week of the Trump presidency, climate change scientists working at several federal research agencies were banned from speaking to the media." In Argentina, President Javier Milei went further, calling climate change a “socialist hoax” (Orfila, 2023).

Extreme right-wing parties also deploy discursive strategies to undercut green research. They organise protests against clean energy, entrench their stances in party platforms, and actively seek to delay or defund decarbonisation initiatives (Geels, 2002; Fraune and Knodt, 2018; Yazar and Haarstad, 2023). They also work to reshape cultural narratives, promoting values opposed to green collaboration and sustainability (Kahan et al., 2011; Funk and Kennedy, 2016). Some target key institutional supports for decarbonisation —opposing subsidies, rewriting laws, or weakening environmental regulations— thereby undercutting global climate targets (Patuelli et al., 2005; Tchorzewska et al., 2022). Their rhetoric often leans on conspiracy theories, portraying green policies as elite-engineered efforts disconnected from popular needs (McCright et al., 2016; Huber, 2020).

In contrast, extreme left-wing parties exhibit far more varied, and generally more positive, views on green research and decarbonisation (Rydgren, 2005; Forchtner et al., 2018; Kulin et al., 2021; Fiorino, 2022; Selk and Kemmerzell, 2022; Yazar and Haarstad, 2023). According to the literature (see Table A1.2), their positions tend to reflect internal diversity and ideological ambivalence (Böhmelt et al., 2016; Clulow, 2019). Many include strong green activist wings —*Syriza* in Greece, *Podemos* in Spain, and Denmark’s Unity List-Red/Green Alliance, for example— whose support for climate action is rooted in principle (McCright et al., 2016; Huber, 2020). Others take a more cautious stance: the Portuguese Communist Party (PCP), for instance, is sceptical of market-based climate tools but favours state-led transitions (Gómez et al., 2016; Ramiro, 2016; Rooduijn et al., 2017). Some left-wing parties do, however, harbour climate denialists, and may pursue policies that hinder climate action indirectly (Vihma et al., 2021). Broadly speaking, any resistance from the extreme left stems more from mistrust of elites and experts —as discussed in the previous section— than from ideological rejection of green objectives.

Green technological innovation refers to processes, products, and systems that directly benefit the environment (Schiederig et al., 2012). However, extreme parties frequently oppose international agreements like the Paris Agreement, which promote global collaboration on renewable technologies and knowledge-sharing (Lockwood and Lockwood, 2022). Nationalism and protectionism, central to their worldview, impede the development and diffusion of green technologies (Kulin et al., 2021).

Climate scepticism has also led to reduced subsidies for green innovation, discouraging inventors and dampening green patenting activity (Rimmer, 2011; Lyu et al., 2024). Citing high costs or technological uncertainty, extreme parties often use economic arguments to block or delay green innovation (Lockwood and Lockwood, 2022).

Extreme right-wing parties, in particular, reject environmental regulation under the guise of affordability. They promote fossil fuel subsidies as more “realistic” alternatives for ordinary citizens (Lockwood, 2018; Selk and Kemmerzell, 2022; Yazar and Haarstad, 2023). As a result, policy instruments essential to green innovation are systematically weakened. These stances are particularly acute in EU countries, where green targets are more institutionalised than in many non-EU settings (Cann and Raymond, 2018; Lockwood and Lockwood, 2022).

By comparison, extreme left-wing parties typically take a more moderate and nuanced position on green innovation. Their critiques —when present— often stem from concerns about equity, monopolisation, and access, rather than denial of climate science itself (Forchtner et al., 2018; Yazar and Haarstad, 2023).

Based on these arguments, we propose the following hypotheses:

Hypothesis 2. *(a):* The overall rise of extreme (including more-radical extreme) voting is negatively associated with green research and innovation.

Hypothesis 2. (b)*:* The rise of extreme (including more-radical extreme) right-wing voting is negatively associated with green research and innovation.

Hypothesis 2. *(c):* The rise of extreme (including more-radical extreme) left-wing voting is not negatively associated with green research and innovation.

3. Methodology

3.1. Data and variables

3.1.1. Research and innovation

To measure scientific research —both overall and green— we draw on publication data from the Web of Science (WOS), a global repository indexing around 9000 peer-reviewed journals. Renowned for its quality and breadth, WOS remains one of the most robust sources for tracking multidisciplinary scientific output (Hoekman et al., 2010). All indexed articles undergo stringent quality assessment, ensuring data reliability.

We track new publications at the NUTS3 level by extracting author affiliations,[3] allowing us to map research output by region. Our analysis focuses on English-language articles across 35 research areas published between 2019 and 2021. This timeframe was chosen because publications are indexed in real time and are likely to reflect political developments with relatively short lags (details in Section 3.2).

Green scientific research is identified using a keyword-based methodology, based on the OECD’s ENV-Tech classification. This system links specific terms in the descriptions of International Patent Classifications (IPC) and Cooperative Patent Classifications (CPC) to environmentally related research. We apply this framework to isolate green publications (Damioli et al., 2024; see also Table B1.1).

The unit of analysis is the institutional affiliation of authors. Between 2019 and 2021, we identified 10,910 research institutions[4] across European regions. Due to incomplete address or postal information, 2.43 % of these could not be geo-located. Notably, just 1.01 % of institutions accounted for over 99 % of the research output, concentrated in 62 regions, mostly in large urban hubs. By contrast, economically weaker, less knowledge-intensive regions tended to produce fewer publications.

For green research, our keyword search across the same period returned publications from 3125 departments. We successfully geocoded 3071 of these institutions. 54 could not be located. Again, green research was highly concentrated: 99 % of green publications came from just 37 institutions, many based in Nordic countries.

To quantify research intensity, we calculate the average number of publications —overall and green— per million inhabitants in each region, using Eurostat population data. As shown in Fig. 5, regions such as Frankfurt and Heidelberg in Germany exhibit exceptionally high scientific output. Östergötlands län in Sweden and Zuidwest-Gelderland in the Netherlands also stand out in terms of green research.

For technological innovation —both general and green— we rely on patent data from the OECD’s RegPAT database (OECD, 2022). Though patents are an imperfect proxy (Ács et al., 2002; Pakes and Griliches, 1980) —they capture only formalised innovation and not all novel activity— they remain the most consistent and geographically detailed measure available. Patents allow us to trace innovation through the locations of inventors and applicants, providing insights into the spatial dynamics of technology development.

We measure regional technological innovation using the number of

[3] All publications are attributed to the institutional affiliations of each author. Where an author lists multiple affiliations within the same region, a single publication may be counted more than once for that region.

[4] Of the publication data extracted from WOS, 272 institutions could not be assigned to a specific NUTS3 region due to incomplete location information. Because publications are linked to regions via authors’ institutional affiliations, only areas with universities or research institutions are recorded as having research activity. This introduces a bias, as many regions without such institutions appear to have no research output.

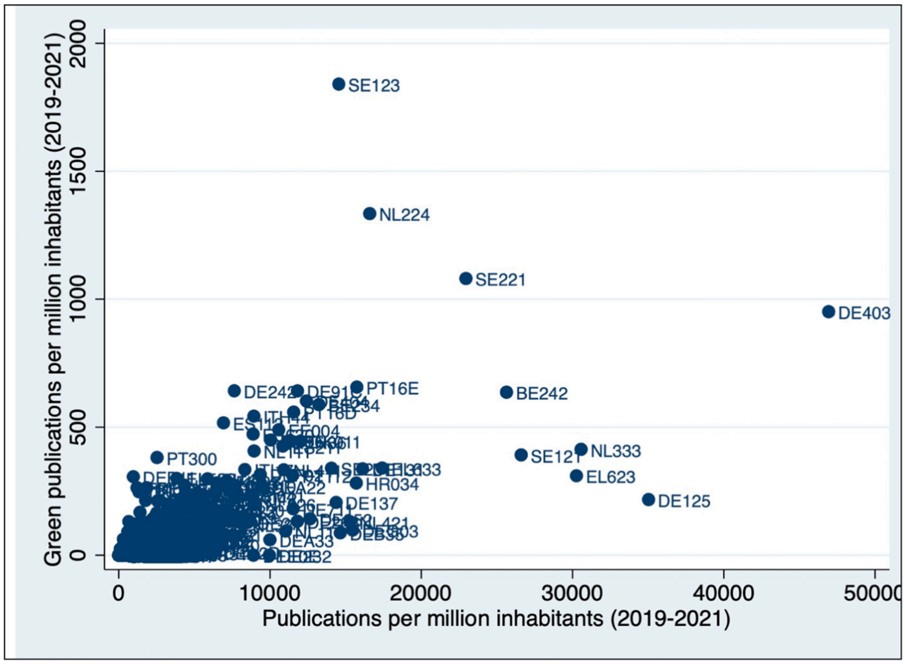

Fig. 5. The distribution of scientific research and green scientific research (2019–2021). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

European Patent Office (EPO) applications[5] per million inhabitants at the NUTS3 level (Coccia, 2014; Rodríguez-Pose et al., 2021b). Green technological innovation is identified using the ENV-Tech classification at the 3-digit IPC level (see Table B2.1). As with scientific research, we use the average number of patent applications over 2019–2021 to mitigate data truncation (Ács et al., 2002).

Fig. 6 shows the geographical distribution of both overall and green patenting activity across the 1137 EU regions included in the study. Patents are far more spatially concentrated than other economic indicators such as income or employment. Most patenting occurs in Western Europe, the Nordic countries, and key urban agglomerations (e.g. Paris, Milan, Brussels). In contrast, Central and Eastern Europe, as well as much of Southern Europe —including Greece and large parts of Spain— recorded limited activity during this period.

Green technological innovation is even more concentrated than overall patenting. Measured as green patents per million inhabitants, it reveals stark gaps. Three-quarters of EU regions —including entire countries such as Bulgaria, Croatia, Greece, Hungary, Latvia, Lithuania, and Romania— recorded no green patents between 2019 and 2021. Green patenting occurred in just 357 regions, leaving 809 with none. This zero-inflation problem requires the use of censored regression models in our empirical analysis (see Section 3.3). Generally, the more developed the country, the higher the concentration of green patents, clustered in hubs like Paris, Frankfurt, Turin, Lower Austria, and Stockholm.

3.1.2. *Extreme voting and more-radical extreme voting*

Determining what constitutes an extreme party is far from straightforward. Classifying political organisations across the ideological spectrum involves a degree of subjectivity, often exposing gaps between how parties present themselves and how they are perceived externally. For this paper, we rely on expert evaluations from the Chapel Hill Expert Survey (CHES) to classify parties on the extreme left and right based on their policy positions (Jolly et al., 2022; see Appendix C).

The CHES dataset compiles expert assessments of political parties' ideological orientations and policy preferences across Europe. Initiated in 1999 by researchers at the University of North Carolina at Chapel Hill, it provides repeated cross-sectional data that track party positions over time. These include left–right placement, attitudes towards immigration, economic intervention, European integration, populism, and environmental policy. Covering economic, social, and environmental dimensions, CHES has become a central resource for scholars, policymakers, and the public (Bakker et al., 2015).

We draw primarily on the 2019 CHES wave,[6] supplemented with 2014 data for early election cycles. The 2019 round includes evaluations by 421 experts across 277 legal parties in the EU. The number of experts per party ranges from two (in smaller countries such as Cyprus or Luxembourg) to 27 (in Czechia), with an average of 14.4 and a median of 15 per party.

The key measure used to classify extreme parties is the CHES left/right indicator, which positions parties on a scale from zero (extreme left) to ten (extreme right). This score reflects each party's overall ideological profile, blending its economic and social views. Left-wing parties generally favour state-led redistribution, welfare expansion, and market regulation. Right-wing parties typically support free-market economics, limited state intervention, and traditional social values (Jolly et al., 2022). To deepen the analysis, we also use CHES issue-specific indicators —spanning 18 categories— to examine party stances on populism, the environment, and their alignment with green research and innovation (see Tables C2 and C3). In our classification, extreme parties are those scoring ≤ 2 (extreme left) or ≥ 8 (extreme right). We designate parties scoring below 1 or above 9 as more-radical

[5] The reason we adopt patent applications rather than patent grants is that elections can affect patent applications in a shorter period of time, while it takes three to five years to affect patent grants (Ács et al., 2002).

[6] As a robustness check, we also use CHES survey data from 2018 to 2022 to construct alternative independent variables and assess whether shifts in support for extreme parties produce different potential effects on research activity. Given the truncation of patent data for 2022, technological innovation is excluded as a dependent variable in this analysis. We also test whether extreme voting from the earlier 2013–2018 period influences scientific and green research outputs in 2022. Full results are reported in Appendix E.

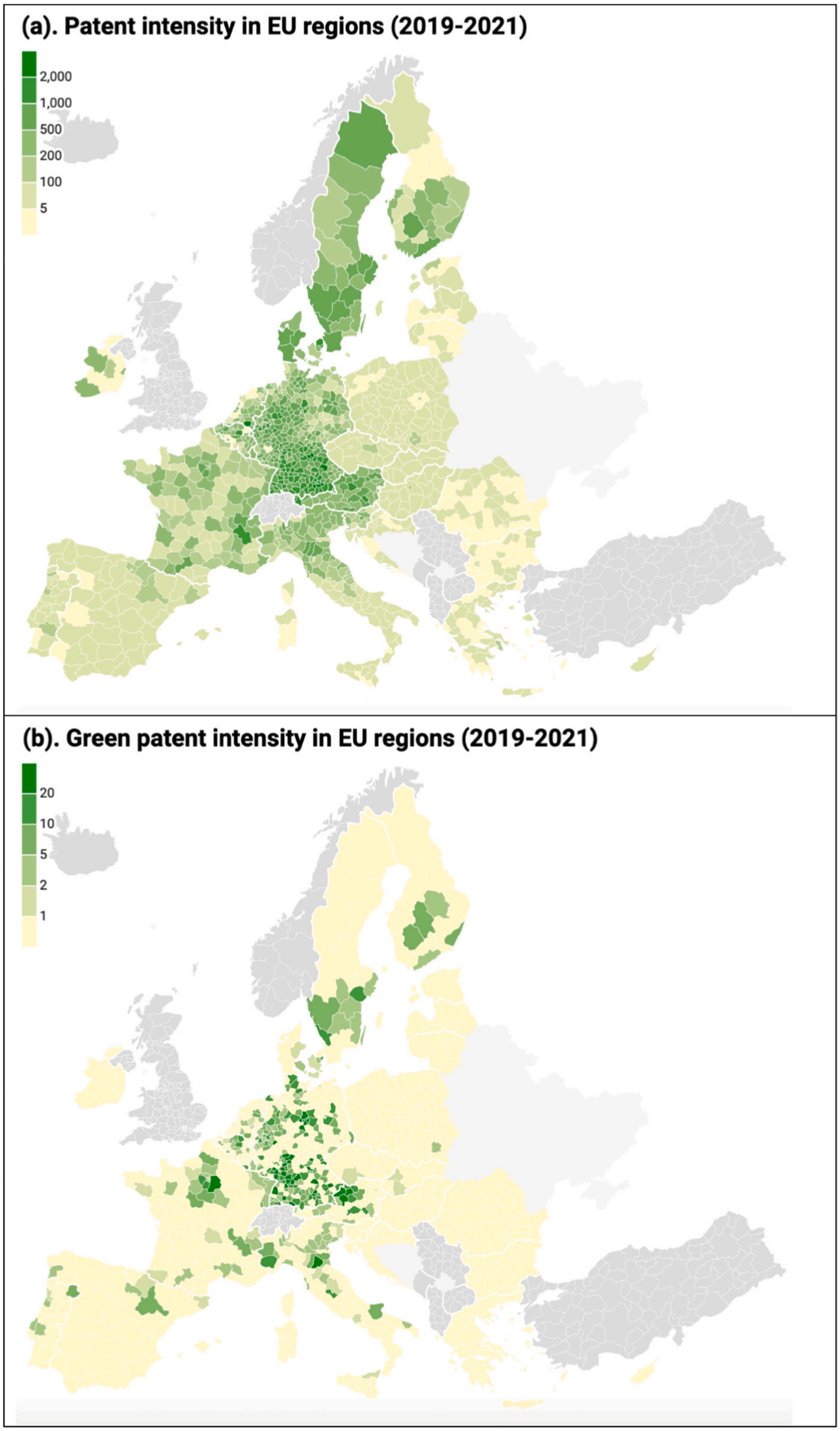

Fig. 6. Geographical distribution of overall and green technological innovation in EU regions (2019–2021). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

extreme parties. A full list of these parties appears in Appendix Table C1. During the 2013–2018 electoral cycle, the average vote share for all extreme parties reached 19.78 %, with the extreme right accounting for 11.68 % and the extreme left 8.10 %. Only 1.82 % of the vote went to more-radical extreme left-wing parties (see Appendix D for the correlation matrix).

Most extreme parties —especially those on the right— exhibit strong anti-elite and anti-establishment rhetoric. The CHES indicator *anti-elite_salience* captures the extent to which such themes dominate party messaging. This score reflects how prominently parties frame elites, institutions, or the political system as corrupt or disconnected from “the people,” offering a proxy for populist discourse.

We also examine positions on key policy areas including immigration, economic regulation, and environmental protection. As shown in Table C2, nearly all extreme right-wing parties strongly oppose immigration and prioritise economic growth over environmental sustainability. Correlation indices in Table C3 reveal that these parties are characterised by opposition to liberal policies, support for traditional social values, authoritarian governance preferences, and nationalist outlooks.

Extreme left-wing parties, by contrast, generally favour government intervention in the economy. However, their views on immigration are more variable. On environmental issues, most extreme left parties express consistent support for climate sustainability across both electoral cycles. Table C3 shows that many also favour strong state control in law and order, placing high value on social stability.

Nonetheless, identifying direct causal links between extreme parties' ideological traits and local patterns of research and innovation remains difficult. Party-level data from CHES do not extend to subnational or regional contexts, limiting our capacity to map ideological preferences onto the geographies of science and technology policy.

To measure extreme voting, we use the vote shares obtained by extreme parties in national legislative elections. We choose national elections because they are commonly regarded as first-order elections. These elections are preferred by political scientists due to their higher voter turnout, clearer party competition, and stronger representation of public opinion compared to second-order elections such as those for the European Parliament (Reif and Schmitt, 1980; Franklin, 2004). First-order elections are more likely to capture the electorate's core policy concerns and better reflect political alignments (Hix and Marsh, 2007; Hobolt and Wittrock, 2011). Their outcomes are less susceptible to protest voting or external influences, offering a more stable basis for our analysis of extreme party support.

3.1.3. Control variables

In line with existing scholarship, we control for several factors shown to influence regional research and innovation capacity. Regional wealth is proxied by GDP per capita (in purchasing power standards) for 2018, a key determinant of innovation intensity (Coccia, 2014). Industrial structure is accounted for through the share of employment in industry relative to total employment in 2018, reflecting the potential link between manufacturing sectors and innovation (Greunz, 2004).

R&D expenditure as a percentage of GDP at the NUTS2 level in 2017 serves as a proxy for research intensity (Bilbao-Osorio and Rodríguez-Pose, 2004). Institutional quality —encompassing government efficiency, rule of law, corruption control, and transparency— is captured using 2017 data from the Quality of Government Institute (Rodríguez-Pose and Di Cataldo, 2015; Charron et al., 2019).

We also include GDP per capita growth to reflect recent economic performance (Rodríguez-Pose et al., 2021b), along with demographic factors: net migration rate and population density (measured per square kilometre). These variables help isolate extreme voting by accounting for broader economic, institutional, and structural characteristics.

3.2. Unit of analysis and time window

Our unit of analysis is the NUTS3 (Nomenclature of Territorial Units for Statistics) level. This administrative division offers a granular territorial scale that captures variation in research and innovation more precisely than higher-level aggregations. Most research, innovation, and green policy interventions are implemented at this regional scale (European Commission, 2019). The dataset includes 1137 NUTS3 regions across all 27 EU member states.

Voting data spans the period 2013–2018. While the connection electoral behaviour on research and innovation may manifest differently over time, a minimum lag of three years is assumed to capture meaningful interaction. Moreover, patent applications require at least one year before publication. The RegPAT dataset, finalised in August 2022, includes patent data up to 2021. To address data sparsity —especially in less patent-intensive regions— and to account for early disruptions from the COVID-19 pandemic, we average patent activity over 2019–2021. This generates a potential time lag between two and seven years, depending on the election year.

While a longer time window would have been preferable, the recent surge in extreme party support limits the feasibility of extending the historical scope. It may also be argued that extreme voting reflects deeper "local cultures" and long-standing attitudes towards innovation, with elections serving as expressions of already embedded societal preferences (James, 2005). Furthermore, issue salience —capturing public concern about specific policy themes— has become more dynamic, reinforcing the feedback loop between politics and innovation (Paul and Fitzgerald, 2021).

To align with the patent data period, we use publication data from 2019 to 2021, despite its real-time indexing. Given the limitations discussed, our findings should be interpreted as associations, not causal relationships (Belderbos et al., 2014).

3.3. Econometric estimations

Our empirical analysis applies Tobit and ordinary least squares (OLS) models to cross-sectional data. The aim is to test whether extreme voting is negatively associated with scientific research and technological innovation, while addressing the uneven availability of research and patent data across regions.

Because many NUTS3 regions report zero outputs —particularly for green scientific publications and green patents— we resort to Tobit models to account for data censoring, following the approach outlined by Cameron and Trivedi (2005). These models treat zero as the lower boundary, allowing us to account for the truncation effect without underestimating innovation activity in regions with no recorded outputs. For overall technological innovation, we complement the Tobit analysis with OLS estimates. This dual approach ensures robustness in evaluating the association between extreme voting patterns and regional scientific and technological performance.

4. Results

4.1. Overall scientific research

Tables 1 and 2 summarise the main findings from the Tobit estimations assessing whether extreme voting is negatively associated with overall and green scientific research. Columns (1)–(3) focus on all extreme voting, while Columns (4)–(6) isolate more-radical extreme voting. As shown in Table 1, control variables such as regional wealth and population density are positively and significantly associated with scientific research, echoing previous studies (Damioli et al., 2024).

In line with *Hypothesis 1(a)* —which posits a negative association between extreme voting and scientific research— we find significant negative coefficients for both overall extreme voting [Column (1); $p < 0.05$] and more-radical extreme voting [Column (4); $p < 0.01$]. These findings suggest that higher support for extreme parties correlates with lower regional research output, likely due to both direct and indirect interference with the research environment (Orfila, 2023).

Support for *Hypothesis 1* (b) is also strong. Both extreme right-wing voting [Column (2); $p < 0.01$] and more-radical extreme right-wing voting [Column (5); $p < 0.01$] are negatively associated with scientific research. These results point to regions with stronger extreme right support exhibiting more pronounced opposition to scientific activity. The lower levels of scientific research are potentially driven by funding cuts, ideological pressure on researchers, or broader mistrust in academic institutions (Pain, 2017).

By contrast, only more-radical extreme left-wing voting [Column (6)] shows a significant and negative connection. However, its magnitude is notably smaller than for its right-wing counterpart [Column (5)],

Table 1
Overall scientific research.

	(1)	(2)	(3)	(4)	(5)	(6)
Extreme voting (<2; >8)	−611.4**					
	(237.8)					
Extreme right-wing voting (>8)		−1273.2***				
		(266.0)				
Extreme left-wing voting (<2)			−122.5			
			(276.6)			
More-radical extreme voting (<1; >9)				−1415.6***		
				(278.0)		
More-radical extreme right-wing voting (>9)					−1563.8***	
					(284.0)	
More-radical extreme left-wing voting (<1)						−815.7**
						(357.8)
GDP per capita	5863.3***	5582.8***	5951.5***	4580.4***	4048.2***	6097.9***
	(1017.6)	(1011.5)	(1030.6)	(1025.8)	(1061.5)	(1018.9)
Employment in industry	−2588.0***	−1855.0**	−2903.0***	−2601.4***	−2534.6***	−3146.5***
	(722.1)	(723.7)	(716.7)	(718.1)	(720.3)	(760.5)
R&D intensity	103.3	356.5	−172.0	194.6	173.1	33.30
	(838.1)	(823.0)	(818.8)	(811.0)	(810.5)	(810.7)
Quality of government	−9439.9***	−10,138.6***	−9914.6***	−5209.0**	−3096.6	−11,045.6***
	(2077.4)	(2102.8)	(2161.6)	(2207.7)	(2349.4)	(2098.6)
GDP per capita growth	274.8	192.2	405.3**	335.5**	420.6**	332.4**
	(172.2)	(174.2)	(173.0)	(170.3)	(176.6)	(168.4)
Net migration	−56.03	−25.55	−63.00	−64.03	−40.84	−93.31
	(64.22)	(65.53)	(63.67)	(63.28)	(64.74)	(64.50)
Population density	667.5***	901.2***	577.4**	1027.4***	1124.3***	511.3**
	(233.7)	(224.0)	(238.6)	(234.5)	(237.2)	(233.9)
Constant	−21,156.9***	−22,072.9***	−21,283.3***	−18,224.3***	−17,762.5***	−20,242.6***
	(3943.1)	(3960.9)	(4012.8)	(3919.9)	(3963.8)	(3899.8)
N	1137	1137	1137	1137	1137	1137
Log likelihood	−4027.0	−4015.7	−4029.6	−4014.4	−4010.7	−4026.7

Notes: Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

consistent with the lower levels of hostility towards science typically found among extreme left parties (Colantone and Stanig, 2019). As such, *Hypotheses 1(a)* and *1* (b) are confirmed, while *Hypothesis 1(c)* receives only partial support.

Robustness checks using alternative lag structures across electoral cycles (Appendix E2.1 and E2.2) corroborate the finding that more-radical extreme right-wing voting is consistently associated with lower scientific research outputs.

Table 2
Green scientific research.

	(1)	(2)	(3)	(4)	(5)	(6)
Extreme voting (<2; >8)	−28.17**					
	(11.19)					
Extreme right-wing voting (>8)		−62.32***				
		(14.81)				
Extreme left-wing voting (<2)			−8.055			
			(11.57)			
More-radical extreme voting (<1; >9)				−76.37***		
				(16.33)		
More-radical extreme right-wing voting (>9)					−91.18***	
					(17.04)	
More-radical extreme left-wing voting (<1)						−24.67
						(15.62)
GDP per capita	249.0***	234.0***	252.9***	178.4***	141.2***	257.9***
	(43.77)	(42.29)	(44.50)	(39.09)	(38.57)	(44.78)
Employment in industry	−86.91***	−48.39*	−102.1***	−83.16***	−79.01***	−108.8***
	(26.66)	(26.54)	(27.71)	(26.51)	(26.11)	(29.70)
R&D intensity	−12.04	0.950	−24.14	−6.438	−5.893	−19.65
	(36.61)	(36.50)	(35.67)	(35.43)	(35.31)	(35.86)
Quality of government	−397.7***	−438.0***	−410.7***	−167.4*	−19.26	−453.9***
	(92.14)	(96.16)	(95.29)	(90.25)	(97.53)	(95.74)
GDP per capita growth	9.142	4.415	14.61**	11.58*	16.16**	13.56**
	(6.940)	(6.845)	(7.243)	(6.879)	(7.238)	(6.848)
Net migration	−2.322	−0.671	−2.723	−2.660	−1.382	−3.539
	(2.655)	(2.712)	(2.644)	(2.615)	(2.679)	(2.640)
Population density	17.15*	29.40***	13.12	38.14***	45.63***	10.67
	(9.848)	(9.233)	(10.27)	(9.835)	(9.899)	(10.49)
Constant	−926.8***	−970.2***	−930.0***	−771.4***	−726.8***	−904.4***
	(172.5)	(176.3)	(175.0)	(160.2)	(158.8)	(172.6)
N	1137	1137	1137	1137	1137	1137
Log likelihood	−2324.8	−2309.4	−2327.7	−2303.8	−2292.2	−2326.4

Notes: Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.2. Green scientific research

Table 2 turns to green scientific research. As expected, regional wealth, economic growth, and population density are positively linked to green research output (Barbieri and Consoli, 2019; Damioli et al., 2024).

For *Hypothesis 2(a)*, we observe a significant negative coefficient for overall extreme voting [Column (1); $p < 0.05$], with the coefficient intensifying for more-radical extreme voting [Column (4); $p < 0.01$]. These results suggest that stronger support for extreme parties —particularly more-radical ones— is associated with diminished green research activity. This is consistent with the antagonistic discourse such parties direct at climate science and the green transition (Geels, 2002; Lockwood, 2018; Yazar and Haarstad, 2023).

Hypothesis 2. (b) is similarly supported: both extreme right-wing [Column (2)] and more-radical extreme right-wing voting [Column (5)] show significant and negative coefficients. These results reflect the ideological alignment of extreme right parties, which often include climate denialism and opposition to green R&D in their platforms (Kahan et al., 2011; Funk and Kennedy, 2016).

In contrast, the coefficients for extreme left-wing voting [Columns (3) and (6)] are statistically insignificant. This aligns with *Hypothesis 2 (c)* and the literature suggesting that extreme left parties hold more variable or ambivalent positions on green research, often supporting sustainability while questioning market-based environmental tools (Böhmelt et al., 2016; Clulow, 2019).

Overall, the results confirm *Hypotheses 2(a), 2* (b) and *2(c)*.

Extended time-lag models (Appendix Tables E3.1 and E3.2) reaffirm the negative relationship between extreme right-wing support and green scientific research, particularly for more-radical factions.

4.3. Overall technological innovation

Table 3 presents the Tobit model estimates for overall technological innovation, with robustness checks from OLS models reported in Appendix Table F1. In both models, Columns (1)–(3) cover all extreme voting, and Columns (4)–(6) focus on more-radical variants. As expected, control variables such as GDP per capita, industrial employment, R&D intensity, migration, population density, and government quality are all positively associated with technological innovation (Feldman and Audretsch, 1999; Crescenzi et al., 2007; Rodríguez-Pose et al., 2023).

Confirming *Hypothesis 1(a)*, regions with stronger support for extreme parties tend to exhibit lower levels of technological innovation. This applies across all specifications: extreme voting [Column (1)] and more-radical extreme voting [Column (4)], both significant at $p < 0.01$. The OLS estimates corroborate the Tobit results, with slightly stronger coefficients.

Support for *Hypotheses 1* (b) and *1(c)* is also evident. Extreme right-wing voting [Columns (2) and (5)] is consistently connected to lower levels of innovation ($p < 0.01$), underscoring how both rhetoric and policy positions among these parties could deter R&D activity (Funk and Kennedy, 2016; Kahan et al., 2011; National Academies of Sciences, 2017).

Extreme left-wing voting is also negatively associated with innovation, though the coefficients are somewhat weaker. In the Tobit model, the coefficient for more-radical extreme left-wing voting [Column (6)] is insignificant, while the OLS model shows significance at the 5 % level. This suggests that although extreme left parties may damage innovation, their impact is less consistent and possibly less structural.

In most specifications, the coefficients for extreme right-wing support are larger than those for extreme left-wing support [compare Columns (2) and (3); (5) and (6)]. These results confirm that extreme party voting —especially on the right— has a more pronounced negative association with technological innovation.

Table 3
Overall technological innovation.

	(1)	(2)	(3)	(4)	(5)	(6)
Extreme voting (<2; >8)	−264.7***					
	(30.45)					
Extreme right-wing voting (>8)		−228.0***				
		(37.13)				
Extreme left-wing voting (<2)			−197.8***			
			(27.14)			
More-radical extreme voting (<1; >9)				−270.2***		
				(44.54)		
More-radical extreme right-wing voting (>9)					−223.8***	
					(37.08)	
More-radical extreme left-wing voting (<1)						−41.34
						(36.94)
GDP per capita	325.6***	304.3***	344.5***	317.0***	298.8***	336.0***
	(86.53)	(84.39)	(87.37)	(85.51)	(84.36)	(88.82)
Employment in industry	224.9***	245.9***	189.9***	224.2***	236.2***	209.7***
	(38.59)	(40.96)	(38.91)	(39.17)	(39.77)	(38.76)
R&D intensity	370.9***	372.6***	347.7***	372.0***	371.1***	350.8***
	(36.07)	(36.82)	(35.44)	(36.35)	(36.59)	(35.69)
Quality of government	516.0**	619.8***	69.62	134.1	315.7	91.79
	(206.7)	(210.8)	(203.5)	(207.4)	(208.8)	(217.0)
GDP per capita growth	−8.303	−9.324	−8.398	−7.168	−8.608	−9.776
	(12.02)	(12.20)	(12.05)	(12.12)	(12.19)	(12.39)
Net migration	9.699***	10.34***	10.11***	10.39***	10.28***	11.80***
	(2.978)	(3.047)	(3.019)	(3.030)	(3.061)	(3.171)
Population density	41.94***	41.83***	43.02***	35.06***	42.01***	39.47***
	(10.51)	(10.70)	(10.46)	(10.64)	(10.65)	(10.98)
Constant	−1694.5***	−1834.6***	−2319.7***	−2321.9***	−2391.1***	−2342.0***
	(391.3)	(373.9)	(419.2)	(411.5)	(419.6)	(423.3)
N	1137	1137	1137	1137	1137	1137
Log likelihood	−7791.9	−7798.0	−7802.3	−7799.7	−7801.9	−7820.6
Dummy country	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors in parentheses, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

4.4. Green technological innovation

We now turn to the relationship between extreme voting and green technological innovation, focusing on whether political extremism acts as a barrier to environmental technological development. Table 4 presents the Tobit estimation results, which remain robust after controlling for regional wealth, industrialisation, R&D intensity, quality of government, economic performance, migration, and population density (Feldman and Audretsch, 1999; Crescenzi et al., 2007; Rodríguez-Pose and Di Cataldo, 2015; Rodríguez-Pose et al., 2023).

Our findings provide strong support for *Hypothesis 2(a)*: higher levels of extreme voting are significantly associated with lower levels of green technological innovation [Columns (1) and (4); $p < 0.01$]. These results are consistent with prior evidence suggesting that extreme party supporters are more likely to challenge the legitimacy of climate science and resist the green transition (Huber, 2020; McCright et al., 2016).

This relationship holds across the political spectrum, though the connection is markedly more pronounced in regions with stronger support for extreme right-wing parties [compare Column (2) with Column (3)]. In Column (2), the negative coefficient for extreme right-wing support is statistically significant ($p < 0.01$), while in Column (3), the coefficient for extreme left-wing support is also negative but weaker and not statistically significant. These results lend strong support to *Hypothesis 2* (b) and further highlight the more consistent antagonism towards green innovation from the far right, while the lack of statistical significance for extreme left-wing also corroborates *Hypothesis 2(c)*.

The results for more-radical variants reinforce these findings. The negative association intensifies in regions with high levels of more-radical extreme voting [Column (4)] and is particularly strong for more-radical extreme right-wing support [Column (5)], confirming that the green innovation penalty is greatest in areas where far-right populism is most entrenched (Geels, 2002; Lockwood, 2018; Yazar and Haarstad, 2023). In contrast, the coefficient for more-radical extreme left-wing voting [Column (6)] is again insignificant, likely due to the limited number of green patenting observations in such regions.

In sum, these results offer consistent support for our hypotheses, while they also reaffirm the asymmetry in how the extreme left and right engage with green technological innovation. While both may express scepticism, it is more-radical extreme right-wing support that most consistently and significantly can be associated with lower levels of green innovation across the EU.

5. Discussion and conclusion

The rise in support for extreme parties across Europe has generated a lively debate about its causes, yet its implications for research and innovation have received comparatively little scrutiny. Extreme parties appeal to narrower constituencies than conventional populists —often those harbouring deep resentment towards political and institutional elites (Powell Jr, 1986; Aichholzer et al., 2014; Cutts and Goodwin, 2014)— and, to varying degrees, they exhibit more pronounced scepticism towards science, expertise, and innovation than mainstream parties (Arzheimer and Berning, 2019; Carvalho, 2023; Fontana et al., 2023).

We have investigated the relationship between support for extreme parties and levels of scientific research and technological innovation across 1137 NUTS3 regions in 27 EU countries. The findings suggest that higher support for extreme parties is consistently associated with weaker research and innovation performance. The analysis identifies traits common to all extreme parties while also accounting for meaningful ideological distinctions between those on the far left and far right. These ideological differences, particularly regarding climate change and the value of scientific knowledge, are associated with varied outcomes in terms of local research and innovation. Given the centrality of climate policy in current political debates, we paid particular attention to green research and innovation. Using publication and patent data, we examined whether regions with stronger support for extreme parties showed lower levels of climate-related scientific and technological activity.

Table 4
Green technological innovation.

	(1)	(2)	(3)	(4)	(5)	(6)
Extreme voting (<2; >8)	−8.700***					
	(3.012)					
Extreme right-wing voting (>8)		−7.945***				
		(2.856)				
Extreme left-wing voting (<2)			−6.335**			
			(2.523)			
More-radical extreme voting (<1; >9)				−10.23***		
				(3.521)		
More-radical extreme right-wing voting (>9)					−8.592***	
					(2.991)	
More-radical extreme left-wing voting (<1)						5.575
						(4.093)
GDP per capita	9.927	9.309	10.84	9.466	9.088	10.59
	(8.365)	(8.416)	(8.418)	(8.404)	(8.472)	(8.481)
Employment in industry	8.051**	9.045***	6.681*	8.612***	8.888***	7.868**
	(3.326)	(3.340)	(3.434)	(3.303)	(3.334)	(3.400)
R&D intensity	23.90***	24.19***	23.29***	24.34***	24.24***	23.54***
	(6.004)	(6.062)	(5.977)	(6.072)	(6.064)	(6.063)
Quality of government	27.62	33.12	9.824	10.09	21.15	16.07
	(30.63)	(32.01)	(29.10)	(29.20)	(30.43)	(30.08)
GDP per capita growth	0.252	0.216	0.351	0.321	0.265	0.343
	(1.592)	(1.617)	(1.614)	(1.590)	(1.622)	(1.655)
Net migration	−0.0856	−0.0749	−0.0609	−0.0271	−0.0518	−0.0393
	(0.325)	(0.329)	(0.318)	(0.315)	(0.326)	(0.317)
Population density	5.435***	5.282***	5.456***	5.087***	5.241***	5.333***
	(1.064)	(1.063)	(1.058)	(1.041)	(1.055)	(1.068)
Constant	−120.7***	−125.8***	−140.7***	−139.8***	−144.9***	−146.1***
	(40.23)	(40.11)	(41.12)	(40.74)	(41.29)	(41.55)
N	1137	1137	1137	1137	1137	1137
Log likelihood	−1858.1	−1858.7	−1859.7	−1858.2	−1858.4	−1862.0
Dummy country	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

This paper represents, to our knowledge, the first comprehensive, EU-wide regional comparison of the relationship between political extremism and both general and green research and innovation outcomes. We hypothesised that regions with greater electoral support for extreme parties would also show reduced scientific and technological capacity, especially in green sectors.

Our results support this hypothesis. Extreme parties frequently attack the credibility of experts, diminish the value of scientific research, and oppose policies promoting intellectual openness, diversity, and international cooperation. These narratives not only demoralise researchers but also shape public perceptions of the role of science in society, weakening the social foundations necessary for sustained research activity (Leshner, 2003; Wang et al., 2019). These effects are not merely rhetorical. They often translate into funding cuts, restrictions on academic independence, and altered scientific agendas. The data suggest that regions with stronger support for extreme parties are more likely to experience lower levels of scientific research.

In the field of technological innovation, similar patterns emerge. Extreme parties often attack international patent frameworks, question the commercial legitimacy of innovation, and highlight barriers to access such as monopolisation and cost. Such critiques resonate in regions experiencing economic frustration and are often used to justify resistance to new technologies. Meanwhile, technological disruption —such as the rise of robotics and AI— can exacerbate unemployment, particularly among middle- and lower-income voters. Extreme parties have seized upon these concerns to question the broader value of innovation itself. The result, in many cases, is marked lower local technological development (Colantone and Stanig, 2019).

These trends are even more pronounced in the case of green research and innovation. Extreme parties —particularly on the right— tend to express deep scepticism, if not outright denial, of climate change, often rejecting the need for green research and questioning its underlying science (Funk and Kennedy, 2016; Vihma et al., 2021). This stance is especially visible in parties such as Germany's AfD or France's National Rally, which frequently challenge the legitimacy of green transitions (Rooduijn et al., 2017; Arzheimer and Berning, 2019). While extreme left-wing parties vary more widely in their positions —some include strong green components, others adopt more ambivalent or statist perspectives— their opposition tends to be more muted.

This asymmetry carries through into outcomes. Regions with strong support for extreme right-wing parties are consistently associated with lower levels of green scientific research. On the innovation side, these parties commonly oppose green technology development, citing cost, complexity, and elitism (Cann and Raymond, 2018; Lockwood and Lockwood, 2022). Such resistance not only weakens inventor motivation but makes it more difficult for green technological projects to succeed, especially in areas already grappling with economic discontent. By contrast, extreme left-wing parties show less resistance, and their negative connection to green innovation appears considerably weaker (Forchtner et al., 2018; Yazar and Haarstad, 2023).

Overall, our findings indicate that support for more radical and extreme parties is associated with reduced scientific and green research outputs. For technological innovation —particularly in green sectors— the connection is even stronger. However, the link with academic research is somewhat less consistent. One possible explanation is that scientific publishing is highly concentrated in a small number of knowledge-intensive regions and universities. These areas often benefit from stronger institutional support, greater external investment, and political insulation, reducing their immediate exposure to electoral fluctuations.

Nonetheless, caution is warranted in interpreting these results. The rise of extreme political movements is a relatively recent phenomenon, emerging most forcefully after the global financial crisis and accelerating in the wake of the European debt crisis and the extreme degrees of these parties might change and shift over time. Earlier periods provide limited comparative data. In addition, the Covid-19 pandemic introduced substantial shocks to innovation patterns across Europe. More fundamentally, the nature of our data and methodology does not allow for definitive causal claims. While our reversed causality tests (Appendix G) offer some insights, they also underscore the complexity of these relationships. Future research should aim to explore causality more rigorously, ideally through longitudinal datasets or quasi-experimental designs that can disentangle these dynamics more precisely.

In any case, our findings open several avenues for future inquiry. One particularly important direction lies in unpacking the differing effects of extreme left and right support across specific research domains or between public and private investment. Understanding how political ideologies shape innovation in different institutional contexts could offer valuable insights into both the risks and potential policy responses.

This research also carries clear implications for policy. The popularity of extreme political movements in Europe is not a symbolic phenomenon. It coincides with tangible, adverse outcomes. Regions that support such parties often experience weakened scientific ecosystems, lower technological competitiveness, and disproportionately limited progress in green innovation. Europe cannot afford such stagnation. The continent is already engaged in a high-stakes race to remain competitive in science and technology while simultaneously leading the green transition. Failing to address the political roots of public discontent could jeopardise both. Equally important is the territorial dimension of innovation. Our analysis highlights how research and green innovation remain heavily concentrated in a small number of high-performing regions. "Left-behind" areas —characterised by low investment and limited institutional capacity— often register the highest levels of discontent and, correspondingly, the highest support for extreme parties (Rodríguez-Pose et al., 2024). This risks creating a self-reinforcing cycle: economic marginalisation fuels political extremism, which in turn erodes the very innovation capacity needed to escape stagnation. Reversing this cycle will require sustained efforts to rebalance investment across Europe. Strengthening research and innovation in lagging and falling-behind regions is not just a matter of fairness; it is critical for ensuring a dynamic, resilient, and cohesive European innovation landscape.

CRediT authorship contribution statement

Andrés Rodríguez-Pose: Writing – original draft, Data curation, Methodology, Writing – review & editing, Formal analysis, Conceptualization. **Zhuoying You:** Formal analysis, Methodology, Data curation, Writing – original draft, Writing – review & editing, Conceptualization. **Peter Teirlinck:** Data curation, Formal analysis, Writing – review & editing, Conceptualization, Methodology, Writing – original draft.

Declaration of competing interest

The authors declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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As always, the usual disclaimer applies: the views expressed in this article are solely those of the authors and do not necessarily reflect those of the institutions with which we are affiliated. Any remaining errors are entirely our own.

Appendix A. Comprehensive literature review for extreme political parties

Table A1.1
Comprehensive literature review on key characteristics of extreme parties.

Source	Theoretical framework	Characteristics of extreme parties (anti)	Different from other parties (mainstream parties/centrist parties/ populist parties)	Case illustration (science/technology/ climate)
Aichholzer et al. (2014)	Conflict transformation; socio-cultural vs. socio-economic issues	Anti-immigration, cultural protectionism, Euroscepticism, welfare chauvinism	Extreme parties break traditional class-based conflict lines; focus on cultural identity and exclusion rather than redistribution; mobilise new voter groups neglected by mainstream parties	FPÖ in Austria attracts lower-educated, working-class voters who are less responsive to scientific discourse or climate change issues
Enders and Uscinski (2021)	Political extremism, misinformation, antiscientific claims, and conspiracy	Opposing the constitution and the political status quo, and excluding interaction with other political parties	Extreme parties often disseminate or endorse conspiracy theories and misinformation, which can undermine democratic norm and public trust	Extreme parties may reject scientific consensus on issues like climate change, promoting scepticism towards environmental policies and regulations
Arzheimer and Berning (2019)	Ideological shift and voter motivations	Nativism, authoritarianism, and anti-immigration stances	Extreme parties are distinct from mainstream parties due to populist rhetoric, anti-establishment positioning, and emphasis on ethno-nationalist identity	While not directly addressing science or climate, the AfD's radical right orientation has implications for its stance on scientific consensus and environmental policies
Carter (2018)	Conceptual reconstruction of right-wing extremism/radicalism, building upon Mudde (1996)	Authoritarianism, anti-democracy, exclusionary and/or holistic nationalism	Extreme right-wing parties differ from mainstream ones by their fundamental opposition to core democratic values and their promotion of exclusionary nationalism	While Carter's article doesn't focus on specific policy areas like science, technology, or climate, the core characteristics can influence such domains. For instance, an extreme right-wing party's nationalist stance might lead to the rejection of international scientific collaborations or climate agreements, viewing them as threats to national sovereignty
Carvalho (2023)	Demand side (protest voting and public salience of immigration) versus supply side (spatial competition theory and internal supply factors) explanations for extreme-right voting	Nationalist, populist, and anti-establishment rhetoric – Chega (Portuguese right-wing political party)	Contrasts with mainstream parties by emphasising authoritarian nationalism, anti-immigration stances, and scepticism towards liberal democratic norms	While not the central focus, Chega's platform includes criticism of environmental/climate regulations perceived as hindering economic growth
Charron et al. (2023)	Government trust, polarization, and populism in European regions	Radical opposition to mainstream political systems; strong in regions with high polarization; emphasising direct democracy and anti-elitism	Extreme parties may adopt more authoritarian stances, whereas populists often rely on direct appeals to the people, without necessarily advocating for centralised control	Extreme parties, both right and left, have used the crisis to challenge government decisions. They have questioned the legitimacy of scientific advice, focusing on government failures rather than the public health crisis itself.
Cutts and Goodwin (2014)	Extreme right voting and electoral performance	Focus on anti-immigration, nationalism, and cultural grievance; success tied to localised grassroots campaigns; organizational capacity is crucial for visibility and vote share	Unlike populists, who appeal broadly to "the people", right-wing extremist parties often target specific grievances and activate latent prejudice or fear through local issue framing and intensive ground campaigning	Extreme right parties like BNP (British National Party) have mobilized voters using anti-environmentalism narratives, portraying green regulations as elite impositions threatening local industry and sovereignty
Fontana et al. (2023)	Historical framework of extremist parties in Italy	Anti-centrist sentiment, root in historical trauma	Unlike centrist parties, they gain and retain supports through long-term memory of extreme trauma, making them less flexible and more resistant to compromise	Not directly discussed. However, implications suggest that historical trauma can influence distrust in institutions and technocratic solutions, which could affect positions on science/technology/climate through broader ideological lenses (e.g., anti-capitalism scepticism of market-based climate policies)
Guglielmi (2022)	Influence of electoral victory of the far-right coalition on science and climate in Italy	Right-wing populist, nationalist, and anti-immigrant	Contrast with previous administrations by indicating a shift towards deprioritizing scientific and environmental issues in favour of nationalist and conservative policies	The new government's stance may lead to reduced support for climate research and a rollback of environmental regulations, impacting Italy's contribution to global climate efforts

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Table A1.1 (*continued*)

Source	Theoretical framework	Characteristics of extreme parties (anti)	Different from other parties (mainstream parties/centrist parties/ populist parties)	Case illustration (science/technology/ climate)
Ignazi (1992)	Two types of extreme right parties	"Old" extreme right parties with fascist legacies; "New" extreme right parties without fascist associations but with anti-system and nationalist ones	New extreme right parties differentiate themselves by focusing on issues like immigration control and law and order, appealing to voters disillusioned with traditional conservative parties	While not directly addressing science or climate, the emphasis on nationalism and scepticism towards supranational entities may influence positions on international scientific collaborations and environmental agreements
March and Mudde (2005)	The ideological evolution, organizational changes, and strategic adaptations of radical left parties	Eco-socialism and left libertarianism	New radical left parties differentiate themselves by embracing issues like environmentalism, feminism, and anti-globalisation, setting them apart from traditional left and mainstream parties	While not directly addressing science or climate, the inclusion of eco-socialist ideologies implies a focus on environmental issues and sustainable development policies
Mudde (1996)	The concept of right-wing extremism	Nativism, authoritarianism, populism; and democracy rejection	Extreme right parties oppose democracy itself	While not directly focused on climate or technology, Mudde's framework helps identify which parties are more likely to reject climate science (typically extreme right) or oppose international environmental cooperation (both more radical and extreme right)
Powell Jr (1986)	Extremist parties and political stability	Nationalism and government distrust	Unlike mainstream parties, extremist parties may challenge democratic norms and institutions, potentially leading to increased political conflict	While not directly addressing science or climate, the study's insights into political instability have implications for policy areas requiring long-term consensus, such as environmental regulation and scientific research funding
Ramiro (2016)	Radical left parties voting	Anti-capitalist, transform the social and economic status quo into an alternative system	Radical left parties have a stronger emphasis on the existence of social inequalities	Radical left parties (e.g., SYRIZA, Podemos) support public investment in green technology, endorse climate policies that promote social justice, and back science-driven regulation in ways that reduce inequality
Rooduijn et al. (2017)	Voter bases for radical left and radical right parties in Europe	Distinct ideological motivations: radical left supporters prioritise economic equality and social justice; radical right supporters focus on cultural identity and nationalism	Radical left parties advocate for systemic economic reforms within democratic frameworks; radical right parties emphasise cultural homogeneity and may challenge liberal democratic norms	Radical left parties often support environmental initiatives and climate change mitigation policies; radical right parties may exhibit climate scepticism and oppose international environmental agreements
Sperber (2010)	Voter profiles and motivations	Anti-capitalism, revolutionary socialism, and rejection of both neoliberalism and authoritarian socialism	Extreme left parties demand systemic economic change, workers' control of production, and are openly revolutionary rather than reformist	Trotskyist parties generally support radical ecological transitions aligned with anti-capitalist principles
Wagner (2012)	Strategic incentives for extreme parties	Extreme positions are often a strategic choice for visibility and voter mobilization; not just ideological	Populists often rely on anti-elite narratives, while extreme parties strategically emphasise radical policies to differentiate from competitors	The Greens' emphasis on radical environmental positions is strategically shaped by voter demand and their niche ownership of climate issues

Table A1.2
Examples of heterogeneity between parties in extreme right and extreme left spectrums.

Sources	Party name	Ideologies towards (green) science/technology
Extreme right spectrum		
Arzheimer and Berning (2019); Rooduijn et al. (2017)	AfD in Germany	Climate scepticism; resistance to "green" transformation narratives
Jolly et al. (2022); Rooduijn et al. (2017)	National Rally in France	Technosceptic, critical of climate action framed by global elites
Aichholzer et al. (2014); Ignazi (1992); Rooduijn et al. (2017)	Freedom Party of Austria (FPO)	Scepticism towards climate science; critical of EU climate policies; supportive of national industry over environmental regulation; frames green technology as elite-driven agenda; occasionally critical of academic/scientific elites
Charron et al. (2022, 20223)	Vox in Spain	Criticizes EU climate policies; opposes renewable energy subsidies; promotes fossil fuels as energy independence strategy
Ignazi (1992); Rooduijn et al. (2017)	VB in Belgium	Opposes carbon taxes; sceptical of climate regulations; downplays urgency of climate change while emphasising energy security
Rooduijn et al. (2017)	Jobbik in Hungary	Sceptical of globalisation and Western institutions, including scientific elites; current stance more ambiguous
Rooduijn et al. (2017)	Party for Freedom in the Netherlands	Sceptical of climate science and EU climate initiatives; has criticized environmental regulations as economically harmful

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Table A1.2 (*continued*)

Sources	Party name	Ideologies towards (green) science/technology
Aichholzer et al. (2014); Rooduijn et al. (2017)	Lega Nord in Italy	Occasionally aligns with climate denial or scepticism; questions the costs of green transitions
Extreme left spectrum		
Rooduijn et al. (2017)	The Left in Germany	Critical of neoliberal technology agendas; strong support for climate justice and green energy
Gómez et al. (2016); Ramiro (2016); Rooduijn et al. (2017)	Partido Comunista Português (PCP) in Portugal	Sceptical of market-based climate action; favours state-led green transition
March and Mudde (2005); Ramiro (2016); Rooduijn et al. (2017)	Communist Party of Greece	Critical of privatised innovation and technocratic governance
Gómez et al. (2016); Ramiro (2016); Rooduijn et al. (2017)	Syriza in Greece	Generally supportive of climate policy in alignment with EU frameworks; embraces progressive modernisation
Rooduijn et al. (2017)	Podemos in Spain	Supportive of climate action, digital democratisation, and public control over technology infrastructure
Gómez et al. (2016)	Unity List-Red/Green Alliance in Denmark	Strongly pro-climate science, environmental justice, anti-nuclear
Gómez et al. (2016)	The Left in Luxemburg	Backs ambitious climate goals with social equity lens

Appendix B. The measurements of dependent variables

B.1. Scientific research and green scientific research

We collect publication data from Web of Science (WOS), aggregated at the NUTS3 regional level for 27 EU countries. Articles indexed in WOS are published in peer-reviewed journals, ensuring there are no year gaps in the data, unlike patent datasets. For consistency with the patent data used in this study, we focus on publications from the period 2019–2021 rather than the most recent data. The criteria for data collection follow several steps.

First, we include only articles that meet a minimum quality threshold, aligning with the concept of “scientific research” as defined in this paper. Second, we limit our selection to English-language articles, as WOS provides more comprehensive coverage for publications in English. Third, we base our selection of 35 research fields on the Netherlands Observatory for Science and Technology (NOWT), which corresponds to WOS research areas such as physics, humanities, and social sciences (Hoekman et al., 2010). As a single article may be assigned to multiple research fields, the total number of publications does not equal the sum of field-specific counts. Finally, to track the total volume of scientific research, we record the different institutional affiliations of each author for each article. By verifying the addresses and postal codes of these affiliations, we assign each article to specific cities and NUTS3 regions. Consequently, a single article may be counted multiple times if authors have affiliations in different regions.

For green scientific research, we identify publications related to “green” topics using keywords derived from the Env-Tech classification issued by the OECD, which are based on terms occurring in the International Patent Classification and Cooperation Patent Classification (Damioli et al., 2024). These keywords, detailed in Table A1.1, are not mutually exclusive across research areas. Additionally, we ensure that all green-related publications have Digital Object Identifiers (DOIs) through a verification process.

To account for population differences across regions, we measure research intensity as the number of publications and green publications per million inhabitants. This metric reflects local capacity for scientific and green scientific research within NUTS3 regions.

However, this approach is not without limitations. First, the WOS database provides lower coverage for research fields such as humanities and social sciences. Second, because all publications are attributed to the affiliations of each author, and some authors have multiple affiliations within the same region, a single publication may be counted multiple times for a region. Third, universities and research centres are typically concentrated in larger regions, while economically disadvantaged regions often lack such institutions. This results in publications being disproportionately distributed in more developed areas. Despite these concerns, WOS remains the most comprehensive and reliable source of data on research activities at the regional level.

Table B1.1
Green-tech keywords to search for publications in WOS.

		Mitigation						Adaptation
Biodiversity	GHG capture	Building	Energy	Production	Transport	Waste-water	Environmental management	Water
biodiv	Absorption	Air condit	Accumulator	Afforestation	Altern fuel	Altern irrig	Air pollution abatement	Desalin
Ecosyst health	Adsorption	Bioethan	Altern fuel	Altern irrig	Biodiesel	Bio pack	Air pollut	Purif water
Ecosyst serv	Bio separ	cogenerat	Batter	Biofeedstock	Bioethan	Bio process	Emission abat	Sanitation
	Carbon capt	Efficien cook	Biodiesel	Bio plastic	Biofuel	Bio reac	Emission mitigat	Sterili water
	carbon stor	Efficien cool	Bioethan	Bio reac	Capacitor	Bio treat	Emission trad	Water collect
	Ccs	Efficien heat	Biofuel	Eco design	Eco design	Disassembl	Greenhouse gas	Water conserve
	Chem separ	Efficien light	Biogas	Efficien input	Emission mitigat	Landfil	Purify air	Water distrib
	Co2 capt	Energ efficien	Biomas	Efficien output	Efficien propuls	Purif water	Environmental management	Water stor
	Co2 stor	Energ light	Efficien input	Emission mitigate	Efficien engin	remanufact	Circular econ	Water treat
	Greenhouse gas capt	Energ reduc	Efficien output	Environm control	Electr motor	Sanitation	Clim change	

(*continued on next page*)

Table B1.1 (*continued*)

		Mitigation						Adaptation
Biodiversity	GHG capture	Building	Energy	Production	Transport	Waste-water	Environmental management	Water
	Greenhouse gas stor	Energ sav	Efficien power	Material minimi	Electr switc	Sterili water	Environm control	
	Methan capt	Energ us	Emission mitigat	Material process	Electr vehic	Waste collect	Environm manag	
		Insulat	Energ alternat	Material recover	Electromobil	Waste dismantl	Pollut abat	
		Led light	Energ conserve	Minimize component	Engin manag	Waste process	Environmental monitoring	
		Natural heta	Energ efficien	Minimize material	Filter vehic	Waste separ	Environm monitor	
		Pv cell	Energ harvest	Modular design	Flywheel	Waste stor	Soil remediation	
			Energ light	Organic fertile	Fuel alternat	Waste transf	Soil remed	
			Energ optim	Pesticide alternativ	Fuel efficien	Waste transport	Waste management	
			Energ recover	Process efficien	Fuel pump	Waste treat	Mater reus	
			Energ reduc	Produc from waste	Fuel sustain	Wastewater treat	recycl	
			Energ sav	Reduc emission	Hybrid vehic		remanufact	
			Energ stor	Reforestation	Mech stor		reus	
			Energ us	Remanufact	Natural gas vehic		Waste management	
			Fuild stor		Regenerative brak			
			Fuel cell		Vehic charg			
			Fuel efficien		Vehic desgin			
			Geotherm					
			Hybrid cell					
			Hydro energ					
			Hydro power					
			Hydroelectric					
			Hydrogen					
			Marin energy					
			Mech stor					
			Ocean energy					
			Photovolt					
			Pump stor					
			Ren energy					
			Smart grid					
			Solar cell					
			Solar concentrate					
			Solar energy					
			Solar heat					
			Solar pond					
			Superconduct elem					
			Therm energy					
			Therm stor					
			Tidal					
			Wind energ					
			Wind power					
			Wind turbin					

B.2. Technological innovation and green technological innovation

Table B2.1
Patent Classification Environment-related Technologies (3-digit).

ID	ENV-TECH	3-digit IPC Class
1.1	Air pollution abatement	B01, F23, F27, C21, F01, F02, G01, C10
1.2	Water pollution abatement	B63, C02, C09, E03, C05, E02
1.3	Waste management	E01, B65, A23, A43, B03, B22, B29, B30, B62, C03, C04, C08, C09, C10, C22, D01, D21, H01, C05, F23, B09, A61
1.4	Soil remediation	B09
1.5	Environmental monitoring	F01, G08
2.1	Demand-side technologies	F16, E03, A47, Y02, A01, C12, F01, G01
2.2	Supply-side technologies	E03
4.1	Renewable energy generation	Y02
4.2	Energy generation from fuels of non-fossil origin	Y02
4.3	Combustion technologies with mitigation potential	Y02
4.4	Nuclear energy	Y02

(*continued on next page*)

Table B2.1 (*continued*)

ID	ENV-TECH	3-digit IPC Class
4.5	Technologies for an efficient electrical power generation, transmission or distribution	Y02
4.6	Enabling technologies	Y02
4.7	Other energy conversion or management systems reducing GHG emissions	Y02
5.1	CO2 capture or storage	Y02
5.2	Capture or disposal of greenhouse gases other than CO2	Y02
6.1	Road transport	Y02
6.2	Rail transport	Y02
6.3	Air transport	Y02
6.4	Maritime or waterways transport	Y02
6.5	Enabling technologies in transport	Y02
7.1	Integration of renewable energy sources in buildings	Y02
7.2	Energy efficiency in buildings	Y02
7.3	Architectural or constructional elements improving the thermal performance of buildings	Y02
7.4	Enabling technologies in buildings	Y02
8.1	Wastewater treatment	Y02
8.2	Solid waste management	Y02
8.3	Enabling technologies or technologies with a potential or indirect contribution to GHG mitigation	Y02
9.1	Technologies related to metal processing	Y02
9.2	Technologies relating to chemical industry	Y02
9.3	Technologies relating to oil refining and petrochemical industry	Y02
9.4	Technologies relating to the processing of minerals	Y02
9.5	Technologies relating to agriculture, livestock or agroalimentary industries	Y02
9.6	Technologies in the production process for final industrial or consumer products	Y02
9.7	Climate change mitigation technologies for sector-wide applications	Y02
9.8	Enabling technologies with a potential contribution to GHG emissions mitigation	Y02

Notes: ENV-Tech classification includes IPC code. The classification can be found at https://www.oecd.org/environment/consumption-innovation/ENV-tech%20search%20strategies,%20version%20for%20OECDstat%20(2016).pdf.

Appendix C. Independent variables: Extreme voting

Table C1
Extreme Parties at Both Ends of the Political Spectrum Considered in the Analysis.

Parties to the extreme right of the political spectrum				Parties to the extreme left of the political spectrum			
Country	Party name in original language	Party name in English	CHES score	Country	Party name in original language	Party name in English	CHES score
GR	Laïkós Sýndesmos—Chrysí Avgí	Popular Association—Golden Dawn	10.00	GR	Kommounistikó Kómma Elládas	Communist Party of Greece	0.22
CY	Ethniko Laiko Metopo	National Popular Front	10.00	BE	Partij van de Arbeid van België/ Parti du Travail de Belgique	Workers' Party of Belgium	0.33
FR	Rassemblement national	National Rally	9.75	SL	Levica	The Left	0.71
HU	Jobbik (2014)	Jobbik	9.71				
ES	Vox	Vox	9.71	IR	Dlúthphairtíocht–Pobal Roimh Bhrabú	Solidarity—People Before Profit	0.80
BE	Vlaams Belang	Flemish Interest	9.58	PT	Partido Comunista Português	Partido Comunista Português	0.88
NL	Forum voor Democratie	Forum for Democracy	9.54	PT	Coligação Democrática Unitária	Democratic Unitarian Coalition	0.88
PL	Konfederacja Wolność i Niepodległość	Confederation Liberty and Independence	9.53	PT	Bloco de Esquerda	Left Bloc	0.88
SK	Ľudová strana Naše Slovensko	Ľudová strana Naše Slovensko	9.31	DK	Enhedslisten—De Rød-Grønne	Unity List-Red/Green Alliance	1.00
HR	Hrvatska konzervativna strank	Croatian Conservative Party	9.26	FR	Parti Communiste Français	French Communist Party	1.13
DE	Alternative für Deutschland	Alternative for Germany	9.24	PT	Partido Ecologista "Os Verdes"	Ecologist Party "The Greens"	1.14
AT	Freiheitliche Partei Österreichs	Freedom Party of Austria	9.10	CZ	Komunistická strana Cech a Moravy	Communist Party of Bohemia and Moravia	1.15
IT	Fratelli d'Italia	Brothers of Italy	9.05	FR	La France Insoumise	Unbowed France	1.25
DK	Nye Borgerlige	The New Righ	9.00	PL	Lewica Razem	Left Together	1.28
GR	Elliniki Lisi	Greek Solution	9.00	ES	Euskal Herria Bildu	Basque Country Unite	1.29
FR	Debout la France	France Arise	9.00	NL	Socialistische Partij	Socialist Party	1.38
CZ	Svoboda a prímá demokracie	Freedom and Direct Democracy	8.85	DE	Die Linke	The Left	1.43

(*continued on next page*)

Table C1 (*continued*)

Parties to the extreme right of the political spectrum				Parties to the extreme left of the political spectrum			
Country	Party name in original language	Party name in English	CHES score	Country	Party name in original language	Party name in English	CHES score
IT	Lega Nord	Northern League	8.79	GR	Métopo Evropaikís Realistikís Anypakoís	European Realistic Disobedience Front [MeRa25]	1.43
SL	Slovenska nacionalna stranka	Slovenian National Party	8.71	IT	Sinistra Italiana	Italian Left	1.44
NL	Partij voor de Vrijheid	Party for Freedom	8.69	FI	Vasemmistoliitto	Left Alliance	1.50
SL	Socialdemokratska stranka Slovenije	Social Democratic Party of Slovenia	8.64	LU	Déi Lénk	The Left	1.50
NL	Staatkundig Gereformeerde Partij	Reformed Political Party	8.54	SW	Vänsterpartiet	Left Party	1.71
SW	Sverigedemokraterna	Sweden Democrats	8.47	ES	Izquierda Unida	United Left	1.87
EST	Eesti Konservatiivne Rahvaerakond	Conservative People's Party	8.46	PL	Wiosna	Spring	1.89
LV	Nacionala apvieniba	National Alliance	8.45	ES	Podemos	We Can	1.93
				GR	Syriza (2014)	Coalition of the Left and Progress	2.00
HR	Hrvatski Demokrtski Sabor Slavonije i Baranje	Croatian Democratic Assembly of Slavonija and Baranje	8.41				
HU	Fidesz	Fidesz	8.33				
DK	Liberal Alliance	Liberal Alliance	8.00				
IR	Renua Ireland	Renua Ireland	8.00				
LU	Alternativ Demokratesch Reformpartei	Alternative Democratic Reform Party	8.00				

Table C2
Extreme parties based on their attitudes on different issues —economics, immigration, environment, anti-establishment sentiment— according to the CHES codebook.

	Extreme right parties	Positions			Extreme left parties	Positions	
Country	(party id CHES) Party name (party id MPD)	Position 2014–2018	Position 2018–2022	Country	(party id CHES) Party name (party id MPD)	Position 2014–2018	Position 2018–2022
GR	415 Popular Association—Golden Dawn (34720)	1.17, 10, 9.40, 10	2.38, 9.88, 7.20, 9.50	GR	404 Communist Party of Greece (34210)	0.13, 2.83, 5.57, 9.78	0, 2.67, 5.67, 7.89
GR	416 Greek Solution (34730)		3.29, 9.5, 7.17, 8.5	GR	417 European Realistic Disobedience Front [MeRa25] (34215)		1.71, 0.67, 2.83, 8.71
CY	4009 National Popular Front (55720)		4, 10, 7, 6.5	GR	403 Coalition of the Left and Progress (34212)	1.13, 2.22, 2.78, 8.56	1.56, 2.11, 4.14, 6.56
FR	610 National Rally (31720)	3.73, 9.80, 7.55, 9.55	3.88, 9.88, 7.25, 9.43	FR	601 French Communist Party (31220)	0.64, 3.60, 6.36, 6.64	0.63, 3.25, 3.86, 6.86
FR	628 France Arise (31626)		5.75, 9.33, 6.5, 8.20	FR	627 Unbowed France (31021)		0.88, 4, 3.88, 9.57
HU	2308 Jobbik (86710)	1.86, 9.33, 5.83, 9.07	2.8, 9.13, 5.60, 6.64	ES	506 Basque Country Unite (33902)		4.87, 5.29, 4.92, 1.15
HU	2302 Fidesz (86421)	1.64, 7.83, 7.15, 4.64	1.29, 9.93, 7.92, 8.15	ES	504 United Left (33220)	1.2, 1.60, 2.78, 5.60	0.93, 2.53, 3.2, 5.43
ES	527 Vox (33710)		8.47, 9.80, 8.80, 6.43	ES	525 We Can (33210)	0.78, 1.40, 3.5, 10	1.2, 1.73, 2.27, 7.29
BE	112 Flemish Interest (21917)	5.25, 9.60, 7.20, 9	4.88, 9.83, 8.33, 8.91	BE	119 Workers' Party of Belgium (21230)	0.25, 1.80, 4.60, 8.40	0.55, 2.55, 4.33, 8.64
NL	1051 Forum for Democracy (22730)		8.55, 9.92, 9.31, 9.91	NL	1014 Socialist Party (22220)	0.89, 4.38, 4.86, 6.57	0.83, 5.25, 4.58, 6.45
NL	1017 Party for Freedom (22722)	4.88, 9.88, 8.20, 9.43	6, 9.92, 9, 9.67	PL	2620 Left Together (92023)		1.28, 1.75, 1.59, 5.13
NL	1006 Reformed Political Party (22952)	5.85, 8.43, 6, 1.17	7, 7.92, 6.91, 1.08	PL	2621 Spring (92455)		2.67, 2.11, 1.74, 3.94
PL	2619 Confederation Liberty and Independence (92070)		8.61, 9.74, 8.82, 9.11	DE	306 The Left (41223)	1.2, 4, 4.78, 5.40	0.68, 2.70, 4.25, 4.45
SK	2817 Ľudová strana Naše Slovensko (96720)		1.69, 10, 7.92, 9.25	IT	838 Italian Left	1, 1.25, 1.6, 6.80	1.4, 6.90, 2.13, 3.79
HR	3119 Croatian Conservative Party (81450)		5.36, 9.26, 6.09, 7.15	DK	213 Unity List-Red/Green Alliance (13229)	0.60, 1.60, 0.78, 5.90	1.54, 2.43, 3, 4.15
HR	3107 Croatian Democratic Assembly of Slavonija and Baranja (81952)	4.14, 7.5, 6.14, 6.78	3.59, 8.80, 5.64, 5.52	CZ	2103 Communist Party of Bohemia and Moravia (82220)	0.62, 6.67, 6.92, 5.69	1.04, 8.96, 7.71, 6.81
DE	310 Alternative for Germany (41953)	7.75, 9.30, 8.67, 7.78	6.67, 9.90, 8.45, 9.70	SL	2912 The Left (97230)	1.3, 1.22, 1.45, 6.75	1.21, 1, 1.93, 7
AT	1303 Freedom Party of Austria (42420)	4.89, 9.89, 6, 8	6.5, 9.8, 8.40, 7.60	SW	1601 Left Party (11220)	0.89, 0.56, 1.79, 5.37	1.06, 1.53, 1.59, 4.75
IT	844 Brothers of Italy (32630)	5.40, 8.75, 7.20, 6.25	5, 9.84, 7.60, 8	IR	709 Solidarity—People Before Profit (53231)	0.80, 5, 3.33, 9.25	0.60, 2.75, 4.20, 8.20

(*continued on next page*)

Table C2 (*continued*)

	Extreme right parties	Positions			Extreme left parties	Positions	
Country	(party id CHES) Party name (party id MPD)	Position 2014–2018	Position 2018–2022	Country	(party id CHES) Party name (party id MPD)	Position 2014–2018	Position 2018–2022
IT	811 Northern League (32720)	6.80, 9.5, 5.80, 8.80	6.18, 9.95, 7.65, 8.83	LU	3806 The Left (23230)	1, 2, 2, 9	5, 1.5, 3, 5.5
DK	220 The New Right (13730)		8.23, 9.64, 6.77, 6.42	PT	1210 Partido Comunista Português (35220)		0.88, 2.29, 3.14, 7.43
DK	218 Liberal Alliance (13001)	8.60, 4.10, 7.75, 3.13	8.31, 6.29, 6.79, 3.54	PT	1208 Left Bloc (35211)	0.5, 0.8, 1.5, 7.5	1.63, 1.5, 2.63, 7.29
CZ	2115 Freedom and Direct Democracy (82721)		3.36, 9.85, 8.86, 9.04	PT	1211 Ecologist Party “The Greens” (35110)		1.29, 2.14, 2.14, 7.33
SL	2907 Slovenian National Party (97710)		5.46, 9.60, 7.17, 7.80	FI	1404 Left Alliance (14223)	1.75, 2.88, 3.5, 6.25	1.36, 2.21, 2.86, 3.77
				HR	3102 Democratic Unitarian Coalition	4.33, 3.71, 5.56, 1.78	3.30, 4.52, 5.09, 1.54
SL	2902 Social Democratic Party of Slovenia (97330)	7.73, 7.80, 6.09, 6.63	7.33, 9.60, 7.33, 7				
SW	1610 Sweden Democrats (11710)	4.47, 9.78, 7.5, 8.89	4.82, 9.76, 7.94, 8.94				
EST	2209 Conservative People’s Party (83720)		4.23, 9.62, 6.08, 8.62				
LV	2406 National Alliance (87071)	6.63, 8.71, 6.33, 5	5.92, 9.67, 5.36, 3.67				
IR	712 Renua Ireland		7.75, 8.40, 7.20, 7.75				
LU	3805 Alternative Democratic Reform Party (23951)	7, 9.5, 4.5, 9	6, 6.5, 4, 6				

Notes: We identify 4 different issues including economic intervention, immigration policy, environment, and anti-elite_salience because these options are used to assess political parties’ positions in both election periods, we don’t put their positions towards nationalism, protectionism, elite vs people, because their position about these issues in two elections are not asked in the CHES codebook.

Econ_interven: state intervention in the economy, 0 = fully in favour of state intervention;10 = fully opposed to state intervention.

Immigrate_policy: immigration policy, 0 = strongly favours a liberal policy on immigration; 10 = strongly favours a restrictive policy on immigration.

Environment: environmental sustainability, 0 = strongly supports environmental protection even at the cost of economic growth; 10 = strongly supports economic growth even at the cost of environmental protection.

Antielite_salience: anti-establishment and anti-elite, 0 = not important at all; 10 = extremely important.

Table C3

Correlation matrix for extreme parties’ positions on economic, immigration, environmental, anti-elite issues.

	1	2	3	4	5	6	7	8	9	10	11	12
1. Extreme right	1.000											
2. EU_intmark	−0.529***	1.000										
3. Galtan	0.439**	−0.325**	1.000									
4. Econ_interven	−0.161	0.138	0.596***	1.000								
5. Civlib_laworder	0.612***	−0.308**	0.955***	0.623***	1.000							
6. Sociallifestyle	0.474***	−0.279**	0.972***	0.552***	0.947***	1.000						
7. Immigrate_policy	0.582***	−0.270**	0.937***	0.668***	0.972***	0.931***	1.000					
8. Multiculturalism	0.524***	−0.284**	0.943***	0.678***	0.969***	0.926***	0.989***	1.000				
9. Environment	0.356*	−0.355***	0.868***	0.653***	0.896***	0.836***	0.917***	0.911***	1.000			
10. Nationalism	0.589***	−0.316**	0.965***	0.611***	0.968***	0.956***	0.960***	0.960***	0.870***	1.000		
11. Protectionism	0.376**	−0.650***	0.304**	−0.399***	0.271**	0.339**	0.188	0.199	0.149	0.297**	1.000	
12. Antielite_salience	0.396**	−0.645***	0.402***	0.040	0.426***	0.378***	0.382***	0.382***	0.444***	0.392***	0.504***	1.000
1. Extreme left	1.000											
2. EU_intmark	0.454**	1.000										
3. Galtan	−0.531***	−0.325**	1.000									
4. Econ_interven	0.210	0.138	0.596***	1.000								
5. Civlib_laworder	−0.665***	−0.308**	0.955***	0.623***	1.000							
6. Sociallifestyle	−0.533***	−0.279**	0.972***	0.552***	0.947***	1.000						
7. Immigrate_policy	−0.478**	−0.270**	0.937***	0.668***	0.972***	0.931***	1.000					
8. Multiculturalism	−0.458**	−0.284**	0.943***	0.678***	0.969***	0.926***	0.989***	1.000				
9. Environment	−0.572***	−0.355***	0.868***	0.653***	0.896***	0.836***	0.917***	0.911***	1.000			
10. Nationalism	−0.374*	−0.316**	0.965***	0.611***	0.968***	0.956***	0.960***	0.960***	0.870***	1.000		
11. Protectionism	−0.397**	−0.650***	0.304**	−0.399***	0.271**	0.339***	0.188	0.199	0.149	0.297**	1.000	
12. Antielite_salience	−0.179	−0.645***	0.402***	0.040	0.426***	0.378***	0.382***	0.382***	0.444***	0.392***	0.504***	1.000

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

EU_intmark: internal market (i.e., free movements of goods, services, capital, and labour), 1 = strongly opposes; 7 = strongly favours.

Galtan: social and culture values, 0 = Libertarian/Postmaterialist; 5 = Center; 10 = Traditional/Authoritarian.

Civlib_laworder: civil liberties vs law and order, 0 = strongly promotes civil liberties; 10 = strongly supports tough measures to fight crime.

Sociallifestyle: social lifestyle, 0 = strongly supports liberal policies, 10 = strongly opposes liberal policies.

Multiculturalism: integration of immigrants and asylum seekers, 0 = strongly favours multiculturalism; 10 = strongly favours assimilation.

Nationalism: cosmopolitanism vs. nationalism, 0 = strongly promotes cosmopolitan conceptions of society; 10 = strongly promotes nationalist conceptions of society.

Table C4
Conception of extreme parties.

Mutual characteristics	Extreme right-wing	Extreme left-wing
Anti-establishment	Rejection of mainstream and liberal economic, political institutions with nationalism ideologies	Resisting of liberal systems with a particular focus on social justice
Anti-elite	Challenging elites for social and cultural perspective (targeting immigrants, globalists, media activists., and so on)	Challenging elites for economic perspective (targeting corporations, governments, capitalists)
Anti-liberality	Opposing to cultural liberalism and globalism	Opposing to market liberalism and privatisation

Appendix D. Descriptive statistics

Table D1
Descriptive statistics.

Variables	Description	N	Mean	St. Dev	Minimum	Maximum
Scientific research	The average value of the number of publications per million inhabitants of each NUTS3 region over the period 2019–2021	1137	1061.392	3462.711	0.000	46,930.33
Green scientific research	The average value of the number of publications on green-related topics per million inhabitants of each NUTS3 region over the period 2019–2021	1137	32.846	115.053	0.000	1840.517
Technological innovation	The average value of the number of patent application per million inhabitants of each NUTS3 region over the period 2019–2021	1137	356.847	520.982	0.000	7754.675
Green technological innovation	The average value of the number of patent application for environment-related technologies per million inhabitants of each NUTS3 region over the period 2019–2021	1137	3.941	13.810	0.000	225.304
Extreme voting (%)	More-radical (and moderate) extreme left-wing voting + more-radical (and moderate) extreme right-wing voting (2013–2018)	1137	19.782	13.195	0.000	61.754
Extreme left-wing voting (%)	votes for more-radical (and moderate) extreme left-wing parties (score ≤ 2) as % of valid votes in each NUTS3 region over the election period 2013–2018	1137	8.100	9.008	0.000	52.253
Extreme right-wing voting (%)	votes for more-radical (and moderate) extreme right-wing parties (score ≥ 8) as % of valid votes in each NUTS3 region over the election period 2013–2018	1137	11.682	8.898	0.000	44.021
More-radical extreme voting (%)	More-radical extreme left-wing voting + more-radical extreme right-wing voting (2013–2018)	1137	9.330	8.563	0.000	37.327
More-radical extreme left-wing voting (%)	votes for more-radical extreme left-wing parties (score ≤ 1) as % of valid votes in each NUTS3 region over the election period 2013–2018	1137	1.822	3.790	0.000	26.972
More-radical extreme right-wing voting (%)	votes for more-radical extreme right-wing parties (score ≥ 9) as % of valid votes in each NUTS3 region over the election period 2013–2018	1137	7.509	7.562	0.000	37.327
Control variables						
GDP per capita	GDP per capita in EU-27 index in 2018 in NUTS3 regions	1137	92.885	44.623	23.209	559.465
Employment in industry (%)	Share of employment in industry in 2018 in NUTS3 regions	1137	18.421	8.946	1.333	52.866
R&D intensity (%)	R&D expenditure (all sectors) as a percentage of GDP in NUTS2 regions in 2017	1137	1.820	1.402	0.060	7.930
Quality of government	Quality of government in NUTS2 regions in 2017	1137	0.536	0.226	0.000	1.000
GDP per capita growth	GDP per capita growth (2010-2018)	1137	1.311	1.551	−3.933	10.955
Net migration	Net migration rate (2010-2018)	1137	2.612	4.814	−15.767	30.389
Population density	Millions of people per square kilometre in 2018	1137	420.936	1075.258	1.900	21,000

Notes: Due to missing value for R&D intensity in 2017, 5 observations of R&D intensity are interpolated. Quality of government is normalized, and 3 of its observations are interpolated. We use interpolation to fill 14 missing values of Science & Technology employment. 16 missing variables of religion types (about 2 % of the total observations) are filled after interpolation. Zero voting for more-extreme left-wing extreme parties in 802 European regions; zero voting for more-moderate right-wing extreme parties in 770 European regions. All independent and control variables (except GDP per capita growth and net migration) are taken as natural logarithms (ln(1 + x)) (Manning, 1998).

Table D2
Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Overall scientific research	1.000														
2. Green scientific research	0.743***	1.000													
3. Extreme voting	0.032	−0.002	1.000												
4. Extreme left-wing voting	0.090***	0.059**	0.735***	1.000											
5. Extreme right-wing voting	−0.058*	−0.105**	0.837***	0.369***	1.000										
6. More-radical extreme voting	−0.041	−0.100***	0.673***	0.681***	0.587***	1.000									
7. More-radical extreme left-wing voting	−0.035	−0.008	0.294***	0.456***	0.059**	0.321***	1.000								
8. More-radical extreme right-wing voting	−0.048	−0.124	0.552	0.586	0.456	0.321	−0.036	1.000							
9. GDP per capita	0.207	0.147	0.266	0.217	0.215	0.190	−0.125	0.214***	1.000						
10. Employment in industry	−0.171***	−0.130***	0.034	−0.201***	0.192***	0.018	−0.299***	0.077***	−0.018	1.000					
11. R&D intensity	0.106***	0.070**	0.380***	0.303***	0.312***	0.336***	−0.054*	0.359***	0.562***	0.095***	1.000				
12. Quality of government	0.075*	0.055*	0.305***	0.306***	0.197***	0.409***	−0.197***	0.483***	0.619***	0.074**	0.615***	1.000			
13. GDP per capita growth	−0.069**	−0.045	−0.306***	−0.417***	−0.134***	−0.105***	−0.326***	−0.017	−0.048	0.458***	−0.086***	0.015	1.000		
14. Net migration	0.114***	0.077**	0.266***	0.226***	0.232***	0.208***	−0.130***	0.239***	0.528***	−0.131***	0.415***	0.419***	−0.215***	1.000	
15. Population density	0.190***	0.106***	0.223***	0.192***	0.267***	0.270***	−0.119***	0.287***	0.544***	−0.143***	0.317***	0.233***	−0.062***	0.389***	1.000
1. Overall technological innovation	1.000														
2. Green technological innovation	0.419***	1.000													
3. Extreme voting	0.190***	0.081***	1.000												
4. Extreme left-wing voting	0.144***	0.069**	0.735***	1.000											
5. Extreme right-wing voting	0.196***	0.093***	0.834***	0.364***	1.000										
6. More-radical extreme voting	0.228***	0.120***	0.670***	0.679***	0.576***	1.000									
7. More-radical extreme left-wing voting	−0.222***	−0.114***	0.292***	0.459***	0.044***	0.323***	1.000								
8. More-radical extreme right-wing voting	0.306***	0.160***	0.549***	0.503***	0.586***	0.893***	−0.045	1.000							
9. GDP per capita	0.547***	0.371***	0.193***	0.173***	0.153***	0.153***	−0.123***	0.181***	1.000						
10. Employment in industry	0.186***	−0.211***	0.165***	0.021	−0.284***	0.076***	0.007	1.000							
11. R&D intensity	0.562***	0.445***	0.284***	0.227***	0.238***	0.281***	−0.081***	0.317***	0.453***	0.101***	1.000				
12. Quality of government	0.507***	0.226***	0.305***	0.323***	0.190***	0.413***	−0.201***	0.489***	0.501***	0.027	0.533***	1.000			
13. GDP per capita growth	0.018	0.017***	−0.304***	−0.410***	−0.132***	−0.101***	−0.326***	−0.009	0.017	0.459***	−0.032	0.016	1.000		
14. Net migration	0.419***	0.181***	0.266***	0.226***	0.232***	0.208***	−0.130***	0.239***	0.448***	−0.125***	0.368***	0.432***	−0.215***	1.000	
15. Population density	0.152***	0.078***	0.072**	0.126***	0.035	0.096***	0.031	0.087***	0.416***	−0.210***	0.124***	0.076**	−0.040	0.042	1.000

*Notes: All independent (and control) variables are adopted based on their natural logarithm, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The value of VIF is below 10.*

Appendix E. Robustness check – extreme voting over two election periods

Table E1
Descriptive statistics for changes in extreme voting over two election periods (2013–2018, 2018–2022).

Variables	Mean	St. Dev	Minimum	Maximum
Extreme voting (2018–2022)	11.598	8.751	0.000	38.161
Extreme right-wing voting (2018–2022)	10.801	8.983	0.000	38.161
Extreme left-wing voting (2018–2022)	0.797	2.519	0.000	23.580
More -radical extreme voting (2018–2022)	21.354	16.149	0.000	63.803
More -radical extreme right-wing voting (2018–2022)	15.228	13.209	0.000	61.863
More-radical extreme left-wing voting (2018–2022)	6.127	7.248	0.000	45.977
Changes in extreme voting (%)	1.496	17.209	−51.151	63.803
Changes in extreme right-wing voting (%)	−2.017	8.704	−47.709	24.404
Changes in extreme left-wing voting (%)	3.514	11.712	−14.361	58.030
Changes in more-radical extreme voting (%)	2.359	10.216	−31.71	36.981
Changes in more-radical extreme right-wing voting (%)	−0.957	3.472	−19.53	16.784
Changes in more-radical extreme left-wing voting (%)	3.316	10.055	−31.71	38.161

Table E2.1
Extreme voting (2013–2018) and overall scientific research (2022)

	(1)	(2)	(3)	(4)	(5)	(6)
Extreme voting (<2; >8)	−177.2**					
	(78.05)					
Extreme right-wing voting (>8)		−379.9***				
		(85.04)				
Extreme left-wing voting (<2)			−14.69			
			(92.04)			
More-radical extreme voting (<1; >9)				−201.9*		
				(107.2)		
More-radical extreme right-wing voting (>9)					−445.3***	
					(89.58)	
More-radical extreme left-wing voting (<1)						−192.8*
						(111.0)
GDP per capita	1783.4***	1699.2***	1815.4***	1740.1***	1264.6***	1839.0***
	(327.9)	(326.0)	(332.3)	(332.8)	(342.0)	(328.1)
Employment in industry	−878.1***	−658.3***	−966.4***	−943.9***	−868.4***	−1027.0***
	(239.0)	(239.4)	(235.5)	(236.0)	(238.4)	(248.9)
R&D intensity	139.2	216.6	51.69	85.78	161.6	108.8
	(267.0)	(263.4)	(260.4)	(259.5)	(259.3)	(258.9)
Quality of government	−3169.0***	−3369.8***	−3344.2***	−2908.3***	−1359.7*	−3574.8***
	(686.7)	(694.0)	(718.5)	(726.8)	(770.3)	(691.4)
GDP per capita growth	80.15	53.55	123.2**	96.74*	121.9**	102.5*
	(54.99)	(55.48)	(55.59)	(53.53)	(55.90)	(53.69)
Net migration	−14.25	−5.181	−16.18	−17.32	−10.82	−23.36
	(20.60)	(20.97)	(20.46)	(20.40)	(20.74)	(20.73)
Population density	210.2***	280.0***	181.5**	236.7***	337.6***	166.9**
	(75.07)	(72.50)	(76.17)	(73.28)	(76.56)	(74.89)
Constant	−6309.8***	−6574.1***	−6390.3***	−6280.9***	−5312.3***	−6082.4***
	(1302.5)	(1311.0)	(1320.8)	(1316.2)	(1311.6)	(1293.0)
N	1137	1137	1137	1137	1137	1137
Log likelihood	−3603.7	−3594.0	−3605.8	−3603.7	−3591.1	−3604.2

Notes: Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table E2.2
Extreme voting (2018–2022) and overall scientific research (2022)

	(1)	(2)	(3)	(4)	(5)	(6)
Extreme voting (<2; >8)	−1.882					
	(84.13)					
Extreme right-wing voting (>8)		−86.84				
		(81.94)				
Extreme left-wing voting (<2)			90.88			
			(96.65)			
More-radical extreme voting (<1; >9)				−526.4***		
				(101.9)		
More-radical extreme right-wing voting (>9)					−499.4***	
					(91.58)	
More-radical extreme left-wing voting (<1)						87.92
						(151.3)
GDP per capita	1819.9***	1844.9***	1790.2***	1874.8***	1875.6***	1824.1***

(*continued on next page*)

Table E2.2 (*continued*)

	(1)	(2)	(3)	(4)	(5)	(6)
	(333.9)	(333.1)	(329.1)	(333.6)	(333.7)	(329.2)
Employment in industry	−965.9***	−952.5***	−917.6***	−941.6***	−873.9***	−945.1***
	(236.6)	(235.2)	(245.6)	(231.8)	(227.2)	(240.5)
R&D intensity	47.81	69.47	25.96	193.9	207.7	47.01
	(259.3)	(257.0)	(259.0)	(257.2)	(257.9)	(255.1)
Quality of government	−3372.9***	−3408.0***	−3533.9***	−3418.5***	−3506.0***	−3366.6***
	(676.4)	(687.8)	(707.7)	(699.4)	(704.5)	(681.0)
GDP per capita growth	126.3**	107.3*	149.3**	−18.16	−3.153	132.4**
	(61.21)	(59.72)	(59.34)	(57.92)	(57.40)	(54.17)
Net migration	−16.07	−15.10	−13.11	−15.32	−8.476	−14.47
	(20.46)	(20.45)	(20.67)	(20.64)	(20.47)	(20.63)
Population density	179.4**	175.4**	185.5**	220.2***	219.8***	178.8**
	(75.54)	(74.92)	(76.06)	(70.90)	(70.47)	(75.11)
Constant	−6410.4***	−6319.3***	−6542.6***	−5728.2***	−6059.4***	−6522.9***
	(1310.3)	(1299.0)	(1336.0)	(1290.9)	(1298.2)	(1302.6)
N	1137	1137	1137	1137	1137	1137
Log likelihood	−3605.8	−3605.3	−3605.5	−3587.9	−3586.3	−3605.6

Notes: Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table E3.1
Extreme voting (2013–2018) and green scientific research (2022)

	(1)	(2)	(3)	(4)	(5)	(6)
Extreme voting (<2; >8)	−9.372**					
	(4.453)					
Extreme right-wing voting (>8)		−23.60***				
		(5.559)				
Extreme left-wing voting (<2)			−1.410			
			(4.817)			
More-radical extreme voting (<1; >9)				−14.61**		
				(6.859)		
More-radical extreme right-wing voting (>9)					−36.36***	
					(6.352)	
More-radical extreme left-wing voting (<1)						−7.147
						(6.219)
GDP per capita	110.8***	105.6***	112.2***	107.7***	68.20***	113.5***
	(18.13)	(17.81)	(18.29)	(17.81)	(16.84)	(18.37)
Employment in industry	−32.80***	−17.72	−37.73***	−35.47***	−29.59***	−39.64***
	(10.86)	(11.05)	(11.02)	(10.89)	(10.66)	(11.74)
R&D intensity	−18.12	−12.57	−22.70	−20.86	−15.17	−21.23
	(15.06)	(14.87)	(14.71)	(14.65)	(14.49)	(14.69)
Quality of government	−179.8***	−194.5***	−186.1***	−158.0***	−26.03	−196.3***
	(37.24)	(38.53)	(38.21)	(38.24)	(40.69)	(38.01)
GDP per capita growth	1.841	−0.307	3.975	2.154	4.103	3.453
	(2.860)	(2.859)	(2.905)	(2.778)	(2.899)	(2.738)
Net migration	−0.838	−0.215	−0.943	−1.020	−0.546	−1.208
	(1.110)	(1.125)	(1.109)	(1.106)	(1.113)	(1.111)
Population density	7.532*	12.28***	6.069	10.09**	19.01***	5.486
	(4.133)	(3.905)	(4.265)	(4.021)	(4.189)	(4.332)
Constant	−419.8***	−437.5***	−422.0***	−419.5***	−338.8***	−413.9***
	(72.77)	(74.49)	(73.47)	(72.60)	(69.20)	(72.89)
N	1137	1137	1137	1137	1137	1137
Log likelihood	−1909.7	−1896.4	−1911.6	−1908.1	−1879.1	−1911.0

Notes: Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table E3.2
Extreme voting (2018–2022) and green scientific research (2022)

	(1)	(2)	(3)	(4)	(5)	(6)
Extreme voting (<2; >8)	3.740					
	(4.837)					
Extreme right-wing voting (>8)		−2.663				
		(4.757)				
Extreme left-wing voting (<2)			3.600			
			(5.462)			
More-radical extreme voting (<1; >9)				−28.76***		
				(6.597)		
More-radical extreme right-wing voting (>9)					−30.55***	
					(6.039)	
More-radical extreme left-wing voting (<1)						14.13*
						(7.419)
GDP per capita	110.9***	113.1***	111.1***	116.7***	117.2***	113.4***

(*continued on next page*)

Table E3.2 (*continued*)

	(1)	(2)	(3)	(4)	(5)	(6)
	(18.24)	(18.31)	(18.37)	(18.85)	(18.86)	(18.35)
Employment in industry	−37.30***	−37.25***	−35.87***	−35.96***	−31.24***	−34.07***
	(10.94)	(11.15)	(11.66)	(10.85)	(10.51)	(11.25)
R&D intensity	−24.31	−22.32	−23.99	−15.82	−14.28	−23.37
	(14.82)	(14.63)	(14.74)	(14.88)	(14.87)	(14.53)
Quality of government	−189.7***	−190.4***	−194.6***	−199.3***	−206.8***	−188.3***
	(37.27)	(37.26)	(38.60)	(39.56)	(40.29)	(37.55)
GDP per capita growth	5.328*	3.736	5.191*	−3.514	−3.577	5.222*
	(3.219)	(3.125)	(3.037)	(3.025)	(2.953)	(2.779)
Net migration	−0.884	−0.894	−0.803	−0.836	−0.342	−0.634
	(1.113)	(1.098)	(1.123)	(1.113)	(1.098)	(1.091)
Population density	6.161	5.773	6.095	8.451**	8.749**	5.738
	(4.306)	(4.272)	(4.306)	(3.953)	(3.924)	(4.247)
Constant	−429.7***	−420.6***	−427.9***	−392.2***	−409.4***	−442.8***
	(74.16)	(73.35)	(74.00)	(71.86)	(73.23)	(74.39)
N	1137	1137	1137	1137	1137	1137
Log likelihood	−1911.4	−1911.5	−1911.5	−1893.7	−1887.1	−1909.7

Notes: Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Appendix F. Robustness check – OLS

Table F1
OLS: Overall technological innovation

	(1)	(2)	(3)	(4)	(5)	(6)
Extreme voting (<2; >8)	−263.7***					
	(30.44)					
Extreme right-wing voting (>8)		−215.3***				
		(35.75)				
Extreme left-wing voting (<2)			−206.0***			
			(26.75)			
More-radical extreme voting (<1; >9)				−270.5***		
				(43.98)		
More-radical extreme right-wing voting (>9)					−220.2***	
					(36.47)	
More-radical extreme left-wing voting (<1)						−60.56**
						(29.69)
GDP per capita	316.2***	294.1***	333.9***	304.9***	286.6***	324.5***
	(84.39)	(82.37)	(85.14)	(83.34)	(82.14)	(86.75)
Employment in industry	184.1***	202.3***	149.2***	182.9***	194.6***	167.2***
	(34.37)	(36.62)	(34.33)	(34.97)	(35.48)	(34.51)
R&D intensity	362.9***	362.7***	339.7***	362.7***	362.8***	342.1***
	(34.95)	(35.61)	(34.30)	(35.18)	(35.49)	(34.46)
Quality of government	505.3***	575.9***	78.79	149.2	308.4	103.9
	(184.9)	(188.9)	(180.9)	(186.8)	(188.2)	(192.5)
GDP per capita growth	−5.921	−7.062	−6.287	−5.090	−6.472	−7.568
	(11.57)	(11.69)	(11.55)	(11.67)	(11.68)	(11.83)
Net migration	9.506***	10.21***	9.851***	10.29***	10.08***	11.66***
	(2.841)	(2.892)	(2.886)	(2.878)	(2.910)	(3.029)
Population density	32.92***	33.37***	34.29***	26.90**	33.75***	30.60***
	(10.17)	(10.42)	(10.09)	(10.44)	(10.39)	(10.61)
Constant	−1479.8***	−1631.0***	−2107.3***	−2105.1***	−2162.8***	−2120.9***
	(365.8)	(351.2)	(393.9)	(388.4)	(395.7)	(399.3)
N	1137	1137	1137	1137	1137	1137
R2	0.528	0.521	0.521	0.522	0.519	0.502
Dummy country	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Appendix G. Robustness check – endogeneity

Table G1.1
OLS: Reversed relationship – all extreme voting

	(1)	(2)	(3)	(4)	(5)	(6)
	extreme voting (<2; >8)		extreme right-wing voting (>8)		extreme left-wing voting (<2)	
Technological innovation	−0.000201***		−0.000179***		−0.000182***	
	(0.0000511)		(0.0000373)		(0.0000625)	
Green technological innovation		−0.00299***		−0.00258***		−0.00233***

(*continued on next page*)

Table G1.1 (*continued*)

	(1)	(2)	(3)	(4)	(5)	(6)
		(0.000673)		(0.000647)		(0.000740)
GDP per capita	0.0486	0.00330	−0.0644	−0.105**	0.124**	0.0805
	(0.0445)	(0.0454)	(0.0455)	(0.0471)	(0.0500)	(0.0506)
Employment in industry	0.0898***	0.0569*	0.183***	0.154***	−0.0677*	−0.0975***
	(0.0335)	(0.0332)	(0.0314)	(0.0312)	(0.0362)	(0.0356)
R&D intensity	0.149***	0.115***	0.159***	0.127***	0.0526	0.0174
	(0.0397)	(0.0365)	(0.0454)	(0.0444)	(0.0419)	(0.0378)
Quality of government	1.564***	1.518***	2.237***	2.197***	−0.0759	−0.114
	(0.323)	(0.331)	(0.358)	(0.365)	(0.348)	(0.355)
GDP per capita growth	0.00494	0.00553	0.00127	0.00182	0.00513	0.00578
	(0.0100)	(0.0102)	(0.00932)	(0.00945)	(0.0111)	(0.0113)
Net migration	−0.00524*	−0.00773**	−0.00393	−0.00614	−0.00591*	−0.00814**
	(0.00313)	(0.00329)	(0.00402)	(0.00415)	(0.00317)	(0.00330)
Population density	0.0114	0.00452	0.0139	0.00780	0.0188	0.0127
	(0.0137)	(0.0139)	(0.0141)	(0.0143)	(0.0150)	(0.0152)
Constant	1.958***	2.277***	1.838***	2.124***	−0.379	−0.0790
	(0.281)	(0.277)	(0.242)	(0.243)	(0.330)	(0.321)
N	1137	1137	1137	1137	1137	1137
R2	0.921	0.918	0.919	0.917	0.890	0.887
Dummy country	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors in parentheses, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table G1.2
OLS: Reversed relationship – all more-radical extreme voting

	(1)	(2)	(3)	(4)	(5)	(6)
	more-radical extreme voting (<1; >9)		more-radical extreme right-wing voting (>9)		more-radical extreme left-wing voting (<1)	
Technological innovation	−0.000149***		−0.000156***		−0.0000160*	
	(0.0000324)		(0.0000347)		(0.00000833)	
Green technological innovation		−0.00225***		−0.00230***		−0.000211
		(0.000595)		(0.000669)		(0.000180)
GDP per capita	−0.00961	−0.0428	−0.103**	−0.138***	0.0730**	0.0693
	(0.0464)	(0.0471)	(0.0468)	(0.0485)	(0.0360)	(0.0357)
Employment in industry	0.0749***	0.0506*	0.141***	0.115***	−0.0338*	−0.0365*
	(0.0258)	(0.0260)	(0.0275)	(0.0277)	(0.0188)	(0.0187)
R&D intensity	0.129***	0.104***	0.149***	0.123***	0.0133	0.0103
	(0.0352)	(0.0343)	(0.0448)	(0.0442)	(0.0215)	(0.0216)
Quality of government	0.204	0.170	0.970**	0.935**	0.0972	0.0938
	(0.277)	(0.283)	(0.384)	(0.389)	(0.193)	(0.193)
GDP per capita growth	0.00826	0.00868	0.00407	0.00452	0.000895	0.000951
	(0.0101)	(0.0102)	(0.00950)	(0.00966)	(0.00769)	(0.00771)
Net migration	−0.00275	−0.00459	−0.00466	−0.00659	0.00291	0.00271
	(0.00313)	(0.00326)	(0.00404)	(0.00418)	(0.00235)	(0.00237)
Population density	−0.0127	−0.0177	0.0147	0.00939	−0.0160	−0.0165
	(0.0129)	(0.0131)	(0.0142)	(0.0144)	(0.0105)	(0.0105)
Constant	−0.302	−0.0686	−0.577**	−0.330	−0.245	−0.219
	(0.231)	(0.232)	(0.254)	(0.253)	(0.188)	(0.183)
N	1137	1137	1137	1137	1137	1137
R2	0.947	0.945	0.939	0.938	0.953	0.953
Dummy country	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors in parentheses, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Data availability

Data will be made available on request.

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