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# Harnessing Strategic Technologies for Europe's Competitiveness: Empirical Evidence from Patents and Productivity.

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Single Market Economics Papers

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# Harnessing Strategic Technologies for Europe's Competitiveness: Empirical Evidence from Patents and Productivity

*Bottoni Anton Giulio, Gentile Marco, Giannini Debora, Macigno Lucrezia, Mariz Davide, Pini Marco*

## Abstract

*This study examines the diffusion of strategic technologies and their contribution to European competitiveness within a rapidly evolving global context. In doing so, it provides a novel perspective on Europe's innovation landscape through an original, data-driven analysis of EU Strategic Technologies (EUST). The purpose of the research is twofold. First, the study aims to assess the degree of innovation of European firms by mapping patents in strategic technologies, as defined by the EU, thereby enabling a comparison of firms both across Member States and vis-à-vis global competitors. Second, it tests whether there is a relationship between strategic technologies and labour productivity at the firm level.*

*The findings reveal that the EU displays a broad base of firms engaged in strategic technologies but lags the United States in terms of patent intensity. Most importantly, the research shows that patents in strategic technologies are associated with significantly higher firm-level labour productivity compared to patents in other technological domains, with effects that are widespread across firm sizes (both small and medium-large firms) and industries (from low- to high-technology sectors). Ultimately, the analysis underscores the crucial role of well-developed capital markets in fostering innovation.*

*These results carry significant policy implications, underscoring the need for targeted measures to foster convergence among Member States and for policies to support the adoption and diffusion of EUST.*

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# 1. Introduction

As the current international landscape looks increasingly oriented towards a multipolar, rather than multilateral, system, strategic competition has reclaimed centre stage. The last decade has indeed been a period of profound transformation and uncertainty as a series of unprecedented economic shocks, environmental challenges, and geopolitical crises have materialised. Given the scope and the depth of the challenges, global actors have recognised the renewed importance of industrial and competitiveness policies to enhance security and provide public goods, namely in the form of the twin transitions (Arjona et al., 2023, 2024; Bontadini & Meliciani, 2025). More importantly, however, the nexus between strategic technologies, competitiveness, and economic security has emerged as a decisive factor shaping international competition. European institutions are no exception. Building upon the framework of Open Strategic Autonomy (Schmitz & Seidl, 2023; Guerrieri & Padoan, 2024), the EU has launched a series of initiatives in which technological sovereignty and economic security stand as core objectives (European Parliamentary Research Service, 2021; European Commission, 2023; Kroll et al., 2023; Edler, 2024). Mario Draghi's report on the "Future of European competitiveness" (Draghi report, 2024), in taking stock of the growing gap vis-à-vis the U.S. economy, pinpoints Europe's innovative capacity as the root cause of its weaknesses. As the EU has struggled with slow productivity growth (recently, Adilbish et al., 2025), declining competitiveness, and lagging technological innovation, it has identified strategic technologies as the necessary instrument to tackle these challenges and ultimately fulfil its security ambitions.

The objective of this paper is to shed light on the diffusion of strategic technologies and their contribution to European competitiveness. To do so, it seeks to address three main research questions. First, how innovative are European firms in terms of strategic technologies? Second, how does the EU compare with other global actors, particularly the United States and China? Additionally, do patterns of innovation vary across Member States? Finally, is there a correlation between the uptake of strategic technologies and firm-level productivity within the main European Member States? The paper will proceed as follows. The second section situates the debate within its wider policy context, examining global shifts, the motives behind the resurgence of industrial policy (Aiginger & Rodrik, 2020), the link between strategic technologies and competitiveness and the European Union's evolving policy. Given the importance of this link, the third section aims at measuring the innovative performance of European firms in terms of strategic technologies – according to STEP and NZIA EU Regulations (Regulation EU 2024/795 and Regulation EU 2024/1735, see European Commission 2024a, 2024b) – against their global counterparts as well as within member states, also highlighting the key role of the Capital market (Bhatia et al., 2019; more recently, Durá & Pasimeni, 2025, Pochet et al., 2025). To this end, we measure innovation in EU Strategic Technologies (EUST) using patent data, mapping 14-digit International Patent Classification codes associated with these technologies. Patents are employed given their recognised relevance for strategic technology development, as highlighted by the European Investment Bank (EIB, 2024). The fourth and fifth sections finally turn to the empirical analysis, estimating, at the EU firm level, the relationship between strategic technology adoption and firm productivity on all EUST while also specifically highlighting the Net-Zero Strategic technologies (Net-Zero EUST), which are part of EUST.

To conclude, we take stock of the results and outline some policy implications. While a mapping of net-zero technologies has been performed in The net-zero manufacturing industrial landscape across the Member States (European Commission - DG ENER, 2024), which identifies the products linked to these technologies, and a mapping of clean-tech patents, even though not explicitly in line with the Net Zero Industry Act, was conducted by the European Investment Bank (EIB, 2024), a complete study of innovation in EUST – as defined by the EU documents – by mapping the patents related to these technologies and the firms owning these patents, has not yet been carried out, to the best of our knowledge. Notwithstanding the long tradition of studies on the impact of patents on various dimensions of firms' performance, such as productivity (Bloom & Reenen, 2000; Bogliacino & Pianta, 2009), it is unclear whether, by focusing only on the firms with patents, a further stronger

effect on firms' performance produced by EUST arises. This study provides evidence potentially useful for EU policies in several ways. Firstly, by highlighting the heterogeneity of innovation in EUST among member states, as well as empirically measuring the gap of the EU with respect to the US and China. Secondly, by empirically demonstrating across EU member states, how EUST act as catalysts for labour productivity at the firm level.

## 2. Institutional background

### 2.1 The rise of strategic technologies and the resurgence of industrial policy

Industrial policies, defined as all government policies explicitly targeting the transformation of the structure of economic activity in pursuit of some public goal (Juhász et al., 2024), have made a comeback in the past two decades. Multiple forces have contributed to this growing interest in state intervention (Aiginger & Rodrik, 2020). First, concerns about globalisation and its side effects, notably in the form of deindustrialisation, have contributed to economic pressures in many advanced economies. The continuing decline in manufacturing (Heikkonen et al., 2025) and the increasing competitiveness threat posed by Chinese overcapacity have pushed in this direction. Second, disruptive technological change, ranging from automation and digitalisation to the Artificial Intelligence revolution, has further enabled these processes, as has the climate crisis and the following energy transition. Third, the current geopolitical recession has reshaped global economics. The Covid-19 pandemic, the Russian war in Ukraine, and the intensifying U.S.-China rivalry have exposed underlying dependencies and the vulnerabilities linked to international supply chains (Arjona et al., 2023, 2024). These intertwining shocks have contributed to the growing weaponisation of economic interdependence, ultimately resulting in the securitisation of economic policy (Farrell & Newman, 2025).

For the EU, having been founded upon the pillars of the eroding multilateral order, this geopolitical shift has been particularly consequential, since it undoubtedly benefits from open participation in global value chains (Arjona et al., 2023). Against this backdrop, the EU has pursued a new approach to industrial policy, built upon the concept of Open Strategic Autonomy, which can be understood as the ability of Europe to act autonomously in strategically important policy areas, and aims at strengthening domestic capacity in strategic sectors to reduce foreign dependence while still fostering open and multilateral trade relations (Schmitz & Seidl, 2023; Guerrieri & Padoan, 2024). While the pursuit of technological sovereignty and openness may seem contradictory at first, the concept of Open strategic autonomy has the merit of reconciling these two objectives (Edler, 2024), also emphasising the significance of strategic technologies within the current landscape.

The designation of certain products, technologies or sectors as strategic reflects their central role in shaping Europe's economic resilience. Some are considered strategic because disruptions in their supply chains could result in severe non-economic consequences (Pisani-Ferry et al., 2024). Others are crucial to ensuring that the EU remains competitive in the global economy. In this regard, a study by the Harvard Kennedy School<sup>1</sup> demonstrates how innovation in five strategic domains – AI, biotechnology, semiconductors, space, and quantum – can drive progress across other sectors, enhancing efficiency and competitiveness throughout the entire technological landscape. Furthermore, lagging in the development of these technologies, especially in the digital realm, risks undermining European technological sovereignty and, by extension, its core values (Terzi et al., 2022). Finally, technologies that support the EU's strategic objectives, particularly those related to the green and digital transitions, are also classified as strategic (Bontadini & Meliciani, 2025). Nonetheless, the EU continues to depend heavily on imports from third countries, most notably

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<sup>1</sup> In the report with Critical and Emerging Technologies Index, June 2025.

Japan, Taiwan, and China<sup>2</sup>, for key components such as batteries, solar panels, and semiconductors (Bonnet & Ciani, 2023).

More recently, European industrial policies have responded not just to the need to safeguard economic security, but also to a long-term view of strategic competitiveness. This shift in perspective, coupled with the recognition that the distinguishing factor of the American and Chinese economies is their capacity to make strategic investments (Lausberg & Riekes, 2025), has led to the adoption of measures which sustain European competitiveness in the digital and green value chains (Bontadini & Meliciani, 2025). Undeniably, the growing economic gap that has opened up between the EU and other global actors, particularly the US, has gained prominence within the European political discourse in the past several months, as emerges from the Draghi report on the Future of European Competitiveness (Draghi Report, 2024) and, more recently, the EU Competitiveness Compass (European Commission, 2025a; Zettelmeyer, 2025).

The Letta report *Much More Than a Market*, in assessing the European Single Market as unfit, called for measures to enhance its functioning to make it a more dynamic environment, capable of fostering technological progress through investments in strategic technologies, to avoid the curse of mature technology (Buti et al., 2025). Similarly, the Draghi report on the Future of European Competitiveness (Draghi report, 2024) correctly identified the linkages between strategic technologies, innovation and competitiveness. By fostering innovation, strategic technologies stimulate productivity growth, which in turn enhances Europe's ability to compete globally, while also reinforcing security by reducing vulnerabilities and dependencies on foreign markets (for an empirical analysis, see Arjona et al., 2023). Following such insights, the European Commission, in January, introduced the Competitiveness Compass (European Commission, 2025a), once again underscoring the urgency of strengthening the manufacturing capacity needed to produce strategic technologies.

Within this framework, while the conceptualisation of industrial policy has evolved – from Open Strategic Autonomy to Economic security – technological sovereignty has remained the fundamental pillar of this commitment. As Europe faces the imperative of securing critical supply chains (Arjona et al., 2024), boosting technological progress, and supporting key industries (European Parliamentary Research Service, 2021; European Commission, 2023; Kroll et al., 2023; Edler, 2024), technological sovereignty has emerged as indispensable for Europe's competitiveness and, therefore, its global standing.

## 2.2 EU Policies for Strategic Technologies

Consistent with what was discussed above, in 2024, the European Commission adopted two legislative initiatives aimed at fostering the development of strategic technologies that are fundamental to fulfilling the EU's ambitions, namely the Net-Zero Industry Act (European Union, 2024b) and the regulation establishing the Strategic Technologies European Platform (European Union, 2024a). The NZIA represents the first plan set out to boost the European net-zero industry by establishing a framework of measures that stimulate the manufacturing capacity of net-zero technologies in the EU and the achievement of specific targets by 2040. To deliver the results for which it has been set out, the European Commission has proposed the following solutions: streamlining administrative and permit-granting procedures; the creation of a Net-Zero Europe Platform to facilitate access to finance; the stimulation of public demand for these technologies; the introduction of regulatory sandboxes for the development of innovative net-zero technologies; and the creation of European net-zero industry academies. Recently, the European Commission has also adopted the Clean Industrial Deal<sup>3</sup> with the objectives of decarbonising energy-intensive sectors and supporting the development of the European clean-tech sectors, while preserving

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<sup>2</sup> For example, for solar photovoltaic technologies and their components, EU's dependency on Chinese imports exceeds 90% in certain upstream segments of the value chain.

<sup>3</sup> COM(2025) 85 final COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS The Clean Industrial Deal: A joint roadmap for competitiveness and decarbonisation

competitiveness vis-à-vis global competitors. To achieve these purposes, the plan sets out clear business incentives for industries to decarbonise within Europe by proposing a set of measures that concern the following six business drivers: affordable energy; lead markets; financing; circularity and access to materials; global markets and international partnerships and skills. To support the Clean Industrial Deal, in June 2025, the European Commission adopted a new State aid framework<sup>4</sup> to enable Member States to push forward the development of clean energy, industrial decarbonization and clean technologies. This new framework, which will be in place until 31 December 2030, aims at simplifying State aid rules in five main areas, such as the roll-out of clean energy; temporary electricity price relief for energy-intensive users; industrial decarbonisation, the development of clean tech manufacturing capacity in the EU; and the de-risking of private investments in clean energy and technologies.

The Regulation establishing the STEP, despite having the same objective as the NZIA, is wider in scope as it aims to promote, develop and safeguard the uptake of critical technologies (and their value chains) not only in the clean technology realm (i.e., technologies under the NZIA) but also in the following two sectors: digital technologies and deep tech innovation, which include AI, quantum technologies, robotics and autonomous systems; and biotechnologies, such as bioinformatics, nanobiotechnologies and process biotechnology techniques. To stimulate investments in these technologies, the regulation advances the rationalisation of eleven EU programs and funds<sup>5</sup>, which can be used to finance the uptake of critical technologies. Furthermore, it introduces two new instruments to attract investments in projects that are in line with STEP objectives: the Sovereignty portal, i.e. a web page to help project promoters and enterprises find support and financing opportunities to develop their STEP investments; and the Sovereignty Seal, granted to projects that contribute to the STEP objectives, to help promoters gain visibility and attract public and private investments. More recently, the European Commission has also decided to allocate €1.3 billion, through the Digital Europe (DIGITAL) work programme for 2025 to 2027, for the deployment of critical technologies that are strategically important for the future of Europe and its tech sovereignty, such as Artificial Intelligence, cybersecurity and high-performance computing. The results of the first year of implementation of the STEP Regulation are reported in the Annual Report on the Strategic Technologies for Europe Platform (STEP) 2024. In 2024, it shows how more than EUR 10 billion in EU funding was aligned with STEP priorities, underlining its role as a key driver of strategic investments. Additionally, the European Commission awarded 162 STEP Seals to projects with a recognised high impact. Looking ahead to 2025, the focus will shift to strengthening STEP's impact through several key actions: increasing available funding by broadening the scope of STEP-aligned calls; promoting more active participation by Member States in the Cohesion Policy and Recovery and Resilience Facility (RRF) to unlock further resources; and enhancing both the STEP Seal and the STEP Portal—for instance, by integrating AI-based tools to improve access to EU funding.

These policies, within the larger framework of an increasingly assertive European Industrial policy, must be understood as a direct response to the evolving geopolitical landscape, which has reframed global competitiveness as a function of technological sovereignty and security. In a context where global actors leverage strategic investments to assert geoeconomic influence and reduce critical dependencies, the EU's move to consolidate funding, rationalise instruments, and prioritise critical technologies reflects an urgent need to enhance its capacity to act autonomously. The proposal of the European Competitiveness Fund<sup>6</sup>, which aims to mobilise public and private investment, among others, towards critical technologies, by linking competitiveness to the ability to make strategic investments, represents a step in this direction.

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<sup>4</sup> C/2025/3602 COMMUNICATION FROM THE COMMISSION Framework for State Aid measures to support the Clean Industrial Deal (Clean Industrial Deal State Aid Framework)

<sup>5</sup> These include, for example, Horizon Europe, the Innovation Fund and the European Defence Fund.

<sup>6</sup> COM(2025) 555 final/2 2025/0555(COD) Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on establishing the European Competitiveness Fund ('ECF'), including the specific programme for defence research and innovation activities, repealing Regulations (EU) 2021/522, (EU) 2021/694, (EU) 2021/697, (EU) 2021/783, and amending Regulations (EU) 2021/696, (EU) 2023/588, (EU) [EDIP]

## 3. EU Strategic technologies through the lens of patents

In this paragraph, we show descriptive statistics concerning firms with patents in EU Strategic technologies (EUST), and the related numbers of patents – also highlighting the part referred to the Net-Zero ones (EUST NZ) – among both World macro regions and EU member countries.

### 3.1 Data

The list of EU Strategic Technologies (EUST) follows the taxonomy defined by the European Commission (Table A1 in Appendix A). Data on patents classified under EUST (see Appendix B for details) and on the corresponding firms holding EUST patents are sourced from Moody's Intellectual Property dataset. The analysis includes firms with patents filed between 1 January 2004 and 1 January 2024. The choice to focus on patents with a maximum legal duration of 20 years is motivated by both regulatory coherence and analytical comparability. This time frame reflects the international standard established by the TRIPS Agreement (Trade-Related Aspects of Intellectual Property Rights, WTO, 1994), which sets the minimum patent protection period at twenty years from the filing date. No restrictions were applied with respect to the patent office of filing, meaning that the dataset may include patents registered in any jurisdiction worldwide. Consequently, the data captures all firms directly owning patents in EUST.

All data refer to the limited companies. Specifically, an indicator was developed to capture the degree of innovation within the entrepreneurial system, i.e. patent intensity, which measures the number of patents in EUST (and EUST NZ) per 100,000 inhabitants, therefore serving as a proxy for the intensity of innovation (i.e., few or many patents). This indicator can provide relevant insights for policy design, as it can shed a light on the trade-offs between supporting wider adoption of innovation across firms and fostering innovation intensity.

### 3.2 EU in the world competition

The data (Table 1, Maps 1-2, and Table A2 and Maps A1-A2 in the Appendix) deliver some unexpected results. Whereas China dominates the rankings of the number of firms which own patents for both EU Strategic Technologies (EUST) and EU Strategic Net-Zero Technologies (EUST NZ), the US and the EU alternate between third and fourth (besides Other Asian in second place) depending on the category. Indeed, while the US outperforms the EU with regard to EUST, it lags behind the EU in terms of EUST NZ.

The results differ if one takes into account the total number of patents and patent intensity (measured as the number of patents per 100,000 inhabitants). Again, while China tops the rankings in absolute terms, it is Japan that registers the highest patent intensity (2,269 patents in EUST and 422 patents in EUST NZ), followed by the US (1,002 and 110 patents respectively) and the EU (385 and 78). Focusing on a comparison with the United States, we can observe that the European Union shows a certain lag in terms of patent propensity also when it comes to firms with patents in Net-Zero technologies. Furthermore, the EU suffers from a significant gap in terms of the overall number of patents. In contrast, when compared to China, the EU holds a position of advantage in terms of patent intensity – this holds true for both EUST and EUST NZ.

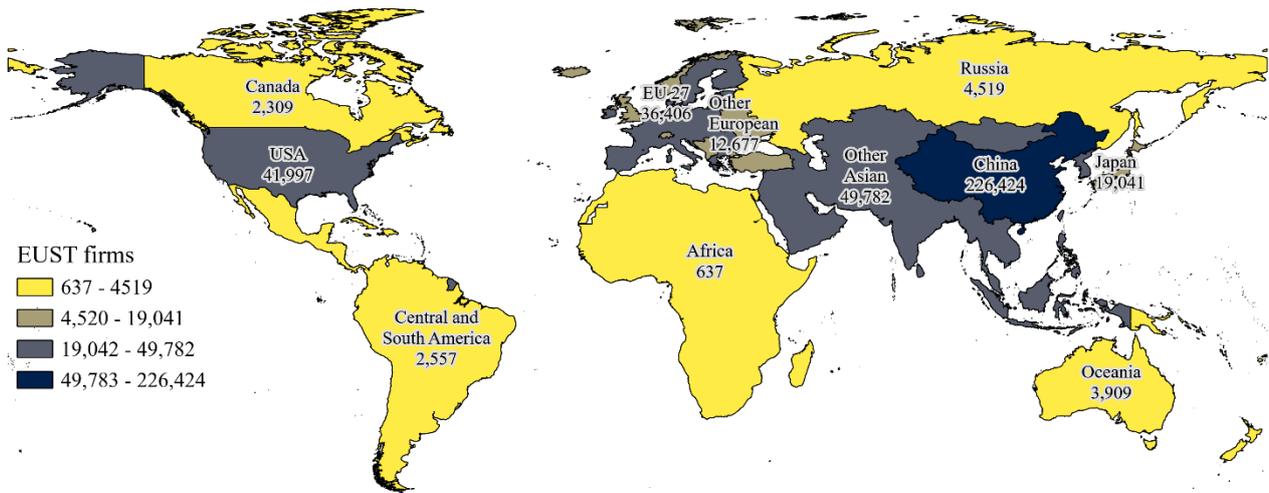
**Table 1. Rankings of the world macro regions for firms\* and patents**

	Firms spread	Patents spread	Patent intensity
Ranking	N. of firms	N. of patents	N. of patents per 100,000 inhabitants
with reference to EUST			
1	China	China	Japan
2	Other Asian	USA	USA
3	USA	Japan	EU 27
4	EU 27	Other Asian	China
5	Japan	EU 27	Canada
with reference to EUST NZ			
1	China	China	Japan
2	Other Asian	Japan	USA
3	EU 27	USA	EU 27
4	USA	EU 27	China
5	Japan	Other Asian	Canada

*\* All data refers to the limited companies.*

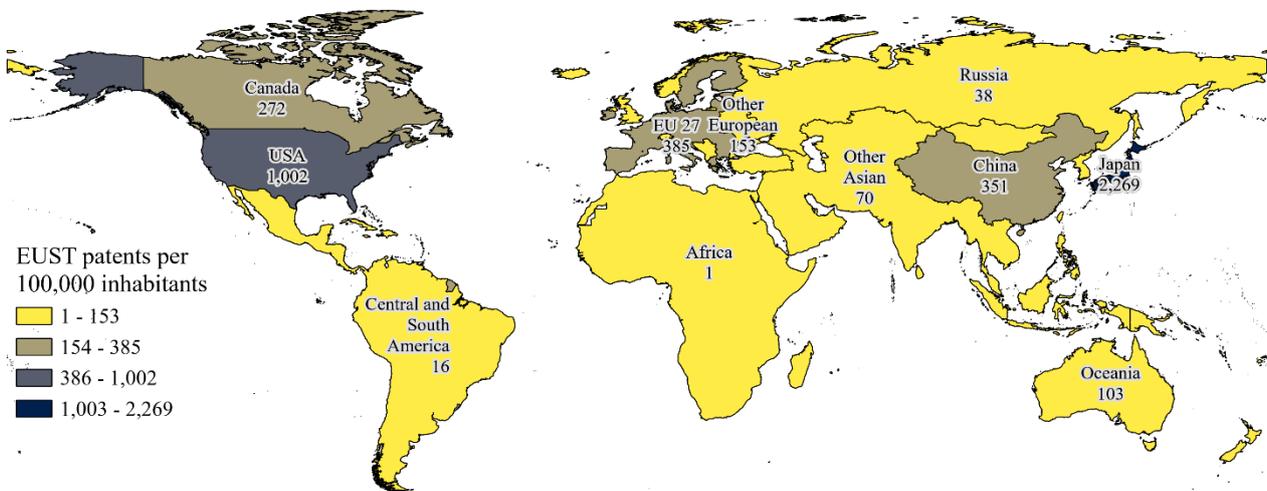
*Source: Istituto Guglielmo Tagliacarne-Unioncamere*

**Map 1. EUST firms (number)**



Source: Istituto Guglielmo Tagliacarne-Unioncamere

**Map 2. EUST patents per 100,000 inhabitants**



Source: Istituto Guglielmo Tagliacarne-Unioncamere

### 3.3 Inside the EU: a cross-country analysis among EU countries

The results (Tables 2-3, Maps 3-4, and Table A3 and Maps A3-A4 in the Appendix) also provide valuable insights into the innovative ecosystem within the European Union and its member states. While the larger economies – Germany, Italy, and France – tend to lead in terms of the number of strategic firms, Germany, France, and Sweden take the lead when it comes to the number of patents in strategic technologies. This could also be the result of firm size, since larger firms are more likely

to get patents. In Germany and Sweden, for instance, the firm's average size is higher than in Italy (respectively, 12.2 and 4.8 vs 4.2 employees per enterprise), which falls in 7th place in terms of number of patents.

However, a different picture emerges when adjusting for population size. For instance, Finland, Sweden, and Ireland stand out for their patent intensity. In this case, the smaller size of a country could amplify the intensity of innovation (indeed, among the first six countries in terms of patent intensity, only the Netherlands has a large population, i.e., in the top-ten EU countries).

Once again, similar patterns emerge with regard to Net Zero strategic technologies. While Germany, France, and Italy report the highest number of firms owning patents – and Germany, France, and the Netherlands account for the largest patent volumes – it is the smaller, yet technologically advanced economies that exhibit higher patent intensity. Notably, Denmark, Luxembourg, and the Netherlands stand out for their cutting-edge patent ecosystems (EUST NZ).

**Table 2. Rankings of Member States of the EU, data on firms\* and patents for EU Strategic technologies**

	Firms spread	Patents spread	Patent intensity
Ranking	N. of firms	N. of patents	N. of patents per 100,000 inhabitants
1	Germany	Germany	Finland
2	Italy	France	Sweden
3	France	Sweden	Ireland
4	Netherlands	Netherlands	Luxembourg
5	Spain	Finland	Netherlands
6	Sweden	Ireland	Denmark
7	Finland	Italy	Germany
8	Poland	Denmark	France
9	Austria	Spain	Austria
10	Belgium	Austria	Belgium
11	Denmark	Belgium	Malta
12	Czech Republic	Poland	Cyprus
13	Ireland	Luxembourg	Italy
14	Bulgaria	Czech Republic	Spain
15	Romania	Portugal	Estonia
16	Hungary	Cyprus	Lithuania

17	Portugal	Hungary	Czech Republic
18	Luxembourg	Slovakia	Slovenia
19	Slovakia	Romania	Slovakia
20	Slovenia	Lithuania	Poland
21	Estonia	Malta	Portugal
22	Cyprus	Bulgaria	Latvia
23	Greece	Slovenia	Hungary
24	Lithuania	Estonia	Bulgaria
25	Croatia	Greece	Croatia
26	Latvia	Latvia	Romania
27	Malta	Croatia	Greece

*\* All data refers to the limited companies.*

*Source: Istituto Guglielmo Tagliacarne-Unioncamere*

**Table 3. Rankings of Member States of the EU, data on firms\* and patents for EU Net Zero Strategic technologies**

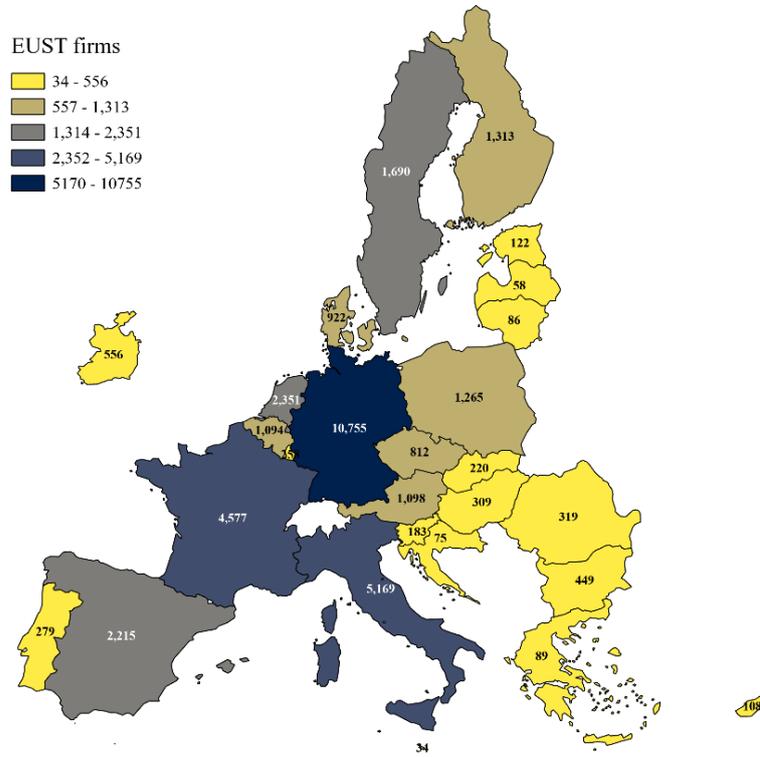
	Firms spread	Patents spread	Patent intensity
Ranking	N. of firms	N. of patents	N. of patents per 100,000 inhabitants
1	Germany	Germany	Denmark
2	France	France	Luxembourg
3	Italy	Netherlands	Netherlands
4	Netherlands	Denmark	Finland
5	Spain	Italy	Germany
6	Sweden	Spain	France
7	Poland	Belgium	Sweden
8	Denmark	Sweden	Belgium
9	Austria	Finland	Austria
10	Finland	Austria	Ireland

11	Belgium	Poland	Spain
12	Czech Republic	Ireland	Italy
13	Ireland	Czech Republic	Estonia
14	Bulgaria	Luxembourg	Cyprus
15	Hungary	Portugal	Czech Republic
16	Romania	Hungary	Slovenia
17	Slovakia	Romania	Poland
18	Luxembourg	Slovakia	Latvia
19	Portugal	Slovenia	Lithuania
20	Slovenia	Lithuania	Portugal
21	Estonia	Estonia	Slovakia
22	Greece	Cyprus	Malta
23	Cyprus	Bulgaria	Hungary
24	Lithuania	Latvia	Croatia
25	Croatia	Croatia	Bulgaria
26	Latvia	Greece	Romania
27	Malta	Malta	Greece

*\* All data refers to the limited companies.*

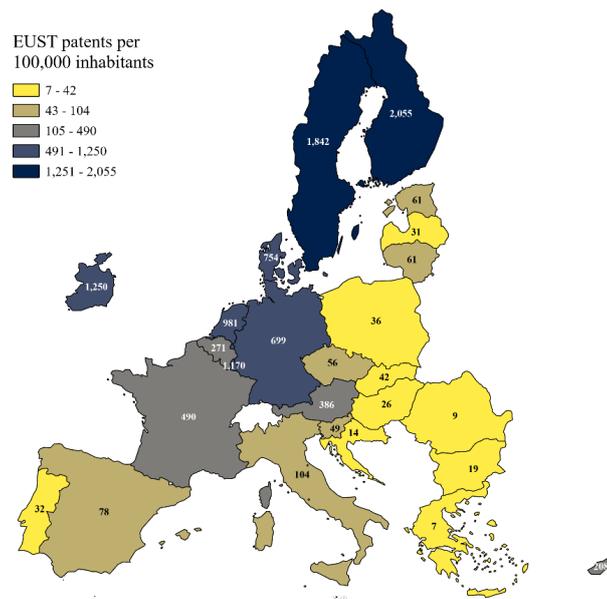
*Source: Istituto Guglielmo Tagliacarne-Unioncamere*

**Map 3. EUST firms (number)**



Source: Istituto Guglielmo Tagliacarne-Unioncamere

**Map 4. EUST patents per 100,000 inhabitants**

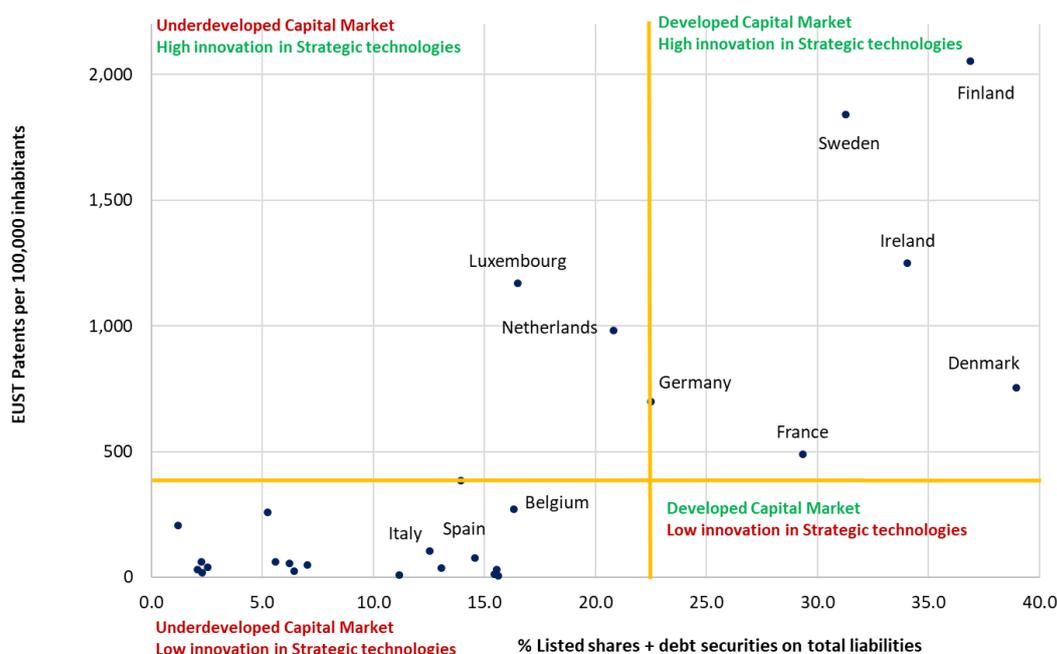


Source: Istituto Guglielmo Tagliacarne-Unioncamere

Finally, given the acknowledged relevance of the Capital Market in supporting innovation, particularly in terms of innovation at the frontier (as referenced in Letta’s Report, 2024, and Draghi Report, 2024), we empirically show the relationship between the development of a country’s capital market and its degree of strategic innovation. When investigating the number of patents in EU strategic technologies per 100,000 inhabitants with a measure of capital market sophistication – measured here as the share of listed shares and debt securities on total liabilities (in line with Bhatia et al., 2019) – as the latter improves, the number of patents increase, with a correlation of 0,77 (statistically significant). Additionally, the countries with the highest patent intensity all exhibit highly developed capital markets (Figure 2), further demonstrating the importance of closing the investment gap to foster investment in innovation (Buti et al., 2025).

Finally, three groups of countries emerge from the charts. The first group, referring to the most advanced countries in terms of both innovation (as measured by EUST) and capital market development, includes Northern European countries such as Finland, Sweden, and Denmark. The second group comprises medium-advanced countries from Central Europe, such as Germany and France. The third group consists of less advanced countries from Southern Europe, such as Italy and Spain.

**Figure 2. EU Patents in Strategic technologies and EU capital market development in EU countries**



Note: Figure reports the name of the main countries, while the points refer to all countries.

Source: Istituto Guglielmo Tagliacarne-Unioncamere and Eurostat

## 4. The relationship between EU strategic technologies and firms' productivity in EU

In this section, we investigate the relationship between innovation in EU Strategic Technologies (EUST) – also by differentiating Deep-Tech technologies and Net-Zero technologies – and firms' labour productivity across EU countries by addressing the following Research Questions (RQ):

*RQ.1. Is there a positive relationship between EUST and labour productivity in the EU?*

*RQ.2. Do Deep-Tech and Net-Zero technologies exhibit different relationships with labour productivity in the EU?*

*RQ.3a. Does the relationship between EUST and labour productivity vary across EU countries?*

*RQ.3b. Does the relationship between Deep-Tech and labour productivity vary across EU countries?*

*RQ.3c. Does the relationship between Net-Zero technologies and labour productivity vary across EU countries?*

Specifically, by focusing on limited companies, we contrast firms holding patents in EUST with firms holding patents unrelated to EUST. We only consider firms with patents to better isolate the “strategic technologies effect”, and also because patents are acknowledged as one of the best indicators of innovation in the literature (Colladon et al., 2025).

We measure labour productivity in terms of average value added per employee – according to balance sheet data – with reference to the 2014-23 period. Concerning the latter aspect, we consider a reference period of more than one year to capture structural relationships between the key variables of interest, thus neutralising the business cycle effect. With regards to the dataset, we refer to the one built in this study (see Section 3). For the EU, we considered the four largest economies—Germany, France, Italy, and Spain—taken as a whole. This choice is mainly driven by data availability. According to the Orbis database, balance sheet information referring to both value added and employment (for the computation of labour productivity) is not consistently available across all years for many EU countries. Specifically, when excluding the four countries under analysis, the coverage rate (i.e. the share of firms with available data throughout the years) of the corresponding data for the remaining 23 EU countries is on average only 27%. While for the four countries considered—Germany, France, Italy, and Spain—the corresponding share amounts to nearly 70%. Moreover, in terms of patent activity, these four economies together account for approximately 60% of the total number of patents registered within the European Union.

We estimated the relationship between innovation in EU Strategic Technologies (EUST) and firms' labour productivity by cross-section linear regression, also controlling for potentially confounding effects of various firms' characteristics that may influence labour productivity. The description of all variables is reported in Table 4, and summary statistics in Table 5. All data — including both balance sheet information and firm characteristics — are sourced from the Orbis database.

**Table 4. Variables description**

Variables	Type	Description
<b>Dependent variables</b>		
InLP	Continuous	Labour productivity (value added per employee), ten-year mean value for the period 2014-23, in log terms
<b>Main independent variables</b>		
EUST	Binary	1 = firm with patents in EU Strategic Technologies; 0 = otherwise
EUST-DT	Binary	1 = firm with patents EU Strategic Deep-Tech Technologies; 0 = otherwise
EUST-NZ	Binary	1 = firm with patents EU Strategic Net-Zero Technologies; 0 = otherwise
<b>Control variables</b>		
Country	Dummies	1 = if the firm belongs to a n-NUTS 1 (IT-Italy, DE-Germany, FR-France, ES-Spain); 0 = otherwise.
Size	Continuous	Number of employees
Industry	Dummies	1 = if the firm belongs to a n-sector (2-digit NACE rev.2 classification); 0 = otherwise (source: elaboration on ISTAT data)
Age	Discrete	Number of years since inception (source: elaboration on ISTAT data)

**Table 5. Summary statistics**

	<b>EU-4</b>	<b>IT</b>	<b>DE</b>	<b>FR</b>	<b>ES</b>
LP	104.053	100.031	116.606	198.276	88.097
EUST	0.226	0.187	0.366	0.368	0.169
EUST-DT	0.148	0.135	0.219	0.198	0.109
EUST-NZ	0.079	0.052	0.147	0.170	0.060
Small	0.545	0.683	0.063	0.250	0.712
Medium	0.305	0.236	0.591	0.362	0.200
Large	0.150	0.081	0.347	0.388	0.089
Manufacturing	0.665	0.742	0.627	0.599	0.563
High-tech manufacturing	0.528	0.589	0.530	0.503	0.419
Low-tech manufacturing	0.472	0.411	0.470	0.497	0.581
Services	0.279	0.214	0.317	0.327	0.363
Knowledge intensive services (KIS)	0.113	0.078	0.145	0.165	0.145
Less Knowledge intensive services (LKIS)	0.887	0.922	0.855	0.835	0.855
Other industries	0.056	0.044	0.056	0.074	0.074
Age	37.912	34.091	51.754	42.556	33.436

## 4.1 Econometric strategy

We estimate the relationship between Strategic technologies and labour productivity in EU using a cross-sectional Ordinary Least Squares (OLS) regression model based on firm-level data from four European countries: Italy, France, Germany, and Spain. The baseline model estimates the average effect of Strategic technologies across the entire EU (the four countries taken as a whole) without distinguishing by country. Analytically, we use the following log-linear model:

$$\ln LP_i = \alpha EUST_i + \delta_1 Age_i + \delta_2 Size_i + \sum_{s=1}^S \lambda_s Industry_{is} + \sum_{c=1}^C \gamma_c Country_{ic} + \varepsilon_i$$

where  $\ln LP$  is the labour productivity (value added per employee) for firm  $i$  expressed in natural logarithmic form, so the estimated coefficients can be interpreted as approximate percentage changes in productivity.  $EUST$  is the main independent variable capturing the innovation in Strategic technologies taking value 1 if the firm hold patents in EU Strategic Technologies and 0 if it holds different types of patents. We include country fixed effects and firm-level controls: firm age (years since establishment), firm size (number of employees), and sector fixed effects based on 2-digit of NACE Rev.2 classification.  $\varepsilon$  is the idiosyncratic error term.

We investigated also the potential differences in the effect of Strategic technologies across countries. We estimated an extended specification including interaction terms between the  $EUST$  dummy and country dummies, so allowing the marginal effect of  $EUST$  to vary by country. The model is estimated without a constant, enabling direct interpretation of the coefficients by country. Analytically:

$$\ln LP_i = \sum_{c=1}^C \beta_c (EUST_i * Country_{ic}) + \sum_{c=1}^C \gamma_c Country_{ic} + \delta_1 Age_i + \delta_2 Size_i + \sum_{s=1}^S \lambda_s Industry_{is} + \varepsilon_i$$

where  $\beta_c$  is country-specific marginal effect of innovation.

Given the log-linear specification, the coefficients of the  $EUST$  variable (and its interactions) represent semi-elasticities.

To provide a more accurate interpretation in percentage terms, we apply the exact transformation:

$$\% \text{ change} = (e^{\hat{\beta}} - 1) * 100$$

This exponential transformation allows us to report more precisely the percentage change in labour productivity associated with Strategic technologies, improving the interpretability and comparability of the estimated effects across countries.

## 4.2 Results

### 4.2.1 Baseline results

Table 6 reports the results. We investigate the relationship between Strategic technologies and labour productivity through a cross-sectional analysis by contrasting the firms with patents in EU Strategic technologies with those with patents in other realms or technologies. As previously discussed (section 4), we conduct this analysis for the EU by considering the four main countries (Italy, Germany, France, and Spain) based on data availability. For the remaining 23 EU countries, numerous missing values were found in the balance sheet variables used to compute labour productivity. We tried to isolate the Strategic technologies' effect by controlling for several firms' structural characteristics (country, industry, age, size).

Concerning the first Research Question (RQ.1. Is there a positive relationship between EUST and labour productivity in the EU?), we find that in the EU there is a positive relationship between Strategic technologies and labour productivity: the coefficient of the variable EUST is positive and statistically significant (Table 6, Model A)<sup>7</sup>. As exactly measured, the firms with patents in EU Strategic Technologies (EUST) have 13.2% higher labour productivity compared to the firms with patents which don't correspond to EUST (Table 7, Column A).

Turning to the second Research Question by looking at the different types of EU Strategic technologies (RQ.2. Do Deep-tech and Net-zero technologies exhibit different relationships with labour productivity in the EU?), the results show that both Deep-Tech technologies (EUST-DT) and Net-Zero technologies (EUST-NZ) are clearly positively related to the labour productivity, since the coefficients are statistically significant at the 1% (Table 6, Model B). What is most interesting is that Net-Zero technologies show a stronger relationship with labour productivity than the Deep-tech ones: precisely, firms holding patents in Net-Zero technologies exhibit higher productivity by 17.4%, while for the firms holding patents in Deep-Tech the productivity premium is 11.1% (Table 7, column B).

Moving on to the research questions focusing on the differences across the individual countries, we start from the EU Strategic technologies as a whole (RQ.3a. Does the relationship between EUST and labour productivity vary across EU countries?). First, in each country, strategic technologies are strongly related to labour productivity as the coefficients are all statistically significant at the 1% (Table 6, Model C). However, we find that in Italy this relationship is less stronger than in Germany and in Spain: as exactly showed in Table 7 (column C) the productivity premium of EUST in Italy is 10.2% in contrast to 16.6% in Germany and 15.0% in Spain (in both last two cases the differences with respect to the value of Italy are statistically significant, Table 8, Panel A).

The positive and statistically significant relationship with labour productivity in each country arises also when considering Deep-Tech technologies, on the one hand, and Net-Zero technologies, on the other (Tables 6-7, columns D-E). Nevertheless, in addressing the research questions RQ3b and RQ3c, in both cases we don't find any statistically significant differences across EU countries (Table 8, Panel B and C).

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<sup>7</sup> We carried out a first preliminary analysis investigating the causality relationship through a difference-in-difference method by contrasting firms with patents in EUST from 2019 onwards and the ones without patents in EUST in the entire period 2014 onwards (sample EU-4 countries). The results indicate a positive effect of EUST on labour productivity: the Average Treatment Effect on the Treated is positive (0.026) and statistically significant ( $p = 0.058$ ). Furthermore, we find a more statistically significant effect on small firms than the medium and large ones.

**Table 6. The relationship between strategic technologies and labour productivity (Log-linear model)**

	<i>lnLP</i>	<i>lnLP</i>	<i>lnLP</i>	<i>lnLP</i>	<i>lnLP</i>
	(A)	(B)	(C)	(D)	(E)
EUST	0.124*** (0.010)				
EUST-DT		0.105*** (0.011)			
EUST-NZ		0.160*** (0.015)			
IT*EUST			0.097*** (0.014)		
DE*EUST			0.154*** (0.017)		
FR*EUST			0.114*** (0.041)		
ES*EUST			0.140*** (0.020)		
IT*EUST-DT				0.065*** (0.016)	
DE*EUST-DT				0.101*** (0.020)	
FR*EUST-DT				0.071* (0.050)	
ES*EUST-DT				0.101*** (0.024)	
IT*EUST-NZ					0.128*** (0.025)
DE*EUST-NZ					0.137*** (0.024)
FR*EUST-NZ					0.099* (0.053)
ES*EUST-NZ					0.156*** (0.031)

Country	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Age	Y	Y	Y	Y	Y
Size	Y	Y	Y	Y	Y
Obs	20,272	20,272	20,272	20,272	20,272
Adj R2	0.984	0.984	0.984	0.983	0.983
F-statistic	1,4852.16***	1,4684.04***	1,4343.09***	1,4268.23***	1,4287.16***

Note: i) the dependent variable is reported at the top of the column; ii) standard errors in parentheses.

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

**Table 7. Marginal Effects from Log-Linear Model (Exact Transformation)**

	<i>lnLP</i>	<i>lnLP</i>	<i>lnLP</i>	<i>lnLP</i>	<i>lnLP</i>
	(A)	(B)	(C)	(D)	(E)
EUST	13.2				
EUST-DT		11.1			
EUST-NZ		17.4			
IT*EUST			10.2		
DE*EUST			16.6		
FR*EUST			12.1		
ES*EUST			15.0		
IT*EUST-DT				6.7	
DE*EUST-DT				10.6	
FR*EUST-DT				7.4	
ES*EUST-DT				10.6	
IT*EUST-NZ					13.7
DE*EUST-NZ					14.7
FR*EUST-NZ					10.4
ES*EUST-NZ					16.9

**Table 8. F tests for the significance of the differences between coefficients across EU countries**

<b>Panel A: Strategic technologies</b>				
	IT*EUST	DE*EUST	FR*EUST	ES*EUST
IT*EUST		6.371**	0.149	2.991*
DE*EUST	6.371**		0.818	0.302
FR*EUST	0.149	0.818		0.315
ES*EUST	2.991*	0.302	0.315	
<b>Panel B: Deep-tech technologies</b>				
	IT*EUST-DT	DE*EUST-DT	FR*EUST-DT	ES*EUST-DT
IT*EUST-DT		1.895	0.013	1.527
DE*EUST-DT			0.311	0.000
FR*EUST-DT	1.895	0.311		0.294
ES*EUST-DT	0.013	0.000	0.294	
<b>Panel C: Net-Zero Technologies</b>				
	IT*EUST-NZ	DE*EUST-NZ	FR*EUST-NZ	ES*EUST-NZ
IT*EUST-NZ		0.060	0.254	0.463
DE*EUST-NZ	0.060		0.426	0.226
FR*EUST-NZ	0.254	0.426		0.846
ES*EUST-NZ	0.463	0.226	0.846	

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

#### 4.2.2 Robustness check: Heterogeneity effects

We investigate if the positive relationship between Strategic technologies and labour productivity shows heterogeneity across: i) firms' size, distinguishing small and medium-large firms; ii) firms' sector, separating high- and low-technology intensive manufacturing industries as well as knowledge (KIS) and less knowledge (LKIS) intensive services<sup>8</sup>. Table 9 reports the results. We find that this relationship persists even when disaggregating into small and medium-large firms (the coefficients are statistically significant at the 1%, Table 9, Models A-B), even if for the medium-large ones it is stronger: the exact measure of the productivity premium for the medium-large firms is 15.7% vs 9.2% for small firms (Table 10, Columns A-B).

<sup>8</sup> According to the OECD-EUROSTAT classification.

The relationship between Strategic technologies and labour productivity is even when accounting for firm sector distinctions (the coefficients are statistically significant at the 1%, Table 9, Models C-F). Nevertheless, of particular interest is the fact that the productivity premium appears to be more pronounced among low-tech manufacturing firms than the high-tech ones (23.2% vs 10.4%) as well as for less knowledge-intensive services firms than the knowledge-intensive services ones (20.0% vs 11.5%) (Table 10, Columns C-F).

**Table 9. Heterogeneity effects across Size and Sector (Log-linear model)**

	Size		Sector			
	Small	Medium	High-tech manuf.	Low-tech manuf.	KIS services	LKIS services
	InLP	InLP	InLP	InLP	InLP	InLP
	(A)	(B)	(C)	(D)	(E)	(F)
EUST	0.088*** (0.015)	0.146*** (0.011)	0.099*** (0.010)	0.209*** (0.035)	0.109*** (0.035)	0.182*** (0.030)
Country	Y	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y	Y
Age	Y	Y	Y	Y	Y	Y
Size	Y	Y	Y	Y	Y	Y
Obs	11,051	9,221	10,711	2,774	2,293	3,368
Adj R2	0.9824	0.9874	0.9903	0.9857	0.9689	0.9774
F-statistic	8,120.66***	8,787.52***	54,667.58***	10,642.52***	2,100.00***	6,631.31***

Note: i) the dependent variable is reported at the top of the column; ii) standard errors in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

**Table 10. Marginal Effects from Log-Linear Model (Exact Transformation)**

	Size		Sector			
	Small	Medium - large	High-tech manuf.	Low-tech manuf.	KIS services	LKIS services
	InLP	InLP	InLP	InLP	InLP	InLP
	(A)	(B)	(C)	(D)	(E)	(F)
EUST	9.2	15.7	12.1	23.2	11.5	20.0

## 5. Conclusion

Within the rapidly evolving landscape, the EU has shifted its policy priorities towards the concept of economic security. In recognising the existing innovation gap vis-à-vis other global actors, the new industrial policy platform, particularly through STEP and NZIA regulations, has identified strategic technologies as the key levers to close the gap and secure technological sovereignty.

Against this backdrop, the present study provides timely empirical evidence on the state of innovation in strategic technologies (EUST) within the European Union, with a focus on those linked to the Net-Zero Regulation. The study's key contribution lies in the mapping of patents to strategic technologies, achieved by combining the European Commission's classification of EUST with the International Patent Classification (IPC) at its most detailed level (14 digits). This approach enables us to benchmark European firms both across Member States and against other international actors, through an original indicator, patent intensity, which captures innovation through the number of EUST patents per 100,000 inhabitants. This contribution offers a novel perspective on Europe's position in the global competition for technological leadership.

The findings reveal several important patterns. To begin with, innovation propensity among firms varies significantly across Member States, testifying to a high degree of heterogeneity within the Union. On a global scale, while the EU exhibits a broader distribution of firms with patents in strategic technologies compared to the U.S., it lags behind in terms of the total number of patents. Most importantly, however, the study demonstrates there is a positive relationship between innovation in EUST and a firm's labour productivity. This effect is further intensified by patents in Net-Zero technologies and appears to be slightly higher for medium and large firms, as well as low-tech firms. Finally, a developed capital market further supports innovation in strategic technologies.

### *A - Policy recommendations*

These results provide useful information for the EU's industrial policy design, specifically concerning innovative firms holding patents. First, heterogeneity among Member States in terms of patent intensity suggests the need for instruments that foster convergence. Without targeted support, structural gaps in innovation capacity risk undermining the cohesion of the Single Market. With regards to this, the first year of implementation of the STEP Regulation has demonstrated its power in aligning Member States towards the same objectives and driving investments in strategic technologies, with over EUR 10 billion invested in 2024 (European Commission, 2025d). Second, as strategic technologies underpin both economic security and productivity growth, policies should go beyond fostering R&D to actively encouraging their adoption and diffusion among innovative firms, as our results show. This is especially relevant for those technologies related to decarbonization, which are associated with even higher productivity gains. Overall, our findings suggest redirecting innovation efforts toward strategic technologies that align more closely with frontier innovation. This is particularly relevant because, as an economic system develops, its future growth increasingly depends on innovation at the technological frontier (Acemoglu, et al., 2006).

Special attention should then be devoted to SMEs and low-tech manufacturing firms and in less-knowledge intensive services (LKIS). Indeed, while SMEs typically exhibit lower productivity premiums, justifying policy interventions that facilitate their scaling up; firms in Low tech manufacturing and LKIS display higher productivity gains when adopting EUST innovations, which could enable them to rapidly close their technological gap. Indeed, as empirically highlighted in the Appendix C, small-sized firms as well as low-tech manufacturing firms and less-knowledge services firms are less likely of holding patents in EUST. Furthermore, as reported in Appendix C, our results indicate a decline in innovation with increasing firm age, suggesting that policy measures should not only target young firms as key drivers of innovation, but also extend their focus to more mature firms in order to foster entrepreneurial convergence in strategic technological innovation. Finally, the observed positive correlation between capital market development and patent intensity in EUST highlights the pivotal role of finance. Indeed, as highlighted in the literature, the presence of an advanced financial system — particularly one grounded in well-functioning capital markets —

plays a strategic role in fostering innovation, especially frontier innovation. (Aghion et al., 2021). Capital markets integration and targeted public subsidies in support of firms operating in high-tech sectors are key to bridge the innovation gap accumulated with respect to global actors and among Member States (Buti et al., 2025). This calls for a decisive acceleration towards the Savings and Investment Union.

In light of these observations, the policy initiatives put forward during the negotiations of the next Multiannual Financial Framework 2028-2034 (MFF) represent a decisive step in support of strategic technologies. The proposed revisions of the Horizon Europe program, for instance, introduce a new section dedicated to Competitiveness that will support R&I in four areas linked to EUST, such as “Support for Clean Transition and Industrial Decarbonization”; “Support for Health, Bioeconomy and Biotechnology Policy”; “Support for Digital Leadership Policy”; “Support for Resilience, Defence Industry and Space Policy”. Moreover, the proposed 42% increase in the resources allocated to this section shows the political willingness to further support the development of EUST (European Commission, 2025b). The proposal to establish a European Competitiveness Fund (ECF), designed to consolidate within a single framework the 14 funding instruments currently included in the Multiannual Financial Framework (MFF), moves in the same direction. This initiative represents a significant milestone in strengthening Europe’s competitiveness in technologies and strategic sectors that are critical for the Union (European Commission, 2025c). Its importance becomes evident when considering the two main challenges it seeks to address: on the one hand, the suboptimal support provided along the entire investment journey of European firms; on the other, the substantial financing needs required to meet Union priorities, particularly the green and digital transitions. In this respect, the design of the ECF appears well aligned with the policy implications identified in this study.

### *B – Directions for future research*

To conclude, while providing new insights into the degree of innovation in the EU, important questions remain for future research. A first line of inquiry would be to move beyond the analysis of EUST patents in the aggregate and examine individual technologies or macro technological area, with the aim of identifying those that contribute most directly to productivity growth and, it follows, to economic security. Second, having established a positive correlation between EUST patenting and firm productivity, future research should delve deeper into causality. Finally, given the gap between knowledge generation and commercial exploitation of patents, future research should assess the quality and economic relevance of patents, investigating the nexus between patenting and a firm’s ability to deploy and commercialize new technologies.

## References

- Acemoglu, D., Aghion, P., & Zilibotti, F. (2006). Distance to frontier, selection, and economic growth. *Journal of the European Economic Association*, 4(1), 37-74.
- Adilbish et al., (2025). Europe's Productivity Weakness: Firm-Level Roots and Remedies, *Single Market Economic Papers (Conference Paper)*, WP 40.
- Aghion, P., Antonin, C., & Bunel, S. (2021). *The power of creative destruction: Economic upheaval and the wealth of nations*. Harvard University Press.
- Aiginger, K. & Rodrik, D. (2020). Rebirth of Industrial Policy and an Agenda for the Twenty-First Century, *Journal of Industry, Competition and Trade* 20, 189-207.
- Arjona, R, Connell, W., Herghelegiu, C. (2024). Supply Chains Tectonics: Empirics on how the EU is plotting its path through global trade fragmentation, *Single Market Economic Papers*, WP 8.
- Arjona, R, Connell, W. & Herghelegiu, C. (2023). "An enhanced methodology to monitor the EU's strategic dependencies and vulnerabilities," *Single Market Economics Papers* WP 14.
- Bhatia, M. A. V., Mitra, M. S., Weber, A., Aiyar, M. S., de Almeida, L. A., Cuervo, C., ... & Gudmundsson, T. (2019). *A capital market union for Europe*. International Monetary Fund.
- Bogliacino, F., & Pianta, M. (2009). *The impact of innovation on labour productivity growth in European industries: Does it depend on firms' competitiveness strategies?* (No. 13/2009). IPTS Working Papers on Corporate R&D and Innovation.
- Bonnet, P., Ciani, A. (2023). *Applying the SCAN methodology to the Semiconductor Value Chain*, JRC Working Papers in Economics and Finance, 2023/8, European Commission, Ispra, 2023, JRC133736.
- Bontadini, F., & Meliciani, V. (2025). *Selective Industrial Policy for the EU Open Strategic Autonomy: the Role of Products' Relatedness*, *Single Market Economic papers (Working paper 30)*.
- Bloom, N., & Reenen, J. V. (2000). *Real options, patents, productivity and market value: Evidence from a panel of British firms* (No. W00/21). IFS Working papers.
- Brown, T., Mann, B., Ryder, N., Subbiah, M., Kaplan, J. et al. (2020). Language Models Are Few-Shot Learners. arXiv:2005.14165
- Buti, M., Messori, M., Revoltella, D., & Vila, D. (2025). *How large is the investment gap in the EU and how to close it?* CEPR Policy Insight No 141, CEPR Press, Paris & London. Retrieved from <https://cepr.org/publications/policy-insight-141-how-large-investment-gap-eu-and-how-close-it>
- Colladon, A. F., Guardabascio, B., & Venturini, F. (2025). A new mapping of technological interdependence. *Research Policy*, 54(1), 105126.
- Draghi Report (2024). The future of the European competitiveness.
- Durá, P., & Pasimeni, P. (2025). The Economic Impact of the European Single Market, *Single Market Economic Papers*, WP 43.
- Edler, J. (2024). Technology sovereignty of the EU: Needs, concepts, pitfalls and ways forward. *EC Report*: [https://ec.europa.eu/assets/rtd/srip/2024/ec\\_rtd\\_srip-report](https://ec.europa.eu/assets/rtd/srip/2024/ec_rtd_srip-report).
- European Commission (2023). On "European economic security strategy", JOIN(2023) 20 final, Brussels, 20.6.2023.
- European Commission - DG ENER (2024). The net-zero manufacturing industrial landscape across the Member States, final Report Rotterdam & Brussels.
- European Union (2024a), *Regulation (EU) 2024/795 of the European Parliament and of the Council of 29 February 2024 establishing the Strategic Technologies for Europe Platform (STEP)*, Brussels, 29.2.2024.

- European Union (2024b), *Regulation (EU) 2024/1735 of the European Parliament and of the Council of 13 June 2024 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724*, Brussels, 28.6.2024.
- European Commission (2025a). A Competitiveness Compass for the EU, COM(25) 30 final, Brussels, 29.1.2025
- European Commission (2025b). Saving and Investments Union. A Strategy to Foster Citizens' Wealth and Economic Competitiveness in the EU. COM (2025) 124 final, Brussels 19.3.2025.
- European Commission (2025c) COM (2025) 322 final REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL 2024 Annual Report on the Strategic Technologies for Europe Platform (STEP)
- European Commission (2025d). Proposal for a Regulation of the European Parliament and of the Council on establishing the European Competitiveness Fund ('ECF') including the specific programme for defence research and innovation activities. COM/2025/555.
- European Parliamentary Research Service (EPRS) (2021), Key enabling technologies for Europe's technological sovereignty, Panel for the Future of Science and Technology, European Parliament, Brussels.
- Farrell, H. & Newman, A. (2025). The Weaponized World Economy, Surviving the New Age of Economic Coercion, *Foreign Affairs* 104 (5), 8-23.
- Guerrieri, P., & Padoan, P. C. (2024). European competitiveness and strategic autonomy. LUISS Institute for European Analysis and Policy, Working paper 5/2024.
- Heikkonen et al., (2025). Mapping the impact of industrial decline on European regions, *Single Market Economic Briefs*, n.16.
- Juhász, R., Lane, N., and Rodrik, D. (2024). The New Economics of Industrial Policy. *Annual Review of Economics* 16, 213-242.
- Kroll, H., Maruseva, V., Ferrante, C., (2023), *Measuring System-Level Open Strategic Autonomy. An Analysis of EU27-Sovereignty Autonomy across Industrial Ecosystems and Strategic Technologies*, JRC Working Papers, European Commission, Seville.
- Lausberg, P. & Riekeles, G. (2025). From mission polity to mission economy: Making the EU a strategic investment power. *European Policy Centre, Discussion Paper*, July 2025.
- Letta Report (2024). Much more than a market.
- Liu, P., Yuan, W., Fu, J., Jiang, Z., Hayashi, H., & Neubig, G. (2023). Pre-train, Prompt, and Predict: A Systematic Survey of Prompting Methods in Natural Language Processing. *ACM Computing Surveys (CSUR)*. arXiv:2107.13586
- Pisani-Ferry, J., B. Weder di Mauro and J. Zettelmeyer (2024). How to de-risk: European economic security in a world of interdependence, *Policy Brief 07/2024, Bruegel*.
- Pochet, P., van Melkebeke, Möller, F. (2025). A modernized European single market for a new reality of economic security, *Single Market Economic Papers (Conference Paper)*, WP 38.
- Regulation (EU) 2024/795 of the European Parliament and of the Council of 29 February 2024 establishing the Strategic Technologies for Europe Platform (STEP), and amending Directive 2003/87/EC and Regulations (EU) 2021/1058, (EU) 2021/1056, (EU) 2021/1057, (EU) No 1303/2013, (EU) No 223/2014, (EU) 2021/1060, (EU) 2021/523, (EU) 2021/695, (EU) 2021/697 and (EU) 2021/241
- Regulation (EU) 2024/1735 of the European Parliament and of the Council of 13 June 2024 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724

- Schmitz, L., & Seidl, T. (2023). As open as possible, as autonomous as necessary: Understanding the rise of open strategic autonomy in EU trade policy. *JCMS: Journal of Common Market Studies*, 61(3), 834-852.
- Stock, J. H., Yogo, M. (2005). Testing for weak instruments in linear IV regression. In Andrews, D.W.K.; Stock, J.H. (Eds) *Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg*, Cambridge University Press: New York, US, 2005, pp. 80–108.
- Wei, J., Wang, X., Schuurmans, D., Bosma, M., Xia, F., Chi, E., Le, Q., & Zhou, D. (2023). Chain-of-Thought Prompting Elicits Reasoning in Large Language Models. arXiv:2201.11903
- Wooldridge, J. M. (2002). Inverse probability weighted M-estimators for sample selection, attrition, and stratification. *Portuguese economic journal*, 1(2), 117-139.
- WTO-World Trade Organization (1994). *Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS)*. In *The Marrakesh Agreement Establishing the World Trade Organization, Annex 1C*. Geneva: WTO. Retrieved from: [https://www.wto.org/english/docs\\_e/legal\\_e/27-trips.pdf](https://www.wto.org/english/docs_e/legal_e/27-trips.pdf)

## Appendix A

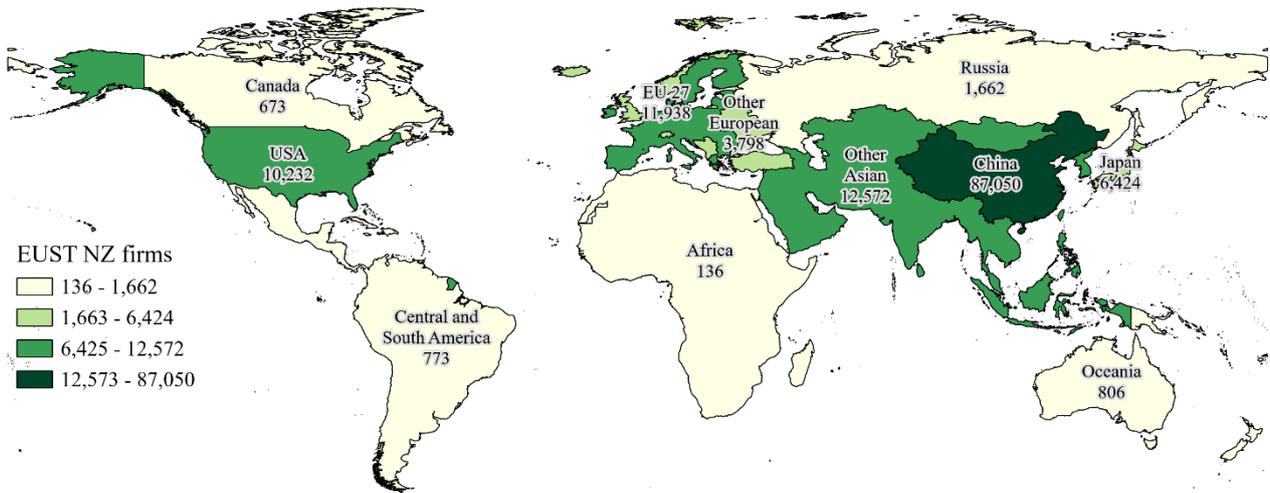
**Table A1. List of EU Strategic Technologies divided into Deep-Tech (EUST-DT) and Net-Zero (EUST-NZ)**

EUST type	Description
EUST-DT	Smart grids and energy storage, batteries
EUST-DT	Additive manufacturing, including in the field
EUST-DT	AI-enabled systems
EUST-DT	Cloud and edge computing
EUST-DT	Computer vision, language processing, object recognition
EUST-DT	Cyber security technologies incl. cyber- surveillance, security and intrusion systems, digital forensics
EUST-DT	Data analytics technologies
EUST-DT	Dedicated space-focused technologies
EUST-DT	Digital controlled micro-precision manufacturing and small-scale laser machining/welding
EUST-DT	Distributed ledger and digital identity technologies
EUST-DT	Electro-optical, radar, chemical, biological, radiation and distributed sensing
EUST-DT	Exoskeletons
EUST-DT	Gene-drive
EUST-DT	Gravity meters and gradiometers
EUST-DT	Guidance, navigation, and control technologies, including avionics and marine positioning
EUST-DT	High frequency chips
EUST-DT	High Performance Computing
EUST-DT	Hydrogen and new fuels
EUST-DT	Internet of Things (IoT) and Virtual Reality
EUST-DT	Magnetometers, magnetic gradiometers
EUST-DT	Microelectronics and Processors
EUST-DT	Net-zero technologies, including photovoltaics
EUST-DT	New genomic technique

EUST-DT	Nuclear fusion technologies, reactors and power generation, radiological Conversion/Enrichment/Recycling Technologies
EUST-DT	Photonics (including high energy laser) technologies
EUST-DT	Propulsion technologies, including hypersonics and components for military use
EUST-DT	Quantum communications
EUST-DT	Quantum computing
EUST-DT	Quantum cryptography
EUST-DT	Quantum sensing and radar
EUST-DT	Robotics and Autonomous Systems
EUST-DT	Robots and robot-controlled precision systems
EUST-DT	Secure communications including Low Earth Orbit (LEO) connectivity
EUST-DT	Secure digital communications and connectivity, such as RAN & Open RAN (Radio Access Network) and 6G
EUST-DT	Semiconductor manufacturing equipment at very advanced node sizes
EUST-DT	Space positioning, navigation and timing (PNT)
EUST-DT	Space surveillance and Earth observation technologies
EUST-DT	Synthetic biology
EUST-DT	Techniques of genetic modification
EUST-DT	Technologies for extraction, processing and recycling of critical raw materials
EUST-DT	Technologies for nanomaterials, smart materials, advanced ceramic materials, stealth materials, safe and sustainable by design materials
EUST-DT	Underwater electric field sensors
EUST-NZ	Battery and energy storage technologies
EUST-NZ	Biomaterials Production Technologies, Including Bio-Based Chemical Production Technologies
EUST-NZ	Carbon Capture and Storage Technologies
EUST-NZ	CO2 transport technologies
EUST-NZ	Electricity Grid Technologies, Including Electric Charging Technologies for Transportation and Technologies to Digitalize the Grid
EUST-NZ	Energy System-Related Energy Efficiency Technologies
EUST-NZ	Heat pumps and geothermal energy technologies

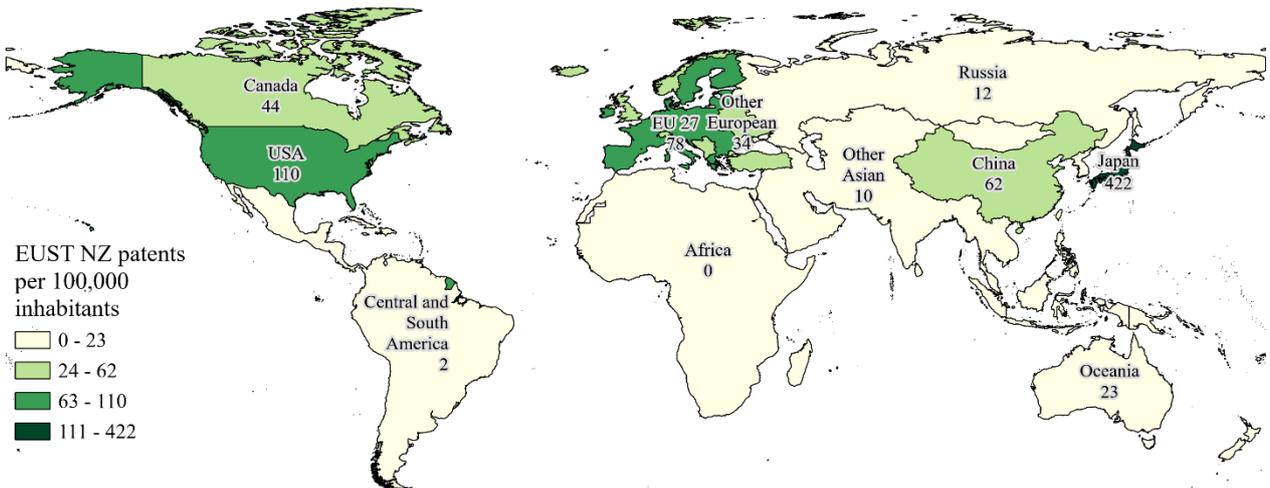
EUST-NZ	Hydrogen technologies, including electrolysers and fuel cells
EUST-NZ	Nuclear Fission Energy Technologies, Including Nuclear Fuel Cycle Technologies
EUST-NZ	Onshore Wind and Offshore Renewable Technologies
EUST-NZ	Sustainable Propulsion Technologies for Transportation
EUST-NZ	Renewable energy technologies not covered under the previous categories (osmotic energy technologies, ambient energy technologies, hydropower technologies, biomass technologies, landfill gas technologies, sewage treatment plant gas technologies, biogas technologies, thermal energy technologies including heat grid technologies)
EUST-NZ	Renewable Fuels of Non-Biological Origin Technologies
EUST-NZ	Solar technologies
EUST-NZ	Sustainable Alternative Fuels Technologies
EUST-NZ	Sustainable biogas and biomethane technologies

**Map A1. EUST NZ firms (number)**



Source: Istituto Guglielmo Tagliacarne-Unioncamere

**Map A2. EUST NZ patents per 100,000 inhabitants**



Source: Istituto Guglielmo Tagliacarne-Unioncamere

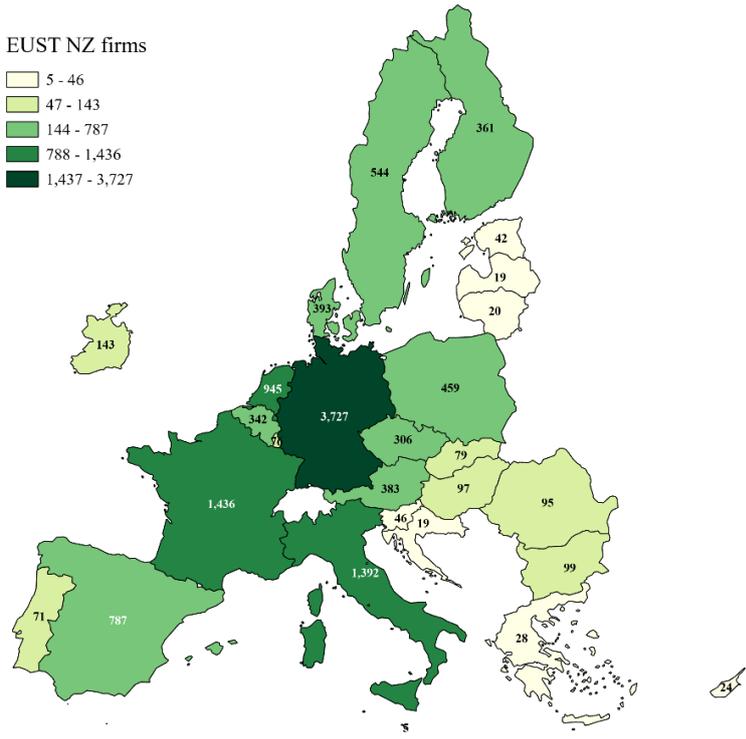
**Table A2. Macro regions**

Macro regions	Firms*		Patents			
	N. firms with patents in EUST	of which with patents in EUST NZ	N. patents in EUST	N. patents in EUST NZ	EUST patents per 100,000 persons	EUST NZ patents per 100,000 persons
EU 27	36,406	11,938	1,726,337	348,279	385	78
USA	41,997	10,232	3,354,968	369,110	1,002	110
China	226,424	87,050	4,953,288	868,339	351	62
Japan	19,041	6,424	2,825,736	525,122	2,269	422
Canada	2,309	673	108,928	17,502	272	44
Russia	4,519	1,662	54,022	16,938	38	12
Central and South America	2,557	773	102,261	10,668	16	2
Africa	637	136	10,018	4,930	1	0
Oceania	3.909	806	46,325	10,225	103	23
Other European	12,677	3,798	359,932	80,055	153	34
Other Asian	49,782	12,572	2,209,069	323,814	70	10
World	400,258	136,064	15,750,884	2,574,982	195	32

\* All data refers to the limited companies.

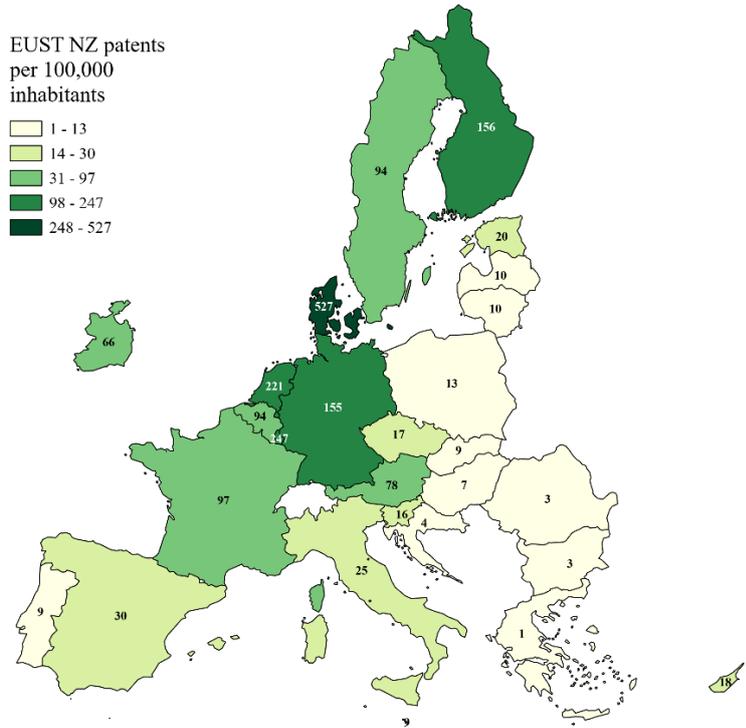
Source: Istituto Guglielmo Tagliacarne-Unioncamere

**Map A3. EUST NZ firms (number)**



Source: Istituto Guglielmo Tagliacarne-Unioncamere

**Map A4. EUST NZ patents per 100,000 inhabitants**



Source: Istituto Guglielmo Tagliacarne-Unioncamere

**Table A3 European Union countries**

EU Regions	Firms*		Patents			
	N. firms with patents in EUST	of which with patents in EUST NZ	N. patents in EUST	N. patents in EUST NZ	EUST patents per 100,000 persons	EUST NZ patents per 100,000 persons
Austria	1,098	383	35,227	7,143	386	78
Belgium	1,094	342	31,958	11,050	271	94
Bulgaria	449	99	1,193	225	19	3
Croatia	75	19	529	149	14	4
Cyprus	108	24	2,795	240	208	18
Czech Republic	812	306	6,053	1,884	56	17
Denmark	922	393	44,860	31,312	754	527
Estonia	122	42	833	272	61	20
Finland	1,313	361	114,728	8,716	2055	156
France	4,577	1,436	334,723	66,092	490	97
Germany	10,755	3,727	581,786	129,472	699	155
Greece	89	28	759	111	7	1
Hungary	309	97	2,494	687	26	7
Ireland	556	143	66,346	3,504	1250	66
Italy	5,169	1,392	61,605	14,529	104	25
Latvia	58	19	576	196	31	10
Lithuania	86	20	1,741	297	61	10
Luxembourg	258	76	7,795	1,647	1170	247
Malta	34	5	1,434	47	259	9
Netherlands	2,351	945	175,334	39,488	981	221
Poland	1,265	459	13,302	4,588	36	13
Portugal	279	71	3,415	903	32	9
Romania	319	95	1,759	489	9	3

Slovakia	220	79	2,255	462	42	9
Slovenia	183	46	1,035	335	49	16
Spain	2,215	787	37,696	14,519	78	30
Sweden	1,690	544	194,106	9,922	1842	94
<b>EU 27</b>	<b>36,406</b>	<b>11,938</b>	<b>1,726,337</b>	<b>348,279</b>	<b>385</b>	<b>78</b>

*\* All data refers to the limited companies.*

*Source: Istituto Guglielmo Tagliacarne-Unioncamere*

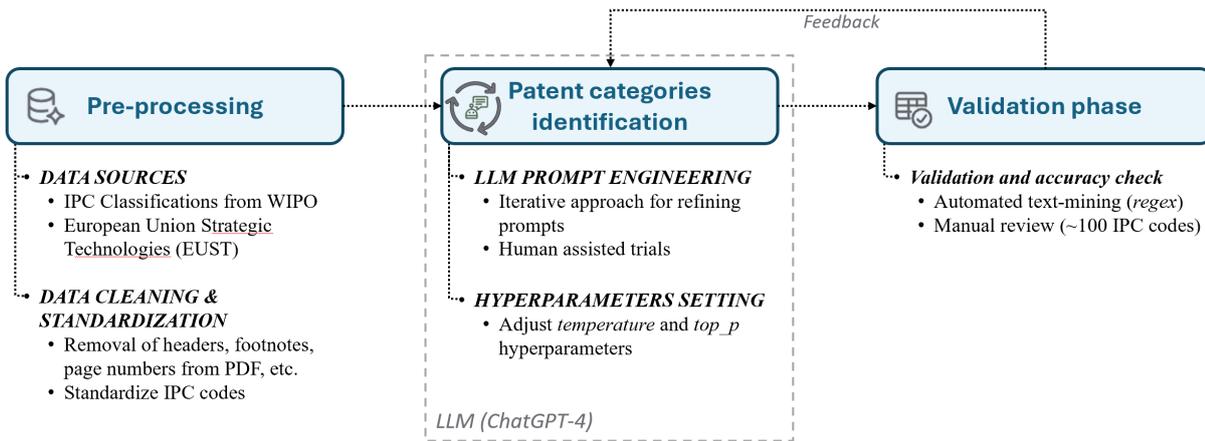
## Appendix B

In this section, we explain the method used to identify the patents linked to EU strategic technologies by taking into account, on the one hand, the list of strategic technologies as defined by the European Commission (Table A1 in Appendix A), and on the other hand, the International Patents Classification (IPC) at the maximum level of detail (14-digit). To achieve this goal, we leveraged a Large Language Model (LLM) to streamline the identification of patent categories corresponding to the European Union Strategic Technologies. Recent literature on innovation by using patents recognized that «a newer generation of textual analysis techniques, for example based on transformers or large language models (ChatGPT, etc.), could be used to this purpose [analysis of patents] in light of their high potential» (Colladon et al., 2025, p. 15).

The analysis proceeded in multiple stages and relied on the content evaluation of several text files, with the goal of accurately matching these technologies to their corresponding International Patent Classification (IPC) codes at the most granular 14-digit level.

As a preliminary step, we performed data cleaning on the input files – provided as PDF documents from the official website of the World Intellectual Property Organization (WIPO) and containing the full IPC classification – to remove superfluous information such as page headers, footnotes, page numbers, and any extraneous textual elements. This pre-processing was essential to enable the LLM to focus on the core classification content, ensuring the extraction of only the semantically relevant patterns while mitigating potential misinterpretations caused by inconsistent text formatting. Additionally, we standardized the textual representation of the IPC codes, reorganizing entries to achieve a uniform data structure, thereby enhancing the efficiency of subsequent automated analyses.

**Figure B1. Workflow for patent category identification using LLM**



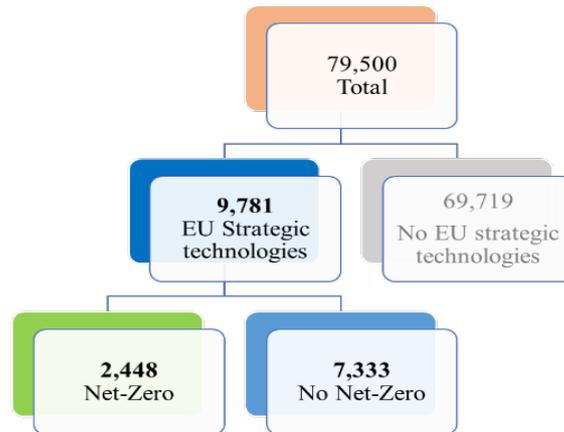
Source: Istituto Guglielmo Tagliacarne-Unioncamere

By providing the cleaned and standardized classification files to ChatGPT-4 – acknowledged at that time as a state-of-the-art multi-modal model for advanced text comprehension and classification tasks and still widely considered reliable for large-scale classification (OpenAI et al., 2023) – we adopted prompt-engineering strategies recommended by recent research (Brown et al., 2020). Specifically, after loading the complete IPC classification and a descriptive guide on how the classification system operates, we iteratively prompted ChatGPT-4 with each target technology and requested the corresponding patent categories. We used the OpenAI API to systematically set and adjust hyperparameters such as temperature and top\_p, ultimately enabling us to optimize the balance between creativity and reliability. In particular, after conducting multiple iterative trials to verify the consistency of generated results across separate runs, we settled on a temperature of 0.3 and a top\_p of 0.9, since this configuration consistently yielded coherent and precise outputs. Although fine-tuning the model for domain specificity was initially considered, the infrastructure available in March 2024 did not yet allow for fully customized fine-tuning of ChatGPT-4; consequently, we employed repeated trials and refined prompts to achieve stable response, an approach often referred to as “prompt refinement” or “prompt stacking” in advanced prompt-engineering literature (Liu et al., 2023; Wei et al., 2023). Figure 1 displays the entire process.

In order to verify the completeness and accuracy of the LLM output, we implemented a series of validation steps. First, we conducted a manual review of approximately 100 randomly selected IPC codes to detect any anomalies or incorrect assignments to the strategic technologies; none were identified. Next, a text-mining procedure employing regular expressions on keywords relevant to each strategic technology (for instance, using “heat pump” for “Heat pumps and geothermal energy technologies”) confirmed that no IPC codes identified by the LLM had been overlooked. Taken together, these measures demonstrated the robustness of the LLM’s classifications.

According to the results of this analysis, we identified 9,781 patents codes (IPC codes 14-digit level) related to EUST, of which 2,448 are related to Net-Zero technologies (EUST NZ)

**Figure B2. Number of 14-digit codes of IPC classification**



Note: The total number of codes (79,500) may change because of introduction of new inventions over time.

Source: Istituto Guglielmo Tagliacarne-Unioncamere

Once patents codes (IPC codes 14-digit level) related to EUST have been mapped, we identified firms with patents in EUST by exploiting Moody’s Intellectual Property dataset. We selected, through a boolean search, the set companies holding these types of patents. The patents were filtered based on the application filing date, including only those with a filing date between 01/01/2004 and 01/01/2024. This time frame was chosen to generally exclude patents with a useful life exceeding 20 years, given that industrial property rights for invention patents extend for 20 years from the filing date.<sup>9</sup> No filters were applied to patent offices, so the selected patents may have been filed at any patent office worldwide. The dataset therefore includes the total patents owned directly by companies.

## Appendix C

### *The determinants of innovation in EUST: an econometric analysis*

In this Appendix we investigate the extent to which some firms’ structural characteristics influences the innovation propensity in EU Strategic Technologies (EUST) in EU. Specifically, through econometric analyses we estimate the probability of holding EUST patents according to several firms’ characteristics such as size, sector and age. Since the dependent variable is binary, we use a probit model (Wooldridge 2010; pp. 453–459), as follows:

$$\text{Prob}(EUST = 1)_i = \Phi(\beta_0 + \beta_1 \text{Size}_i + \beta_2 \text{Sector}_i + \beta_3 \text{Age}_i + \beta_4 C_i + \varepsilon_i)$$

where EUST is a binary dependent variable that takes the value 1 if the firm holds patents in EU Strategic technologies, and 0 = if the firm holds patents in others technologies; Size is a categorical variable where 1 = Small (up to 49 employees); 2 = Medium (from 50 to 249 employees); 3 = Large (250 employees and over); Sector is categorical variable where (according to the OECD/Eurostat

<sup>9</sup> Industrial property rights last 20 years from the filing date for invention patents, 20 years from the grant date for plant variety rights, and 10 years from the filing date for utility models, starting from the filing date.

taxonomy) 1 = HTM (high/medium-high manufacturing technology intensive sector); 1 = LTM (low/medium-low manufacturing technology intensive sector); 3 = KIS (Knowledge intensive service sector); 3 = LKIS (Less-Knowledge intensive service sector); Age is a continuous variable counting the number of years since inception; C is a control variable related to the country dummies. Finally,  $\varepsilon_i$  is the normally distributed random error with zero mean and constant variance  $N(0, \sigma^2)$  that captures any other unknown factors. To know the effects of any explanatory variable on the response probability  $P(Y = 1|x)$  we calculated the marginal effects (average marginal effects). The dataset refers to same dataset used for all econometric analysis in this paper (It should be noted that for the EU we considered the four largest economies—Germany, France, Italy, and Spain—taken as a whole).

**Table C1. Structural firms' features as determinants of EUST**  
(marginal effects of probit regression)

	All firms	Manufacturing	Services
	EUST	EUST	EUST
	(A)	(B)	(C)
Small (ref. cat.)			
Medium	0.070*** (0.007)	0.069*** (0.008)	0.090*** (0.016)
Large	0.213*** (0.009)	0.254*** (0.010)	0.128*** (0.017)
HTM (ref. cat.)			
LTM	-0.168*** (0.010)	-0.158*** (0.009)	
KIS	0.136*** (0.008)		
LKIS	-0.034*** (0.008)		-0.206*** (0.01)
Age	-0.000*** (0.000)	-0.000** (0.000)	-0.001*** (0.000)
Country	Y	Y	Y
Obs	19,153	13,489	5,664
Pseudo R2	0.104	0.113	0.088

Note: i) the dependent variable is reported at the top of the column; ii) standard errors in parentheses; iii) ref.cat.: reference category.

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

The results (Table C1) indicate that medium-sized firms, and even more so large firms, are more likely to hold patents in EUST than small firms, by 7.0% and 21.3%, respectively (Column A). From a sectoral perspective, we find that within manufacturing, firms operating in low-tech industries

exhibit a 15.8% lower propensity to innovate in EUST compared to those in high-tech industries (Column B). Similarly, among service firms, the propensity to innovate in EUST is 20.6% lower in less knowledge-intensive industries relative to high-knowledge-intensive ones (Column C).

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