The role of European universities in patenting and innovation

A study of academic inventions at the EPO

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Office européen des brevets

in collaboration with Fraunhofer ISI

Executive summary

Technology breakthroughs and innovation are widely recognised as powerful engines of economic growth in developed economies. As a result, research carried out in universities has gained increasing attention as a lever to securing a nation's competitiveness. However, transferring knowledge to the market often remains a challenge for universities, whose primary missions are related to education and academic research.

This challenge is especially acute in the case of European universities. Europe is typically perceived as a world class academic power with top universities and publications. Compared to other advanced economies, however, it often faces difficulties in transforming science into commercial activity. Market and policy fragmentation, a lack of funding in university research ecosystems and an overall sentiment that is risk-averse are often cited among the causes of this "European paradox", which has become a central policy topic in most European countries and at EU level.

The present study was conducted under the aegis of the EPO Observatory on Patents and Technology, as a contribution to the debate on the European paradox. Patents are key instruments for technology transfers, and potent indicators of knowledge diffusion from universities to the market. By using data on European patent applications to track such transfers across a broad variety of channels over a long period of time, the study provides the first ever comprehensive overview of the role European universities play in patenting and innovation on the European scale.

Our findings shed fresh light on the role of universities as a source of innovation in Europe. The **contribution of academic researchers to European patent applications has increased steadily** in recent decades, and now exceeds 10% of all patents filed by European applicants at the EPO. A broad variety of models exist as to how these inventions are protected and eventually transferred to market. Their analysis reveals structural changes in universities' approach to intellectual property, as well as persistent differences between national innovation systems across Europe.

The **distinction between direct and indirect academic patent applications** provides valuable insights into available channels of knowledge diffusion. Indirect applications are typically filed by companies, and thus more likely to respond to industry's immediate needs. In contrast, patents that are directly filed by universities are more likely to be science-based, and they still have to find a path to commercialisation. The significant shift towards the latter observed in many countries was supported by reforms encouraging universities to take more responsibility for technology commercialisation. It reveals both the challenges and opportunities of commercialising advanced scientific research to foster disruptive innovation in Europe.

The stronger emphasis put on patent commercialisation highlights in particular the **strategic importance of the functions performed by knowledge transfer offices (KTOs)** across a wide variety of universities. Some of them have long-established KTOs managing large patent portfolios in advanced scientific fields. These top-tier universities already achieve significant impact via technology transfers, as evidenced by their revenues from IP or the numbers of European startups benefiting of their inventions. On the other end of the spectrum, small universities also achieve impact in their respective ecosystems through local collaborations and patenting by partner companies. The positioning of other universities between these two models largely depends on their research performance and KTO capabilities. It is crucial to take into account this diversity when defining technology transfer strategies and policy.

The **diversity of national models in academic patenting** represents another challenge, as most European universities transfer knowledge to their respective national or regional ecosystems. And they typically do so within specific institutional frameworks of ownership and research collaborations that have been long-established at the national level. This is illustrated, for instance, by the remarkably low rate of university ownership in Nordic countries, or by the high rate of academic patents that are co-filed by universities with other public research organisations in some other countries.

This fragmentation illustrates the effect of distance (geographic, institutional or cultural) as a barrier to knowledge diffusion. It also validates the emphasis put on local ecosystems and smart specialisation in the EU's innovation strategy. Nevertheless, the additional transaction costs tied to multiple national frameworks, and the ability of a few large companies to overcome these barriers by sourcing technology across borders, suggest there is potential for further harmonisation and integration in Europe's markets for academic inventions. Mario Draghi's report on the future of European competitiveness, as well as Enrico Letta's on the future of the Single Market, highlight that this fragmented innovation ecosystem is central to Europe's struggle to translate innovation into commercialisation. Mario Draghi points to the lack of connected innovation clusters across countries and sectors – spanning both private industry and universities – as a key obstacle in the innovation pipeline. The fact that 10% of startups with European academic patents are headquartered in the US highlights the ongoing difficulties in commercialising new technologies within the EU single market. The recent creation of the Unitary Patent marks a concrete step towards addressing these challenges, complementing other EU initiatives to promote industry-academia collaboration and provide financial support for science-based startups.

Key findings

1. **The impact of European universities on the European patent system has been steadily increasing over the past two decades. More than 10% of all patents filed at the EPO by European applicants in 2019 originated in universities.**

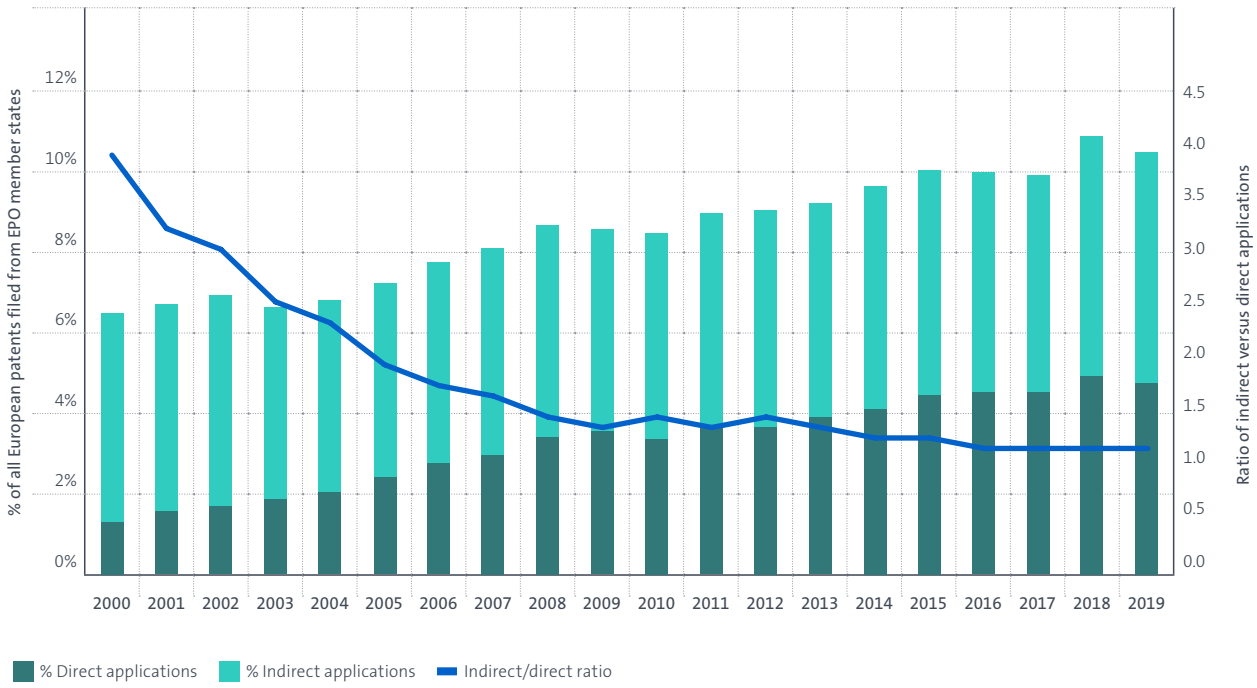
This study uses European patent applications for academic inventions as the reference metric for assessing the patent footprint of European universities. In addition to direct applications filed by the universities themselves ("direct applications"), the data also include patent applications not filed by universities but which include university-affiliated researchers among the inventors listed. These indirect applications are typically filed by companies, as a result of knowledge transfer through research collaborations, entrepreneurship or informal contacts.

The combined weight of direct and indirect patent applications stemming from European universities has increased steadily in recent decades, from 6.2% of all European patent applications in 2000 to 10.2% in 2019 (a share comparable to the total number of applications from Switzerland in 2023).

Looking at this period as a whole, only one-third of academic inventions were patented directly by the inventor's university. However, the IP policy of European universities has been shifting, with a dramatic increase in the proportion of academic inventions filed directly. As a result, direct patent applications represented 45% of academic patents in 2019, up from 24% in 2000.

Figure E1

Academic patents as a share of all European patent applications filed from EPO member states, 2000–2019



Note: Results for 2020 are not reported due to a time truncation of the data for this year.

Source: ETER, EPO - PATSTAT, Elsevier Scopus

2. More than 1 200 European universities have generated patent applications at the EPO, forming a very diverse landscape.

The leading countries in terms of both number of patenting universities and number of academic patents are Germany and France, followed by the UK and Italy. However, smaller countries like Sweden, Switzerland, Denmark, Belgium, Finland, Austria and Belgium show the highest number of academic patents per university on average.

Nearly two-thirds of universities (62%) filed less than one patent application per year on average, accounting for only 8% in total of all European patent applications filed by European universities. These are typically small institutions and tend to focus their applications on technology fields closely related to engineering (e.g. civil engineering, machine tools). Compared with other universities, they are over-represented in Central and Eastern European countries and own a relatively small share of their academic inventions.

By contrast, just 5% of universities account for half of all patent applications, with more than 250 applications each between 2000 and 2020. These institutions are more likely to file direct patent applications for their academic inventions and enjoy significant revenue from IP generated by well-staffed and experienced knowledge transfer offices (KTOs). While their patent portfolios typically span a broad range of technology fields, they are also the only category of universities to show a pattern of specialising in science-based fields, such as audio-visual technologies, telecommunications, nanotechnologies or pharmaceuticals and biotechnology.

Figure E2

Distribution of academic patents by European universities and countries, 2000–2020

Note: The name of the university with the largest number of academic patents in each country is shown in the corresponding cell where possible. For deeper insights into universities by number of academic patents per country, see Annex 2.

Source: ETER, EPO - PATSTAT, Elsevier Scopus

3. Most countries have evolved towards more frequent university ownership of academic inventions, while academic patenting by other applicants has receded. However, major differences between national models persist.

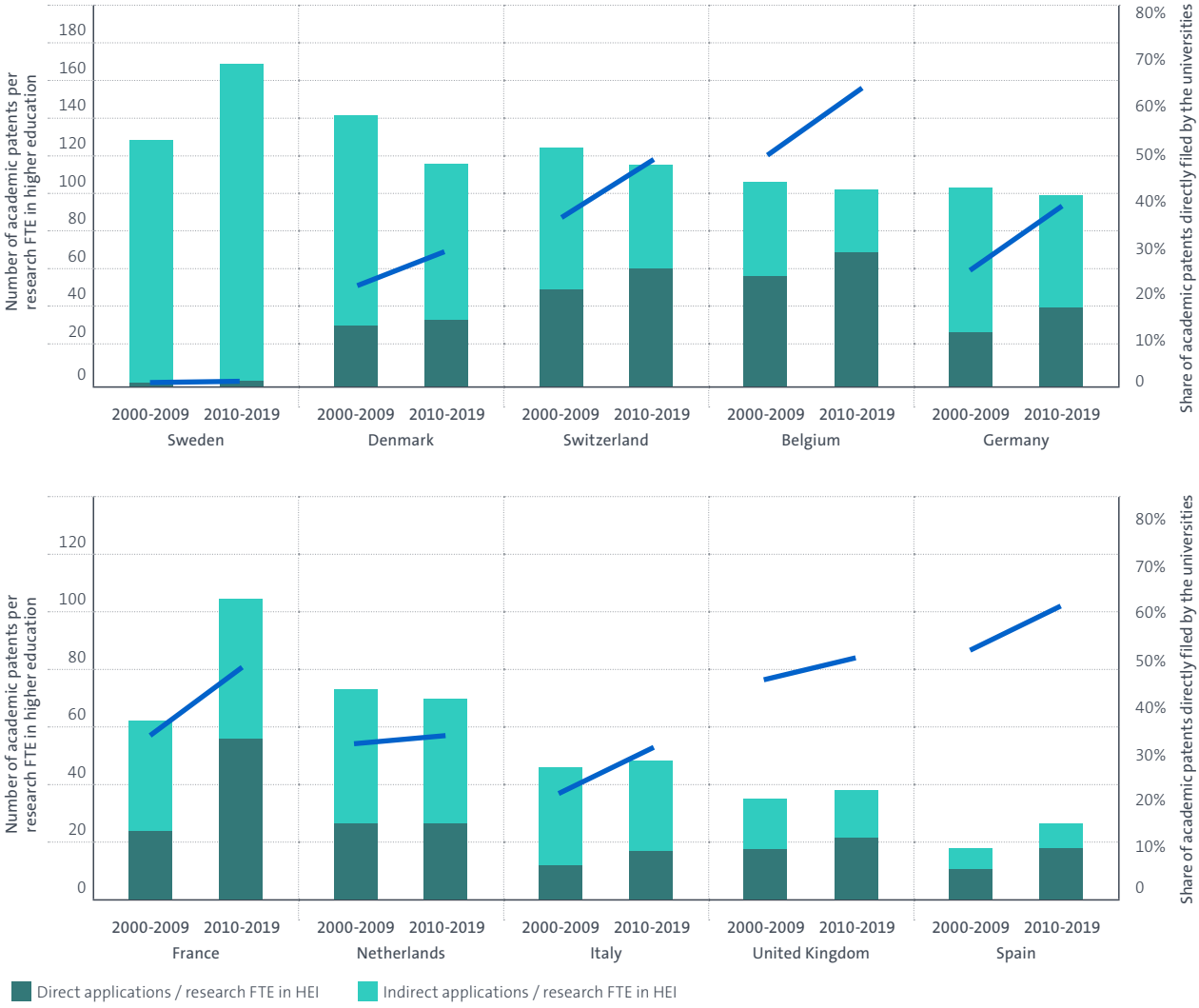
Most countries have seen an increase in the share of direct applications, denoting a systemic shift towards ownership of academic inventions by universities. This trend has been supported by various reforms aiming to foster the commercialisation of academic inventions, such as the abolition of professor's privilege in several countries.[1] However, there are notable differences in the legislation and its application across countries, influenced by the structure of their university systems. Several leading countries (Denmark, Switzerland, Belgium, Germany) show a net decrease in the overall number of academic patents per researcher, in line with other studies that find a general decline in research productivity.

However, important differences between European countries persist. Sweden and other Nordic countries have a different model, with a high number of academic patents per researcher but only a small proportion of (often highly cited) academic patents directly filed by universities. In other countries, such as France and Belgium, universities file most of academic patents, often with large public research organisations as co-applicants.

[1] Professor's privilege, whereby university researchers enjoy full rights to their inventions, was abolished in Denmark, Germany, Austria, Norway and Finland between 2001 and 2007.

Figure E3

Academic patents per research FTE in higher education in the top 10 countries, 2000–2009 versus 2010–2019



Note : The figure is based on counts of European patent applications directly or indirectly generated by universities. The top 10 countries are ranked in the figure by their total number of academic patents over the combined periods 2000–2009 and 2010–2019. The absolute levels of productivity reported by country and time period do not take into account other academic inventions stemming from universities for which patent applications have been filed only at their respective national offices.

Source: EPO - PATSTAT, Elsevier Scopus, Eurostat

4. Co-applications filed by universities with other research partners reveal dense collaboration networks at the country level, in which large research organisations often play a major role.

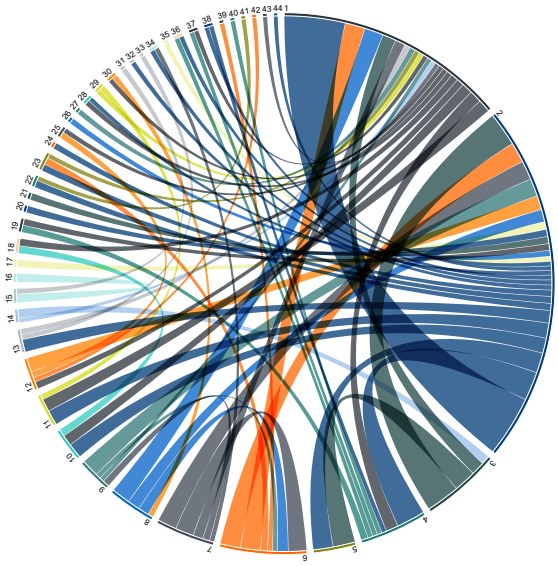
Co-applications signal close research collaborations with elaborate framework agreements governing exploitation of patents. Over the period 2015–2019 they represented 36% of the European patent applications filed by European universities, and mostly involved other research organisations from the same country as co-applicants. France stands out for its very high share of patents filed with a co-applicant (nearly 80%). Belgium (45%) and Italy (39%) are the only other leading countries where more than one-third of direct patent applications have a co-applicant.

The main co-applicants with French universities are large public research organisations (PROs) such as the CNRS and INSERM, with which university laboratories are often affiliated. Because they have a claim on a large share of the inventions produced by most French universities, these PROs occupy a central position in the network of French co-applications. Large PROs are also regular co-applicants with universities in Germany (the Fraunhofer and Max Planck Institutes), Belgium (IMEC, VIB), Spain (CSIC) and Italy (CNR). However, they usually only collaborate with a limited subset of universities. Other organisations such as research hospitals and foundations are also frequent co-applicants with universities across European countries.

Figure E4

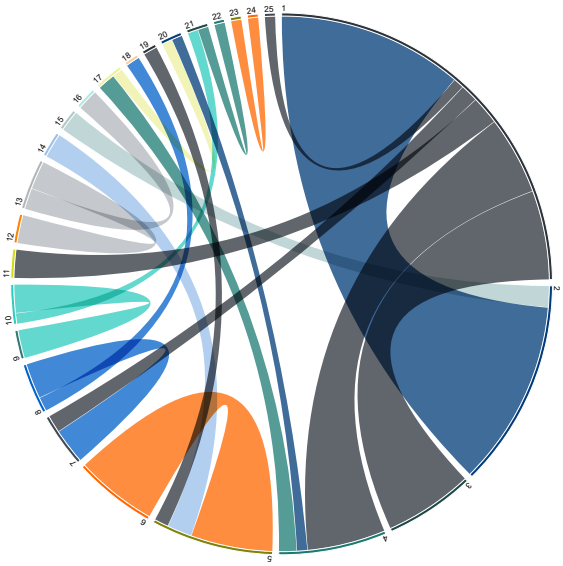
Main pairs of university co-applicants in France and Germany, 2015–2019

France



1 Institut national de la santé et de la recherche médicale (INSERM)
2 Centre national de la recherche scientifique (CNRS)
3 Université de Bordeaux
4 Université Claude Bernard Lyon 1
5 Institut polytechnique de Bordeaux
6 Université Paris Cité
7 Sorbonne Université
8 Assistance publique-hôpitaux de Paris
9 École supérieure de physique et de chimie industrielle de la Ville de Paris (ESPCI)
10 Nantes Université
11 Université de Toulouse
12 Université de Lille
13 Université d'Aix-Marseille
14 Centre Hospitalier Universitaire de Bordeaux
15 Université Grenoble-Alpes
16 Institut polytechnique de Grenoble
17 Commissariat à l'énergie atomique et aux énergies alternatives
18 Centre Hospitalier Universitaire de Nantes
19 École normale supérieure de Lyon
20 Université de Strasbourg
21 Université de Haute-Alsace
22 Université de Montpellier
23 Université Paris-Saclay
24 École normale supérieure (de Paris)
25 Centre Hospitalier Universitaire de Lille

Germany



1 Fraunhofer Gesellschaft
2 Friedrich-Alexander-Universität Erlangen-Nürnberg
3 Technische Universität Dresden
4 Friedrich-Schiller-Universität Jena
5 Deutsches Krebsforschungszentrum (DFKZ)
6 Universität Heidelberg
7 Rheinisch-Westfälische Technische Hochschule Aachen University
8 Forschungszentrum Jülich
9 Ludwig-Maxilillians-Universität München
10 Max-Planck-Gesellschaft
11 Technische Universität Ilmenau
12 Technische Universität Braunschweig
13 Medizinische Hochschule Hannover
14 Eberhard-Karls-Universität Tübingen
15 Uniklinikum Erlangen
16 Leibniz Universität Hannover
17 Leibniz Gemeinschaft
18 Universität Münster
19 Albert-Ludwigs-Universität Freiburg
20 Uniklinikum Jena
21 Technische Universität München
22 Helmholtz Association
23 Philipps-Universität Marburg
24 Justus-Liebig-Universität Giessen
25 Universität Regensburg

Note: The chord diagram for France is based on all pairs of co-applicants that share at least 21 co-applications over the period 2015–2019. The diagram for Germany is based on all pairs of co-applicants that share at least three co-applications during the same period.

Source: EPO - PATSTAT, Elsevier Scopus

5. Three-quarters of applicants for indirect patent applications were based in the same country as the academic inventor's university. Companies generated 80% of these indirect applications, and SMEs alone one-third. Startups filed 12% of all academic patents, either alone or as co-applicants with universities.

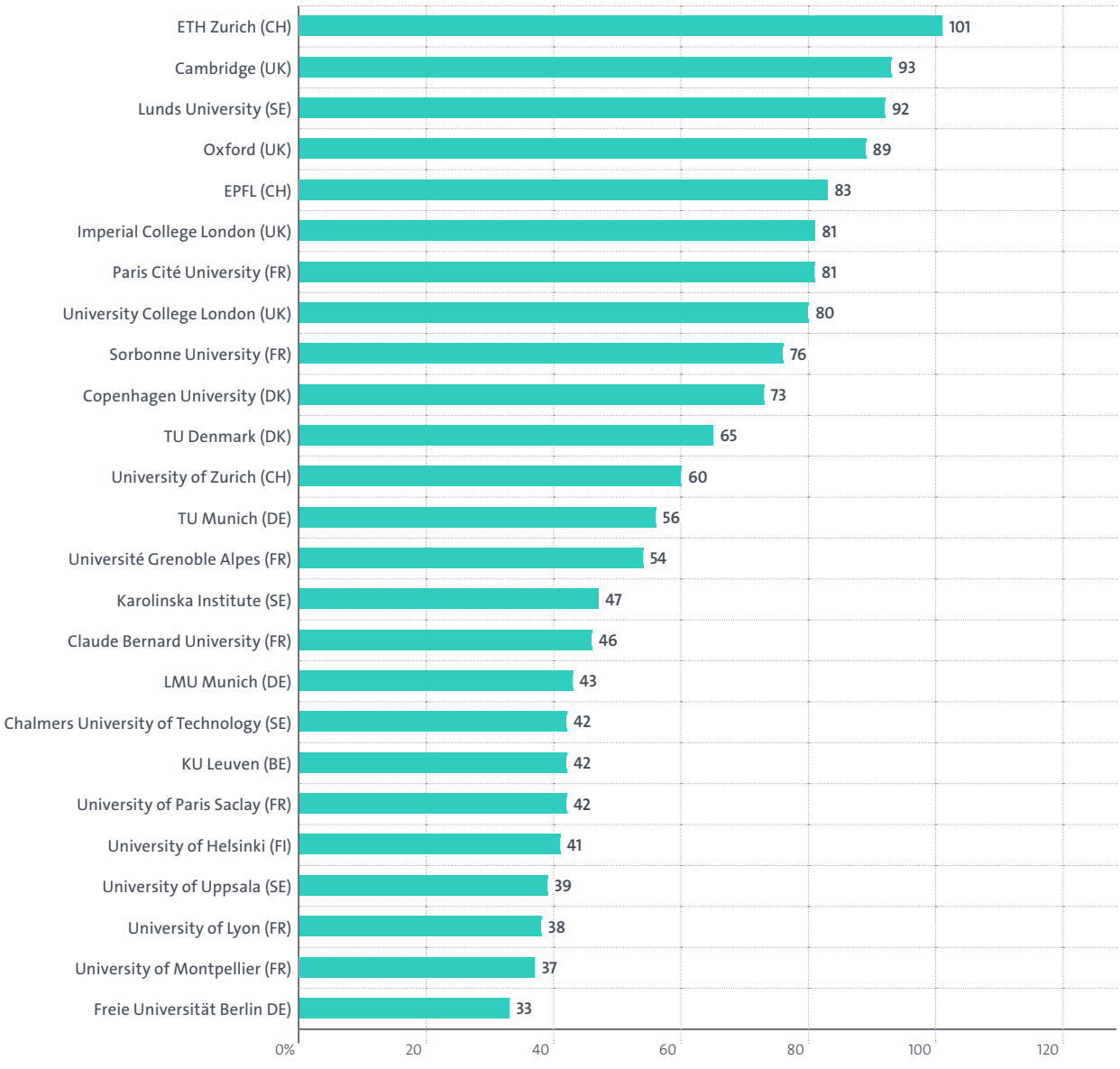
Over the period 2015–2019 indirect applications accounted for between 40% and 70% of all academic patents in most countries. Sweden (2%), Finland (9%), Hungary (7%) and Denmark (29%) stand out as exceptions, with a low propensity for universities to own patent applications on academic inventions. Overall, 76% of applicants for indirect applications were based in the same country as the academic inventor's university, while applicants located in other European countries represented another 15% (11% for the EU27 countries).

About 80% of indirect applications with university-affiliated inventors were filed by companies over the period 2015-2019, and 33% by SMEs. The top 25 co-applicants alone accounted for 32% of academic patents. In addition to six large national PROs they include multinational companies sourcing academic inventions mainly from their headquarter countries. However some, such as Siemens and telecom equipment companies Ericsson, Nokia and Huawei, collaborate with universities across a broader spectrum of European countries.

University research also benefits young companies: 12% of all academic patents were filed by more than 1 500 European startups. Three quarters of these companies sourced their academic inventions from a short list of 25 high-profile European universities.

Figure E5

Top 25 universities by number of startups with academic patent applications at the EPO, 2000–2020



Source: EPO - PATSTAT, Elsevier Scopus, Dealroom

6. The patent footprint of universities depends heavily on local industry ecosystems.

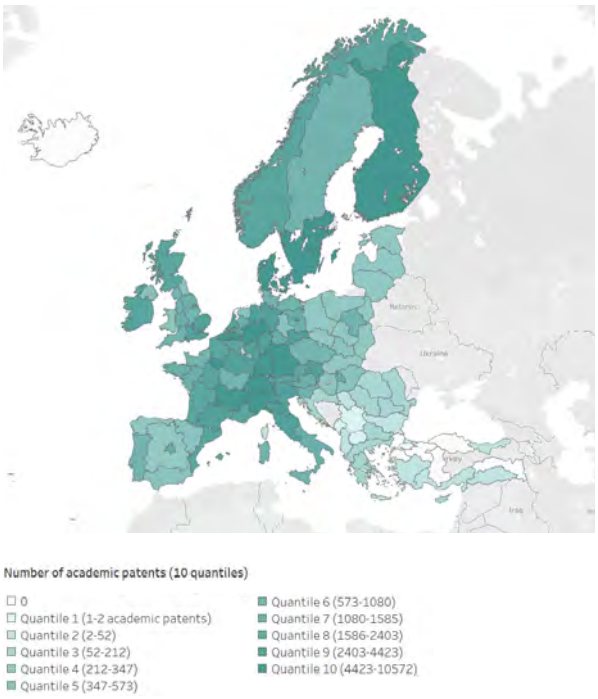
The number of academic patents generated by universities is larger in the more industrialised regions of Europe where opportunities for collaboration and technology transfers with industry are greatest. These regions also contain most of the universities that filed a large number of patent applications with the EPO over the period 2000–2019. However, academic patents represent only a relatively small share of all patents filed from these regions, due to the large number filed by local industry.

By contrast, universities in regions with lower GDP per capita, especially in Central and Eastern Europe, are mostly occasional applicants at the EPO, and generate relatively small numbers of academic patents. However, they account for a large proportion of local patent applications, which are frequently filed by partner companies rather than the universities themselves. They are essential components of innovation ecosystems in these regions and a key to development and smart specialisation.

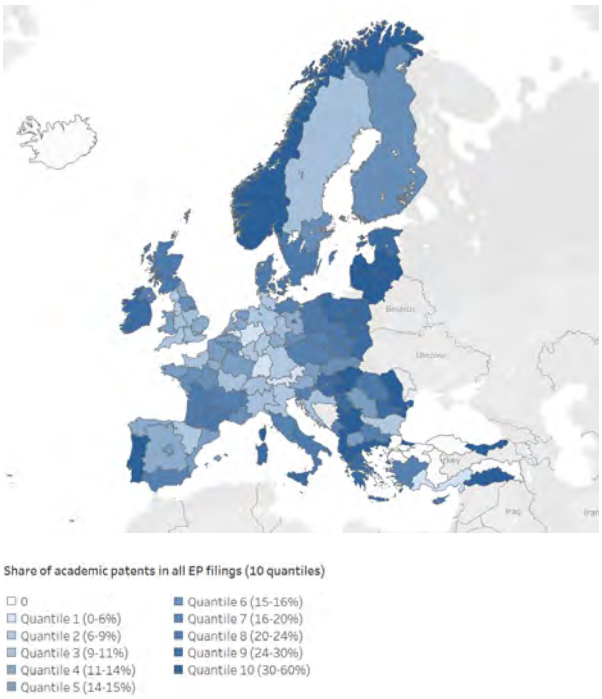
Figure E6

Academic patenting by European regions: number of European patents by NUTS 1 region, 2000–2020

Number of academic patents filed at the EPO by NUTS 1 region



Academic patents as a share of total patent filings at the EPO by NUTS 1 region



Note: Location is based on the applicant's address. The colour coding is based on 12.5% quantiles.
The darker the colour, the larger the plotted value.

Source: EPO - PATSTAT, Elsevier Scopus

The full report is available for download at:
epo.org/university-innovation-study

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