Europäisches Patentamt
European Patent Office
Office européen des brevets

EUIPO
EUROPEAN UNION INTELLECTUAL PROPERTY OFFICE

Intellectual property rights and firm performance in the European Union

Firm-level analysis report, January 2025

Foreword

By effectively protecting their intellectual property, innovative companies can secure financing, grow, collaborate and create value. But how does owning intellectual property rights (IPRs) impact their performance? In a series of studies, the European Union Intellectual Property Office (EUIPO) and the European Patent Office (EPO) have explored this relationship. Previous studies have shown that companies that own trade marks, patents and registered designs perform better financially, are more likely to achieve sustained growth, and have better access to venture capital financing than firms that do not own IP rights.

This joint follow-up report by the EUIPO and the EPO covering the period from 2013 to 2022 delves deeper into the role of IPRs by analysing a representative sample of over 119 000 European firms from all 27 EU Member States. According to this analysis, firms that own IPRs generate higher revenues per employee, create more employment and pay higher wages than their counterparts without an IP portfolio. These relationships between IPR ownership and economic performance are particularly strong for small and medium-sized enterprises (SMEs). However, fewer than 10% of European SMEs own IPRs. This, in our view, is a critical piece of information for European businesses and policymakers. Our latest report not only outlines the virtuous cycle between IP and economic performance, but also the considerable scope for value gains by making IP more accessible to SMEs.

This report echoes several key objectives set out in the EPO Strategic Plan 2028 and the EUIPO Strategic Plan 2030. Under its Strategic Plan 2028, the EPO will collaborate closely with partners to increase quality and enhance the accessibility of the patent system for all, ensuring that innovation flourishes and that the patent system reaches its full potential for society. In the EUIPO Strategic Plan 2030, one of the priority areas is the 'Promotion of Innovation', containing several key initiatives that aim to improve access to the IP system to start-ups and other innovative SMEs, helping them translate their innovations into products and services for the marketplace. In pursuing their strategic goals, both offices support many of the recommendations in Mario Draghi's report published in September 2024, which contains an analysis of the problems facing European innovators and sets out proposals to address those problems.

By contributing to a wider understanding of the role played by IPRs in the EU's economy and society, the present report supports the innovation agenda and helps bring home the fundamental message that IPRs are for everyone.

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1. Executive summary

This study aims to provide insights into how European companies utilise intellectual property rights (IPRs) and how to identify the distinguishing features of IPR-owning firms compared to those that do not register such rights. It builds upon previous company-specific research carried out by the EUIPO [1] in 2015 (OHIM, 2015) and collaboratively by the EPO and EUIPO in 2021 (EPO/EUIPO, 2021). These firm-level analyses have served as a basis for further research in this field. The comprehensive datasets developed for these projects have enabled further investigations into various aspects of how IPR ownership relates to business performance. These additional studies examined the link between IPR ownership and subsequent company growth (EPO/EUIPO, 2019), as well as its impact on accessing financial resources for start-ups (EUIPO/EPO, 2023). Consequently, general firm-level analyses can be viewed as fundamental to understanding the broader implications of IPR ownership.

This report presents the results of the analysis of a large representative panel of over 119 000 European firms from all 27 Member States of the European Union over a 10-year period (2013-2022). The analysis covers patents, trade marks and designs registered at the EPO, EUIPO and at the national and regional IP offices in the EU.

The final dataset contains information extracted from the IPR registers and matched with data contained in the commercial database ORBIS. ORBIS draws upon the obligatory accounting information provided by millions of European firms to the commercial registers specific to their country of origin. As there are differences in accounting practices between countries, revenue per employee (rather than profitability measures such as EBIT) was chosen as the main indicator of firm performance.

The dataset was constructed in such a way that the sample accurately reflects the characteristics of the EU firms' population and permits inferences about this population. The research presented here encompasses a larger and more comprehensive dataset than similar investigations, offering a robust basis for comprehending the characteristics of IPR owners. These insights can be valuable for guiding policy decisions and improving the general public's understanding of IPRs throughout the EU.

Since this study is based on data for the 27 EU Member States and employs an improved matching and sampling algorithm, the results reflect significant changes in data stratification and dataset construction. Consequently, they are not directly comparable to those presented in previous firm-level analysis reports (OHIM, 2015; EPO/EUIPO, 2021).

1 The EUIPO was called Office for Harmonisation in the Internal Market (OHIM) at the time of the publication of the study.

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1.1. Key findings

In the EU, IPR ownership is significantly lower among SMEs compared to large firms. In the sample analysed, fewer than 10% of SMEs hold any of the three types of IPR (patents, trade marks, or designs), whereas nearly 50% of large firms own at least one type of IPR or a combination thereof.

The disparity is evident across individual IPR categories as well (see Table E1). Around 1.1% of SMEs own patents, compared to 12.3% of large firms. For trade marks, the ownership rates are 9.2% for SMEs and 46.1% for large firms. Similarly, design ownership stands at 1.1% among SMEs and 10.7% for large firms.

Table E1:
IPR ownership by firm size

	Large (%)	SME (%)	Overall (%)
IPR non-owners	50.99	90.26	90.19
IPR owners	49.01	9.74	9.81
	100	**100**	**100**
Patent non-owners	87.28	98.91	98.89
Patent owners	12.72	1.09	1.11
	100	**100**	**100**
Trade mark non-owners	53.88	90.79	90.73
Trade mark owners	46.12	9.21	9.27
	100	**100**	**100**
Design non-owners	89.29	98.89	98.87
Design owners	10.71	1.11	1.13
	100	**100**	**100**

Table E2 presents the differences between owners of IPRs and those that do not register IPRs in several different categories such as size, revenue per employee and wages per employee for the 4 most recent years in the sample.

Table E2:
Average values of selected variables by IPR ownership, 2019-2022

		Number of employees	Revenue per employee (EUR '000/year)	Wages per employee (EUR '000/year)
Non-IPR owners		4.17	147.23	25.43
IPR owners	**Any IPRs**	9.08	182.27	31.04
	% difference compared with non-owners	117.75%	23.79%	22.07%
	Patent owners	13	189.49	36.42
	% difference compared with non-owners	211.69%	28.7%	43.26%
	Trade mark owners	9.06	181.56	30.74
	% difference compared with non-owners	117.19%	23.32%	20.9%
	Design owners	11.67	190.44	31.73
	% difference compared with non-owners	179.91%	29.34%	24.79%

Note: Employment and performance indicators (revenue per employee and wages per employee) are calculated as the weighted mean value of the per-firm averages of variables over the period 2019-2022. The 'Non-IPR owners' group is defined as firms with no stock of any registered IPR (patent, trade mark or design). The 'IPR owners' group is defined as firms that owned at least one patent, trade mark or design, or any combination thereof. The 'Patent owners', 'Trade mark owners' and 'Design owners' groups are defined as firms that owned at least one of these particular IPRs. Since many firms own bundles of IPRs, the various groups of IPR owners overlap. 'Any' refers to ownership of either national or European-level IP rights of the respective IPR type.

As shown in Table E2, firms that own IPRs tend to be larger than firms that do not, as measured by the number of employees (9 versus 4 employees on average). For this reason, economic performance metrics are expressed on a per-employee basis.

Firms that own IPRs have on average 23.8% higher revenue per employee than firms that do not. In terms of types of IPR, owners of patents have 28.7% higher revenue per employee, trade mark owners 23.3% and designs owners 29.3%. The last column of Table E2 shows that firms that register IPRs pay on average 22% higher salaries than firms that do not. The highest salaries are paid by patent owners (43.3%), followed by design owners (24.8%) and trade mark owners (20.9%).

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Table E3 shows the sectors with the highest share of IPR owners. Information and communication is on top, with 14.8% of firms in this sector registering at least one IPR. Other sectors with a relatively high percentage of IPR owners are manufacturing (14.2%), water supply, sewerage, waste management and remediation activities (12%) and then professional, scientific and technical activities (10.7%).

Table E3: Top 10 NACE* categories for IPR ownership

NACE section	IPR ownership (%)
J: Information and communication	14.79
C: Manufacturing	14.21
E: Water supply, sewerage, waste management and remediation activities	11.98
M: Professional, scientific and technical activities	10.68
G: Wholesale and retail trade, repair of motor vehicles and motorcycles	10.63
N: Administrative and support service activities	9.55
I: Accommodation and food service activities	9.39
L: Real estate activities	8.61
S: Other service activities	7.63
D: Electricity, gas, steam and air conditioning supply	7.24
B: Mining	6.36
F: Construction	5.82
H: Transporting and storage	5.2

*Note: The table illustrates the share of IPR owners within the total number of firms in the sample representing each NACE section. NACE (Nomenclature statistique des activités économiques dans la Communauté européenne) is Eurostat's classification system for economic activity in the EU.

The econometric analysis allows for a more precise investigation of the relationship between revenue per employee and the IPR status of firms, controlling other variables that might be correlated with performance and the likelihood to register IPRs, such as company size, country of origin, or sector of activity. While this analysis does not prove a causal relationship between IPR ownership and firm performance, it strongly suggests that there is a systematic, positive relationship between ownership of IPRs and the economic performance of firms.

Table E4 summarises the main findings from the econometric analysis. With corrections for other relevant factors, revenue per employee is 41% higher for IPR owners than for firms that do not register IPRs. This relationship is particularly pronounced for SMEs. In this group of firms, the difference in revenue per employee between owners of IPRs and firms without registered IPRs is 44%. While the rate of ownership among SMEs is relatively low at just under 10%, it seems those SMEs that do register IPRs perform much better than their counterparts without.

IPR owners among the large firms also perform better than the large firms without IPR registrations, but in this group the difference is much smaller than among SMEs. Revenue per employee is 16% higher for large IPR-owning firms compared to non-owners.

Table E4:
Main results of the econometric analysis

	Difference in revenue per employee between IPR owners and non-IPR owners
Large companies	+16%
SMEs	+44%
Total	**+41%**

Note: Based on observations of a total of 10 988 firms. Differences are statistically significant at the 99% confidence level.

Section 5 also shows that firm performance is not only associated with IPR ownership, but to the type and combination of IPRs a company registers. For SMEs, the highest revenue per employee premium (47%) is related to the ownership of trade marks and the combined ownership of patents, trade marks and designs (51%) and for the large firms to the combination of patents and designs (38%) and that of patents, trade marks and designs (27%).

1.2 Discussion and conclusions

This research, based on the analysis of the very large and representative sample of European firms, demonstrates that companies that own intellectual property rights outperform firms without these rights, specifically as regards per-employee revenue and average employee compensation. This finding is consistent with the earlier studies carried out in 2015 and 2021.

The findings presented in this study should be approached with a degree of caution due to inherent constraints in data and methodology. The results of the econometric analysis do not definitively prove a causal relationship between registering IPRs and enhanced business performance. Other significant factors, which could not be accounted for in this analysis (for example, the company's strategy or the quality of its management), might influence both a company's performance and its propensity to register IPRs. Nevertheless, theoretical arguments support the crucial role of intangible assets and IPRs in fostering innovation, boosting productivity, and ultimately improving individual firm performance. The current study's empirical confirmation of a positive correlation between IPR ownership and economic performance lends support to these theoretical assumptions.

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2. Introduction

This report presents the findings of an empirical analysis of the performance of owners of intellectual property rights (IPRs) in Europe compared to the performance of firms that did not register IPRs. The study is part of a workstream of firm-level studies that the EUIPO and EPO have been developing since 2015 (OHIM, 2015; EPO/EUIPO, 2019; EPO/EUIPO, 2021; EPO/EUIPO, 2023), focusing on various aspects of the link between IPR activity and a firm's economic performance, its growth potential, and its ability to obtain financing.

The present study quantifies the ownership of IPRs in terms of firm performance indicators. It is analytical in nature: the unit of analysis being the individual firm. A very large sample of over 119 000 companies has been analysed using statistical and econometric techniques to discern any association between IPR ownership and the economic performance of a firm. This analysis is important as it provides an indication of the relevance of IPR for European firms, especially SMEs.

2.1. Setting the scene – The importance of intellectual property rights for firms

Intangibles play an increasing role in the modern economy. Recent World Intangible Investment Highlights revealed that between 2008-2023, intangible investments grew three times faster than tangible investments (WIPO, 2024). Intangible investments are particularly important for the most dynamic and fast-growing firms. According to the European Commission (2020), investments in intangible assets make up almost 75% of all investments of the fastest growing firms. Innovative ideas are becoming more important to firms than traditional factors of production and decisions about the management of intangibles are becoming the most important strategic decisions that may decide the fate of a firm.

Intangible assets exhibit characteristics similar to public goods (Crouzet et al. 2022), and without implementing proper means of protection, innovative firms risk losing the most valuable outcomes of their creative endeavours to competitors in the market. Organisations can choose from various protective strategies, with specific approaches determined by factors such as financial resources, industry sector, and the operational practices of their regular business partners. IPRs play an important role in these considerations. Registering patents, trade marks or designs offers legal protection and expands opportunities for leveraging these assets. These rights enable companies to either commercialise their innovations independently or collaborate with partners who possess essential complementary resources for successful market entry. Modern businesses are increasingly adopting a comprehensive IPR strategy, combining various types of intellectual property protections to enhance their market competitiveness and likelihood of success.

The methods of protecting intellectual property can be divided into two broad categories: informal methods of intellectual property protection (e.g. speed to market and trade secrecy) and formal IPRs. Formal IPRs include patents, trade marks, designs, copyright, geographical indications and plant variety rights. This study focuses on patents, trade marks and designs, because firm-level data for the other formal types of IPR was not available. Table Box 1 summarises the main aspects of each of these three IPRs.

Table Box 1: Patents, trade marks and designs

	Patents	Trade marks	Designs
Subject-matter	Industrially applicable invention in all fields of technology, involving an inventive step	Distinctive signs that distinguish a company's goods or services from others	Ornamental and non-functional features of an article or product
Conferred rights	Exclusive right to make, use and sell the patented invention	Exclusive right to use the trade mark in trade and prevent its use by others for similar or identical goods or services	Exclusive right to use the design and prevent its use by others
Benefits	Incentive for innovation; protection of knowledge; full technical disclosure of invention	Promotes quality and competition between brands; provides the public with brand information and use in commerce	Ornamental and non-functional features of an article or product; provides a means for product differentiation and promotes competition between brands
Duration	Typically maximum 20 years from filing	Commonly 10 years from filing, but can be renewed indefinitely for successive periods	Commonly 5 years from filing, renewable, with a usual maximum term of 25 years

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2.2. Contribution of the study

The present study builds on the EUIPO's 2015 and the EPO/EUIPO's 2021 studies.

The major methodological changes in comparison to the 2021 study consist of the:

- elimination of firms based in the United Kingdom from the dataset;
- improved sampling methodology to ensure that the results are representative for the population of European firms (and, whenever possible, a stratified sample has been drawn considering the country of origin, firm size and sector (at the Section level)[2];
- improved method for matching IP register and ORBIS data, which has been standardised into a set of functions available in a separate R library, which will improve the comparability of similar studies in the future;
- panel data over a 10-year period (2013-2022).

2.3. Outline of the report

The structure of this report is as follows:

- Chapter 3 describes the data sources, the data-matching methodology applied, the resulting dataset and the types of analysis carried out in this study.
- Chapter 4 provides a first look at the evidence, in the form of descriptive statistics of the data.
- Chapter 5 sets out the main findings of the econometric analysis.
- Chapter 6 summarises and discusses the findings of the study.

2 A sample drawn for the 2021 report considered both the country of origin and the firm size, but not the distribution of the EU firms across sectors. 'Section level' refers to the highest level of sectoral aggregation in Eurostat's classification system of economic activities, such as manufacturing, construction, or wholesale and retail trade.

3. Data and methodology

The main purpose of the present study is to examine the relationship between firms' ownership of IPRs as registered in the official national and European IPR registers and their economic performance. As in the previous studies, productivity (revenue per employee) was chosen as the main measure of economic performance. The availability of revenue information in ORBIS is relatively high and is less subject to accounting considerations than other metrics such as profit. The main features of the methodology applied in this study are summarised in Table 1. It specifies the types of IPR included in the research, the level at which the analysis was conducted, the IPR metrics used and the performance measures employed.

Table 1:
Key characteristics of the methodological approach

Characteristics of the analysis	
Type of IPR	– National patents – European patents – National trade marks – European Union trade marks – National designs – Registered Community designs
Level of analysis	Firm level
IPR metrics	– Whether or not the firm owns IPRs – Stocks of IPR per employee
Performance metrics	Revenue per employee
Methodological approach	– Descriptive statistics – Econometric panel analysis

The analysis is based on three main categories of IPRs: patents, trade marks and designs. A distinction is made between IPRs granted/registered at European level and those granted/registered at national level. The IPR data was obtained from the EPO's PATSTAT database, the EUIPO's trade marks and designs register and from the TMvView and DesignView, databases collecting information on national trade mark and design rights. A description of these databases is provided in section 3.1.1 below.

The relationship between economic performance and IPR ownership is assessed in this study at firm level. Information on financial performance and the basic characteristics of firms was obtained from the ORBIS database and was matched with the IPR data described above. A more detailed discussion of these issues is provided in section 3.3.

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This study employs two methodological approaches to identify links between IPR status and performance: descriptive statistics and econometric analysis.

These methodological approaches are complementary. The descriptive statistics provide a basic overview of the characteristics of the firms included in the dataset and identify the extent to which the level of IPR ownership differs between firms with different characteristics (e.g. sector, country, size, etc.). The econometric analysis moves beyond pure description and seeks to identify the relationship between IPR ownership and the performance of a firm, controlling for the other factors that may affect performance. The results of these two types of analysis are presented in Sections 4 and 5 respectively.

In particular, the descriptive statistics have been calculated using post-stratification, with weights adjusted to account for any observations with that have missing values of for the key variables and to match the firms' distribution among the EU Member States. In the econometric models, additional controls, such as the number of employees, have been added to account for factors that might have an impact on revenue per employee, to strengthen the statistical validity of the analysis.

The results presented in this report are based on a newly produced dataset which that consists of a 10-year panel of 10 years (2013-2022) and that includes information on more than 119 000 companies from all 27 EU Member States as of 1 January 2024. The dataset used for this study combines the financial information reported by a large number of European firms (extracted from the ORBIS database) and details of the intellectual property rights owned by these firms from national and European IP offices (see the following sub-section for a description of the data sources). To the best of the authors' knowledge, the coverage of the firm- level datasets developed by the EPO and EUIPO is significantly larger than that of any other data source of this type currently available.

3.1. Firm data

The source of data on the firms' demographic and financial variables was the ORBIS dataset. This dataset, compiled by Bureau van Dijk, a subsidiary of Moody's, contains information on millions of firms in Europe. The advantage of ORBIS, compared to other commercial firm-level datasets, is the breadth and scope of the data available. The data is collected from publicly available national business registers in which all firms are obliged to disclose annual financial information. ORBIS covers firms of all types and sizes, although financial data availability may be lower for some firm categories, such as small firms, for which the reporting regime in some Member States is less stringent than for larger companies.

The selection of a random sample of firms from ORBIS was the first step in the data preparation process. The sample selection process was conducted separately in four different size strata: micro, small, medium and large companies. This ensured a sufficient number of observations in each stratum to obtain statistically significant results for the various analyses. The number of observations in each stratum and country was pre-determined based on the population of each country and the number of firms whose principal place of business was based in each country as shown in the Eurostat statistics. Firms were also preselected based on the availability of their turnover and employment data in ORBIS, with preference being given to firms for whom both employment and turnover data were available.

Firms were drawn into each stratum (defined by Member State and size) respecting the distribution of firms of a given size between the different industrial sectors (defined in the section, or letter, level in NACE). If Eurostat data did not allow a precise industrial distribution of firms in a given stratum, the EU27 sectorial distribution for a given firms' size was used to draw firms into that stratum. Due to the relatively lower availability of turnover and employment data, this procedure could not be used for firms based in the Netherlands and Luxembourg. In these cases, firms were drawn into each stratum based on completely random criteria, without respecting the firms' distribution into industrial sectors as reported by Eurostat.

The final sample resulted in a dataset that consists of a 10-year panel (2013-2022) and includes information on 119 045 firms from the 27 EU Member States as of 1 January 2024. It is shown in Table 2.

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Table 2:
Distribution of firms in the sample

Member state	Large	Medium	Small	Micro	Total firms
AT	299	996	998	1 998	**4 291**
BE	349	999	1002	1 999	**4 349**
BG	301	501	750	1 500	**3 052**
CY	39	47	97	147	**330**
CZ	351	1 002	999	2 001	**4 353**
DE	1 001	2 000	3 001	5 000	**11 002**
DK	300	498	750	1 498	**3 046**
EE	100	199	500	998	**1 797**
ES	999	2 001	3 000	5 001	**11 001**
FI	299	500	751	1498	**3048**
FR	1 000	1 999	3 001	4 998	**10 998**
GR	351	1 000	1 001	2 000	**4 352**
HR	101	200	501	1 001	**1 803**
HU	349	1 002	1 000	2 001	**4 352**
IE	293	497	749	1 499	**3 038**
IT	1 001	2 000	3 001	4 992	**10 994**
LT	99	200	500	999	**1 798**
LU	49	50	99	148	**346**
LV	100	202	499	1 002	**1 803**
MT	25	47	99	148	**319**
NL	351	998	985	1 753	**4 087**
PL	1001	2000	3 002	5 001	**11 004**
PT	348	1 001	1 000	2 001	**4 350**
RO	348	994	996	1 997	**4 335**
SE	351	1 001	999	1 999	**4 350**
SI	99	199	500	1 000	**1 798**
SK	300	500	749	1 500	**3 049**
Overall by size	**10 204**	**22 633**	**30 529**	**55 679**	**119 045**

As the size of each stratum in the final dataset does not completely reflect the distribution of the population of European firms across the Member States and size categories, subsequent analyses were conducted using weights specific to each stratum (descriptive statistics) or using relevant size, Member State and sector controls (econometric analysis).

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3.2. IPR data

Once the sample of firms had been selected, the following IPR data repositories were queried for information on IPRs registered by the firms in the sample.

- PATSTAT, the EPO's Worldwide Patent Statistical Database. This database contains all records of published patents filed at the EPO and at most national patent offices around the world. It includes information such as filing and grant dates, legal events, citations and classification data. The dataset used in this report was extracted from PATSTAT's April 2024 version.
- The EUIPO Register. The Register contains data on the filing, registration and expiry of EU trade marks and registered Community designs[3] at the EUIPO.
- TMview and DesignView. Maintained by the EUIPO, these databases provided information on national trade marks and designs.

Part of the statistical analysis in this study relies on the construction of stocks of IPRs. It was therefore necessary to account for the application and expiry dates of each individual IPR. This information is well covered in the European-level IPR repositories. For some countries, however, although information on current status was available, the exact expiry date of specific IPRs that are no longer valid was not included in the data. In these cases, the expiry year was imputed based on the average validity period of the same type of national IPR with similar status in the same Member State or within the entire dataset of national rights.

3.3. Matching process

As there was no common identifier available in all the data sources, several fields available in all the datasets (i.e. name of firm, legal form (extracted from the name field) and address) served to identify the firms across multiple databases. Before the final matching was executed, the relevant fields in all the data sources were cleaned of non-distinctive information, such as legal forms, and standardised using the same pre-processing algorithms. The data cleaning and standardisation processes were modelled on the algorithms prepared by the Catholic University Leuven (Magerman et al., 2006) and were further refined by the project team.

The join between the various data sources was performed using the standardised and harmonised name fields. The matching process included out-of-sample ORBIS records to verify whether a match between firms included in the sample and IPR records was the best possible one. The exact matching process was used to match ORBIS with the IPR data.

In cases where several ORBIS records linked to one IPR record, the matches were ranked taking the similarity of non-harmonised names, legal forms, seat region (NUTS3), city and the entire address into account. If the out-of-sample firms provided a better match than the firms included in the sample, the match between the sample firm and the IPR records was deemed to have failed and was rejected.

3 Following adoption of Regulation (EU) 2024/2822 of the European Parliament and of the Council of 23 October 2024 amending Council Regulation (EC) No 6/2002 on Community designs and repealing Commission Regulation (EC) No 2246/2002, the registered Community design will be renamed the EU Design in early 2025.

All the functions used for the cleaning of names and addresses, harmonisation and normalisation, firm matching and ranking have been included in the R library CleanMatch developed for the project.

Since the same firm may be associated with different identifiers in the IPR repositories, after matching, the stock of IPR information was consolidated at the level of the ORBIS identifier (which identifies the individual firm's location in the final panel dataset). Since the authors were interested in comparing the performance of firms that were indicated as owners of IPRs in IPR registers with those that were not, neither IPR ownership data nor financial and employment variables were consolidated at the economic group level. This may introduce some bias, as the benefits of IPRs may be distributed among a wider array of firms within the same group, including those that are not formal owners of IPRs. Consequently, some of the firms with non-IPR owner status in the data may in fact benefit from the IPRs held within the economic groups of which they are members.

All the analyses in the present report were conducted on the entire sample with the necessary post-stratification adjustments.

3.4. Variables included in the dataset

Firm variables

- ORBIS identifier;
- Member State where company is located;
- year of incorporation;
- industry derived from NACE class data available in ORBIS (in practice, both in descriptive statistics and econometric models, the aggregated NACE division (2-digit) code is used);
- revenue;
- number of employees;
- size: micro, small, medium or large according to the European Commission definition (to assign a firm to a specific size category, both employment and turnover were considered – whenever the size indicators (calculated on employment and revenue) did not coincide, the firm was assigned to the larger size category);
- wages (cost of employees).

IPR variables

- Binary indicators of IPR ownership
  Based on the sample data, several variables were constructed to capture the IPR ownership status of each firm. The focus of the study is to assess systematic performance differences between two groups of firms: those that are IPR-active and those that are not using registered IPR. IPR ownership status was therefore defined as a time-invariant variable with IPR owner status assigned to a firm if it was the owner of any IPR during any of the years covered by the panel (10 years) or descriptive statistics dataset (4 years). In the descriptive statistics and econometric models, several combinations of binary IPR variables were used to reflect the entire set of possible ownership of individual IPRs and their bundles at both national and European level.

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➔ Stocks of IP rights

The application and expiry dates for each firm in each of the years covered in the panel were used to construct its individual stocks of IPRs:

- European patent stock including applications with filing dates starting from 1978;
- national patent stock including applications with filing dates starting from 1902;
- European Union trade mark stock including applications with filing dates starting from 1996;
- national trade mark stock including applications with filing dates starting from 1875;
- registered Community design stock including applications with filing dates starting from 2003;
- national design stock including applications with filing dates starting from 1905.

Due to the complexity of the data cleaning, standardisation and matching processes and the quality of information on national IPRs, the matching to national IPRs was restricted only to rights assigned in the country of origin of each firm in the sample.

3.5. Summary and limitations of the data

The present study is built on the foundations of a carefully constructed dataset. To the best of the authors' knowledge, the coverage of the dataset is significantly larger than any other data source of this type currently available, ensuring a sufficiently large sample to draw robust and representative conclusions. Nevertheless, there are limitations as regards both the data and the methodology that must be noted.

One of the limitations of this study is the lack of data on intangible assets (some of which can be protected by IPRs, such as investment in R&D and design and marketing activities) and on the quality of those assets. It is therefore impossible to monitor this characteristic in the analysis. If, for example, firms that have many IPRs are also those that invest more in intangible assets in general, then the apparent relationship between IPR ownership and economic performance found in this study could be explained by the higher investment in intangibles. Without data on intangible investments, this hypothesis cannot be ruled out, nor can its potential impact on the results be assessed.

The quality of the economic and financial data in ORBIS largely depends on the reporting requirements in the various Member States, and on the degree to which firms comply with these requirements. Significant efforts were made in this study to correct this problem. Nevertheless, the fact remains that if data is not supplied by firms to the relevant national authorities, there is no alternative source of gathering this data — it simply does not exist in an accessible form.

There is no common unique identifier that allows a precise matching of the information available in the business data repository (ORBIS) with the data stored in the IPR repositories (EUIPO, PATSTAT, national trade mark and design registries). In the process of matching, names of applicants are extensively cleaned and harmonised. Although due care is taken during this laborious process, the matching process may produce some errors, for example, when no match is found for IPR applicants, or the wrong company is matched. It is very much dependent on the quality of the data available in ORBIS and the IPR repositories.

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The econometric analysis was conducted in such a way as to correct potential problems in the data, such as unobserved heterogeneity. However, the fact remains that the observed relationships in the data could be a result of underlying factors that are difficult to measure, such as the quality of the management or the innovative features that may be correlated with the propensity of a firm to use IPR to boost its economic performance. This is an inherent potential risk in every econometric analysis.

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4. Descriptive statistics

This section presents the descriptive statistics that explore the patterns of IPR ownership by firms in Europe. It starts by focusing on whether, on average, IPR-owning firms exhibit significant differences compared to non-IPR-owning firms, in terms of key financial and company variables, including revenue and number of employees. Next, it investigates how IPR ownership is associated with a firm's characteristics. The analysis relies on cross-tabulations to study how IPR ownership varies across large firms and SMEs and firms in different sectors or different Member States. In addition, this part of the study also analyses the average stocks of IPRs and compares them across firm types. In the tables in this section, the number of firms (indicated for each variable in the tables) may vary throughout the tables since not all variables are available for all firms.

To compute the means, the data has been truncated to limit the influence of outlier observations. In effect, the analyses present a mean of observations lying between the 5th and 95th percentiles of the available values. All the calculations in this section have been performed on the post-stratified sample. Each observation in the sample has been assigned a specific individual weight reflecting the number of firms with similar characteristics (in terms of size and country of origin) in the overall population of EU firms. This procedure enables the calculation of statistics that are representative for the EU. Since SMEs constitute the majority of the firms in the overall population of firms in the EU Member States, the weight of those firms in the overall result is much higher than the weight of large firms. As a result, the descriptive statistics in the overall sample are driven mainly by the results of the SME subgroup.

4.1. Key financial and company variables

Table 3 summarises key financial and company variables in the sample (revenue per employee, number of employees, average wages), broken down by owners and non-owners of IPRs and also by type of IPR. Significance tests were conducted to determine whether the mean values of interest between the group of owners and the group of non-owners were significantly different for each type of IPR.

The results of these statistical tests show the following data.

- ➔ Revenue per employee is greater for IPR owners than for non-owners. For owners of any IPR, revenue per employee is 23.8% higher than it is for non-owners. Breaking this down, the average premium for patent owners is 28.7%, for trade mark owners, 23.3%, and for design owners, 29.3%.
- ➔ IPR owners have a greater number of employees than non-owners (employing almost twice as many workers as non-owners). These differences are higher in the case of patent and design owners than for trade mark owners, and for firms that own European-level rights compared to firms that protect their IPR at national level.

Table 3:
Average values of performance variables by IPR ownership

		Employment	Revenue per employee (EUR '000/ year)	Wages per employee (EUR '000/ year)
Non-IPR owners		**4.17**	**147.23**	**25.43**
	Number of observations	N = 89 178	N = 83 216	N = 57 615
IPR owners	**Any IPR**	**9.08**	**182.27**	**31.04**
	% difference compared to non-owners	117.75***	23.79***	22.07***
	Number of observations	N = 20 346	N = 20 812	N = 17 011
Patent owners	**Patent owner**	**13**	**189.49**	**36.42**
	% difference compared to non-owners	211.69***	28.7***	43.26***
	Number of observations	N = 2 769	N = 3014	N = 2267
	European patent owner	**14.2**	**196.45**	**39.29**
	% difference compared to non-owners	240.51***	33.42***	54.51***
	Number of observations	N = 1 593	N = 1 779	N = 1 273
	National patent owner	**13.79**	**193.9**	**37.25**
	% difference compared to non-owners	230.66***	31.69***	46.48***
	Number of observations	N = 2 087	N = 2 280	N = 1 762
Trade mark owners	**Any trade mark owner**	**9.06**	**181.56**	**30.74**
	% difference compared to non-owners	117.19***	23.32***	20.9***
	Number of observations	N = 19 284	N = 19 719	N = 16 189
	EU trade mark owner	**13.74**	**207.38**	**32.63**
	% difference compared to non-owners	229.52***	40.85***	28.32***
	Number of observations	N = 6 920	N = 7 222	N = 5 822
	National trade mark owner	**8.96**	**179.13**	**30.68**
	% difference compared to non-owners	114.86***	21.66***	20.66***
	Number of observations	N = 17 013	N = 17 483	N = 14 482
Design owners	**Any design owner**	**11.67**	**190.44**	**31.73**
	% difference compared to non-owners	179.91***	29.34***	24.79***
	Number of observations	N = 2 649	N = 2 924	N = 2 368
	Registered Community design owner	**16.46**	**200.31**	**29.55**
	% difference compared to non-owners	294.61***	36.05***	16.23***
	Number of observations	N = 1 471	N = 1 673	N = 1 332
	National design owner	**10.72**	**187.95**	**33.39**
	% difference compared to non-owners	157.14***	27.65***	31.33***
	Number of observations	N = 1 503	N = 1 656	N = 1 320

Note: Employment and performance indicators (revenue per employee and wages per employee) are calculated as the weighted mean value of the per-firm averages of variables over the 2019-2022 period. The asterisks denote that the null hypothesis that the weighted group means are equal is rejected at the 10% (*), 5% (**) or 1% (***) significance level. The 'Non-IPR owners' group is defined as firms with no stock of any registered IPR (patent, trade mark or design). The 'Any IPR owners' group is defined as firms that owned at least one patent, trade mark or design, or any combination thereof. The 'Patent owners', 'Trade mark owners' and 'Design owners' groups are defined as firms that owned at least one of the particular IPRs. Since many firms own bundles of IPRs, the various groups of IPR owners overlap. Values of indicators represent weighted averages for firms in the sample, with post-stratification weights adjusted to obtain results representative for the EU. There are wide differences in data availability between countries, which are reflected in final weights used to calculate indicator values. The weights are truncated at 5 to limit the excessive influence of individual observations in the final results.

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Employees of firms with IPR registrations earn higher wages (22% on average) than those who work for companies that do not register their IPRs. This is particularly the case for firms that register patents, followed by those that register trade marks or designs. In general, wages are higher in firms that registered European-level IPRs, with the exception of designs, where firms registering national designs paid slightly higher wages.

4.2. IPR ownership by characteristic of the firm

This sub-section presents an analysis of the differences in IPR ownership related to the size of the firm and the sector in which the firm operates.

4.2.1. IPR ownership by firm size

Table 4 shows the distribution of IPR ownership by firm size. The main finding is that IPR ownership is considerably lower among SMEs than among large firms. Less than 10% of the SMEs in the sample own any of the three types of IPR or a combination thereof, compared with almost 50% of the large firms.

A similar picture emerges when considering individual IPRs. Slightly more than 1% of SMEs own a patent, compared with more than 12% of the large firms. For trade marks, the corresponding percentages are 9.2% and 46.1%, respectively, and for designs, 1.1% and 10.7%.

It should once again be stressed that firms that are not formal IPR owners can still use IPRs. For example, a firm that is part of a company group may not be the entity in the group that formally owns the IPRs, but it can still use them.

Table 4:
IPR ownership by firm size

	Large (%)	SME (%)	Overall (%)
IPR non-owner	50.99	90.26	90.19
IPR owners	49.01	9.74	9.81
	100	**100**	**100**
Patent non-owners	87.28	98.91	98.89
National patents only	3.39	0.46	0.47
European patents only	2.92	0.32	0.33
National and European patents	6.42	0.31	0.32
	100	**100**	**100**
Trade mark non-owners	53.88	90.79	90.73
National trade marks only	21.88	7.09	7.11
EU trade marks only	4.63	0.85	0.86
National and EU trade marks	19.61	1.27	1.30
	100	**100**	**100**
Design non-owners	89.29	98.89	98.87
National designs only	3.71	0.72	0.73
Registered Community Designs only	4.13	0.33	0.34
National and RCDs	2.87	0.06	0.06
	100	**100**	**100**

Tables 5, 6 and 7 dive deeper into the characteristics of IPR ownership. In Table 5, ownership of national and European-level rights is compared across the size categories of firms. In general, SMEs tend to own national rights while large firms tend to own European-level rights or combine national and European IPRs. Therefore, among patent owners, 42% of SMEs only own national patents, while 28% of them own both national and European patents. In the case of large firms, these proportions are almost reversed: 27% only own national patents, while 50% own both national and European patents.

Among trade mark owners, 77% of SMEs and 47.5% of large firms only own national trade marks, while 42.5% of large firms compared to 14% of SMEs combine national trade marks with European Union trade marks (EUTMs). Only about 9% of SMEs and 10% of large firms exclusively own EUTMs.

In the case of designs, the differences between large and small owners are somewhat less pronounced. 65% of SME design owners only own national designs compared to 35% of large firms. Among large firm owners, 37% exclusively own registered Community designs (RCDs), while in the case of SMEs, the corresponding number reaches almost 30%. Large firm design owners are more likely to combine RCDs with national designs (27%) than SMEs (5%).

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Table 5:
Ownership of European and national IPRs by firm size (IPR owners only)

Type of IPR	Geography of IPRs	Large (%)	SME (%)	Overall (%)
Patents (N = 3 210)	National only	26,63	42,33	42,01
	European only	22,93	29,64	29,51
	National and European	50,44	28,03	28,49
		100	**100**	**100**
Trade marks (N = 21 061)	National only	47,44	76,97	76,71
	European only	10,05	9,25	9,25
	National and European	42,51	13,78	14,04
		100	**100**	**100**
Designs (N = 3 090)	National only	34,61	65,06	64,54
	European only	38,62	29,67	29,82
	National and European	26,77	5,27	5,64
		100	**100**	**100**

(N = 22 234)

Note: 'National only' indicates that the firm owns a national patent but no European patents. It may nevertheless own other types of IPR. If a firm owns a bundle of IPRs it may appear in more than one IPR owner category.

Table 6 examines the differences in patterns of IPRs ownership between large firms and SMEs. Only a small proportion of IPR-owning large firms (3.7%) and SMEs (2.7%) register patents exclusively. SME owners, however, are much more likely than large firm owners to only register trade marks, 80% and 63% respectively. Very few firms only own designs. In the large firm's group, it is only 1.3% and in the case of SMEs, 2.5%.

Large firms are more likely to combine (bundle) various types of IPR. Close to 10% of large firms register all three types of IPR, compared to 2.5% of SMEs. More than 11% of large firms and close to 6% of SMEs combine patents and trade marks, which is the most popular combination of IPRs. Relatively few firms register a combination of patents and designs. This option is chosen by only 0.8% of large firms and 0.3% of SMEs.

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Table 6:
Type of IPR ownership by size (IPR owners only)

Type of IPR	Large (%) (N = 4 725)	SME (%) (N = 17 509)	Overall (%) (N = 22 234)
Patents only	3.73	2.69	2.70
Trade marks only	63.09	80.12	79.97
Designs only	1.31	2.49	2.47
Patents and trade marks	11.34	5.75	5.80
Patents and designs	0.84	0.30	0.31
Trade marks and designs	9.65	6.18	6.21
Patents, trade marks and designs	10.04	2.48	2.54

Table 7 presents the analysis of the stocks (number) of IPRs. In general, large firms own more IPRs than SMEs. The difference between average stock of large firms and SMEs is the largest in case of national designs and European patents. Large firms own almost 6 times more European patents (23.3 vs. 4) than SMEs, 5 times more national designs (52.5 vs. 10.1) and 4.5 more national trade marks (15.9 vs. 3.5). Those differences are somewhat smaller in case of RCDs, EUTMs and national patents.

Table 7:
Average stock (counts) of IPRs by firm size (IPR owners only), 2021

	EUTMs (N = 7 249)	National trade marks (N = 18 083)	RCDs (N = 1 530)	National designs (N = 1 717)	European patents (N = 1 803)	National patents (N = 2 207)
Large	8.42	15.89	31.25	52.58	23.29	13.35
SME	2.82	3.47	11.84	10.08	3.99	2.78
Overall	2.94	3.58	12.52	10.71	4.51	3.03

N = 21 456

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4.2.2. IPR ownership by economic sector

Table 8 presents the differences in ownership of IPRs depending on the main activity of the firms concerned, as defined by the NACE classification.

Table 8:
IPR ownership according to NACE category

NACE section	Size	N	Any IPR (%)	Patents (%)	TMs (%)	Designs (%)
B: Mining	Large	45	41.37	26.57	37.01	0
	SME	203	6.05	0.21	5.89	0
	Overall	248	6.36	0.44	6.16	0
C: Manufacturing	Large	3 699	59.37	25.52	54.1	20.24
	SME	17 520	13.87	2.22	12.32	2.52
	Overall	21 219	14.21	2.39	12.63	2.65
D: Electricity, gas, steam and air conditioning supply	Large	138	50.92	4.57	49.25	3.91
	SME	620	7.09	0.82	6.74	0.74
	Overall	758	7.24	0.84	6.89	0.75
E: Water supply, sewerage, waste management and remediation activities	Large	227	45.95	7.92	43.08	4.16
	SME	848	11.6	3.82	11.15	1.86
	Overall	1 075	11.98	3.86	11.5	1.89
F: Construction	Large	474	44.39	11.27	39.58	5.84
	SME	15 076	5.8	0.98	5.43	0.93
	Overall	15 550	5.82	0.99	5.45	0.93
G: Wholesale and retail trade, repair of motor vehicles and motorcycles	Large	1 789	46.2	4.59	44.92	7.8
	SME	25 283	10.58	0.96	10.13	1.1
	Overall	27 072	10.63	0.96	10.17	1.11
H: Transporting and storage	Large	837	34.53	3.3	33.46	3.33
	SME	7 164	5.12	0.58	4.86	0.38
	Overall	8 001	5.2	0.58	4.94	0.39
I: Accommodation and food service activities	Large	376	50.78	1.06	50.78	4.75
	SME	9 176	9.36	0.6	9.16	1.23
	Overall	9 552	9.39	0.6	9.19	1.23
J: Information and communication	Large	654	53.19	5.77	51.57	5.41
	SME	5 419	14.7	1	14.17	0.9
	Overall	6 073	14.79	1.01	14.26	0.91
L: Real estate activities	Large	100	32.14	0	32.14	1.19
	SME	4 414	8.6	1.06	8.47	0.8
	Overall	4 514	8.61	1.06	8.48	0.8
M: Professional, scientific and technical activities	Large	594	47.03	12.46	44.26	6.99
	SME	14 870	10.66	1.38	9.95	1.01
	Overall	15 464	10.68	1.39	9.97	1.02
N: Administrative and support service activities	Large	1261	33.99	2.61	33.45	2.39
	SME	7 704	9.46	0.57	9.15	0.89
	Overall	8 965	9.55	0.57	9.24	0.89
S: Other service activities	Large	10	52.35	7.57	52.35	17.9
	SME	544	7.62	0.48	6.99	1.59
	Overall	554	7.63	0.48	7.01	1.59

Note: The table shows the share of IPR owners within the total population of firms representing each NACE section within a specific size bracket. Only NACE sections with 100 or more firms in the sample are shown

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The largest sectors represented in the sample are wholesale and retail trade, manufacturing, construction and professional, scientific and technical activities. As shown in Table 8, there are significant differences between the NACE sections as regards the level of IPR registration. The NACE section with the highest percentage of IPR owners is 'Information and communication' (with almost 15% of firms registering an IPR), followed by 'Manufacturing' (14.2%) and 'Water supply, sewerage, waste management and remediation activities' (12%). The NACE sections with the lowest shares of IPR owners are 'Transporting and storage' (5.2%), 'Construction' (5.8%) and 'Mining' (6.3%).

There are also important differences in the firms' level of intensity of IPR registration when zooming in on the different types of IPRs.

As the overall statistics on IPR ownership are driven mainly by trade marks, the ranking of the NACE sections with the highest percentage of trade mark owners is very similar to the ranking of general IPR activity, with 'Information and communication' (14.3%), 'Manufacturing' (12.6%) and 'Water supply, sewerage, waste management and remediation activities' (11.5%) being at the top.

The highest percentage of patent owners is within the 'Water supply; sewerage, waste management and remediation activities' section with almost 4% of firms registering patents. Patent ownership is also relatively high among manufacturing firms (2.4%) and firms in the 'Professional, scientific and technical activities' sector (1.4%).

'Manufacturing' is the NACE section with the highest percentage of design owners (2.7%), followed by 'Water supply; sewerage, waste management and remediation activities' (1.9%) and 'Other service activities' (1.6%).

Figure 1 to Figure 3 show the NACE divisions[4] with the highest share of patents, trade marks and designs respectively. 'Scientific research and development' is the division with the highest ratio of patent owners by a large margin (10.8%), followed by the manufacturing industries: 'Manufacture of computer, electronic and optical products' (6.7%) and 'Manufacture of machinery and equipment' (6.5%).

The 'Manufacture of basic pharmaceuticals' is the division with the highest share of trade mark owners (40.5%), followed by the 'Manufacture of beverages' (36.9%) and 'Manufacture of chemicals and chemical products' (28.3%) divisions.

As shown in Table 4 and Table 8, in general, the rate of design ownership among European firms is relatively low in comparison to trade mark or patent ownership. This is confirmed by analysis of the NACE divisions with the highest share of design owners. 'Manufacture of rubber and plastic products' is the division with the highest percentage of design owners (6.8%), followed by 'Manufacture of computer, electronic and optical products' (6.3%) and 'Manufacture of beverages' (5.7%) divisions.

4 Each NACE section, denoted by a letter, is divided into several divisions, denoted by 2-digit codes. For example, Section C, Manufacturing, contains 24 divisions, numbered from 10 to 33.

Figure 1:
NACE divisions with the highest share of patent owners

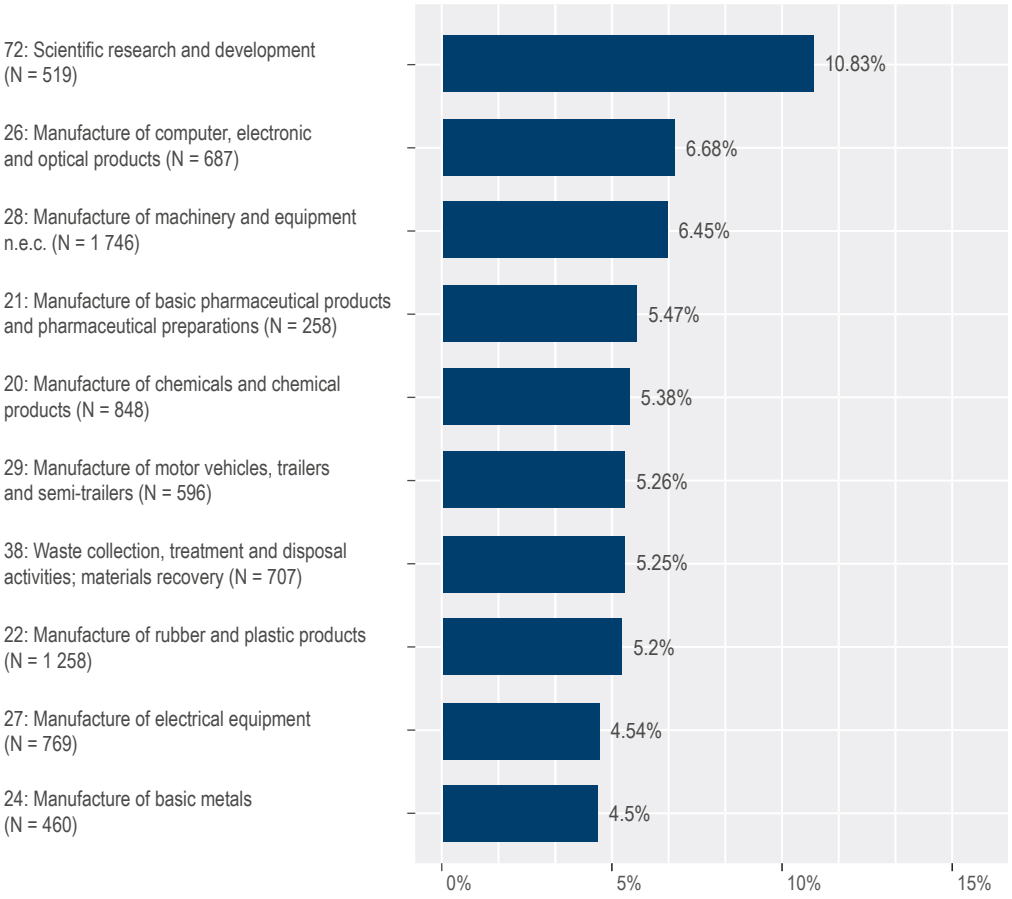

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Figure 2:
NACE divisions with the highest share of trade mark owners

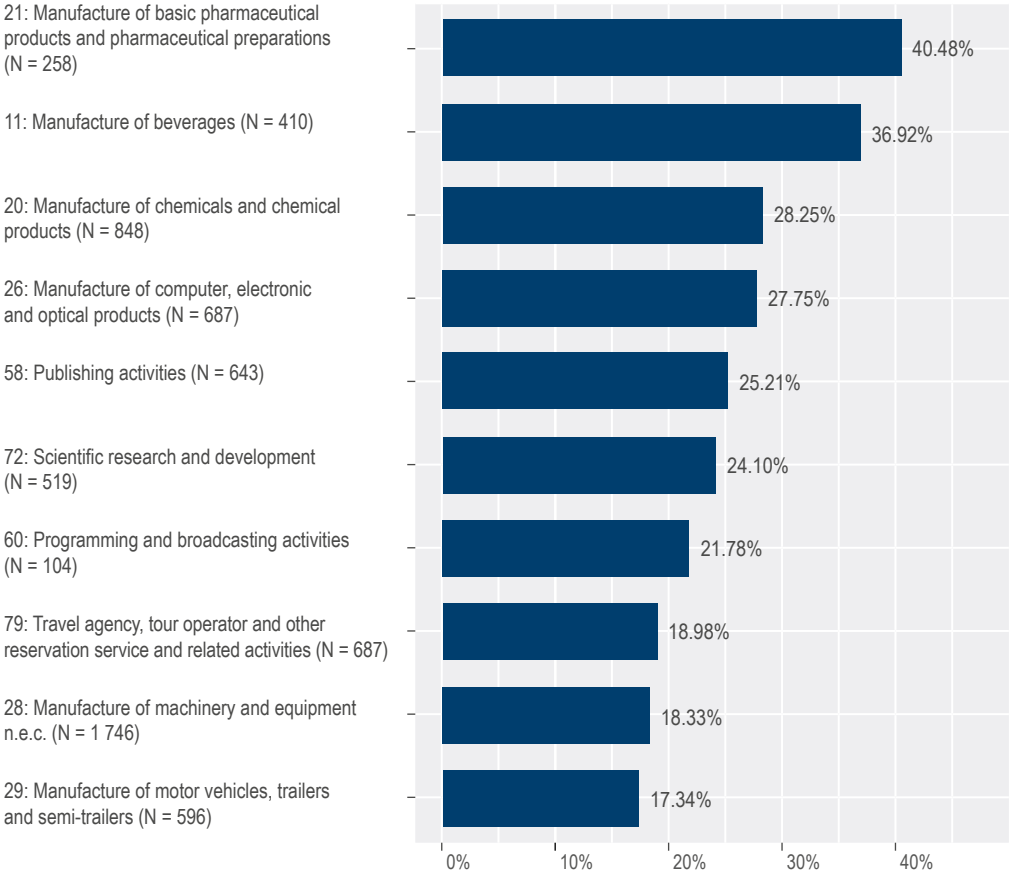

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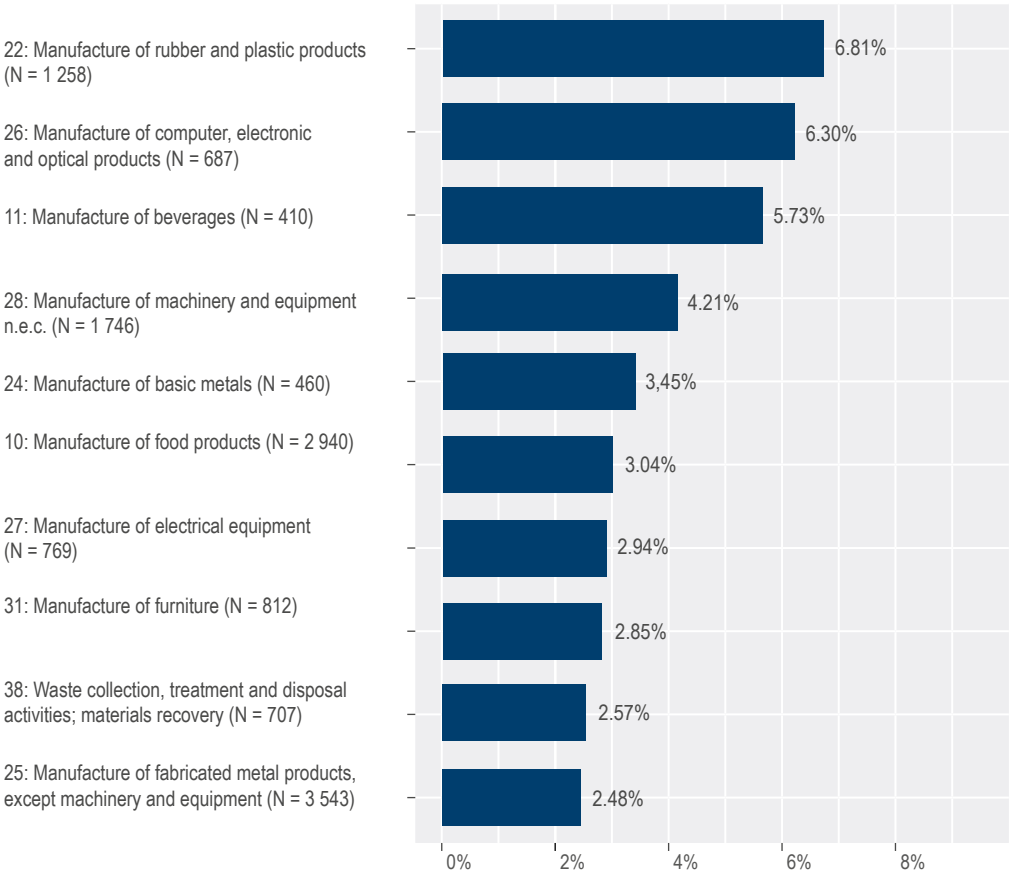
Figure 3:
NACE divisions with the highest share of design owners



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5. IPRs and firm performance: econometric analysis

This chapter examines the link between IPRs and firm performance in more depth. In particular, econometric modelling is applied to estimate the relationship between a firm's performance and its ownership of IPRs overall, but also the ownership of patents, trade marks and registered designs separately.

Econometric models make it possible to control additional factors that, besides IPR ownership, may influence firm performance.

5.1. Selection of variables

Econometric analysis uses statistical techniques to examine the relationship between a variable whose movements the researcher seeks to explain (called the dependent variable) using a set of explanatory or independent variables. This section describes the selection of the dependent variable and the independent variables.

5.1.1. Dependent variables

The purpose of this study is to analyse the relationship between IPR ownership and firm performance. Therefore, the dependent variable of the models needs to be an indicator of company performance. The ORBIS database, described in section 2.1, contains several potential candidates, including various measures of revenue, sales and profit or loss. Given that this study relies on data from all the EU Member States, it is important that the basis on which the dependent variable is constructed is identical between countries over time as this will minimise the risk that data quality will lead to biased results. For this reason, various measures of profitability, which are often affected by accounting and tax considerations, were discarded in favour of revenue as the basis of the performance measure in the models. Given the substantial variation in revenue between firms of different sizes, the decision was made to transform the performance measure by dividing it by the number of the firm employees. Therefore, revenue per employee (operating revenue per employee in a given year) is the measure of performance used in the econometric models.

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5.1.2. Explanatory variables

The differences in performance between firms, as represented by revenue per employee, are then explained by a set of explanatory variables, which fall into two main categories. The first category consists of binary or dummy variables that indicate whether the firm owns IPRs (or whether it owns a particular type of IPR):

- IPR owner: takes the value 1 if the firm owns any type of IPR in any of the years, and 0 otherwise.
- A set of dummy variables which indicate whether a firm owned a specific combination of IPRs in any of the years and which divides the sample into eight corresponding groups:
  - Patents only: takes the value 1 if the firm owned patents but no other type of IPR, and 0 otherwise.
  - Trade marks only: takes the value 1 if the firm owned trade marks but no other type of IPR, and 0 otherwise.
  - Designs only: takes the value 1 if the firm owned design rights but no other type of IPR, and 0 otherwise.
  - Patents and trade marks: takes the value 1 if the firm owned patents and trade marks but not designs, and 0 otherwise.
  - Patents and designs: takes the value 1 if the firm owned patents and designs but not trade marks, and 0 otherwise.
  - Trade marks and designs: takes the value 1 if the firm owned trade marks and designs but not patents, and 0 otherwise.
  - Patents, trade marks and designs: takes the value 1 if the firm owned all three types of IPR, and 0 otherwise
  - No IPRs: takes the value 1 if the firm did not own any type of IPR, and 0 otherwise.

In addition, so-called control variables were also used. These are variables which indicate, or control non-IPR factors which might affect company performance and which therefore need to be taken into account when analysing the relationship between performance and IPR ownership.

- **Country:** the country in which the firm is domiciled.
- **Sector:** the sector in which the firm is active (NACE sections).
- **Year:** the year (to control the effects of the economic cycle).
- **SME:** a dummy variable which takes the value 1 if the firm is an SME, and 0 if the firm is large (in cases where the company moved between categories during the panel period, the size category with the latest available data is assigned).
- **Age of company:** a variable that indicates the age of the firm.
- **Employment:** a variable indicating the number of employees in the firm.

5.2. Econometric methodology

5.2.1. Panel data

The dataset used to run econometric models consists of 109 888 firms, with up to 10 (annual) observations per firm (2013-2022). However, not all firms have data for the entire period, either because they were founded after 2013, or there is data missing for some of the years. On average, there is data for 5.7 years per firm, yielding more than 620 000 observations in total. However, in practice, the number of firms and overall observations included in the final models is somewhat lower, around 600 000, because outlier observations were eliminated from the analysis.

The dataset has a so-called panel format as it contains both a cross-sectional and a time-series dimension. Panel data makes it possible to exploit not only cross-sectional variation (differences between firms at one point in time) but also time-series variation (changes for one firm over time). Since both dimensions of variation within the data can be exploited simultaneously, panel data estimates are based on a larger sample size and are thus potentially more accurate than those obtained through simple cross-section or time-series regressions.

This study focuses on the systematic differences in performance between the group of IPR-active firms and the group of firms that did not use IPR protection over a period of 10 years, and analyses those differences using a so-called random effects model. The main variable of interest – IPR activity – has been defined as a binary and time-invariant variable. As a fixed-effects estimator ignores all the variations in the explanatory variables across individual firms, it cannot be used to estimate a relationship between IPR status and firm performance in such a setup. Random effects models combine the cross-sectional (between firms) and time-series (within firms) features of the data for model estimation. This enables the estimation of time-invariant variables (Wooldridge 2013). This technique relies, however, on the assumption that firm-specific unobservable characteristics have a non-systematic (i.e. random) influence on performance and are uncorrelated with the explanatory variables.

5.2.2. Logarithmic transformation

In regression analysis, it is common to logarithmically transform variables where a non-linear relationship exists between the independent and dependent variables. This approach enables the inclusion of a non-linear focal relationship, while still preserving the linear regression model. Logarithmic transformations are also a convenient means of transforming a highly skewed variable, such as revenue per employee in our study, into one that is more approximately normal. Finally, it is appropriate to make a logarithmic transformation when it is suspected that a given percentage change in an explanatory variable will lead to a constant percentage change in the dependent variable. Consequently, in the regressions presented below, the dependent variable (revenue per employee) and the continuous explanatory variable (employment) are expressed in logarithms.

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5.3. Results

5.3.1. Interpreting regression results

To interpret the regression results presented in the tables below, a little background knowledge of econometrics and statistics is required. In this section, the necessary knowledge to understand the discussion that follows is provided.

The tables containing the regression results consist of the following columns:

Variable	Coefficient

The 'Variable' column contains the explanatory variables of the regression model. Explanatory variables are those factors that are believed to have an impact on firm performance. The 'Coefficient' column shows the impact of each explanatory variable on firm performance. A positive value for the coefficient means that an increase in the value of the focal variable is associated with better performance, whilst a negative coefficient means that an increase in the value of the variable is related to weaker performance. The greater the magnitude of the coefficient (either positive or negative), the greater the association between the control variable and the performance of the firm. It is important to note that not all variables have a statistically significant influence on the dependent variable. Statisticians and econometricians use significance tests to determine whether a particular explanatory variable has a statistically significant relationship to the dependent variable. The significance level indicates the probability of a false rejection of the null hypothesis, for example, that the coefficient is different from zero, in a statistical test. In other words, it indicates the probability that the coefficient appears to be non-zero solely as a result of chance. In the tables of results, a single asterisk next to an entry in the 'Coefficient' column indicates that the coefficient is significantly different from zero at the 10% significance level, whilst a double asterisk indicates that it is significant at the 5% level and a triple asterisk indicates that it is significant at the 1% level. The confidence that the independent variable truly has an impact on the dependent variable is greater if the coefficient is significant at the 1% level than if it is significant at the 5% or even 10% level. Some of the variables included in the regressions are 'dummy variables', which take a value of either zero or one. For example, some of the models include a dummy variable that takes a value of one if the company owns IPRs (or, in some models, a specific type of IPR), and zero otherwise. Interpreting the coefficients on dummy variables is slightly more complex than interpreting the coefficients on standard logarithmic variables. The coefficient on a dummy variable indicates the change in firm performance, given a change in the value of the dummy variable from zero to one. For example, a positive and significant coefficient on the 'IPR owner' dummy variable in a regression examining whether IPR owners exhibit superior performance to non-owners would be interpreted as follows:

IPR owners have higher revenue per employee compared with non-IPR owners, all else being equal.

It is also important to note that the dummy variables enter the models without a logarithmic transformation. All the models with IPR dummies have the log-linear form. In these models, for a small change in log (y), the coefficients, when multiplied by 100, approximate the percentage change in the dependent variable well. However, as the change in log (y) becomes larger, the approximation $\% \Delta y \approx 100 * \Delta \log(y)$ becomes inaccurate. To calculate the exact percentage difference in the revenue per employee between IPR owners and non-IPR owners, the coefficients must be transformed using the following formula:

%change = 100 * (exp(coef) – 1)

In the results tables below, the entry in the 'Coef' column for all dummy variables presents the estimated coefficient. The calculated marginal effects, according to the formula above, are shown graphically immediately following the regression results.

5.3.2. IPR ownership and firm performance

The purpose of this first set of models is to analyse whether the firms that own IPRs exhibit superior economic performance compared to those that do not. The variables of interest in these models are dummy variables which take a value of either zero or one, indicating:

- ➔ whether or not a firm owns any form of IPR ('IPR owner'), and
- ➔ whether or not a firm owns a specific combination of IPRs ('patents only', 'trade marks only', 'designs only', 'patents and trade marks', 'patents and designs', 'trade marks and designs', 'patents, trade marks and designs').

All the models include controls for country, sector, year, age of firm, SME dummy (in model 1), and a proxy for firm size based on the number of employees.

The first set of results is shown in Table 9. In these regressions, carried out for the sample as a whole (column 1 in the table) and separately for SMEs (column 2) and for large firms (column 3), a single dummy variable 'IPR owner' is added to the set of control variables to identify whether or not a firm has ever owned any type of formal IPR protection. The SME dummy variable is only applicable in the model in column 1, since the other two columns contain models with only one type of firm.

Table 9 shows that there is a strong and positive relationship between IPR ownership and revenue per employee. This relationship is particularly strong in the case of SMEs. Whereas the relevant coefficient for IP ownership in model 2 (SMEs) is 0.367, in the case of large firms (model 3) it is 0.145.

Table 9:
Results of models with IPR ownership dummy

	Dependent variable		
	Revenue per employee (log)		
	Full sample (1)	SMEs (2)	Large (3)
IPR owner	0.347***	0.367***	0.145***
	(0.007)	(0.008)	(0.017)
SME	-1.159***		
	(0.011)		
Age	0.008***	0.009***	0.002***
	(0.0002)	(0.0002)	(0.0004)
Employment (log)	-0.241***	-0.226***	-0.307***
	(0.001)	(0.002)	(0.003)
Constant	13.774***	12.731***	14.209***
	(0.298)	(0.400)	(0.392)
Country control?	Yes	Yes	Yes
Sector control?	Yes	Yes	Yes
Year?	Yes	Yes	Yes
Observations	595,259	523,900	71,359
R^2	0.715	0.727	0.644
Adjusted R^2	0.715	0.727	0.643

Note: *p<0.1; **p<0.05; ***p<0.01

As discussed above, when the dependent variable is log-transformed, binary coefficients of independent variables may be interpreted as semi-elasticities. In that case, it indicates what the expected percentage change in a firm's performance is, when the firm has changed IPR status. To arrive at that value, regression coefficients must be transformed using the following formula:

%change = 100 * (exp(coef) – 1)

Figure 4 presents recalculated estimations of expected differences in revenue per employee depending on the IPR owner's status. The results of the first set of models presented in Table 9 indicate that:

- ➔ the revenue per employee of IPR owners is 41% higher than that of non-IPR owners;
- ➔ for SMEs, this difference is even higher and reaches 44%;
- ➔ for large firms, the IPR ownership premium is 16%.

These results can be considered the main conclusions of the present study.

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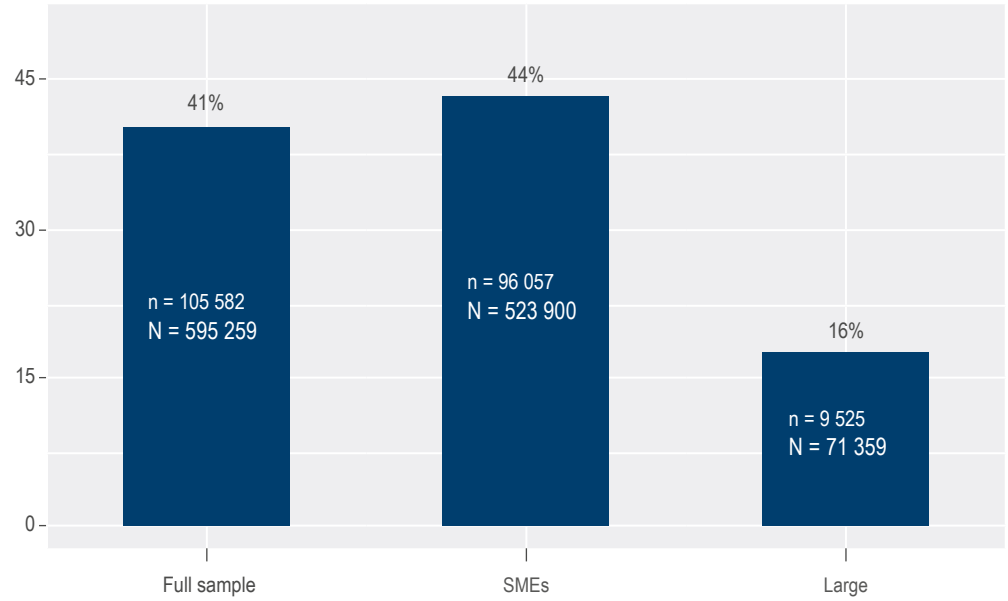
Figure 4:
Differences in IPR ownership premium by firm size



Note: n indicates number of individual firms and N indicates total number of observations.

Table 10 delves deeper into the relationship between IPR ownership and the firms' performance. 'IPR owner' variable is replaced by a set of dummies representing various combinations of IPRs that were owned by the firm during the period under consideration. This table has a similar structure to Table 9, with column (1) representing a model estimated on the full sample, column (2) a model estimated only for SMEs and column (3) a model estimated for large firms.

The analysis presented in Table 10 shows that all types of IPR ownership are positively related with firm performance. There are, however, some combinations of IPRs that are on average more strongly related with a firm's performance than others. Interestingly, in the overall (1) and SMEs (2) models, trade mark ownership alone and IPR bundles involving trade marks are associated with the highest performance premium. In the case of large firms (model 3), the highest premium is associated with sole patent ownership or bundles involving patents. However, as shown in Table 11 through Table 13 in the Annex, the differences between the coefficients of many of these combinations are not statistically significant, meaning that the hypothesis that these coefficients are equal cannot be rejected.

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Table 10:
Results of models with IPR ownership type dummies by firm size

	Dependent variable		
	Revenue per employee (log)		
	Full sample (1)	SMEs (2)	Large (3)
Patents only	0.187***	0.173***	0.204***
	(0.034)	(0.039)	(0.060)
Trade marks only	0.367***	0.385***	0.128***
	(0.008)	(0.009)	(0.019)
Designs only	0.187***	0.193***	0.082
	(0.046)	(0.049)	(0.109)
Patents and trade marks	0.271***	0.291***	0.175***
	(0.023)	(0.027)	(0.039)
Patents and designs	0.279***	0.237**	0.323***
	(0.081)	(0.098)	(0.123)
Trade marks and designs	0.329***	0.352***	0.122***
	(0.023)	(0.027)	(0.040)
Patents, trade marks and designs	0.338***	0.412***	0.237***
	(0.029)	(0.037)	(0.041)
SME	-1.161***		
	(0.011)		
Age	0.008***	0.009***	0.002***
	(0.0002)	(0.0002)	(0.0004)
Employment (log)	-0.241***	-0.226***	-0.308***
	(0.001)	(0.002)	(0.003)
Constant	13.793***	12.750***	14.199***
	(0.298)	(0.400)	(0.392)
Country control?	Yes	Yes	Yes
Sector control?	Yes	Yes	Yes
Year?	Yes	Yes	Yes
Observations	595,259	523,900	71,359
R^2	0.715	0.727	0.644
Adjusted R^2	0.715	0.727	0.643

Note: *p<0.1; **p<0.05; ***p<0.01

Figure 5 converts the coefficients shown in Table 10 into semi-elasticities, allowing us to estimate the expected percentage differences in performance between owners of specific IPR bundles and firms that did not own any IPRs during the period under consideration. The highest performance premium is thus obtained by firms that own patents, trade marks and designs. Firms that own this type of bundle have 40% higher revenue per employee than firms that do not own IP rights. In the case of SMEs, this performance premium rises to 51%.

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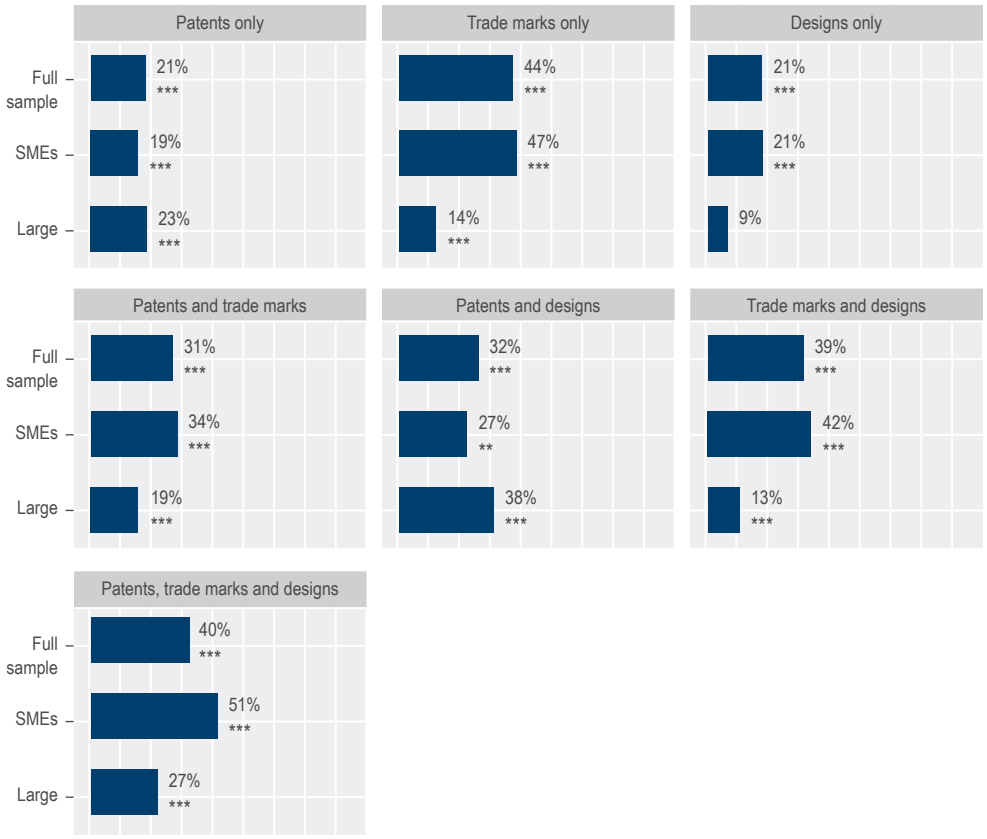
Figure 5:
Differences in the various types of IPR ownership premiums by firm size



5.4. Discussion and limitations of the study

The econometric analysis in this section confirms the findings from the descriptive statistics in Section 4. In particular, it has shown that:

- ➔ **IPR owners perform better than non-owners.** Controlling the relevant factors, revenue per employee is 41% higher for IPR owners than for firms that do not own IPRs. This positive relationship between IPR owner status and performance is particularly true for SMEs. Small and medium-sized firms have, on average, 44% higher revenue per employee than SMEs that do not own any IPRs. In the case of large firms, revenue per employee is 16% higher for IPR owners than for non-owners.
- ➔ **There is quite a large variability in the IPR premium depending on the type and combination of IPRs.** For SMEs, the highest increases in revenue per employee are related to trade marks and a combination of trade marks with other types of IPRs. For large firms, the highest premiums in revenue per employee stem from patent registrations or registrations of bundles of rights, including patents.

The results of the study must be interpreted with caution as there are a number of data and methodological limitations.

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The data preparation process involved many data sources, each with different structures and features specific to each EU Member State and data type. For instance, a company's name could be written in a different way in the business register and the IPR repository. Data cleaning and processing for some countries may be easier than for others, so the success rate of the matching process may vary between different countries. Therefore, unsuccessful matching efforts may distort IPR ownership ratios for some countries, and as a result, some IPR owners could be erroneously treated as non-owners.

Due care has been taken to construct a representative sample of European firms that would enable us to draw conclusions that are representative for the EU. This carefully constructed dataset might, however, be affected by specific data availability issues in business registers. For instance, the availability of both revenue and employment data for micro firms is extremely low in ORBIS for some countries, for example, Luxembourg and the Netherlands. Even though, during the computation of the descriptive statistics, the weights associated with all the observations were readjusted to account for data availability, sometimes this process led to very high weighting for some observations in the dataset. To avoid an excessive impact of these observations, the maximum weights applied to the final calculations were truncated. This may lead to a situation whereby some sample statistics (such as wages per employee) may not be fully representative for the population of the EU firms.

In the econometric analysis, control variables were used to account for some important factors that may impact the relationship between IPR status and revenue per employee, such as the industry in which a firm is active, the country of origin, age or size of the firm. It cannot be ruled out, however, that there are still some important variables correlated with both IPR status and a firm's performance for which data is not easily obtained. For example, a firm's management quality or level of investment in intangible assets. As a result of the bias caused by these possible omitted variables, IPR coefficients estimated in an econometric analysis could reflect not only the effect of IPR registrations, but also the positive effects of intangible investments overall or the quality of management. Even if the impact of these omitted variables is limited, with IPR ownership dummies, the eventual positive impact of IPRs is only partially captured. This is because even though a firm is not an owner of IPR, it may still benefit from IPRs registered by others, for example, as a licensee of the IPRs registered by other companies in the same economic group that the firm is a part of, or the IPRs registered by third parties. The relatively low ownership ratios of the large firms in the sample could be due to some large firms creating special purpose entities to manage the IPRs registered for the benefit of the economic group as a whole and, therefore, they are not recognised as the owners of the IPR assets in the IPR registries.

For all these reasons, the results of the econometric models should not be interpreted as proving the existence of an unambiguous causal link between IPR ownership status and firm performance. Besides the possibility of being confounded by the omission of other important variables, the positive relationship between IPR ownership and firm performance could have a reverse explanation: higher revenue per employee may trigger firms to register IPRs to protect their future returns with enforceable rights.

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Alternatively, economic theory suggests that the IPR activity of a firm may be an indicator of its superior economic performance. IPRs were historically established to allow companies to recoup innovation-related costs by granting temporary exclusivity to innovators (North, 1991). This exclusivity enhances appropriability (Teece, 1986), the degree to which a firm can benefit from the value created by its innovative activity, thereby increasing the incentive to carry out innovative activities (Schumpeter, 1942). Innovation is crucial for productivity growth, as it allows companies to introduce new products or services that better meet consumer needs or to produce their existing offerings more efficiently. Improved productivity ultimately leads to better firm performance by enabling faster revenue growth relative to costs.

Registered IPRs also promote licensing activity that enables firms to scale-up faster and to increase their revenue without the necessity to secure the ownership of crucial complementary resources.

The existence of a link between previous IPR registration and subsequent growth of revenue was at least partially confirmed in a previous EPO/EUIPO (2019) empirical study that focused on the relationship between patterns of IPR registrations and the odds of subsequent (high) growth.

6. Conclusions

The main conclusion of the series of firm-level studies, including the present one, is that ownership of registered IPRs, namely, patents, trade marks and designs, is strongly related to economic performance at individual firm level. This association is particularly strong in the case of SMEs.

The descriptive statistics in section 4 show the following trends.

- IPR owners employ on average more workers than firms that do not register IPR. This difference in employment between IPR owners and non-owners is most notable in the case of owners of registered Community designs and can reach 4 times more workers.
- The difference in revenue per employee between IPR owners and non-owners amounts to 24%. It is highest among design owners (29.3%), closely followed by patent owners (28.7%) and then trade mark owners (23.3%). The difference in revenue per employee is notably higher among IPR owners at European level than those whose rights are protected at national level. This difference in favour of EU rights owners is highest in the case of trade marks, where EU trade mark owners have double the revenue per employee than owners of national trade marks.
- Most firms (over 90%) do not register IPRs. The proportion of firms that register IPRs is particularly low in the case of SMEs at only 9.7%.
- Most IPR owners only register trade marks. This pattern is particularly visible among SMEs, where more than 80% of IPR owners are only trade mark owners. Bundling different IPRs is much more common among large IPR-owning firms. Large IPR-owning firms are much more likely to bundle patents with other IPRs, with more than 11% combining patents and trade marks, almost 10% combining trade marks and designs and 10% combining all the three types of registered IPRs covered in the current study. The proportion of owners bundling all three IPRs is 4 times higher among large firms than among SMEs. Large firms also own more IPRs than SMEs across all the IPR types.

The econometric analysis in section 5 strengthens the findings from the descriptive statistics as regards the differences in revenue per employee between firms that register IPRs and those that do not. In general, firms that own IPRs have 41% higher revenue per employee, when other relevant factors such as sector, country and size are taken into account. This positive relationship between IPR ownership and performance is particularly strong in the case of SMEs, as SMEs that own IPRs have 44% higher revenue per employee than SMEs that do not.

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The findings of the present study confirm the main outcomes of previous reports focusing on firm-level patterns of IPR ownership. Although the composition of samples varies across the various studies, and there were some methodological changes introduced to the preparation of the final datasets and analysis to improve their representativity as regards the population of EU firms, all the studies found that IPR owners perform better in terms of revenue per employee and, in general, offer better pay than firms that do not register IPRs.

The dataset prepared for the present study will be used in the future to further understand the factors that drive IPR ownership and the processes that help IPR owners use these valuable assets to benefit their firms and the EU economy as a whole.

Nevertheless, due to data and methodological limitations, caution is needed when interpreting these findings, as discussed in Section 5.4.

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Annex 1: Supplementary econometric analysis

Table A1:
Results of the tests of a single linear combination of parameters for full sample model shown in Table 10

	Trade marks only	Designs only	Patents and trade marks	Patents and designs	Trade marks and designs	Patents, trade marks and designs
1. Patents only	0.000	0.998	0.035	0.290	0.000	0.001
2. Trade marks only		0.000	0.000	0.276	0.107	0.316
3. Designs only			0.096	0.319	0.005	0.005
4. Patents and trade marks				0.927	0.068	0.060
5. Patents and designs					0.549	0.487
6. Trade marks and designs						0.801

Note: The table presents p values of the tests of the hypotheses regarding equality of the IPR coefficients: H0 : $\beta 1 = \beta 2$. P values below 0.05 (shaded in grey) indicate that the difference between coefficients is statistically significant at the 5% significance level.

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Table A2:
Results of the tests of a single linear combination of parameters for the SMEs model shown in Table 10

	Trade marks only	Designs only	Patents and trade marks	Patents and designs	Trade marks and designs	Patents, trade marks and designs
1. Patents only	0.000	0.749	0.011	0.547	0.000	0.000
2. Trade marks only		0.000	0.001	0.130	0.221	0.477
3. Designs only			0.076	0.691	0.004	0.000
4. Patents and trade marks				0.588	0.108	0.007
5. Patents and designs					0.256	0.093
6. Trade marks and designs						0.179

Note: The table presents p values of the tests of the hypotheses regarding equality of the IPR coefficients: H0 : β1 = β2 . P values below 0.05 (shaded in grey) indicate that the difference between coefficients is statistically significant at the 5% significance level.

Table A3:
Results of the tests of a single linear combination of parameters for the large firms model shown in Table 10

	Trade marks only	Designs only	Patents and trade marks	Patents and designs	Trade marks and designs	Patents, trade marks and designs
1. Patents only	0.215	0.320	0.673	0.377	0.245	0.629
2. Trade marks only		0.673	0.235	0.114	0.893	0.010
3. Designs only			0.413	0.139	0.722	0.174
4. Patents and trade marks				0.244	0.314	0.229
5. Patents and designs					0.117	0.501
6. Trade marks and designs						0.033

Note: The table presents p values of the tests of the hypotheses regarding equality of the IPR coefficients: H0 : β1 = β2 . P values below 0.05 (shaded in grey) indicate that the difference between coefficients is statistically significant at the 5% significance level.

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