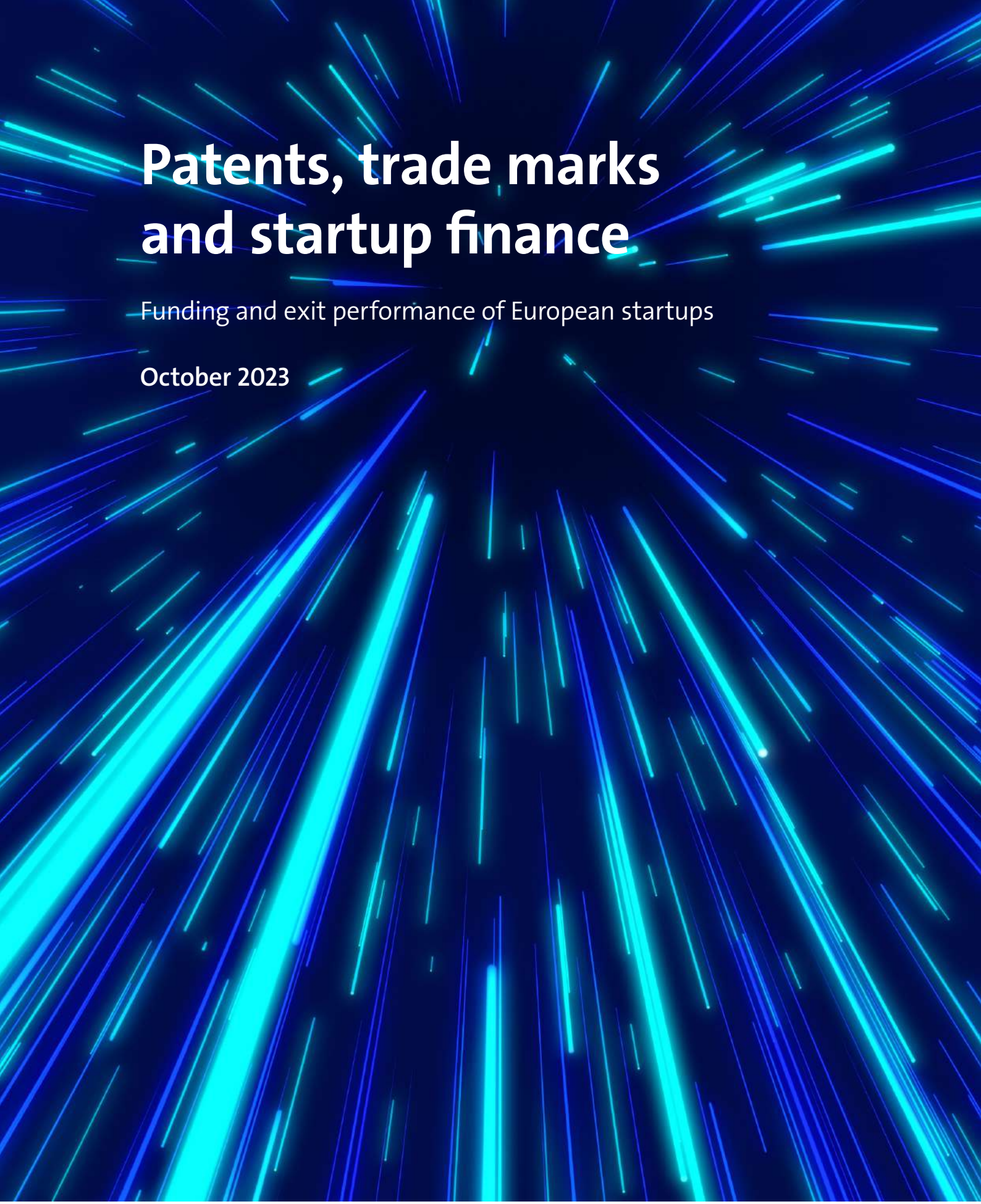

Patents, trade marks and startup finance

Funding and exit performance of European startups

October 2023

Europäisches Patentamt
European Patent Office
Office européen des brevets

50 years 1973 / 2023

EUIPO
EUROPEAN UNION INTELLECTUAL PROPERTY OFFICE

Foreword

In a set of joint studies carried out over the past ten years, our two organisations have highlighted the importance of intellectual property for the European economy, whether on the level of the entire economy, sectors or individual firms. The macro-level studies have shown that industries that use IP rights intensively account for a high and increasing share of Europe's economic output, employment and trade.

On the level of individual companies, ownership of patents, trade marks and designs is associated with superior performance in terms of job creation and productivity (as measured by revenue per employee). This relationship is even stronger when the IP rights registered by the company are European-level rights.

The link between IP rights and company performance is especially clear in the case of small and medium-sized enterprises (SMEs). We have also shown that companies that are active in the area of IP rights are more likely than other companies to experience high growth in subsequent years.

The present study adds a further dimension to the body of knowledge on the importance of IP. It focuses on how newly started, innovative companies obtain the financing that allows them to develop their ideas into products in the marketplace. It also examines how IP rights facilitate successful exit of the providers of initial financing through sale to another company or a flotation on the stock market.

The evidence adds up: IP rights are a crucial underpinning of the modern economy.

Innovation, and the need to support it, will play an even more important role in the future. Europe is facing challenges from climate change, possible future pandemics and strategic competition with other regions of the world, but at the same time needs to create future growth and jobs. IP rights facilitate this innovation by making it possible for the inventors and creators to protect their inventions and creations, helping them to access financing and later earn their rewards through a successful exit.

Europe still lags behind other regions, including the US, when it comes to financing innovative startups. The actions needed to meet this challenge are varied, but making the IP system more accessible to newly started, innovative companies is part of the solution. EU trade marks and European patents appear to be instrumental in this, and as of this year the Unitary Patent also paves the way for deep-tech ventures to scale up in a much larger market. Making IP even more accessible is also what drives the vision behind the strategic plans of both the EPO and the EUIPO in their programmes to support SMEs, as well as initiatives such as the IP Action Plan of the European Commission.

We hope that this report contributes to a better understanding of the role of IP in EU's society and economy, driving home the fundamental message that IP is for everyone.

António Campinos
President, European Patent Office

João Negrão
Executive Director, the EUIPO

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List of abbreviations

EUIPO	European Union Intellectual Property Office
EPO	European Patent Office
EUTM	European trade mark
FTO	Freedom to operate
IP	Intellectual property
IPO	Initial public offering
IPR	Intellectual property right
OEM	Original equipment manufacturer
PE	Private equity
R&D	Research and development
SME	Small and medium-sized enterprise
TTE	Time to event
TTO	Technology transfer office
VC	Venture capital

List of countries

AL	Albania
AT	Austria
BE	Belgium
BG	Bulgaria
CH	Switzerland
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GB	United Kingdom
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IS	Iceland
IT	Italy
LI	Liechtenstein
LT	Lithuania
LU	Luxembourg
LV	Latvia
ME	Montenegro
MK	North Macedonia
MT	Malta
NL	Netherlands
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
RS	Serbia
SE	Sweden
SI	Slovenia
SK	Slovakia
SM	San Marino
TR	Türkiye

1. Executive summary

The spectacular growth of the European startup ecosystem in recent years has been a major boost for the European economy. Startups are increasingly seen as engines of economic growth, with strong potential to address the key European challenges of digitalisation, sustainability and industry competitiveness through innovation. Nevertheless, Europe still faces significant challenges in bridging its funding gap with respect to the US.

This study examines the role of intellectual property (IP) rights – specifically patents and trade marks – in facilitating access to finance for European startups. To this end, it assesses the links between the filing of IPRs by startup firms and their success in raising venture capital (VC), as well as the signalling power of patents and trade marks as predictors of successful exit strategies for investors.

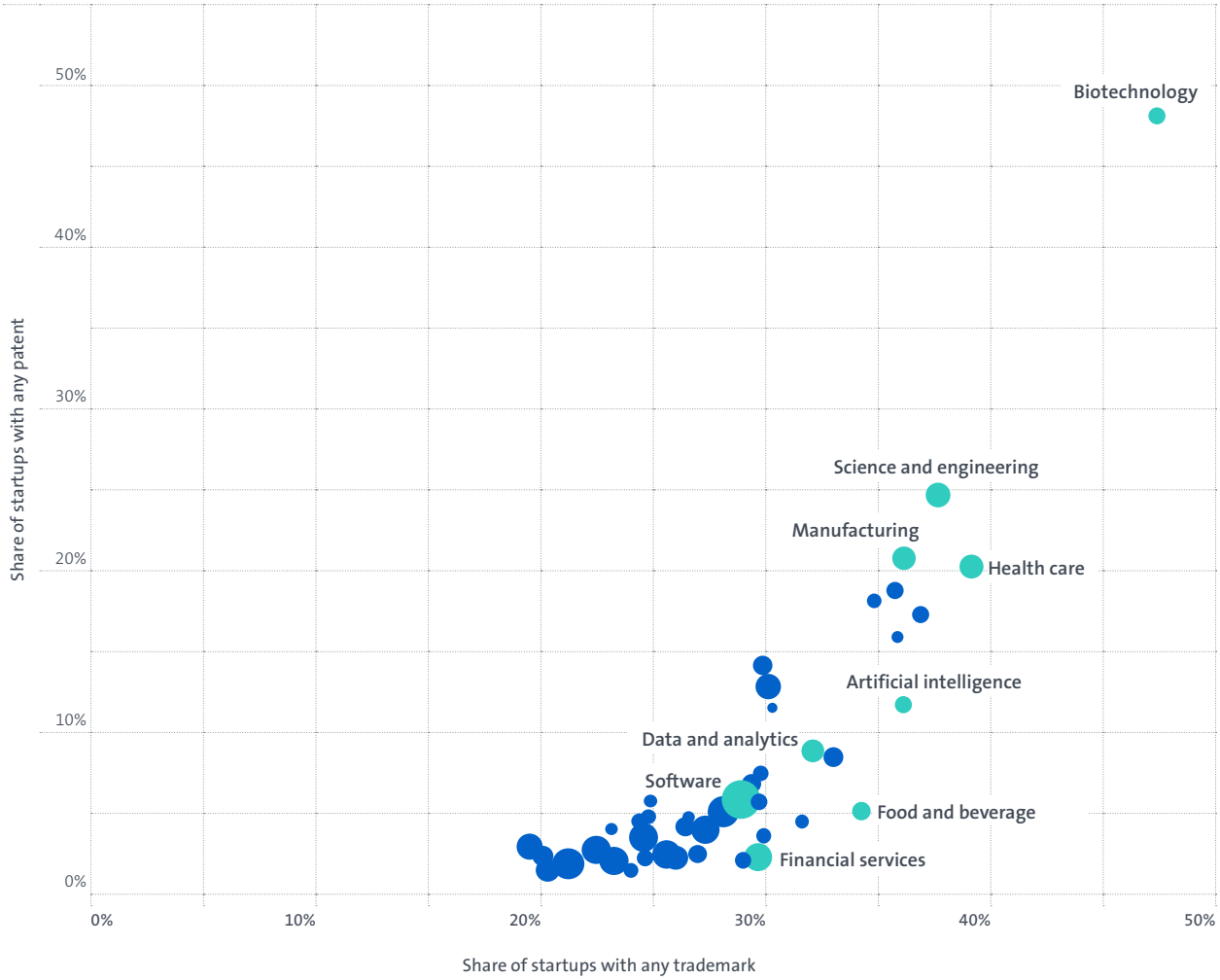
These questions are especially relevant today, after the shock of COVID-19 and the recent monetary policy tightening led to a decline in investment in European startups in 2022. As reduced VC spending and weaker growth forecasts are putting an end to an era of easy access to venture capital, IP rights deserve strong attention as a means not only of capturing the value potential of their intellectual assets but also of signalling this value to investors.

Main findings

On average, 29% of European startups have filed for registered IP rights, though there are significant differences between industry sectors. Biotechnology is by far the most IP intensive sector, with nearly half of startups using patents or registered trade marks. Other IP-intensive sectors include science and engineering (with patent users at 25% and trade mark users at 38%), healthcare (patent users at 20% and trade mark users at 40%) and manufacturing (patent users at 20% and trade mark users at 36%). Startups with registered IP rights exist in all sectors, with a stronger reliance on trade marks in sectors that are not IP-intensive, whereas startups that use patents tend to be more concentrated in a smaller number of technology-related sectors.

Figure E1

Share of startups with patents or trade mark applications by sector



Note: The Figure compares shares of patent and trade mark applicants by sector in the initial sample. The size of the circles represents the number of firms from the sector in the initial sample.

Startups increasingly make use of IP rights as they grow, with a strong focus on European IP rights at all growth stages. While 10% of startups that were invested in by VCs in seed stage rounds have filed a patent application, this proportion rises to 28% in the early growth stage and 44% in the late stage rounds (Series C and beyond). The share of trade mark users similarly increases from 28% in the seed stage rounds to 53% in the early stage rounds and 72% in the late stage rounds. More than 80% of startups with a patent in the seed stage financial rounds have filed a European patent application. The share of startups with a trade mark that have filed for an EU trade mark increases from 47% in the seed stage rounds to 81% in the late stage rounds.

Figure E2

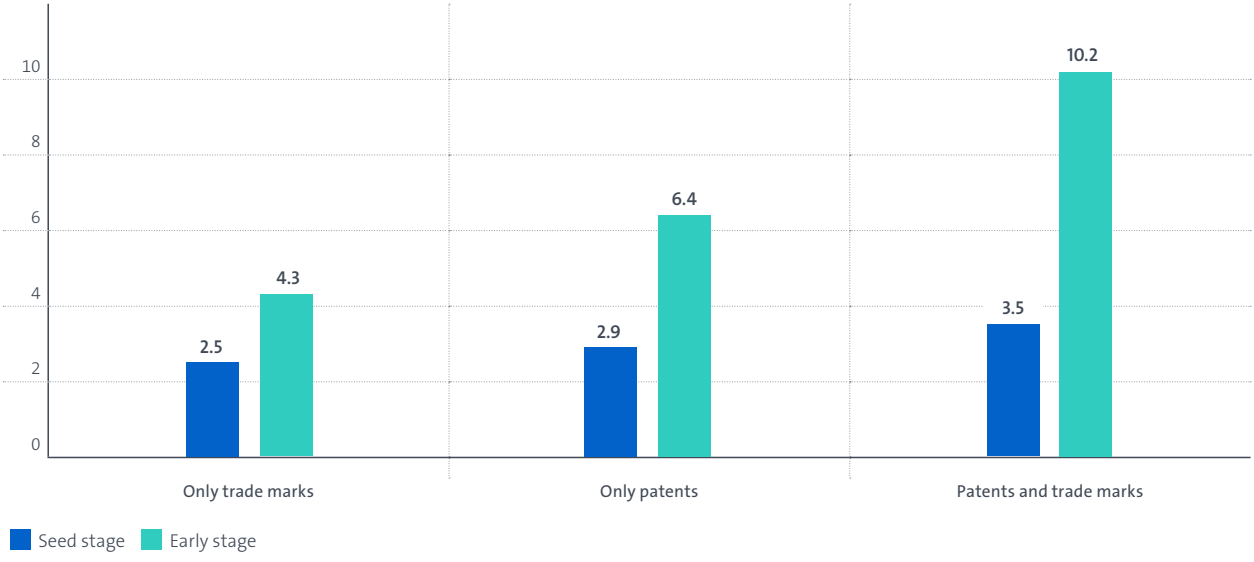
Share of startups with IPR at different stages of financing

Note: The first panel presents the number of events in each stage of financial round. The second panel shows the share of startups having applied for various combinations of IPRs prior to the date of the financial round. The third panel presents the share of startups within each category that applied for protection in the form of an EUTM, a European patent or both prior to the date of the financial round.

The filing of patent and trade mark applications in the seed or early growth stage is associated with a higher likelihood of subsequent VC funding. This effect is particularly important in the early stage, with a 4.3 times higher likelihood of funding for startups that filed for trade marks, and a 6.4 times higher likelihood of funding for startups that filed for patents. Startups that filed for both trade marks and patents show the highest likelihood of funding in both the seed and the early stage.

Figure E3

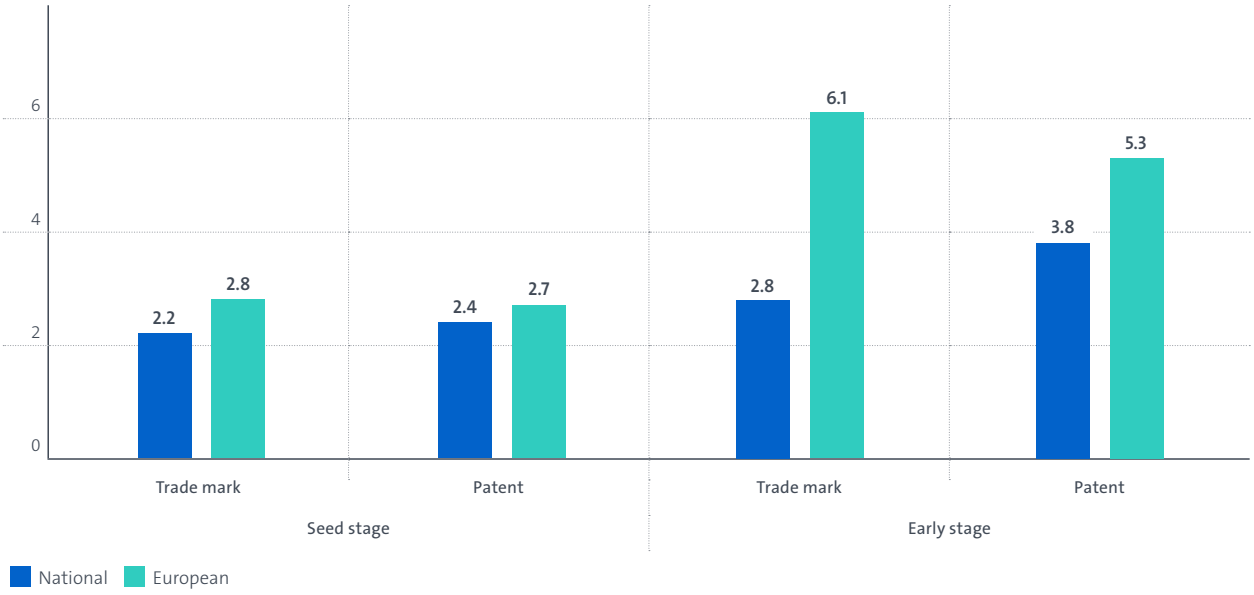
Increase in odds of funding for startups with prior patent or trade mark applications



The filing of European patent and trade mark applications is associated with an even higher likelihood of subsequent VC funding for startups. Although this result can already be observed in the seed stage, it is especially strong in the early growth stage. Startups with an EU trade mark application have a 6.1 times higher likelihood of obtaining early-stage funding, compared to 2.8 times for those that only filed for a national trade mark. European patents are associated with a 5.3 times higher likelihood of early-stage funding, compared with 3.8 times for the relatively smaller number of startups that have only national patents.

Figure E4

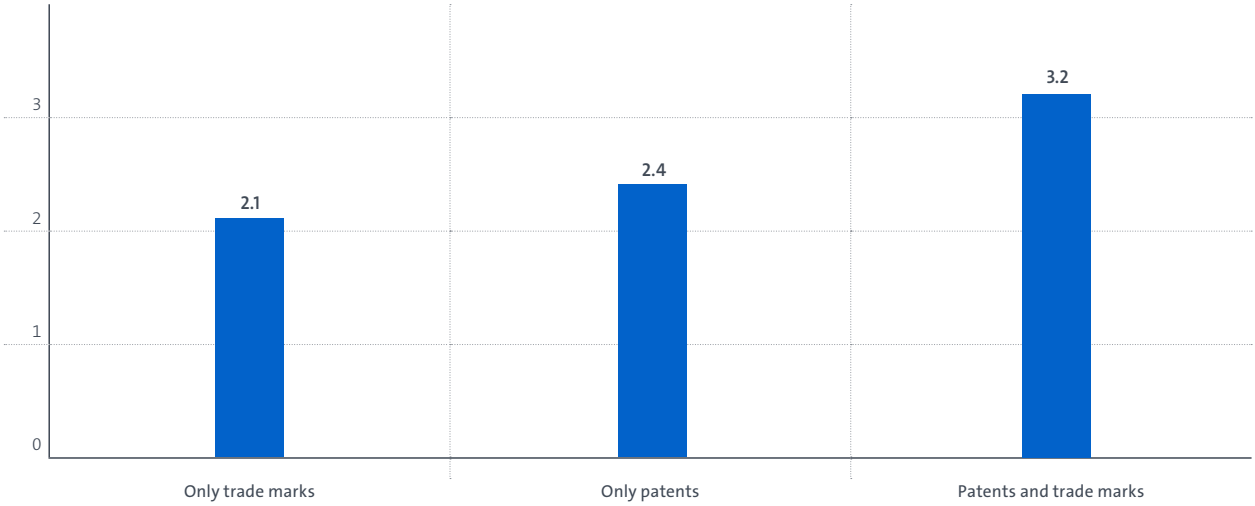
Increase in odds of funding for startups with European versus national patent or trade mark applications



The filing of patent and/or trade mark applications is associated with a more than twice as high likelihood of successful exit for investors. The highest likelihood of initial public offering (IPO) or acquisition is observed for startups that filed for both patents and trade marks. A higher likelihood is also observed for startups that filed for European IP rights than for those that make use of national-level rights only.

Figure E5

Increase in odds of exit for startups with prior patent or trade mark applications



2. Introduction

Recent years have seen a spectacular growth of the startup ecosystem in Europe – with a venture capital (VC) deal value reaching EUR 110.8bn in 2021, compared to EUR 9.4bn in 2013 (PitchBook, 2023). A new generation of European ventures has emerged on the world stage as a result. This development, which resulted in the emergence of a more mature European VC industry, along with growing interest from non-European investors, has yielded a major boost for the European economy. Startups are viewed with growing interest by policymakers as engines of economic growth, with strong potential to address the key European challenges of digitalisation, sustainability and industry competitiveness through innovation and the leveraging of cutting-edge technologies. As a result, various policy schemes have been established at the national and EU levels to further support this ecosystem.

Nevertheless, Europe still faces significant challenges in bridging its funding gap as compared with the US. Besides a specific lack of support for university spin-offs and the persistent challenges of scaling up across European countries, the relative scarcity of funds large enough to support high-growth companies through their successive growth stages remains an important issue (Quas et al., 2022). Difficulties are compounded for so-called "deep-tech" startups that develop new technologies and engineering approaches. Indeed, such ventures typically have both a high R&D intensity and a high asset intensity. As a result, they require high amounts of long-term capital to bring novel technology to market, with few investors being prepared to embrace such risks (EIC, 2022; Hello Tomorrow and BCG, 2021).

Against this backdrop, this study assesses the role of intellectual property rights (IPRs) – specifically patents and trade marks – in facilitating access to finance for European startups. This question is especially relevant today, after the shock of COVID-19 and the recent monetary policy tightening led to investment in European startups reverting in 2022 to its level in 2020 (Sifted, 2022). As reduced VC spending and weaker growth forecasts are putting an end to an era of easy access to venture capital, IP rights deserve strong attention as a means not only of capturing the value potential of their intellectual assets but also of signalling this value to investors.

2.1 The challenges of startup funding and exit

Because their lean organisation allows for creativity and agility, startups are particularly suited to innovation. However, they also face specific challenges in converting innovative ideas into market success. Their business models are riskier – thus reducing their access to capital markets (Lee et al., 2015), both by limiting the scope of potential lenders and by increasing the cost of financing. Moreover, the intangible assets developed by innovative startups are a source of information asymmetry with investors, making it all the more difficult for the traditional financial sector to value and support such innovative ventures (Lerner, 2002; Colombo, 2021). According to some estimates, only one in thousand achieve successful financial exit for investors such as an initial public offering (IPO) or high-value acquisition (Catalini et al., 2019), but those that do achieve such an exit have a disproportionately high impact on the economy.

Due to the higher risks and information asymmetries involved in their business ventures, startups tend to rely more on equity finance from VC funds than on debt (Hall, 2010). VC funds can be defined as equity-linked financial investments in private companies, where the investor performs an active advisory role in the management of the financed entity (Kortum and Lerner, 2000). A deeper insight into the strategy of financed firms, coupled with market expertise, allows VC investors to reduce information asymmetry gaps and enables them to provide finance for ventures that may be too risky for other investors (Lerner, 1995). They can also reduce the risks related with early-stage investments by remaining actively involved in the management of the financed company (Lerner, 2002) and facilitating access to key complementary assets (Park and Steensma, 2012) to increase the odds of subsequent innovation (Arqué-Castells, 2012) and its implementation (Kortum and Lerner, 2000).

Only a small fraction of startups reach maturity with the original founder still exerting control over the company. Entrepreneurial exit through an initial public offering (IPO) or acquisition may be the best solution for further growth of the company by providing funds for R&D investments and market expansion. In some sectors, due to prohibitive costs of placing new products on the market, exit is the only viable option for small-scale

startups to further finance innovation (Renko et al., 2022) while offering liquidity and freeing up resources that the entrepreneurial founder can use for other innovative ventures (Aggarwal and Hsu, 2014). As such, a successful exit is a key indicator of entrepreneurial success, and is of vital importance not only for the entrepreneurial founder but also for investors.

2.2 Startups and IP rights

Small innovating firms typically have few assets early on in their lives, apart from their foundational intellectual assets. In particular they lack complementary assets, such as expertise and infrastructure for product development, manufacturing, legal matters, sales, distribution and customer service activities (Arora et al., 2001). In this context, decisions regarding intangible assets and related IPRs may be key drivers of the entrepreneur's success and exit options in the longer term.

There are various ways in which formal IPRs such as patents and trade marks can support the development of innovative startups. Patents give the right to prevent others from using the invented technologies, while trade marks are a legal safeguard for investment in intangibles and unique product characteristics appealing to consumers. The protection that patents and trade marks confer is primarily needed to secure the exclusive exploitation of innovative ideas in the market, thereby enabling the startup to generate sufficient returns on risky investments (Arora et al., 2008). Results from surveys of European patent applicants show, for instance, that "commercial exploitation" and the "prevention of imitation" are the two key motives for filing a patent, and that these two motives are even more important for small and medium-sized enterprises (Torrisi et al., 2016; EUIPO, 2016; EPO, 2019; EPO/EIB, 2022). Importantly, IPRs also help ensure freedom to operate (FTO) by protecting ongoing or future development and providing a lever to negotiate cross-licensing agreements in the case of infringement of third-party IPRs (Torrisi et al., 2016; Walsh et al, 2016).

Besides these fundamental functions, well-managed IPRs can generate an even wider range of benefits, such as setting up collaborations and licensing arrangements, securing investment and facilitating technology transactions (Brant and Lohse, 2013; Castaldi, 2019; de Rassenfosse et al., 2016). These benefits are particularly significant for innovative startups, as a means to compensate for their resource constraints.

Engaging in collaborations with other companies or research organisations is a way for startups to leverage their strengths while using their partners' assets to fill gaps in expertise and resources (Park et al., 2002; Lee et al., 2010; Zeng et al., 2010; Hsu and Ziedonis, 2013). IPRs play a pivotal role in this. Besides protecting the intellectual assets initially contributed by the parties, they are used to organise the exploitation of joint results and to share the associated benefits. Licensing out IPRs is likewise an effective means for small businesses to leverage the partners' assets and expertise with a view to rapidly scaling up their activities, reaching out to new markets and generating additional revenues from innovation (Arora and Ceccagnoli, 2008). Available evidence indicates, for instance, that European SMEs are willing to license up to 48% of their patented inventions, as compared with 16% for large companies, and that they actually license about a third of these inventions, while large companies license only 9% of theirs (Gambardella et al., 2005).

Appropriating a startup's intellectual assets and leveraging them to seize growth opportunities requires a proactive and resource-effective approach to IPR management (EPO, 2017). Rather than focusing on the short term, a startup must anticipate the interplay between IP management and commercial success in order to formulate an effective IP strategy early on (Neuhäusler, 2012). Failure to do so can create problems subsequently, such as foreclosing partnership or funding opportunities, or exposing the startup to litigation risks. Developing an IPR strategy is especially challenging for smaller firms that are scaling up their activities beyond their domestic market (OECD, 2010; Hall et al., 2013). To secure effective protection in future strategic markets, firms must indeed be prepared to invest significant resources in building an international IPR portfolio at an early stage of their development process.

2.3 IP rights as a signal for investors

IP rights play an important role in facilitating access to finance for innovative startups. Public information on IPRs granted by independent authorities conveys valuable information about technological and marketing activities of a startup (Long, 2002), thus reducing information asymmetries between the innovative entrepreneur, business partners and the prospective financiers (Veugelers and Schneider, 2018). As a result, early investment in securing IP protection may constitute a credible signal of otherwise unobservable value to VC

managers and investors (Colombo, 2021; Spence, 1973), helping them make decisions under uncertainty (Long, 2002; Hottenrott et al., 2016; Farre-Mensa et al., 2016).

IPRs help secure higher returns for investors by reducing competitive pressures, achieving price premiums over the competitors or increasing revenue through licensing agreements (Hsu and Ziedonis, 2013). Recent research on US startups concludes, for instance, that a patent grant generates on average 55% higher employment growth and 80% higher sales growth five years later, and that the patent owner also pursues more, and higher-quality, follow-on innovation. (Farre-Mensa et al., 2020). Available evidence from Europe likewise points to a higher turnover (EPO/EUIPO, 2021; OHIM, 2015) and higher chances of achieving (high) growth (EPO/EUIPO, 2019) for small firms owning IP rights. A proprietary product or technology for which a startup has an exclusive right may thus be a key argument for a VC to invest in a company or to get the best exit terms. Control over critical IPR may also increase the bargaining power of startups for securing the financial resources necessary for their business plan implementation and help them getting access to such resources. Patents have also been found to be associated with a reduction in time to IPO for startups (Stuart et al., 1999). Conversely, lack of patent protection over crucial technologies may be seen as an important limiting factor, reducing startup odds of market success in the future (Lerner, 2002).

Patents and trade marks play different but complementary roles in this context.

Patent filings are effective indicators of the technical capabilities of the firms and their employees, which can facilitate access to finance for both small and large firms (Hottenrott et al., 2016). Once granted, patents certify the novelty and scope of the invention, as well as giving it legal protection. They may involve significant costs but also lengthen the time needed to market new products, thus lending credibility to the founders' claims about the long-term growth prospects of their ventures (Kleinert, 2023). A number of studies provide consistent evidence of the effectiveness of such signals in attracting VC investors in Europe (Häussler et al., 2012: Colombo et al., 2023), the US (Hsu and Ziedonis, 2013; Hoenig and Henkel, 2015; Farre-Mensa et al., 2016), China (Chen et al., 2018; Zhang et al., 2019) and Israel (Conti et al., 2013; Colombo et al., 2023). The use of patents as a protection mechanism and a signal mainly concerns high technology startups, in sectors such as the life sciences, medical devices, semi-conductors and information and communication technologies, although patented inventions also may prove particularly valuable assets in sectors where they are usually scant. Recent evidence underlines the active role of VC investors in exploiting patent information, with the most experienced funds being better able to deal at an early stage with radical inventions, both with more earning potential and more risks (Colombo et al., 2023).

Trade mark protection, due to its relatively lower costs, is especially attractive to small firms, including startups. It provides information on the commercial potential of startups (Renko et al., 2022; Gruber, 2004), while demonstrating their founders' awareness of the importance of marketing assets protection (Block et al., 2014). Trade marks reinforce the benefits from other forms of formal and informal IP protection, such as the first mover advantage or trade secrets. Like patents, they are signals of innovativeness (Flikkema et al., 2014), especially in sectors where patents and other IPR protection mechanisms have limited use, such as services (Schmoch, 2003; Block et al., 2014). New trade mark filings may be particularly strong signals of the maturity of "scale-up" companies which have overcome the exploratory phase of their development, found suitable market niches and are ready to scale up their activities.[1]

Importantly, both patents and trade marks survive beyond bankruptcy, therefore providing further security to investors and lenders (de Rassenfosse and Fischer, 2016). Available evidence shows that in the US, patent-secured venture debt was used to finance 36% of technology startups in the sectors of computer software, semiconductors and medical devices, and that startups with patent-backed loans tend to raise more equity capital than those without (Hochberg et al., 2018). Another study finds that almost 70% of patents from failed US startups have been sold (Serrano and Ziedonis, 2018), thus highlighting the need for a market for IPRs to enable IPR-backed loans for startups. Another recent study focusing on France finds that firms from diverse industries use selected trade marks (72%) and patents (26%) as collateral assets to secure loans, with large positive effects on debt financing, in particular for small,

1 Such companies are defined in the academic literature as those that have passed the seed and series A stages and are ready for the series B stage or higher stages (Duruflé et al. 2017)

financially constrained firms, and a positive impact on firm-level growth (Ciaramella et al. 2022). Studies also found that venture capitalists are more likely to fund, or value highly, those ventures that could already claim (plans for) the commercialisation of their product through trade mark ownership (Block et al., 2014; Zhou et al., 2016).

Against this background, Häussler et al. (2012) find that having at least one patent application reduces the time span from application to the first VC investment. In addition, startups with higher patent quality appear to receive financing faster than other ventures. Previous studies have confirmed that firm governance choices at birth, including decisions on IPR protection strategies, are indicative of the underlying quality of the firm, and thus are related to the probability of obtaining VC finance and equity growth (Catalini et al., 2019). Patents were also found to matter more for startups that do not have alternative means for demonstrating their quality, and in earlier stages of financing (Hsu and Ziedonis, 2013). However, Block et al. (2014) find that trade marks may be an even better predictor of VC financing than patent application stocks, as pending patent applications do not yet secure legal exclusivity.

2.4 About this study

In the present report, the signalling value of the IPR portfolio for bridging information gaps between entrepreneurial founders and the financial market will be tested empirically. The main purpose of the study is to examine whether there is a link between the filing of patent and trade mark applications by startup firms and:

- access to finance, in particular through investment vehicles (venture capital funds, corporate venture funds, etc.)
- successful exit strategies of innovative startups

This study complements our previous reports, which focused on the relationship between IPR behaviour on one hand with turnover and growth on the other. Those performance metrics are less relevant in case of technologically oriented startups, as the most successful startups are often acquired or go public even before they break even or achieve substantial sales (Renko et al., 2022).

The IP rights considered in this study are patents and trade marks, both at the national level and the European level. The literature summarised above has shown that these two IP rights are good indicators of innovation and are often complementary, with patents signalling technological innovation and trade marks indicating the development of new products and services as well as the likelihood of entry into new markets. It is those characteristics of a startup that are of interest to providers of financing.

3. Data and methodology

The purpose of this study is to investigate the link between the filing for IP rights by startups and their access to finance. To that end, data on patent and trade mark applications are combined with data on startup financing at their seed, early (Series A or B) or late (Series C and beyond) funding stages.[2]

The link between IPR and financing is explored using descriptive statistics as well as econometric analysis. This section explains the data sources and the methodology used.

3.1 Data on VC financing and exit

Basic demographic and financial information about startups was sourced from Crunchbase.[3] Crunchbase is a commercial database that provides data on startups of potential interest for financiers or acquirers. A distinctive feature of Crunchbase is the inclusion of information about startups' funding and subsequent public listings or acquisitions. However, only a fraction of firms available in Crunchbase participated in any financial rounds or experienced acquisition or IPO. Crunchbase data is generated by an active community of contributors, including the venture capital community, with more than 4 000 members, and subsequently verified by Crunchbase staff.[4]

The funding information in Crunchbase includes the type of financial round which a startup participated in and the date on which the financial round was announced and, in some cases, the amount of finance obtained by the startup. Crunchbase also provides information about acquisitions and initial public offerings (IPOs), with the date on which the exit events were announced and, in some cases, the exit value of a firm. Crunchbase classes a firm in one or several sectors. This classification is unique to Crunchbase and does not follow standard industry classifications used by Eurostat or other statistical offices.[5]

Crunchbase covers firms active in all countries of the world. The final sample of startups used in this study is restricted to firms available in Crunchbase that were founded after 1999 and have a registered office in one of the member states of the European Patent Organisation. Overall, the project sample includes information on 298 665 firms meeting those criteria. The final sample used in econometric models includes both firms that participated in financial rounds or experienced exit and firms that did not experience such events.

Previous research suggests that the signalling power of IPR is most effective at the initial stages of startup development. Hsu and Ziedonis (2013) have shown that the importance of patents as a signal of startup quality diminishes over time. Block et al. (2014) established the same pattern for trade mark signalling. IPRs play a more important role in earlier funding rounds when the information asymmetries between founders and VCs are most pronounced. In subsequent rounds, more information about the startup's prospects is revealed via other mechanisms. In fact, staged financing rounds have been institutionalised to reduce the uncertainty around the performance of the company being financed. At earlier stages the financial resources involved are relatively low. The amount of financing rises in subsequent rounds as the startup gains experience and a track record, making for greater availability of information related to its prospects (Stuart et al., 1999). Additionally, the seed and early-stage financial rounds are more numerous than later-stage events. As seen in Figure 6, the data set used in this study contains many more observations for seed and early-stage financial rounds than for later stage rounds.

Therefore, seed and early-stage financial rounds are one of the two focus areas of the present study. However, since a successful transition from startup to a self-sustaining business often involves an exit event such as an IPO or the sale of the company, exit is the other focus area for the analysis in section 5.

2 See section 5 for a more detailed description of the funding stages.

3 For more information, see https://www.crunchbase.com/.

4 Although the inclusion of firms in the Crunchbase database is a rigorous process and the data quality is frequently monitored, the subset of newly founded firms that are added to this repository may not be complete and the criteria used for adding new firms are not fully transparent. The database coverage may therefore differ depending on the country of registered office and sector. Nevertheless, a comprehensive assessment of Crunchbase performed by the OECD has shown that aggregate statistics on VC funding "tend to be reasonably similar to the same figures produced with an alternative and more established source" (Dalle et al., 2017). Crunchbase data have been used as a source of data on startups in numerous academic papers in recent years.

5 A full description of sector classification in Crunchbase is available at https://support.crunchbase.com/hc/en-us/articles/360043146954-What-Industries-are-included-in-Crunchbase.

3.2 Data on IPR status of startups

The two IP rights whose relationship to funding is analysed in this study are patents and trade marks.

Häussler et al. (2012) argue that due to the length of the examination process, VCs may be willing to base their decisions on patent applications rather than on patent grants. VCs often have access to the documentation delivered by patent attorneys and have the expertise allowing them to assess the probability of patent grant. Due to the skewed distribution of patents' values, patent quality assessment ability is crucial for the VCs investing in high-technology sectors. This was confirmed by Häussler et al. (2012), who found that VCs are able to detect high-quality patent applications even before the availability of additional information, such as forward citations or a positive examination result. The grant event does not contribute to the probability of obtaining VC financing, as the pertinent information has already been accounted for by VCs (Häussler et al., 2012).

Given these arguments, in the present study, the IPR activity of startups is measured by **applications** for patent and trade mark protection at national IP offices, the European Patent Office and the European Union Intellectual Property Office. The EPO's patent databases were the principal source of data on national and European patents. Information on national patent status includes the first patent application filed in any national office, including offices located outside Europe. The EUIPO's trade mark register was the source of data on European Union trade mark (EUTM) applications filed by startups. Information on national trade mark applications was sourced from TMview records.[6] Since the data stored in TMview is limited in scope, the project team was able to examine startup filings at national offices only in the country where the startup in question is registered.

The main variables of interest in this study relate to a startup's record of patent and trade mark applications – or "IPR status" – at a given point in time. This is determined by the date of filing of the first patent or trade mark application, distinguishing between national and European filings.

The IPR databases were matched with the Crunchbase database in order to obtain as complete a picture as possible of the IPR activity of and the financing obtained by the startups in the sample.

3.3 Econometric estimations

The data gathered for the present study contains not only information on whether a startup participated in a financing round or underwent a successful exit, but also includes information about the exact timing of those events. Such data are best analysed using the "time-to-event" (TTE) family of models. The Cox Proportional Hazard model (Cox, 1972; Fox and Weisberg, 2002) is the most popular time-to-event regression model, capable of analysing associations between the event incidence and a set of background variables. In the traditional proportional hazard model, the variables of interest are set at the baseline time and do not change during the observation period. However, the IPR variables in our dataset are time-dependent. Most often firms start as non-owners of IPR, and apply for IPR protection at different stages of their development. Thus, during the observation period, they may change their IPR status several times. There are extensions to the basic Cox model that are able to handle such cases (Therneau et al., 2017). In the present report, all the Cox regression models are based on time-variant IPR status.[7]

The proportional hazard model takes the following form:

$$h(t|X)=h_0(t)\ \exp(\beta' X) \qquad (1)$$

where h(t|X) is the hazard function (the probability function of a funding or exit event) at time t given the matrix of background variables X, and $h_0(t)$ is the baseline hazard function. β is the vector with estimated regression coefficients. In all such models, the IPR variables of interest are dichotomous variables, denoting the IPR activity of a startup. The model coefficients can be interpreted as measuring the increases in the odds of the "hazard" related to IPR activity in comparison to firms that are not IPR-active. In this context, the "hazard" is interpreted as the likelihood of participation in a financial round or a successful exit (through sale of the

6 TMview is a database maintained by the EUIPO that contains trade mark information on more than 114 million trade marks filed in Europe and beyond. For more detail, see: https://www.tmdn.org/tmview/welcome#/tmview.

7 In the case of IPR applicants, the period of observation is divided into sub-periods related to changes in IPR status. Each sub-period is treated as a new observation in the dataset, with its start and end related to IPR application events. A firm that has been financed or has experienced exit is observed until participation in a financial round or exit. In such cases the value of the variable *status* is updated to 1. For the majority of firms in the sample that did not experience such events, the end of observation is associated with the date of the last information update in Crunchbase. In such cases, the value of the variable *status* remains 0 throughout the whole period from founding to the last update in Crunchbase.

company or an IPO). The hazard function is capable of gauging the strength of the tendency to change a status (obtaining finance or undergoing a successful exit) at any time point given the characteristics of the startup, including its IPR status, at that time point (Tuts and Schmid, 2016). Therefore, it is a tool that is capable of capturing the underlying dynamics of interplay between IPR activity, the odds of obtaining finance and the odds of a successful exit.

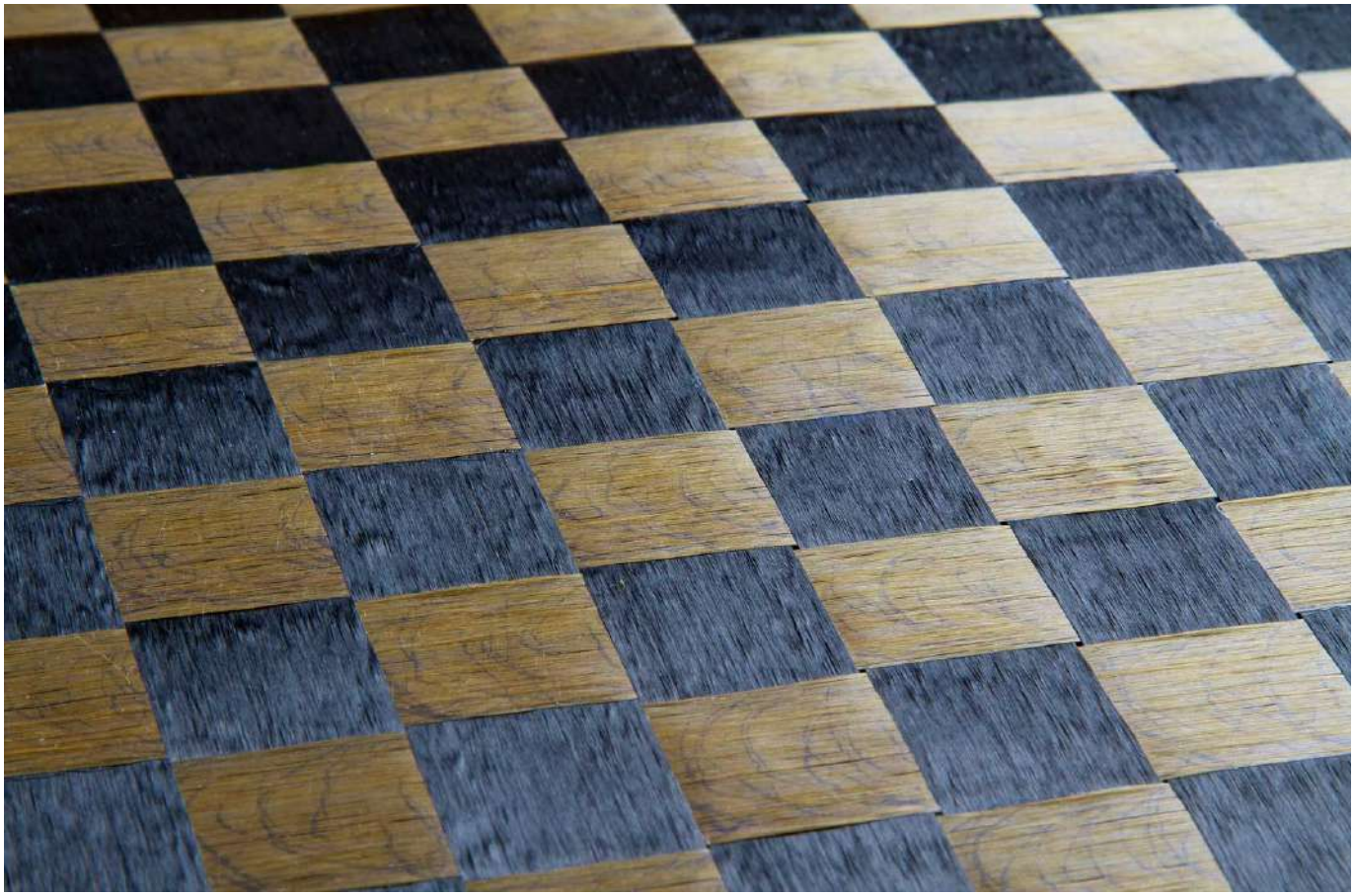
Some startups might have participated in several financing rounds of the same type, or they may have been subjected to more than one acquisition. The standard proportional hazard models are not able to handle multiple events. There are alternative models that are able to handle such cases. However, since the number of such cases in the dataset is relatively low, the decision was taken to consider only the first event of a particular type for each startup, and to estimate the models using Cox proportional hazard models with time-dependent IPR variables.

3.4 Control variables

In a regression analysis, it is necessary to take into account additional variables besides the variables of principal interest (in this case, IPR status of the startup). Such control variables, when specified correctly, allow the effect of the variable of interest on the dependent variable to be isolated. In this study, the main control variables are the sector in which the startup operates and the country in which it is based.

As seen in Figure 2 in section 4, the different sectors are not equally represented in the dataset. Also, the IPR profiles of firms differ considerably, depending on their sectors of activity. Figure 7 and Figure 12 illustrate that firms' propensity to participate in various stages of financing and firms' probability of exit may be determined to a large extent by the firms' sectors of activity.

The presence of venture capital, the availability of funds and the strength of the capital market are also characteristics that vary across the countries present in the dataset. Therefore, controls for the sector of activity and for the country where the startup is registered are important aspects of the analysis.



TEXTREME spread tow carbon fabrics

Case study: OXEON

Company:	Oxeon AB
Locations:	Borås, Sweden
Founded:	2003
No. of employees:	34
Products:	Tape-woven textiles, weaving technologies

"Securing patent protection allowed us to have several options when developing our business."
Nandan Khokar, R&D manager and main inventor, Oxeon

Oxeon, a startup co-founded by Dr Nandan Khokar in 2003, has revolutionised the textile industry with its innovative weaving technology. Recognised as Sweden's fastest-growing company in 2010, Oxeon's success is rooted in the patented tape-weaving technologies acquired from Tape Weaving Sweden, a holding company for the patents. This acquisition allowed Oxeon to license the required IP, forming the basis of their unique tape-woven textiles. These textiles, designed for extreme conditions, have found applications in a wide range of markets and industries, including sports, industrial and aerospace sectors.

Revitalising the textile industry

Weaving and textile industries have almost vanished in many advanced economies, since these activities are often outsourced to emerging nations. Oxeon emerged from the ashes of the 19th-century Swedish textile capital Borås, developing 21st-century textiles using carbon fibres. The company's unique "spread tow" technologies offer better mechanical performance, very low areal weight and ease of fabric handling. They can employ different types of fibres and tapes in the production process, resulting in a variety of products for different industries. Initially, sports equipment was seen as a good market segment, open to experimentation. This strategy has paid off in the long run – Oxeon's TEXTREME fabric is now used to reinforce the rotor blades and other parts of Ingenuity, NASA's first Mars helicopter.

Innovation through intellectual property

Oxeon's IP strategy has been instrumental to its growth and success. The company has several patented inventions, reflecting the continued development of its technologies. The firm's broad patent portfolio protects its production methods as well as its unique tape-woven materials. The company has also registered the trade mark TEXTREME for its materials. This trade mark is registered mainly as a word trade mark for different classes of goods and services in many countries, including Australia, China, Japan, Russia, Turkey and the US, as well as in the EU. Trade mark protection is important for consumer goods, for example for sporting equipment, where TEXTREME is visible and contributes to brand recognition.

Driving innovation through licensing

Oxeon's business model includes both licensing and product sales in different market segments. This hybrid business model has allowed Oxeon to handle its patented technologies as a portfolio of commercial opportunities to support business growth through different development phases. The early evaluation of selling machinery led to the idea of licensing the process technology as a parallel commercial avenue. This early licence agreement became a good source of revenue for Oxeon, enabling the co-financing of technology and business development in other application areas.

Benefitting from the local innovation ecosystem

Oxeon's creation was not managed by a university technology transfer office (TTO). Instead, the firm benefited from other structures within the Chalmers University innovation ecosystem, including the Chalmers School of Entrepreneurship (CSE) for business development support and Chalmersinvest (now Chalmers Ventures) for financial investment.

A holistic approach to IP

Oxeon follows a strategic approach when it develops its IP portfolio. It always considers different options, analysing the pros and cons and choosing the most suitable IP rights. In some cases, Oxeon has chosen not to patent certain inventions and instead keep them as trade secrets. This strategy is typically used for some manufacturing processes that are difficult to reverse-engineer from end products and for which infringement is difficult to detect and prove.

4. The IPR profile of European startups

This section presents statistics on the filing of trade mark and patent applications by our sample of European startups. While other studies have shown that in general, only a small fraction (about 9%) of European SMEs own IP rights,[8] the proportion is significantly higher for the startups in the Crunchbase database, since the focus of Crunchbase is on innovative firms aiming to set up and validate a scalable business model, and such firms have a greater need to protect their innovations by registering IPR.

4.1 Use of IPRs by European startups

Table 1 presents the sample used for the present study by country. The first column shows the number of startups from each country, while the subsequent columns show the percentages of filers of any[9] IP right, any trade mark, any patent, or a bundle of trade marks and patents.

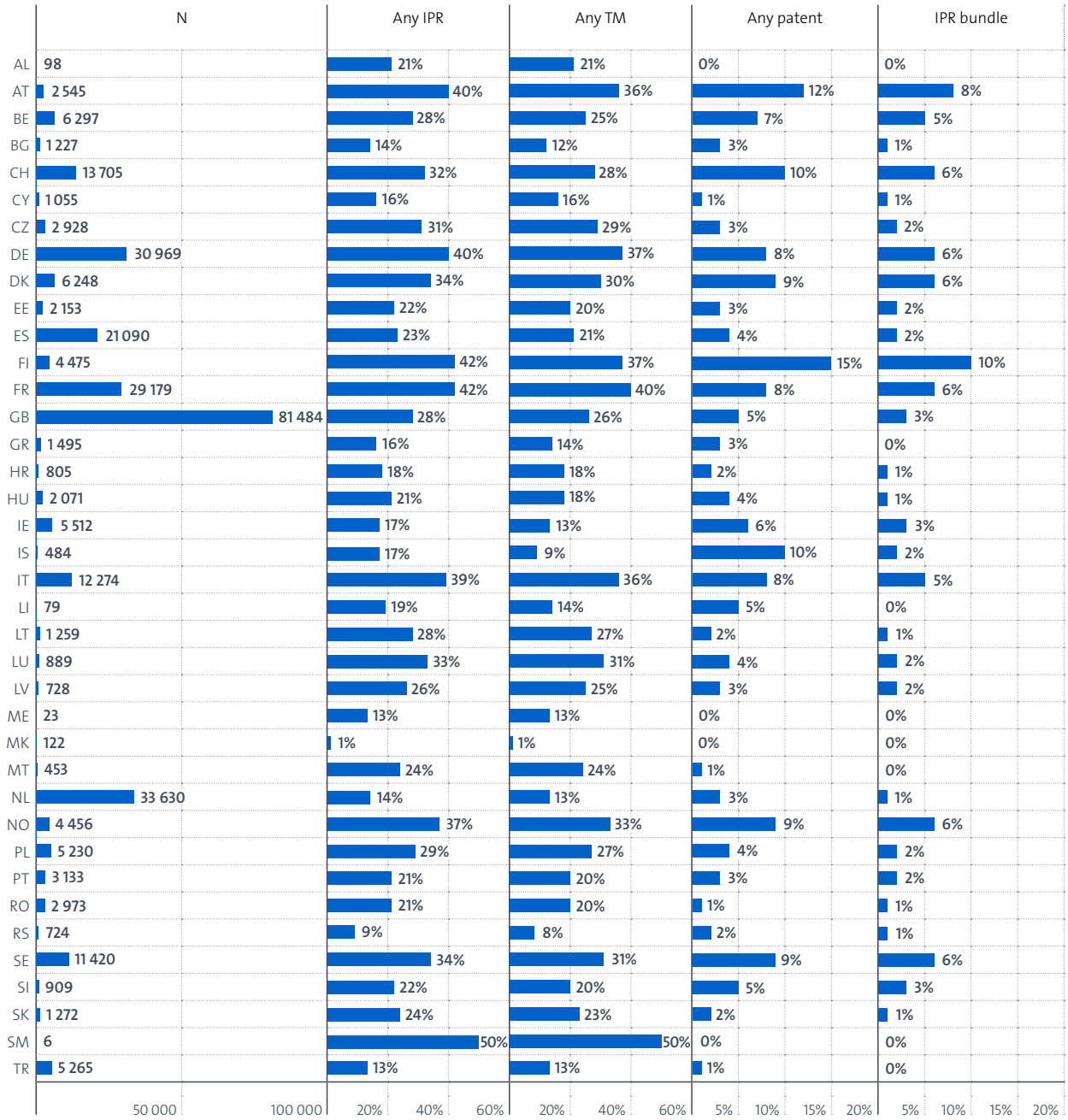
In the entire sample, 29% of the startups applied for a patent or a trade mark at some point, with 27% having applied for trade marks, 6% having filed patent applications and 2% having filed both patent and trade mark applications. However, there is significant variation among the countries in the sample, as shown in the table. Startups based in Austria, Switzerland, the Czech Republic, Germany, Denmark, Finland, France, Italy, Luxembourg, Norway and Sweden are more likely than average to have applied for any IP right. Companies from those countries are also the most likely to file trade mark and patent applications, and to bundle the two IP rights. This is especially true for startups from Austria, Switzerland, France and the Nordic countries.

8 See, for example, EPO/EUIPO, 2021.

9 "Any" refers to the fact that both national and European IP rights are considered.

Figure 1

Share of start-ups filing IP rights per country

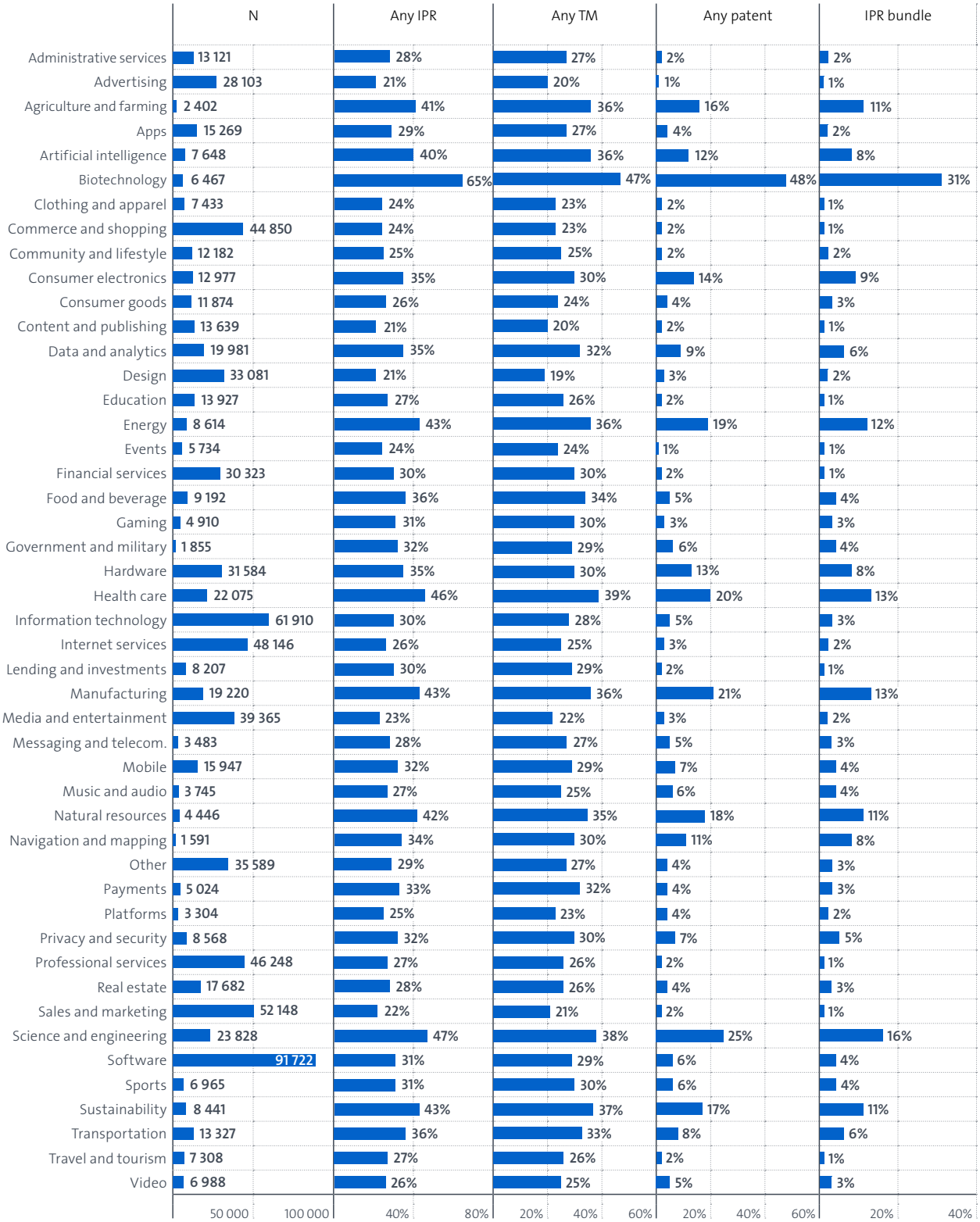


In addition to the variation across countries, there is also great variation among sectors of economic activity with regard to IPR application propensity, as shown in Table 2. As in Table 1, the first column shows the number of startups in the sample from each sector, while the subsequent columns show the number of IPR applications filed by startups from that sector.

In terms of presence in the sample, the three sectors with the most startups are software, information technology and internet services. Other digital economy sectors, as well as service sectors such as commerce, finance and media and entertainment, are also well represented.

Figure 2

Share of start-ups filing IP rights per sector



Note: This Figure is based on the industry classification established by Crunchbase.

Differences among sectors when it comes to firms' propensity to apply for IP rights are driven partly by the inherent characteristics of each sector, and partly by the patentability of the innovations generated by the startups in that sector. While all products and services can be branded, and those brands can be protected by trade mark registration, there are many sectors, particularly in services, whose innovations are not patentable.

The IPR intensities – defined here as the share of startups that have been filing for registered IP rights – of different sectors are reported graphically in Figure 3. The sectors whose startups use patents and trade marks most intensively are highlighted in the Figure. The biotechnology sector is the most intensive user of both patents and trade marks, with close to half of the startups in that sector applying for one or both of those IP rights. Other sectors intensive in their use of both rights are manufacturing, health care, artificial intelligence, and data and analytics. Software, food and beverages, and financial services are not patent-intensive, but the startups from those sectors make intensive use of trade marks.

Startups from the highlighted IPR-intensive sectors are the subject of the in-depth analysis in sections 5 and 6.

Figure 3

Comparison of trade mark and patent use by sector

Note: The size of each circle represents the number of firms in the sector in the initial sample.

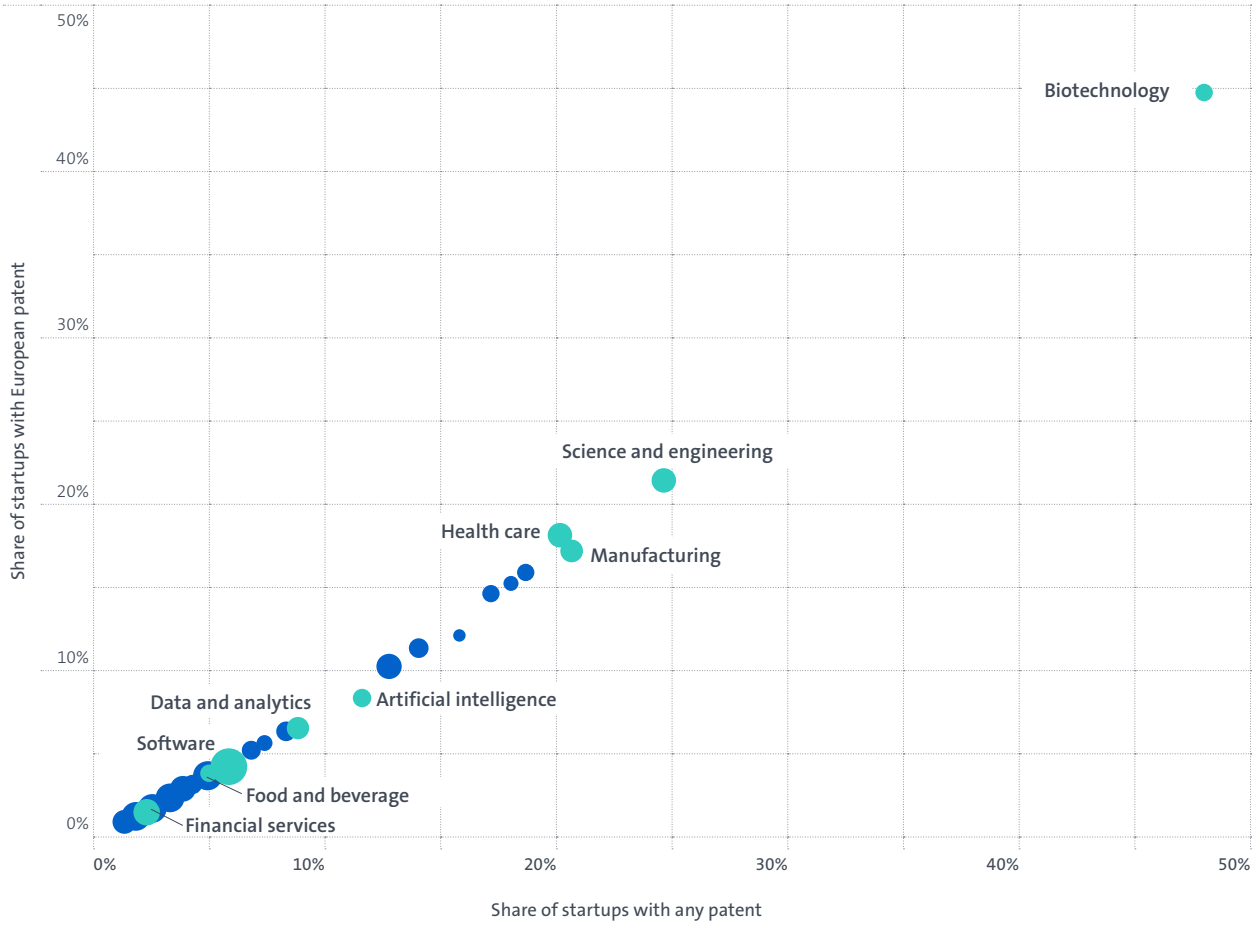
4.2 Use of IPRs by European startups

While section 4.1 considered any patent or any trade mark (national or European), in Figures 4 and 5 the focus is on European-level rights.

Looking first at patents (Figure 4), the biotechnology, science and engineering, health care and manufacturing sectors have high propensities to use patents in general, and European patents in particular.

Figure 4

Comparison of patent intensity with share of European patents users



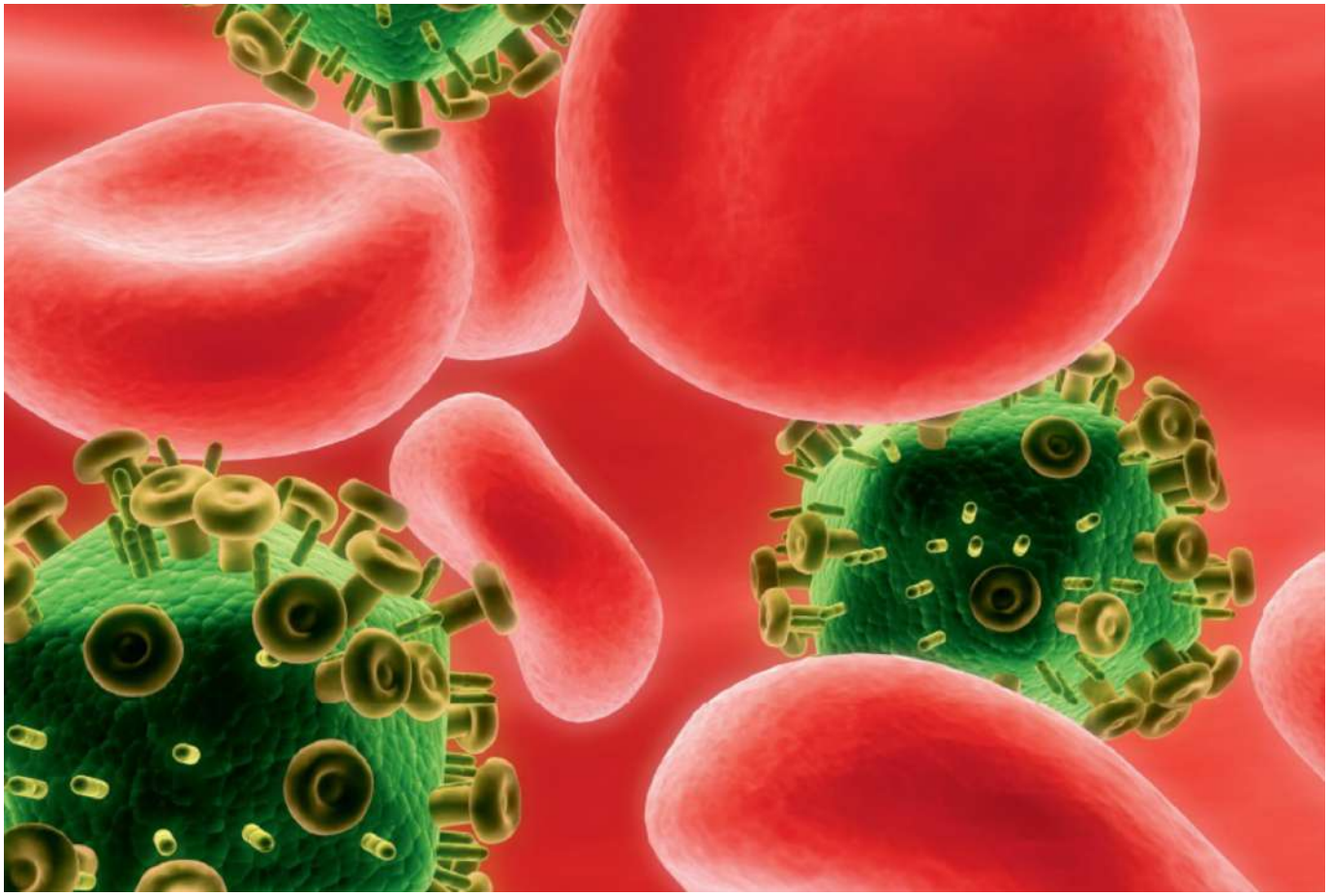
Note: The Figure compares general patent intensity of a sector with its European patent intensity. The size of the circles reflects the size of each sector in the initial sample.

Figure 5 shows the corresponding information for trade marks. A difference in behaviour compared to patenting emerges. While the most patent-intensive sectors in Figure 4 have roughly equal propensities to apply for national and European patents, in Figure 5 the trademark-intensive sectors have relatively lower rates of EUTM activity. For example, 36% of manufacturing startups have applied for a trade mark, but only about 17% have applied for an EUTM. In the same sector, 21% of startups have applied for a patent, compared to about 17% that have applied for a European patent, a much smaller difference.

Figure 5

Comparison of trade mark intensity with share of EUTM users

Note: The Figure compares general trade mark intensity of a sector with its EUTM intensity. The size of the circles reflects the size of each sector in the initial sample.



Marinomed develops therapies against respiratory diseases based on an anti-viral respiratory technology platform.

Case study: MARINOMED

Company:	Marinomed Biotech AG
Locations:	Vienna, Austria
Founded:	2006
No. of employees:	25
Products:	Anti-viral and immunological treatments

"Marinomed is an IP-driven company. It is vital that we own and manage the IP associated with our products."
Andreas Grassauer, CEO, Marinomed

Marinomed is a biopharmaceutical spin-off from the Veterinary University of Vienna. The company was founded in 2006 to commercialise a proprietary technology platform based on Carragelose. This natural polymer is isolated from red algae and is used in various therapies against respiratory diseases. Drug discovery companies like Marinomed rely heavily on IP rights to protect their technology and to secure vital funding to bridge the gap between research and commercialisation.

Sea of possibility

Derived from red algae, Carragelose works by forming a protective barrier that prevents viruses from infecting mucosal cells. It is used in treatments such as throat sprays, nasal sprays and lozenges, making it easy and convenient for patients to use. While these over-the-counter products are subject to shorter regulatory approval processes, it can still take around three to five years and cost several million euros before they can be marketed.

The initial research was funded with public money and conducted at the university. When the company was spun out, it set up an agreement under which Marinomed would retain all IP rights and award the university a share in the business. Marinomed's patent portfolio is built upon three core inventions: the main patent family which relates to the use of Carragelose against cold-causing rhinoviruses, a second family to cover the use of the compound against other respiratory viruses, and a third related to a different polymer.

Global coverage

The three key patents are validated in almost 100 countries and supported by a trade mark registered in more than 30 countries. Marinomed has chosen such broad coverage for several reasons. Medical compounds are relatively easy to copy and patents can be effective in fending off generic producers or copycats. While Marinomed has experienced patent infringement, it was able to resolve these cases without lengthy and costly court battles.

The firm's IP portfolio has helped it to establish two distinct business models: licensing and distribution partnerships. Marinomed offers a classical licence agreement which gives licensees the rights to produce, market and distribute the product in certain countries. In addition, their distribution deals enable partners to purchase Marinomed products and sell these in defined geographical territories. The products can be tailored to only include the partner's name and logo.

Marinomed owns a trade mark for Carragelose and its licensing partners have their own trade marks. While these partners do not need the Carragelose mark, under the distribution partnership, the licences for the patents are sometimes combined with a trade mark licence. This enables partners to capitalise on the international use of the brand. The decision to file for a trade mark is based on a cost/benefit analysis, taking into account the needs of the partners.

IP portfolio review

The company has invested heavily in its IP portfolio and carefully manages the intellectual assets included. In cooperation with the business development unit, the management team reviews the portfolio at least once each year, and adjusts its IP strategy to streamline patent-related expenditure. For example, the firm may abandon a patent in countries where it is no longer needed, or abandon a patent altogether. Licensing and distribution partners are included in these decisions and, to retain patent protection, may agree to bear the costs.

5. IPR and funding

This section explores the relationship between the ability of startups to obtain financing and their IPR profile, as evidenced by their filings of patent and trade mark applications. As the previous section showed, one can observe a strong correlation at the sectoral level between the use of trade marks and patents, suggesting a strong complementarity between the two IP rights.

Funding of startups usually occurs through successive financing rounds. Seed funding refers to the money raised by a startup in the very initial stages of development, when the company does not yet have a track record. The goal of seed funding is to help the startup develop its business plans and refine its ideas to the point of being able to attract larger sums from investors in subsequent funding rounds.

Early-stage funding (Series A and Series B) is sought by startups that have already established themselves with viable products/services and business models, and that now need funds to scale up their operations and achieve sustainable growth. While seed capital may come from private sources or from the founders themselves, Series A/B funding will typically come from VC or private equity (PE) investors. The amounts invested will also be considerably larger than those invested at the seed stage.

In the late-stage funding rounds, known as Series C, D, E, and later (although Series D and beyond are quite rare), the objective is to provide funds for the already successful business to expand into new markets or to develop new products.

Finally, the investors in the earlier funding rounds will seek a successful exit from their investment, usually through an IPO or the sale of the startup to another company. This stage of the life cycle of a startup is crucial, since the investors in the funding rounds described above would be reluctant to provide funding without the prospect of realising gains on their investment. The relationship between IPR and successful exit events is the subject of section 6.

5.1 Funding record of European startups

Figure 6 shows the number of funding events in the sample at different funding stages, grouped into seed, early-stage and late-stage funding. The chart includes only those startups that obtained funding at each specific stage.

By far the most frequent type of funding in the sample is seed financing, with more than 56 000 observations. Within that category, the most common category is seed funding, with almost 36 000 events. There are 12 000 early-stage financing rounds, with Series A funding being the most frequent type.

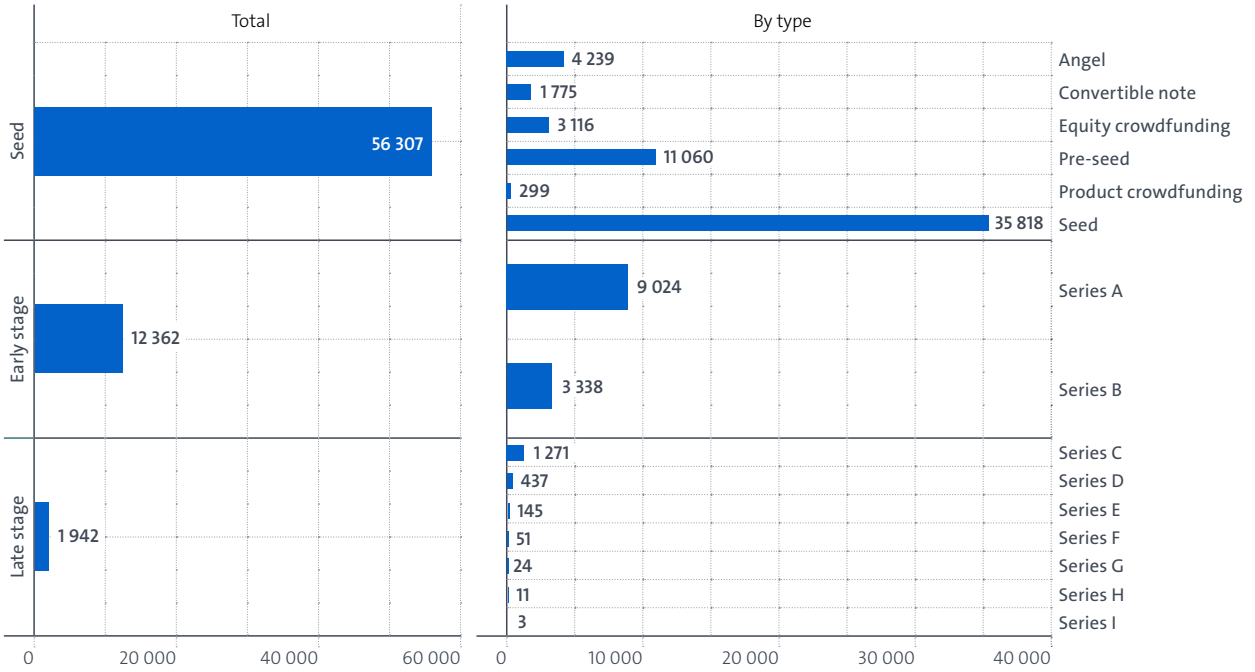
Only a relatively small number of startups make it to the late stage; in our sample there are just under 2 000 late stage rounds, with funding rounds beyond Series C being quite infrequent.

In Figure 7, the information on funding of startups is presented by sector. The first columns show the total number of startups in the sample by sector, while the subsequent columns show the proportion of startups in each sector that obtained the respective funding round financing.

The sectors in which startups were most successful in obtaining seed financing include artificial intelligence (41% of startups in this sector received such funding), biotechnology (27%), data and analytics (27%), navigation and mapping (26%) and payment services (26%). However, in subsequent funding rounds the most successful sector is biotechnology, with 10% of biotech startups obtaining early-stage financing and more than 3% going on to late-stage financing. Other sectors with startups relatively successful in obtaining early-stage and late-stage financing include health care, artificial intelligence, payments, and science and engineering.

Figure 6

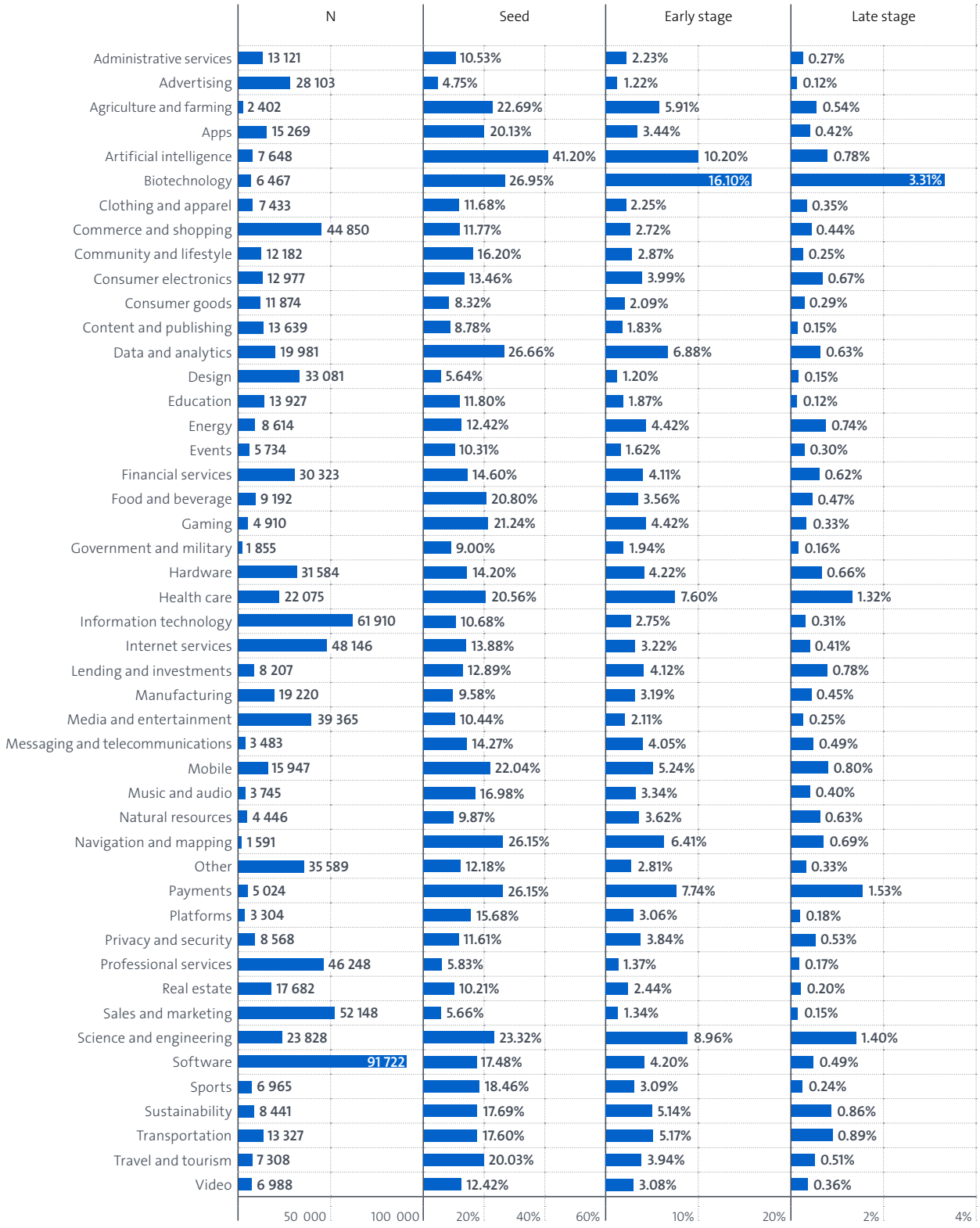
Funding events in the dataset



Note: The first panel presents the total number of funding events by stage of funding. The second panel presents the distribution of funding events by specific funding types within each of the three categories.

Figure 7

Participation of startups at different stages of financing



Note: The first panel shows the number of startups in the initial sample by sector. Subsequent panels present the shares of startups in the initial sample that obtained financing in each stage of funding rounds.

5.2 IPR use at different funding stages

On average, only about a third of all startups file IPRs before the seed stages. In most of these cases, the firms have applied for a trade mark before these funding rounds (28%), while only 10% have already filed a patent. The proportion of startups that file patents increases significantly during the series A and B stages, reaching about 45% by the late stages. The same pattern can be observed for trade marks, which have been filed for by 70 to 80% of startups at late stages. The more frequent use of patents and trade marks by relatively mature startups probably reflects their progress in developing technologies and products that qualify for IPR protection.

Among those startups that apply for IPR prior to each funding round, the percentage that applied for European rights is shown in the last panel of the Figure. In this respect, there is a difference between trade mark and patent users. Of the 28% of seed funding recipients that had filed for a trade mark before the funding event, 47% had filed for an EUTM. In the case of patents, 81% of the patent filings were at the European level already at this early stage. By the late-stage funding rounds, 92% of patent filers had filed for a European patent, compared to 81% of trade mark filers that had filed an EUTM application.

Figure 8

Share of startups with IPR at different stages of financing

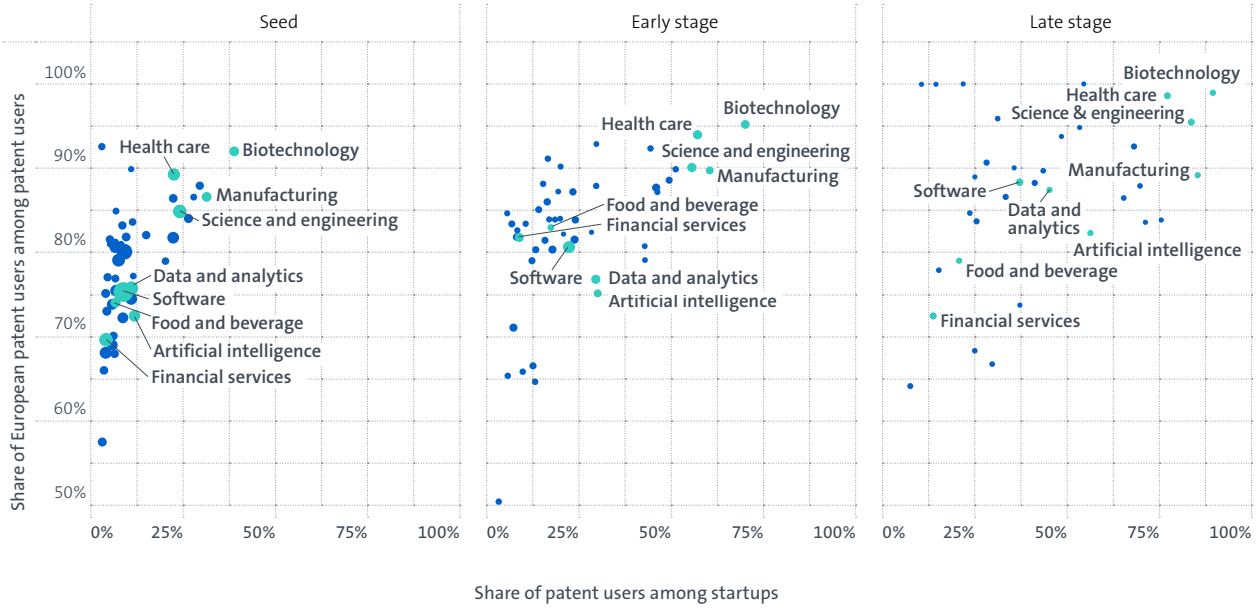
Note: The first panel presents the number of events in each stage of financial rounds. The second panel shows the share of startups having applied for various combinations of IPR prior to the date of that financing round. The third panel presents the share of startups within each category that applied for protection of EUTM, a European patent or both prior to the date of the relevant financing round.

Additional charts showing the distribution of IP rights in each funding round by sector and by IP rights is shown in Annex A.

Figures 9 and 10 present scatterplots showing the correlations between applications for patents (Figure 9) and trade marks (Figure 10), and European patents and EUTMs, respectively, at each of the three funding stages. While, for both IPR types, the proportion of startups with both trade mark and patent filings increases as firms progress through the funding rounds, there are significant differences among sectors. These differences mean that in the econometric analyses in the next sections, the sector of activity of the startup must be taken into account.

Figure 9

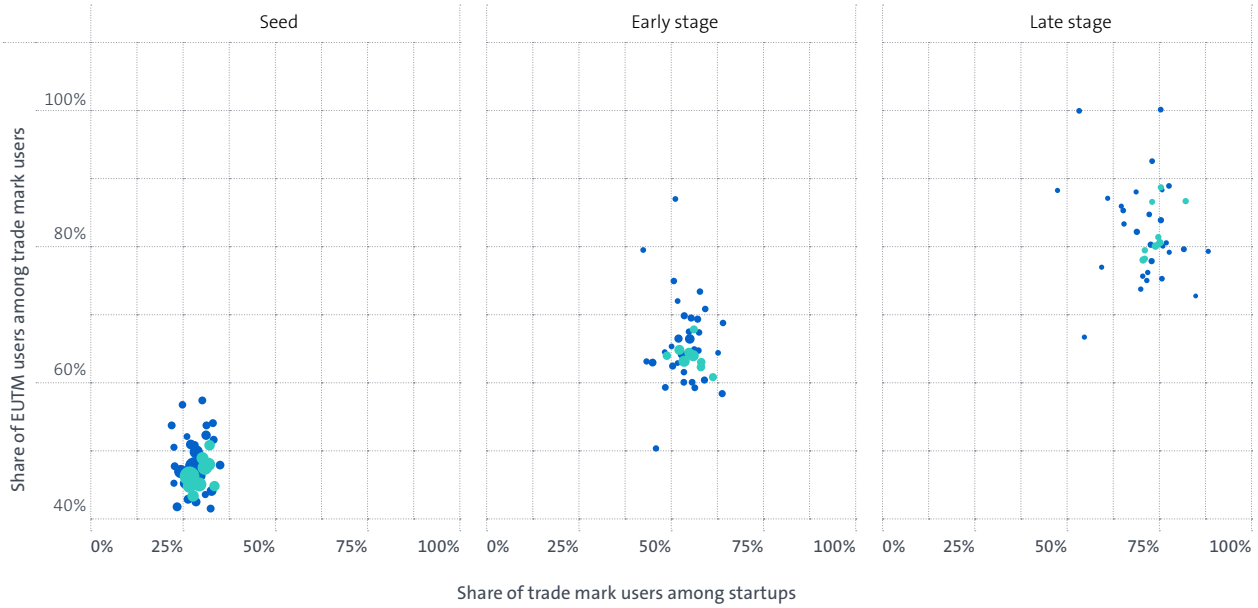
Relationship between general patent intensity and share of European patent usage among patent users at the sectoral level



Note: The Figure compares general patent intensities of sectors with the share of patent users that have filed for at least one European patent.

Figure 10

Relationship between general trade mark intensity and share of EUTM usage among trade mark users at the sectoral level

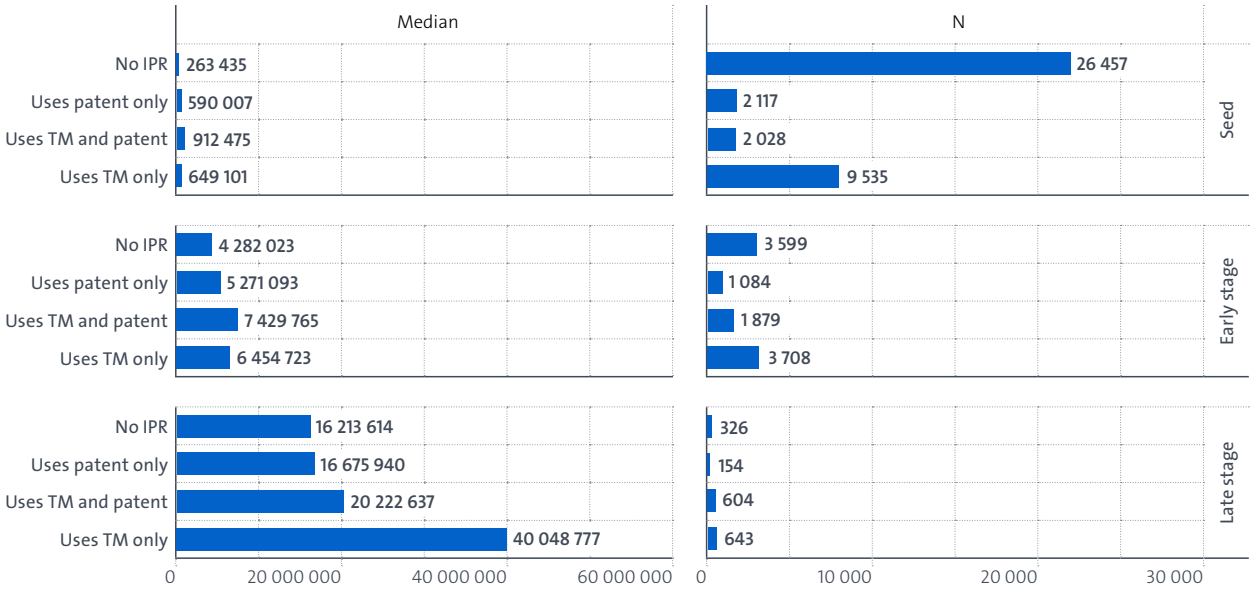


Note: The Figure compares general trade mark intensities of sectors with the shares of trade mark users that have filed for at least one EUTM.

Finally, Figure 11 shows the amount of funding received by the median startup in each funding round, by the IPR status of the company. Among the startups that received seed financing, those that had applied for either a trade mark or a patent prior to funding received considerably higher sums than those that had not applied for either IP right. Those startups that had applied for both a patent and a trade mark received the highest amount of seed funding, more than EUR 900 000. The same pattern holds for early-stage financing, while in late-stage financing rounds trade mark users receive the most funding, perhaps reflecting the fact that companies at this stage are already quite successful and their value (hence also their funding) is more driven by marketing success than by technological innovation at this point.

Figure 11

Relationship between IPR status and amount of financing obtained at different stages of funding



Note: Panels present median values and the number of financing events by stage of financial round and type of IPR use.

5.3 IPR use and odds of funding

In section 5.2, a descriptive analysis of the relationship between IPR and funding was presented. Significant differences were found among sectors and funding rounds, calling for an econometric analysis of the impact of prior IPR use on the likelihood of funding while controlling for relevant factors, in particular the country in which the startup is based and the sector in which it is active. This analysis is presented below for the seed and early-stage funding rounds, while section 6 considers the exit events.

The methodology of the econometric analysis is described in sections 3.3 and 3.4 above. In all cases, the dependent variable is the occurrence of a funding event at a given point in time, and the main independent variables are variables indicating whether or not the startup has applied for the IP right indicated. Control variables are used for the startups' respective countries and sectors (the corresponding coefficients have no intrinsic interest and are therefore omitted in the Tables).

Tables 1 and 2 show the regression results for the seed funding rounds. The coefficients can be interpreted as the increase in the odds of obtaining funding (compared to a startup that has not filed any IPR application). The first column in Table 1 shows that a startup that has applied for an IPR has 2.6 times higher odds of obtaining seed funding than a startup that has not applied for any IPR. The second column repeats this analysis, now distinguishing between the two types of IPR and a combination of them. The analysis shows that the odds of obtaining funding increase significantly for startups with trade marks, but even more so for startups with patents. Startups with both patents and trade marks experience the highest increase in odds of obtaining seed funding.

Table 1

Cox proportional hazard models with time-dependent IPR variables (seed stage)

	(1)	(2)
Uses any IPR	2.614*** p = 0.000	
Uses only TM		2.463*** p = 0.000
Uses only patent		2.916*** p = 0.000
Bundles TMs with patents		3.464*** p = 0.000
Country controls	Yes	Yes
Sector controls	Yes	Yes
Observations	383,363	383,363
R^2	0.064	0.064
Log likelihood	−366,887.800	−366,835.600
Wald test	28,113.220*** (df = 86)	28,344.670*** (df = 88)
LR test	25,415.670*** (df = 86)	25,520.210*** (df = 88)
Score (logrank) test	32,454.060*** (df = 86)	32,863.650*** (df = 88)

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

Original coefficients exponentiated to represent odds of getting finance as compared to reference value

In Table 2, the analysis focuses on whether the IP rights applied for by the startup are national or European-level rights. The first column shows that while patent filings increase the odds of funding, the increase is more pronounced when the startup has filed for a European patent. The same is true for trade marks: as shown in the second column, filing for an EUTM is associated with a significantly higher increase in odds of seed funding than filing for a national trade mark application. It appears that seed investors value a startup's intention to expand internationally, as evidenced by its trade mark and patent filings.

Table 2

Cox proportional hazard models with time-dependent IPR variables. Focus on geographical scope of IPR (seed stage)

	(1)	(2)
Uses national patent only	2.436*** p = 0.000	
Uses European patent	2.651*** p = 0.000	
Uses national TM only		2.191*** p = 0.000
Uses EUTM		2.816*** p = 0.000
Country controls	Yes	Yes
Sector controls	Yes	Yes
Observations	383,363	383,363
R^2	0.057	0.062
Log likelihood	−368,292.700	−367,390.000
Wald test (df = 87)	25,046.790***	27,156.730***
LR test (df = 87)	22,606,000***	24,411.300***
Score (logrank) test (df = 87)	28,907.050***	31,320.700***

Note:
Original coefficients exponentiated to represent odds of getting finance as compared to reference value

*p<0.1; **p<0.05; ***p<0.01

Tables 3 and 4 show the results of the analysis of the odds of early-stage (Series A and B) funding. The increase in odds of a successful funding round associated with IPR activity is much greater than was the case in the seed funding models. For example, a startup that bundles patents with trade marks has a ten-fold increase in the odds of obtaining early-stage funding, compared to a tripling of the odds of obtaining seed funding.

The same is true when analysing the differential impact of European versus national-level rights in Table 4. Here, the increase in odds of funding associated with European-level rights is significantly higher than the corresponding increase seen in Table 2 for seed funding. Investors in early-stage financing seem to value international expansion prospects even more than do investors in the seed funding stages.

It should also be noted that all estimated coefficients are statistically significant at the 99% confidence level. In addition, three test statistics confirm the overall validity of the models (by rejecting the hypothesis that all the coefficients in the model are zero): the Wald test, the likelihood ratio (LR) test and the score logrank test.

Table 3

Cox proportional hazard models with time-dependent IPR variables (early stage)

	(1)	(2)
Uses any IPR	5.200*** p = 0.000	
Uses only TM		4.349*** p = 0.000
Uses only patent		6.410*** p = 0.000
Bundles TMs with patents		10.188*** p = 0.000
Country controls	Yes	Yes
Sector controls	Yes	Yes
Observations	394,249	394,249
R^2	0.034	0.035
Log likelihood	−98,849.180	−98,594.580
Wald test	14,742.910*** (df = 86)	16,053.760*** (df = 88)
LR test	13,646.400*** (df = 86)	14,155.620*** (df = 88)
Score (logrank) test	20,004.540*** (df = 86)	23,511.240*** (df = 88)

Note:
Original coefficients exponentiated to represent odds of getting finance as compared to reference value

*p<0.1; **p<0.05; ***p<0.01

Table 4

Cox proportional hazard models with time-dependent IPR variables. Focus on geographical scope of IPR (early stage)

	(1)	(2)
Uses national patent only	3.826*** p = 0.000	
Uses European patent	5.267*** p = 0.000	
Uses national TM only		2.808*** p = 0.000
Uses EUTM		6.091*** p = 0.000
Country controls	Yes	Yes
Sector controls	Yes	Yes
Observations	394,249	394,249
R^2	0.028	0.032
Log likelihood	–100,051.600	–99,229.180
Wald test (df = 87)	14,344.070***	15,255.690***
LR test (df = 87)	11,241.570***	12,886.410***
Score (logrank) test (df = 87)	19,665.710***	20,667.950***

Note:
Original coefficients exponentiated to represent odds of getting finance as compared to reference value

*p<0.1; **p<0.05; ***p<0.01

Blubrake's integrated ABS system for e-bikes an e-cargos

Case study: BLUBRAKE

Company:	Blubrake
Locations:	Milan, Italy
Founded:	2015
No. of employees:	32
Products:	Integrated ABS system for e-bikes

"IP is important in two main respects. Firstly, it helps to attract investors when companies are mature enough to grow. Secondly, it is important for exit purposes as it increases corporate value."
Fabio Todeschini, co-founder and general manager, Blubrake

Blubrake is an Italian scale-up that develops and produces advanced braking systems for the growing global e-bike and e-cargo bike industry. The company was founded through a collaboration between researchers at Politecnico di Milano (Polimi) and e-Novia, a startup accelerator that supports companies in robotics, artificial intelligence and mobility. Blubrake's open-platform ABS solutions can be integrated with third-party braking systems and battery kits, meeting the needs of the original equipment manufacturers (OEMs). The company both sells its ABS systems to OEMs, and provides them with a technology platform that enables Blubrake systems to be adapted to specific needs and bike models.

Kickstarting the innovation cycle

In 2015, a group of entrepreneurs established e-Novia to scale up promising technologies. Once they had identified a potential breakthrough, e-Novia combined IP, expertise and financial resources to establish spin-offs that had the potential to achieve international success. In this business model, company creation follows a clear path from idea (generating innovation) to invention (transforming innovation) to enterprises (transferring innovation).

At around the same time, Polimi Professor Sergio Matteo Savaresi and his research group had been working on braking control systems for vehicles. Some of the group's researchers began collaborating with e-Novia to develop braking systems for light electric vehicles. This collaboration led to Savaresi and Fabio Todeschini co-founding Blubrake.

IP laid the foundation for the company through unorthodox university-based technology transfer. Ordinarily, universities will file for a patent as a prerequisite for testing technology and enabling scientific publications. Blubrake was created from the outset around a specific unique selling point and market. The firm's solutions were developed with IP in mind, with the team identifying and using various methods to protect new inventions early on. The company initially relied on trade secrets, with Blubrake and Polimi filing for the first jointly owned patent on a control system for e bikes, ABS, in 2016. In 2019, the company registered the Blubrake trade mark in Italy and the UK, with further registrations at the EUIPO and in Japan and the US in 2020 and 2021.

Funding the journey

For deep-tech startups, early funding is essential as it supports R&D and, in the case of Blubrake, enabled the new company to thoroughly test its technology to meet stringent safety standards. E-Novia helped attract financing, negotiated with early backers and funding the filing and maintenance fees for patent applications. In return for this support, e-Novia was given a majority share in Blubrake.

In addition to funding from e-Novia and other early investors, Blubrake was supported by a grant from the European Commission's Executive Agency for Small and Medium-sized Enterprises. Towards the end of 2020, the company raised EUR 5.2 million from private investors. This investment was used to develop the second generation of ABS – a miniaturised system that can be fully integrated into the bike frame. In their due diligence, the investors emphasised the importance of proprietary technology, IP protection and a technical roadmap that was matched by parallel patent protection.

Beyond financing, Blubrake's IP portfolio ensures that it is recognised as a skilled technology player. Since the firm's solutions are open-ended, IP here enables the company to retain control of its technology while collaborating with partners and reinforcing its bargaining position in global supply chains.

6. IPR and exit performance

This section presents statistics on the interplay between the filing of trade mark and patent applications by European startups and the odds of successful exit for their investors. Taking the perspective of the VC funds, a "success" is defined as the occurrence of an initial public offering (IPO) or acquisition.

The assumption underlying this section is that filing for IP rights denotes a specific focus of the startups on the development and protection of intellectual assets, which may in turn be associated with higher odds of success. Accordingly, the purpose of the analysis is to determine whether the prior filing of IP rights can be exploited by investors as a predictor of the future chances of success of the startups. Importantly, this prediction effect should not be interpreted as a direct causal one: the mere filing for an IP right does not ensure a successful exit, but it may signal a startup's stronger ability to achieve a successful exit through the creation, protection and exploitation of intellectual assets.

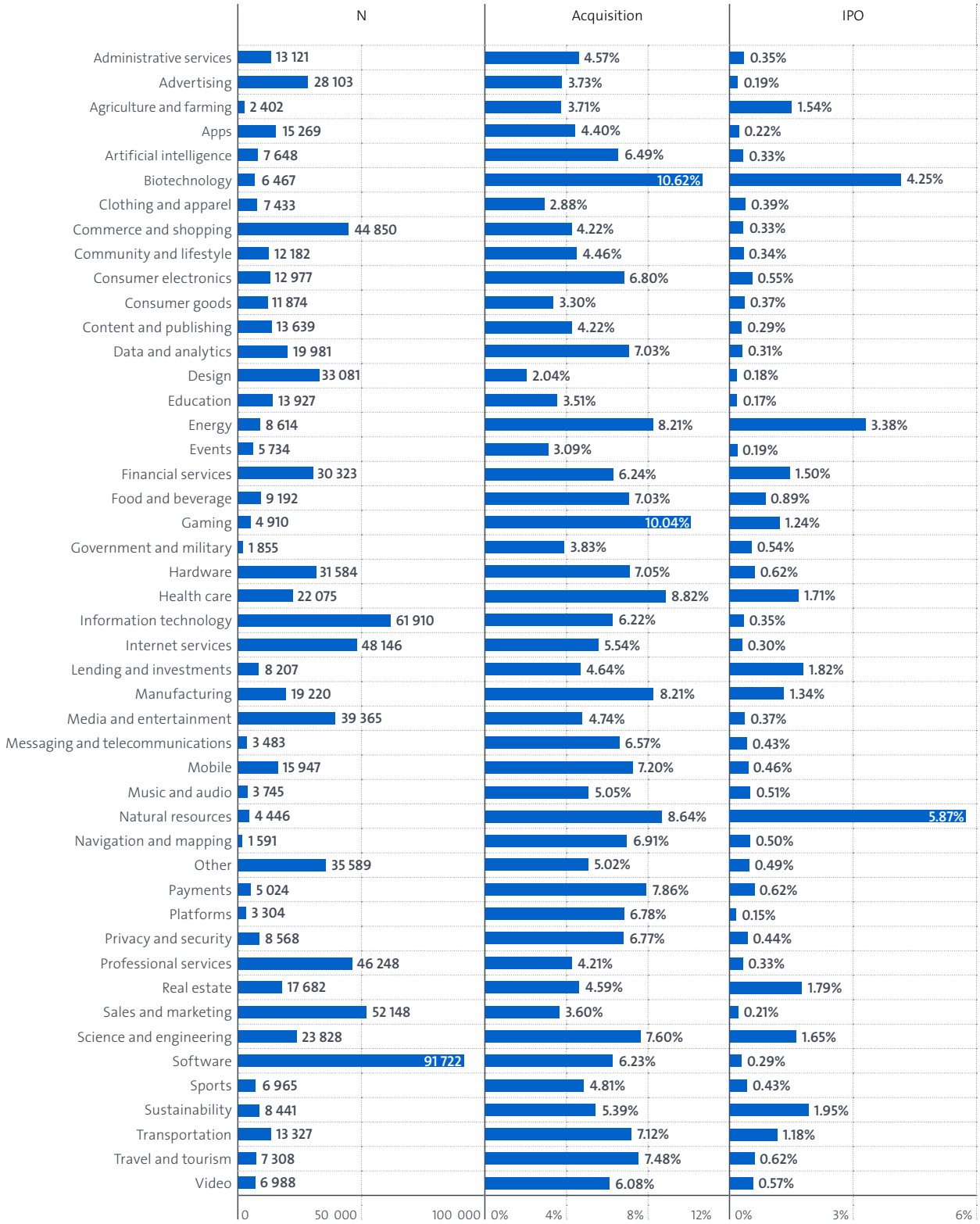
6.1 IPR use at exit

Figure 12 presents the population of startups that have achieved exit, across sectors of economic activity. The first column shows the total number of startups for each sector. The subsequent columns present the percentages of those startups that successfully exited through either an acquisition (second column) or an IPO (third column).

In the entire sample, 7.32% of the startups report a successful exit, most often through acquisitions (6.53%). Biotechnology stands out with high exit rates with respect to both acquisitions (10.62%) and IPOs (4.25%). Natural resources, energy, gaming and health care also report compounded shares of exiting startups above 10%. Other IP-intensive sectors should be noted which show above-average exit rates, including manufacturing (9.55%), science and engineering (9.25%), or food and beverages (7.92%).

Figure 12

Startups with successful exit by sector



Note: The first panel presents the number of startups in the initial sample by sector. Subsequent panels present the shares of startups in the initial sample that achieve successful exit by type of exit.

The proportions of IP rights users among the startups that successfully exited is in turn reported in Figure 13. Those proportions are larger for trade mark users (39% for exits through acquisition, 40% for exits through an IPO) than for patent users (13% and 21% respectively). The shares are in all cases significantly larger than the shares of trade mark and patent owners in the entire population of European startups (27% and 6% respectively). Compared with other startups that filed for IP rights, those that exited also have an above-average share of European IP rights, and they rely more frequently on a bundle of patents and trade marks. Interestingly, the relatively small number of startups that exited via an IPO show the highest score with respect to all indicators of IPR intensity.

Figure 13

Distribution of startups by IPR use in the initial sample and at exit

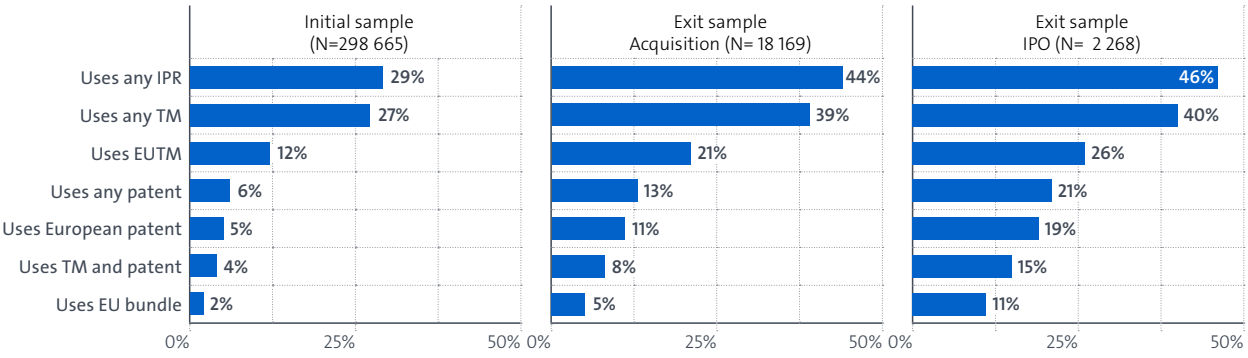
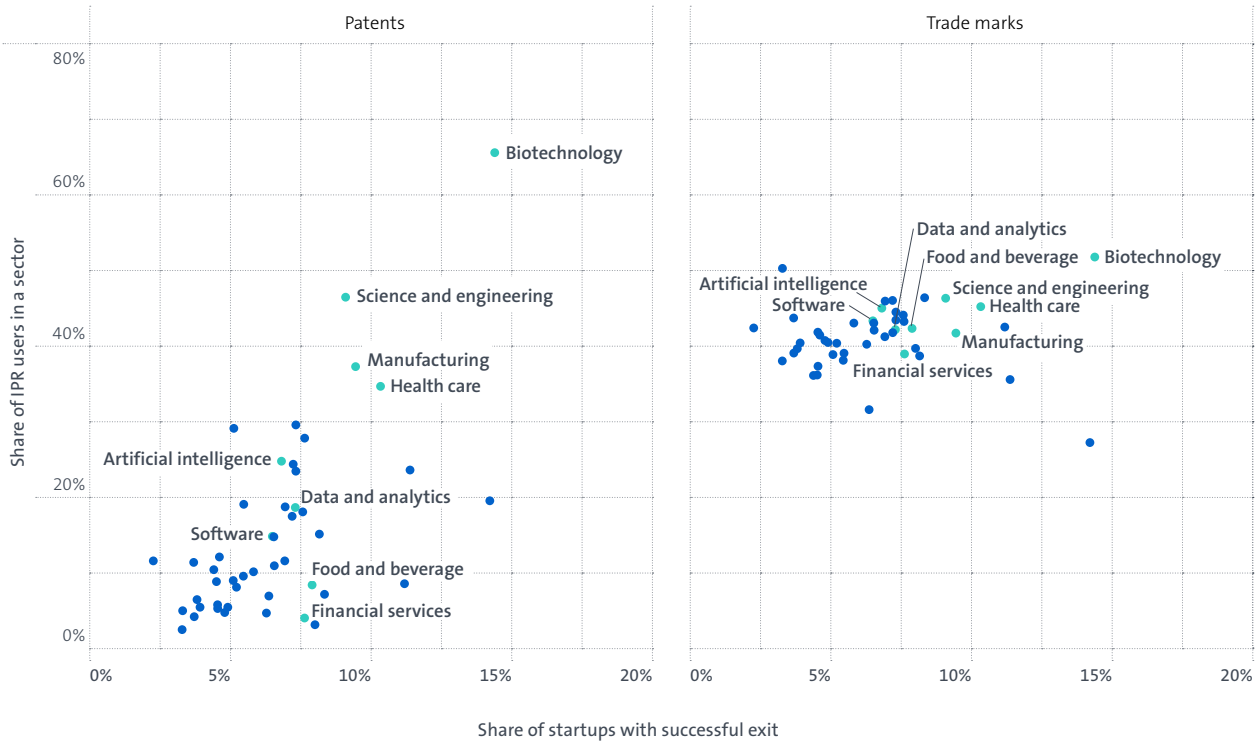


Figure 14 provides a high-level view of the correlation between the proportion of patents and trade mark applicants at the sectoral level and the share of exits at the sectoral level. This comparison reveals a clear correlation between the frequency of acquisitions in a sector and the proportion of patent users in that sector. While patent users tend to be concentrated in technology-oriented sectors, trade mark users are more evenly distributed across sectors. As a result, there is no clear correlation between trade mark intensity and the frequency of exit at the sectoral level. Further analysis is thus needed to uncover such correlations at the firm level within given sectors.

Figure 14

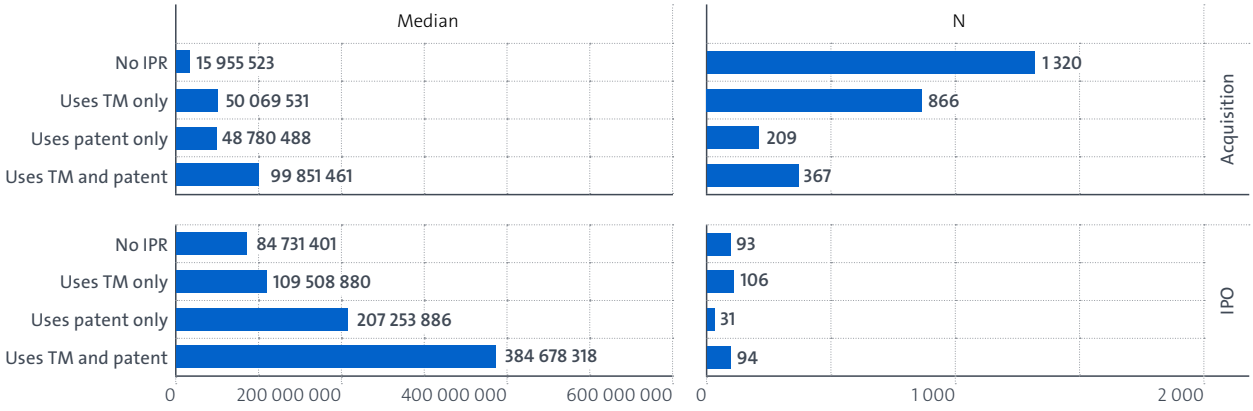
Relationship between IPR intensity and share of firms with successful exit at the sectoral level



The Crunchbase data offer further interesting insights into the exit value of startups. However, they should be interpreted with caution, due to missing observations and potential selection biases. The first column of Figure 15 shows the median exit value of startups as a function of their IPR profile, with the number of corresponding observations reported in the second column. It reveals higher median values for startups that own patents or trade marks prior to exit, compared to those without any IP rights. Interestingly, the reported median values are particularly large for startups that bundle patents and trade marks – up to two to three times higher than for those that own only one category of IP rights.

Figure 15

Relationship between IPR status and exit value



Note: The panels present median values and the number of exits by exit type and by the type of IPR use.

6.2 IPR use and odds of successful exit

This section presents further empirical analyses on the potential value of IP rights as a signal of increased chances of successful exit. The results complement the descriptive analyses of the previous section with an econometric estimation of the signalling effect of IPRs at the firm level.

The predictive power of IPRs as a signal of likely exit was assessed using the Cox Proportional Hazard model introduced in section 3. Therefore, the dependent variable of interest is the occurrence of an exit at a given point in time. In line with the econometric results reported in section 5, different regression models are estimated to account for different types of IP rights or bundles thereof, taking into account the time at which the patent or trade mark applications took place. Besides those IPR variables, the estimated model takes into account other factors that may influence the chances of exit, including the sector and country in which the startups operate (the corresponding coefficients have no intrinsic interest and are therefore omitted in the Tables).

The two model estimations reported in Table 5 make it possible to assess the reliability of any IP right (model 1) or of specific categories of IP rights (model 2) as a signal of their owners' chances of exit. They show, in all cases, a positive and significant effect of IP ownership on the odds of exit. In model 1, filing for any registered IPR is associated with 2.265 higher odds of exit in periods, compared with startups without IPR applications. The results of model 2 make it possible to further decompose that effect. The filing of trade mark applications only is associated with an increase of the odds of exit by a factor of 2.112. Patent applications are in turn associated with a 2.408 increase in the odds of exit. The bundling of trade marks and patents yields the largest effect, with an increase of the odds of exit by a factor of 3.156.

Table 5

Cox proportional hazard models with time-dependent IPR variables (exit)

	(1)	(2)
Uses any IPR	2.265*** p = 0.000	
Uses only TM		2.112*** p = 0.000
Uses only patent		2.408*** p = 0.000
Bundles TMs with patents		3.156*** p = 0.000
Observations	394,874	394,874
R^2	0.028	0.029
Log likelihood	−229,536.900	−229,445.600
Wald test	10,493.530*** (df = 86)	10,885.120*** (df = 88)
LR test	11,373.490*** (df = 86)	11.556.090*** (df = 88)
Score (logrank) test	11,544.190*** (df = 86)	12,201.670 *** (df = 88)
Country controls	Yes	Yes
Sector controls	Yes	Yes

Note:
Original coefficients exponentiated to represent odds of exit as compared to reference value

*p<0.1; **p<0.05; ***p<0.01

The models reported in Table 6 in turn compare the effect of national versus European IP rights as predictors of increased chances of future exit. Model 1 focuses on patents and shows a positive effect of both national and European patents, with odds of exit increased by, respectively, a factor of 1.985 and a factor of 2.301, compared to startups that do not own any patent. The effect is significantly stronger for European patents. Model 2 shows similar results in the case of trade marks. Both national and European trade marks are associated with a significant increase in the odds of exit (by a factor of 1.627 and a factor of 2.860, respectively). The effect is particularly strong in the case of EU trade marks, which are usually filed for less frequently and later than for national trade marks. Econometric estimations therefore point to a strong signalling effect of both European patents and EU trade marks, reflecting the broader market potential of startups that are filing for such European IP rights.

Table 6

Cox proportional hazard models with time-dependent IPR variables. Focus on geographical scope of IPR (exit)

	(1)	(2)
Uses national patent only	1.985*** p = 0.000	
Uses European patent	2.301*** p = 0.000	
Uses national TM only		1.627*** p = 0.000
Uses EUTM		2.860*** p = 0.000
Country controls	Yes	Yes
Sector controls	Yes	Yes
Observations	394,874	394,874
R^2	0.024	0.029
Log likelihood	−230,385.400	−229,485.000
Wald test (df = 87)	9,038.690*** (df = 86)	11,017.140***
LR test (df = 87)	9,676.335*** (df = 86)	11,477.180***
Score (logrank) test (df = 87)	10,101.170*** (df = 86)	12,321.010***

Note:
Original coefficients exponentiated to represent odds of exit as compared to reference value

*p<0.1; **p<0.05; ***p<0.01

7. Discussion

In the EPO/EUIPO (2019) study of high-growth firms, a strong correlation was found between an SME's use of IP rights and its subsequent growth performance. This relationship was especially strong for firms that registered not only national but also European-level rights, and for firms that bundled patents and trade marks.

The study of high-growth firms did not delve into the mechanisms through which IP rights could contribute to enhance a firm's growth prospects; it merely found that such a correlation exists. The present study goes one step further and looks at one possible mechanism: the registration of patents and trade marks by a startup increases the odds of obtaining financing. The study has indeed shown that startups that register IP rights are considerably more likely than other startups to obtain seed and early-stage financing, and are also more likely to reward the early investors through a successful exit via an IPO or a sale to another company.

The odds of obtaining seed financing and achieving a successful exit rise even more for startups that apply for European-level rights and those that bundle patents and trade marks. Such activity is a signal to potential financiers that the company has created one or more intellectual assets that are eligible for formal IPR protection, and that the firm intends to legally protect and exploit those intellectual assets in the marketplace. A patent is an indication that the startup has created a technological innovation, and trade mark registration signals the intent and ability to bring new products and services to the marketplace. Registering those rights on the European level signals to investors that the startup plans to expand outside its home country, further enhancing its growth prospects and increasing its attractiveness to the venture capital community.

The implication for startups is then that IPR protection choices have an impact on their future prospects, both in terms of access to finance and value harvesting through successful exit.

European policymakers have established the goal to decarbonise the continent by 2050, while at the same time creating growth and jobs to ensure continued prosperity for European citizens. Many of the startups that are the subject of the present study contribute to these objectives through their innovation and subsequent growth. But in order to achieve that, these companies need access to financing, in particular venture capital, that is prepared to assume the inherent risks. The challenge for policymakers is thus to foster an environment that is conducive to VC activity and to make IP protection attractive to the startups through a strong IP system from registration to enforcement. The challenge for IP offices is to make the IPR system even more accessible to small companies and to raise awareness among entrepreneurs and the general population of the important economic role played by IP rights. Hopefully this report has made a contribution to this goal.

7.1 Limitations

The data available to the research team had some limitations.

The national trade marks repository does not include applicants' address information, which might be helpful for improving the quality of the matching of the various databases concerned. In particular, there may be false positive cases where a startup has been associated with a trade mark applicant even though the two firms are not related. A random check of the matched data has shown that due to the requirement for an exact match of names, the number of such cases is relatively low, and that they mainly concern firms that are relatively frequent in a given country.

The data lacks some potentially important control variables which, if included in the models, could help to more precisely assess the relationship between the IPR activity of startups, their access to venture finance and exit. In particular, the dataset does not contain data on founders, their previous experience, education or specific skills. Those characteristics may be correlated with the propensity of firms to protect their intellectual assets by applying for patents or trade marks, as well as with the probability of participating in financing rounds and a successful exit. Future studies may improve the estimations by including such founder-related variables in their models.

The present study spans over 20 years of startup activity in Europe. During this time, VC activity and the number of acquisitions and IPOs has gone through various periods of ups and downs. VC funding or better exit terms may

be more easily accessible for startups during periods of healthy economic growth than during a recession. Also, various policy programmes have been established during recent decades to incentivise VC activity in different European countries. Controlling for those economic conditions or policy initiatives may allow future research projects to better capture the relationship between IPR applications and the odds of participation in VC financial rounds or exit.

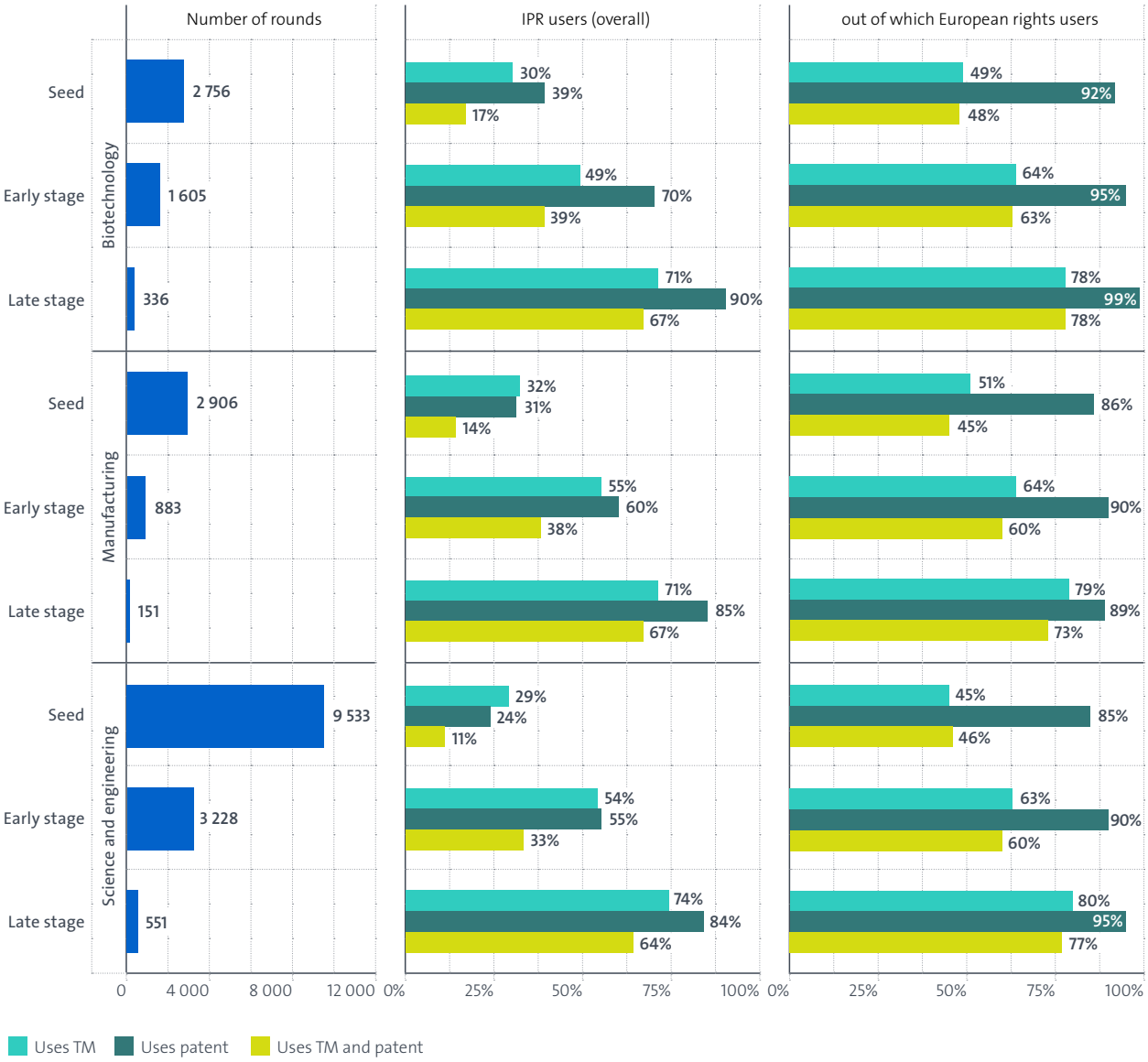
There are also other firm-related variables that may be useful for more precisely estimating the relationship between IPR and access to finance or exit, such as firms' employment or sales. However, those variables are not available in sufficient detail, and for that reason they could not be included in the models.

Annex 1 Additional details

Shares of startups with IPR at different stages of funding by sector and by IP right

Figure A1

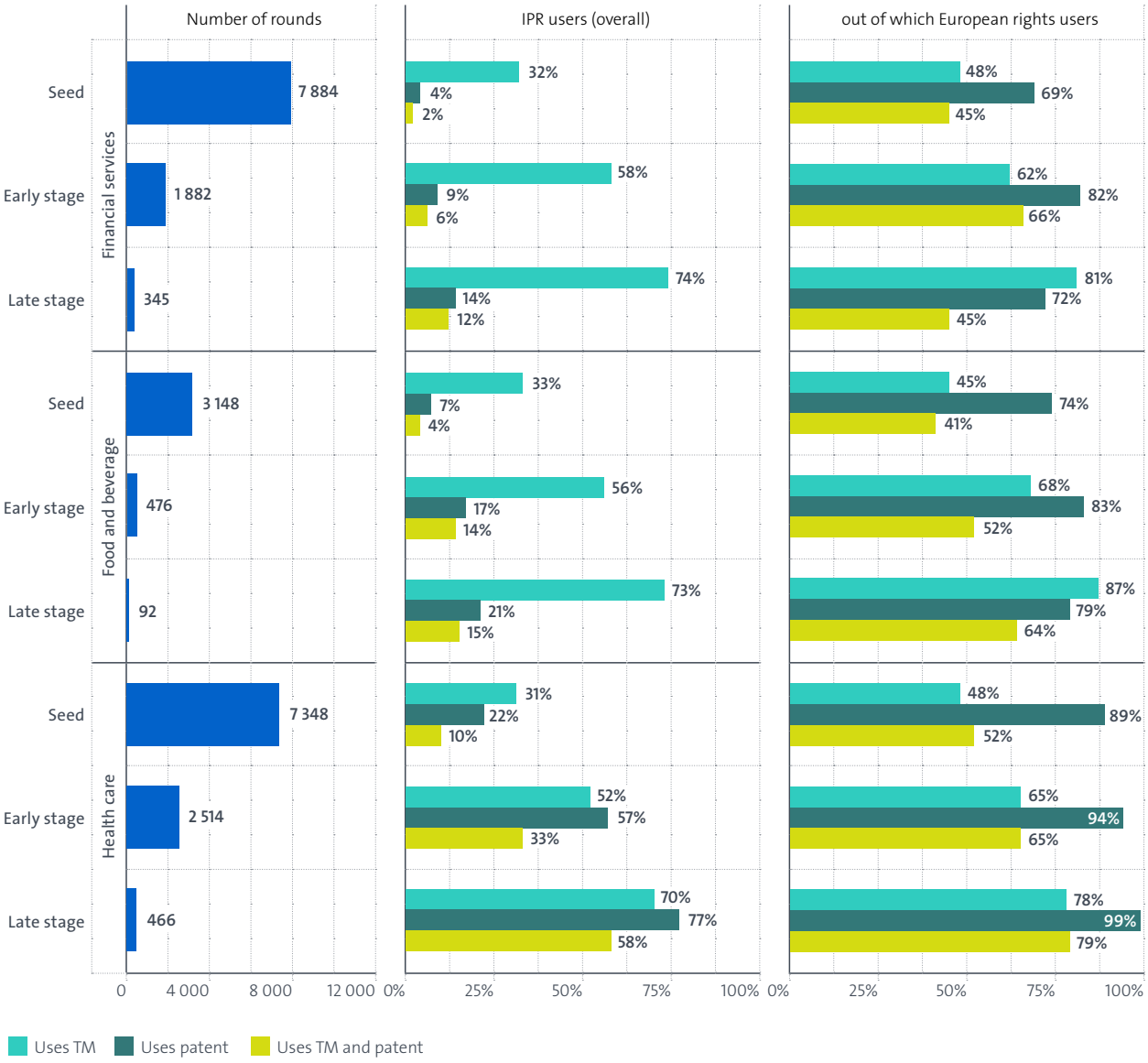
Share of startups with IPR at different stages of financing. Sectors using patents intensively



Note: The first panel presents the number of events in each stage of financial rounds. The second panel shows the share of startups having applied for the various combinations of IPR prior to the date of the financial round. The third panel presents the share of IPR users within each category that applied for protection of EUTM, European patent or both prior to the date of the financial round.

Figure A2

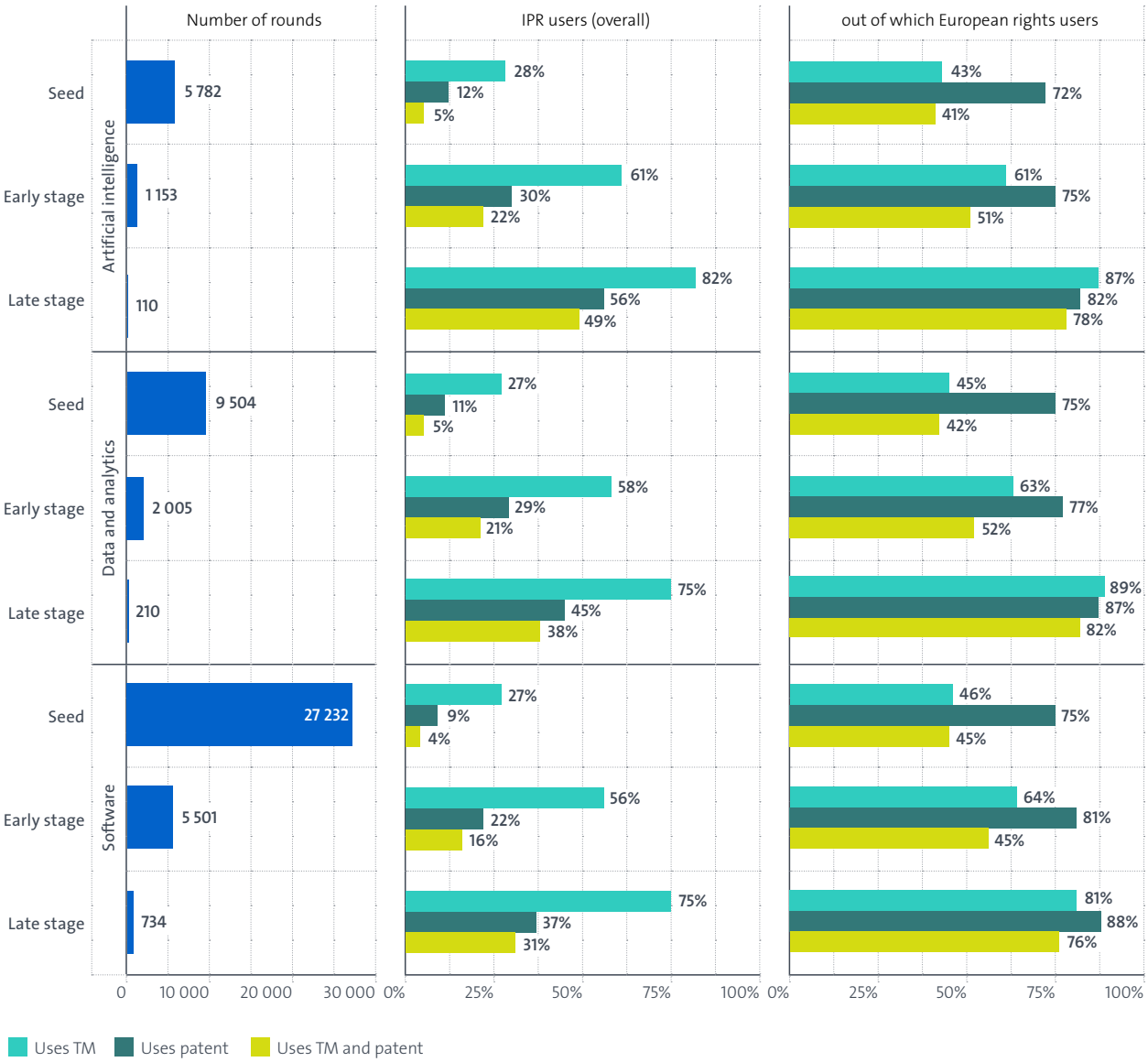
Share of startups with IPR at different stages of financing. Sectors using trade marks intensively



Note: The first panel presents the number of events in each stage of financial rounds. The second panel shows the share of startups having applied for the various combinations of IPR prior to the date of the financial round. The third panel presents the share of IPR users within each category that applied for protection of EUTM, European patent or both prior to the date of the financial round.

Figure A3

Share of startups with IPR at different stages of financing. Digital sectors



Note: The first panel presents the number of events in each stage of financial rounds. The second panel shows the share of startups having applied for the various combinations of IPR prior to the date of the financial round. The third panel presents the share of IPR users within each category that applied for protection of EUTM, European patent or both prior to the date of the financial round.

References

Aggarwal, V. A., and Hsu, D. H., "Entrepreneurial exits and innovation". Management Science, 2014, 60(4), 867-887.

Arora, A., Ceccagnoli, M., Cohen, W. M., "R&D and the patent premium", International journal of industrial organization, 2008, 26(5), 1153-1179.

Arora, A., Fosfuri, A., and Gambardella, A., "Markets for Technology and Their Implications for Corporate Strategy", Industrial and Corporate Change 10(2), 2001, 419–451.

Arqué-Castells, P., "How Venture Capitalists Spur Invention in Spain: Evidence from Patent Trajectories", Research Policy 41(5), 2012, 897– 912.

Block, J. H., de Vries, G., Schumann, J. H., and Sandner, P., "Trademarks and Venture Capital Valuation", Journal of Business Venturing 29(4), 2014, 525–542.

Brant, J., Lohse, S., "Enhancing intellectual property management and appropriation by innovative SMEs", ICC (International Chamber of Commerce) Innovation and Intellectual Property Research Paper (1), 2013.

Catalini, C., Guzman, J., and Stern, S., "Passive versus active growth: Evidence from founder choices and venture capital investment", Technical Report. National Bureau of Economic Research, 2019.

Ciaramella, L., Heller, D., Leitzinger, L., "Intellectual property as loan collateral", 2022, available at SSRN.

Chen, S., Meng, W., and Lu, H., "Patent as a Quality Signal in Entrepreneurial Finance: A Look Beneath the Surface", Asia-Pacific Journal of Financial Studies 47, 2018, 280–305.

Colombo, O., "The Use of Signals in New-venture Financing: A Review and Research Agenda", Journal of Management 47(1), 2021, 237–259.

Colombo, O., Guerini, M., Hoisl, K., and Zeiner, N., "The Dark Side of Signals: Patents Protecting Radical Inventions and Venture Capital Investments", Research Policy 52(5), 2023.

Conti, A., Thursby, J., and Thursby, M.,. "Patents as Signals for Startup Financing", Journal of Industrial Economics 16, 2013, 592–622.

Cox, D. R. "Regression Models and Life-tables", Journal of the Royal Statistical Society: Series B (Methodological) 34(2), 1972, 187-202.

Dalle, J., den Besten, M. and Menon, C., "Using Crunchbase for economic and managerial research", OECD Science, Technology and Industry Working Papers, No. 2017/08, OECD Publishing, Paris.

Dealroom/Sifted, "European Startups. The definitive data behind the past, present and future of European tech", 2022.

De Rassenfosse, G., Fischer, T., "Venture debt financing: Determinants of the lending decision", Strategic Entrepreneurship Journal, 2016, 10(3), 235-256.

Duruflé, G., Hellmann, T., and Wilson, K. E., "From startup to scale-up: Examining public policies for the financing of high-growth ventures", Bruegel Working Paper, No. 2017/04. Bruegel, Brussels, 2017.

European Innovation Council, "Backing visionary entrepreneurs. Realising the Deep-Tech Entrepreneurial Talent of Europe", Report of the EIC expert group on design of the EIC Marketplace and Tech to Market activities. April 2002.

EPO, "Unlocking untapped value: EPO SME case studies on IP strategy and IP management", 2017.

EPO, "Market success for inventions. Patent commercialisation scoreboard: European SMEs", 2019.

EPO/EIB, "Deep tech innovation in smart connected technologies. A comparative analysis of SMEs in Europe and the United States", 2022.

EPO/EUIPO, "High-growth firms and intellectual property rights. IPR profile of high-potential SMEs in Europe", May 2019.

EPO/EUIPO,. "Intellectual Property Rights and firm performance in the European Union", Firm-level analysis report, 2021.

Farre-Mensa, J., Hegde, D., Ljungqvist, A., "Do patents facilitate entrepreneurs' access to venture capital", Harvard Business School, Harvard, MA, 2016.

Farre-Mensa, J., Hegde, D., Ljungqvist, A., "What is a patent worth? Evidence from the US patent "lottery". The Journal of Finance, 2020 75(2), 639-682.

Flikkema, M., De Man, A.-P., and Castaldi, C.,"Are Trademark Counts a Valid Indicator of Innovation? Results of an In-Depth Study of New Benelux Trademarks Filed by SMEs", Industry and Innovation 21(4), 2014, 310–331.

Fox, J., and Weisberg, S. "Cox proportional-hazards regression for survival data. An R and S-PLUS companion to applied regression", 2002

Gruber, M., "Marketing in New Ventures: Theory and Empirical Evidence", Schmalenbach Business Review 56(2), 2004, 164–199.

Hall, B. H., "The Financing of Innovative Firms", Review of Economics and Institutions 1(1), 2010.

Hall, B., Helmers, C., Rogers, M., Sena, V., "The importance (or not) of patents to UK firms", Oxford Economics Papers, 2013, 65(3), 603-629.

Häussler, C., Harhoff, D., and Müller, E., "To be financed or not... The role of patents for venture capital-financing", ZEW-Centre for European Economic Research Discussion Paper (09-003), 2012.

Hello Tomorrow / Boston Consulting Group, "The Deep Tech Investment Paradox: A call to redesign the investor model", 2021.

Hochberg, Y. V., Serrano, C. J., Ziedonis, R. H., "Patent collateral, investor commitment, and the market for venture lending", Journal of Financial Economics, 2018, 130(1), 74-94.

Hoenig, D., and Henkel, J., "Quality Signals? The Role of Patents, Alliances, and Team Experience in Venture Capital Financing", Research Policy 44(5), 2015, 1049–1064.

Hottenrott, H., Hall, B., and Czarnitzki, D., "Patents as Quality Signals? The Implications for Financing Constraints on R&D", Economics of Innovation and New Technology 25(3), 2016, 197-217.

Hsu, D. H., and Ziedonis, R. H., "Resources as Dual Sources of Advantage: Implications for Valuing Entrepreneurial-Firm Patents" Strategic Management Journal 34(7), 2013, 761–781.

Kleinert, S., "The Promise of New Ventures' Growth Ambitions in Early-Stage Funding:
On the Crossroads between Cheap Talk and Credible Signals", Entrepreneurship Theory and Practice, 2023.

Kortum, S., and Lerner, J., "Assessing the Contribution of Venture Capital to Innovation",
RAND Journal of Economics 31(4), 2000, 674–692.

Lee S., Park G., Yoon B., Park J., "Open innovation in SMEs: An intermediated network model", Research Policy 39, 2010, 290–300

Lee, N., Sameen, H., and Cowling, M.,. "Access to Finance for Innovative SMEs since the Financial Crisis",
Research Policy 44(2), 2015, 370–380.

Lerner, J., "Venture Capitalists and the Oversight of Private Firms", Journal of Finance 50(1), 1995, 301–318.

Lerner, J., "When Bureaucrats Meet Entrepreneurs: The Design of Effective 'Public Venture Capital' Programmes",
The Economic Journal 112(477), 2002, F73-F84.

Long, C., "Patent Signals", The University of Chicago Law Review 69(2), 2002, 625–679.

OECD, "Innovative SMEs and Entrepreneurship for Job Creation and Growth: 'Bologna + 10' High-Level Meeting on Lessons from the Global Crisis and the Way forward to Job Creation and Growth", OECD Publishing, Paris, 2010.

OHIM, "Intellectual property rights and firm performance in Europe: An economic analysis", 2015.

Neuhäusler P., "The use of patents and informal appropriation mechanisms: differences between sectors and among companies", Technovation 32, 2012, 681–693.

Park, H. D., and Steensma, H. K., "When Does Corporate Venture Capital Add Value for New Ventures? ",
Strategic Management Journal 33(1), 2012, 1–22.

PitchBook, "European Venture Report. Q1 2023", 2023.

Quas, A., Mason, C., Compañó, R., Testa, G., and Gavigan, J. P., "The Scale-up Finance Gap in the EU:
Causes, Consequences, and Policy Solutions", European Management Journal 40(5), 2022, 645-652.

Renko, M., Yli-Renko, H., and Denoo, L., "Sold, Not Bought: Market Orientation and Technology as Drivers of Acquisitions of Private Biotechnology Ventures", Journal of Business Venturing 37(1), 2022, 106022.

Schmoch, U., "Service Marks as Novel Innovation Indicator", Research Evaluation 12(2), 2003, 149–156.

Serrano, C., Ziedonis, R. H., "How Redeployable are Patent Assets? Evidence from Failed Startups", 2018, NBER Working Paper No. 24526.

Spence, M., "Job Market Signaling", The Quarterly Journal of Economics 87(3), 1973, 355.

Stuart, T. E., Hoang, H., and Hybels, R. C., "Interorganizational Endorsements and the Performance of Entrepreneurial Ventures", Administrative Science Quarterly 44(2), 1999, 315–349.

Therneau, T., Crowson, C., and Atkinson, E., "Using Time Dependent Covariates and
Time Dependent Coefficients in the Cox Model" Survival Vignettes 2(3), 2017, 1-25.

Torrisi, S., Gambardella, A., Giuri, P., Harhoff, D., Hoisl, K., Mariani, M., "Used, blocking and sleeping patents: Empirical evidence from a large-scale inventor survey", Research policy, 2016, 45(7), 1374-1385.

Veugelers, R., and Schneider, C., "Which IP Strategies Do Young Highly Innovative Firms Choose?", Small Business Economics 50, 2018, 113–129.

Walsh, J. P., Lee, Y. N., Jung, T., "Win, lose or draw? The fate of patented inventions", Research Policy, 2016, 45(7), 1362-1373.

Zhang, L., Ying, G., and Sun, G., "How Patent Signals Affect Venture Capital: The Evidence of Biopharmaceutical Startups in China", Technological Forecasting and Social Change 145, 2019, 93–104.

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