Econometric analysis of the use of systems for the protection of intellectual property in Belgium

Analytical Report | January 2022

economie

FPS Economy, S.M.E.s, Self-employed and Energy

BOIP — Benelux Office for Intellectual Property

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1 / Introduction and literature summary

A whole raft of studies have demonstrated the importance of Small and Medium-sized Enterprises (SMEs) for innovation and economic growth. Given the potential of intellectual property rights (IPR) as a catalyst for research and development and as a means of achieving appropriation, FPS Economy and the BOIP are working to acquire a clear understanding of IPR activities within the Belgian corporate landscape, with a particular focus on the role of SMEs. The findings of this study are instrumental for the design of a customised approach aimed at sensitising Belgian SMEs to the use of various types of IPR.

1.1. The role of SMEs within the economy

During the course of the last century, the role of innovation as a key component in the process of economic growth became generally recognised (Schumpeter, 1912/1934, Solow, 1957; Romer, 1990; Pradhan et al., 2020; Mtar & Belazreg, 2021). In the economy research work that helped establish this insight, the contribution of entrepreneurial businesses (small and medium-sized enterprises SMEs) has been discussed in detail. There are a number of arguments that justify the degree of attention focused on the role of SMEs in shifting technological boundaries.

One clear and obvious argument is the important role played by SMEs in the economic structure of industrialised countries. SMEs are viewed as the backbone of the economy. As the following factsheet reveals, in Belgium they represent 99.8% of all businesses active within the non-financial sector (reference year 2018). They are responsible for 67% of total employment. In respect of these aspects, Belgium reflects the picture for the whole of the EU-28. In terms of added value, the role of SMEs in Belgium (at 63%) is more pronounced than on a European level (56%). In and of themselves, these figures provide sufficient reason to focus attention on the innovative capacity of SMEs as a determining factor in the competitiveness of a country.

Class size	Number of enterprises			Number of persons employed			Value added		
	Belgium		EU-28	Belgium		EU-28	Belgium		EU-28
	Number	Share	Share	Number	Share	Share	Billion €	Share	Share
Micro	572,668	94.6%	93.0%	968,280	34.2%	29.7%	55.5	24.7%	20.8%
Small	27,754	4.6%	5.9%	550,109	19.5%	20.1%	47.8	21.2%	17.6%
Medium-sized	4,221	0.7%	0.9%	426,539	15.1%	16.8%	39.0	17.3%	18.0%
SMEs	604,643	99.8%	99.8%	1,944,928	68.8%	66.6%	142.3	63.3%	56.4%
Large	944	0.2%	0.2%	882,302	31.2%	33.4%	82.5	36.7%	43.6%
Total	605,587	100.0%	100.0%	2,827,230	100.0%	100.0%	224.8	100.0%	100.0%

These are estimates for 2018 produced by DIW Econ, based on 2008-2016 figures from the Structural Business Statistics Database (Eurostat). The data cover the 'non-financial business economy', which includes industry, construction, trade, and services (NACE Rev. 2 sections B to J, L, M and N), but not enterprises in agriculture, forestry and fisheries and the largely non-market service sectors such as education and health. The following size-class definitions are applied: micro firms (0-9 persons employed), small firms (10-49 persons employed), medium-sized firms (50-249 persons employed), and large firms (250+ persons employed). The advantage of using Eurostat data is that the statistics are harmonised and comparable across countries. The disadvantage is that for some countries the data may be different from those published by national authorities.

A second argument relates to the specific role allocated by researchers to (at least a segment of) the SME population. In studies into industrial organisations, for more than a century, the question of how the size of businesses relates to their innovative capacity has been a subject of discussion (Tether et al., 1997; Cohen, 2010; Knott & Vieregger, 2020). Schumpeter (1911) was one of the first to consider the contribution of entrepreneurs to the process of innovation. In his initial work, he places entrepreneurs at the very heart of the 'creative destruction process': they question stagnation and introduce innovations that can result in new products, in the establishment of new industries, or in the fundamental adjustment of existing industries. In his later work (1942), Schumpeter argued that as the corporate landscape matured, monopolistic large companies would take over this role, whereby innovation processes would become more and more routine in established enterprises. In the subsequent discussion, these apparently opposing views of Schumpeter were reconciled. In line with others (Pavitt, 1984; Pavitt et al., 1989; Rothwell, 1989; Scherer and Ross, 1990), Baumol (2002; 2004) introduced further nuance to Schumpeter's vision (1911; 1942). Whereas Schumpeter argued that large enterprises would eventually substitute small enterprises within the free market economy, it is now recognised that established companies and small businesses can play a complementary role in a process in which the smaller businesses (entrepreneurs) are quicker to embrace more radical innovations. A series of empirical studies confirm this perspective (Prusa en Schmitz, 1991; CHI Research, 2003; Baumol, 2004; Block en Keller, 2009; Knott & Vieregger, 2020).

1.2. The use of IPR and the relationship with company performance within SMEs and large companies

The relevant research into their activities in the field of intellectual property underpins the crucial role played by SMEs with regard to innovation. With a view to encouraging activities of this kind, it became particularly relevant to be able to demonstrate the extent to which IPR relates to company performance.

A recent report about IPR and company performance on a European level (EPO & EUIPO, 2021) reveals that IPR has a clear leverage effect on company performance. Moreover, this leverage effect is far more pronounced within SMEs than large companies.

The report shows that owners of IPR within the EU generate considerably more revenue per employee than non-IPR owners. This difference is far more pronounced within SMEs (delta of 68%) than in large companies (delta of 18%). These deltas continue to rise proportionally to the types and combinations of IPR, whereby the highest premiums are achieved by businesses that own trademarks and designs, and by businesses that also own patents. A similar finding is reported in a study into high-growth businesses (EPO & EUIPO, 2019a), whereby a positive relationship was confirmed between IPR activity and the probability of achieving high growth rates in the subsequent years. There is robust evidence across all of these studies that the leverage effect of IPR is more pronounced within SMEs than large companies (see also Andries & Faems, 2013). According to the current study only 3% of the Belgian enterprises obtained an IPR between 2010 and 2019. . The reasons for this discrepancy can best be sought in a lack of knowledge of IPR, combined with high perceived costs and lack of resources within SMEs (Kitching & Blackburn, 1998; Burrone, 2005; Nikzad, 2015; EUIPO, 2019). Tailor-made measures will be needed to remove these obstacles (Enjolras et al., 2015; Viana & Maicher, 2015). A series of European initiatives were recently launched, including the EPO Strategic Plan 2023, the EUIPO Strategic Plan 2025 and the European Commission's SME Strategy (EC, 2020).

The EPO & EUIPO 2019 report referred to above also suggests that businesses are increasingly recognising the value of a combination of intellectual property types. IPR bundles after all reinforce their competitive position and the complementarity between different types of IPR may be a source of additional income as well as reinforcing the financial performance of businesses (EUIPO, 2020).

It has also been determined (at least for patents and trademarks; but not for designs) that the premium is higher for rights at European level than for rights at national (i.e. Benelux) level. Moreover, in comparison with large companies, SMEs focus more on national levels, a fact more clearly pronounced in relation to trademarks (i.e. via Benelux trademarks).

2 / Approach

The empirical findings outlined above and their underlying theoretical models reinforce the relevance of mapping out and monitoring the share of SMEs within development and innovation. That is the aim of this study, for the Belgian corporate landscape. The study comprises two phases.

Phase one involves gathering data and developing a data platform in which IPR data and company characteristics are combined at the level of Belgian businesses. The size classification of businesses is integrated in this platform, whereby a distinction is made between micro, small, medium-sized and large companies. This approach is based on previous studies in which the IPR activity of large companies and SMEs were compared, in order to assess their respective contributions to innovation (CHI Research, 2003; Perrin and Speck, 2004; Jensen and Webster, 2006; Iversen et al., 2009; Keupp et al., 2009; Thoma et al., 2010; Helmers and Rogers, 2011; Squicciarini and Dernis, 2012; Frietsch et al., 2013; Tarasconi & Menon, 2017; Balsmeier et al., 2018; EPO & EUIPO, 2021). Details of the approach employed in this study and their relationship to previous efforts are described in Report 1 of this study: "*Accompanying Report to database "Corporate IP in Belgium"*.

Phase two comprises applied analyses, based on the dataset developed in phase one. This report is a discussion of this analytical phase. Based on descriptive statistics and econometric analyses, the relationship between company size and IPR profiles is analysed, with a view to determining the extent to which these IPR profiles influence company performance. In these analyses, the difference between SMEs and large companies is specifically considered.

3 / Dataset of IPR-active companies

As a result of the previous steps (i.e. the matching (and validation) of enterprises that have acquired IPR, with the Bel-first database), we developed an IPR dataset that contains 15 193 unique Belgian enterprises (counted on the basis of a unique BvD number) that acquired at least a single intellectual property right in the period from 2010 through to 2019, legally valid in Belgium or beyond[1].

Based on the Bel-first and IP databases, indicators were developed that make it possible to conduct statistical analyses aimed at answering the research questions. These variables are IPR-related variables, company-specific variables and variables relating to company performance. The variables used are briefly explained below.

3.1.   IPR-related variables

In this study, we examine four types of IPR for each company:

▶   Design rights

▶   Trademark rights

▶   Plant breeders' rights

▶   Patents

We assess a variety of indicators for each type of intellectual property right. Firstly, the variables relating to the various types of IPR are explained below. We then also consider overarching variables, namely total IPR and IPR scope.

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[1] In the remainder of this report, reference is regularly made to 'all companies with IPR'. It is important to note that wherever used, this refers to companies that acquired IPR in the period 2010 through to 2019.

3.1.1 Variables relating to the IPR types

Design rights. A design right protects the external appearance of a product or part of a product. The external aspect of a product is composed of the lines, circumference, colours, shape, texture or materials of the product itself, or of its decoration[2].

This study considers design rights of Belgian holders, with national (Benelux) and international validity, in the period 2010-2019. The data sources for the design rights are: BOIP (Benelux), EUIPO (European) and WIPO (International)[3].

Table 1 Variables relating to design rights

ds_dum	Company has at least a single design right valid in the Benelux or beyond	0/1
ds_be	Number of design rights held by the company valid in the Benelux	Number
ds_be_dum	Company has at least a single design right valid in the Benelux	0/1
ds_eu	Number of design rights held by the company valid in Europe	Number
ds_eu_dum	Company has at least a single design right valid in Europe	0/1
ds_intl	Number of design rights held by the company valid outside Europe	Number
ds_intl_dum	Company has at least a single design right valid outside Europe	0/1
ds_sum	Total number of design rights held by the company	Number
ds_dif	Indicates whether the company has one, two or three types of design rights (of different types: valid in Benelux, Europe or beyond Europe).	Variable adopts value 0, 1, 2 or 3

Trademark rights. A trademark is a mark used by an enterprise to identify its products and services. Thanks to that mark, the public can distinguish between products and services placed on the market by another company. In order to acquire the trademark right for a mark, being the first to use this mark is not sufficient. Firstly, a mark must be registered for specific categories of goods and services. As soon as the trademark is registered, the holder acquires a number of exclusive rights to the use of the mark which is protected from that moment.[4]

This study considers trademark rights of Belgian holders, with national (Benelux) and international validity, in the period 2010-2019. The data sources for the design rights are: BOIP (Benelux), BOIP and EUIPO (European) and BOIP (International).

Table 2 Variables relating to trademark rights

tm_dum	Company has at least a single trademark right valid in the Benelux or beyond	0/1
tm_be	Number of trademark rights held by the company valid in Benelux	Number
tm_be_dum	Company has at least a single trademark right valid in the Benelux	0/1
tm_eu	Number of trademark rights held by the company valid in Europe	Number
tm_eu_dum	Company has at least a single trademark right valid in Europe	0/1
tm_intl	Number of trademark rights held by the company valid outside Europe	Number

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[2] https://economie.fgov.be/nl/themas/intellectuele-eigendom/intellectuele-eigendomsrechten/tekeningen-en-modellen; www.boip.int
[3] For more details, refer to the accompanying report to phase 1 of the study (*"Report 1 – Accompanying Report to database "Corporate IP in Belgium"*)
[4] https://economie.fgov.be/nl/themas/intellectuele-eigendom/intellectuele-eigendomsrechten/merken; www.boip.int

tm_intl_dum	Company has at least a single trademark right valid outside Europe	0/1
tm_sum	Total number of trademark rights held by the company	Number
tm_dif	Indicates whether the company has one, two or three types of trademark rights (of different types: valid in Benelux, Europe or international).	Variable adopts value 0, 1, 2 or 3

Patents. A patent is an exclusive right to an invention according to which you can forbid another party from commercial application of the invention in a specified legal area, for a specified period. As a rule, an invention is a technical solution to a specific problem. It may relate to a product or a process or a specific application. An invention can be patented if it is new, can be industrially applied and is the result of inventive activity.[5]

This study considers patents of Belgian holders, with national (Benelux) and international validity, in the period 2010-2019. The data sources for patents are: FOD register and PATSTAT (National), PATSTAT (European) and PATSTAT (International). An additional count was performed at patent family level; it is after all possible for one and the same invention to be patented via different routes. The count at family level, rather than at individual document level, removes duplications across validity levels (national / European / international). However, for the intended purpose of this study, the decision was taken to count at individual document level, and not to remove duplications for different regions and validity. After all, for this study, it is relevant to make a distinction between an SME with a portfolio that contains exclusively national applications for a specific invention on the one hand, and an SME is that seeking both national and international protection for the same invention, on the other.

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[5]https://www.vlaanderen.be/octrooi-of-patent

Table 3 Variables relating to patents

pat_dum	Company has at least a single patent valid in Belgium or beyond	0/1
pat_be	Number of patents held by the company valid in Belgium	Number
pat_be_dum	Company has at least a single patent valid in Belgium	0/1
pat_ep	Number of patents held by the company valid in Europe	Number
pat_ep_dum	Company has at least a single patent valid in Europe	0/1
pat_frgn	Number of patents held by the company at a foreign, national patent office	Number
pat_frgn_dum	Company has at least a single patent at a foreign, national patent office	0/1
pat_intl	Number of patents held by the company obtained via the PCT route (worldwide)	Number
pat_intl_dum	Company has at least a single patent obtained via the PCT route (worldwide)	0/1
pat_sum	Total number of patents held by the company	Number
pat_fam_docdb	Total number of patent families held by the company	Number

Plant breeders' rights. Whenever a plant breed satisfies a number of conditions, such as novelty, distinguishability, homogeneity and resistance, a plant breeders' right can be applied for. The plant breeders' right grants the breeder a number of exclusive rights to the cultivation of and trade in the new plant breed. No one else is permitted to cultivate or trade the variety for commercial purposes without the breeder's consent. Plant breeders' rights are valid for 30 years for trees, vines and potatoes, and 25 years for other plant varieties, unless they lapse earlier, for example if the breeder fails to pay the maintenance charges.

This study considers plant breeders' rights of Belgian holders, with national (Benelux) and European validity, in the period 2010-2019. The data sources for the plant breeders' rights are: BOIP register (National) and CVPO register (European).

Table 4 Variables relating to plant breeders rights

plant_dum	Company has at least a single plant breeders' right valid in Belgium or beyond	0/1
plant_be	Number of plant breeders' rights held by the company valid in Belgium	Number
plant_be_dum	Company has at least a single plant breeders' right valid in Belgium	0/1
plant_eu	Number of plant breeders' rights held by the company valid in Europe	Number
plant_eu_dum	Company has at least a single plant breeders' right valid in Europe	0/1
plant_sum	Total number of plant breeders' rights held by the company	Number
plant_dif	Indicates whether the company has one or two types of plant breeders' rights (with different types valid in Belgium or Europe).	Variable adopts value 0, 1 or 2

3.1.2　Overarching variables

We then included two overarching IPR variables in the analyses, namely the total number of IPR held by a company between 2010 and 2019, and the number of different types of IPR held by a company.

Table 5 Overarching variables

Total IPR	Total number of intellectual property rights held by the company (all four types together)	Number ds_sum + tm_sum + pat_sum + plant_sum
IPR scope	Total number of different types of intellectual property rights held by the company (value from 1 to 4)	Number ds_dum + tm_dum + pat_dum + plant_dum

3.2.　Company-specific variables

In addition to IPR-related variables, the dataset also contains a number of variables relating to important company-specific characteristics. These variables were created on the basis of the data provided in Bel-first.

Age. The age of the company is determined by looking up the year of establishment of the company in Bel-first.

Status. By definition, the enterprises in our dataset have acquired at least a single type of intellectual property right in the period between 2010 and 2019. It is therefore possible that since acquiring their IPR, enterprises have ceased their activity. It is possible to see in Bel-first whether a company is or is not currently active. More specifically, the enterprises are divided into four possible categories, namely active, inactive, provisional legal situation or unknown. Only active companies are included in the multivariate analyses[6]. For this purpose, we have created the dummy variable *active*. This variable acquires the value 1 if the company is active and the value 0 if the status of the company is recorded as inactive, provisional legal situation or unknown.

Sector. The sector in which the company is active is determined by the NACE code for the company, appearing in Bel-first. More specifically, an overview is provided in the next chapter of the 'NACE section' (i.e. the letter (from A to U) that corresponds to the activities of the company) and of the 'NACE department' (i.e. the more detailed two-figure code that corresponds to the activities of the company). For the multivariate analyses, the NACE sections are further divided into 6 classes, namely the 5 most frequently occurring sections, and a class 'other', that combines the less frequently occurring sections. The 5 most frequently occurring sections are: sector section G (Wholesale and retail trade; repair of motor vehicles and motorcycles), sector section M (Professional scientific and technical activities), sector section C (Manufacturing), sector section J (Information and communication) and sector section N (Administrative and support service activities).

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[6] Measured at the time of the study and the development of the variables, i.e. spring - summer 2021

Location. Information from Bel-first about the province in which the company is established is used for the descriptive analysis. In the multivariate analyses, the *region* in which the company is established is used as a location variable. The variable region contains 3 categories: Flanders, Wallonia and Brussels-Capital Region.[7]

Company size. A key variable in this study is the size of the company[8], and whether the company satisfies the definition SME:

▶ Based on the Bel-first data, we first and foremost distinguish between *size classes* of enterprises. To allocate these classes, we first started with the size classification from the European Commission based on the number of persons employed and turnover or balance sheet total (see Table 6).[9] In this way we were able to allocate 9846 enterprises to a size class. Because many companies do not report the number of persons employed, we received many 'unknown' results. The decision was then taken to further supplement the 'unknown' values on the basis of (1) the variable 'range of employees'[10], which in certain cases were available in Bel-first if the specific number of employees is not given per year, or (2) taking account only of the balance sheet total since, unlike turnover and employment/numbers of persons employed, this figure generally is provided. In this way, we allocated five company categories: 'micro', 'small', 'medium-sized', 'large' and 'unknown'.

Table 6 Definition SME and European Commission categories

Category	Number of persons employed	Turnover		Balance sheet total
Micro	< 10	≤ 2 m EUR	OR	≤ 2 m EUR
Small	< 50	≤ 10 m EUR		≤ 10 m EUR
Medium-sized	< 250	≤ 50 m EUR		≤ 43 m EUR

▶ When it then comes to determining whether the company can be classified in the dataset as *SME*, as well as being classified a micro, small or medium-sized, the company must also satisfy the *autonomous enterprise criterion.* More specifically, according to the definition employed by the Flemish government[11], not more than 25% of the business may be held by an enterprise that does not satisfy the SME definition. Within this study, we assessed this autonomous enterprise criterion on the basis of the information about the ownership structure of the business (global ultimate owners or GUO), available in Bel-first. More specifically, we considered whether an enterprise is an autonomous business (i.e. it has no GUO) or it is part of a larger group of companies (i.e. does have a GUO). If the company does have a GUO, a check is carried out to determine whether this

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[7] Measured at the time of the study and the development of the variables, i.e. spring - summer 2021
[8] Measured at the time of the study and the development of the variables, i.e. spring - summer 2021
[9] To determine the size class, we started with the figures for 2019, unless these were not provided, and then took the figures for the last two available years in Bel-first.
[10] 'Range of employees', available in Bel-first, provides an interval in the number of persons employed (i.e., 1-4; 5-9; 10-19; …; 500-999; +1000)
[11] see also: https://www.vlaanderen.be/economie-en-ondernemen/financiering/een-kmo-volgens-de-europese-kmo-definitie-kleine-of-middelgrote-onderneming:

GUO can be classified as micro, small or medium-sized. Due to a lack of data, here we classified the GUO as micro, small or medium-sized, if the balance sheet total of the GUO was not more than 43 million euro. This decision making process is depicted in Figure 1. On this basis, the variable SME acquires the value 1 if the enterprise is an SME, 0 if the company is not an SME and no value is entered if insufficient data are available to make a determination (unknown).

Figure 1 Decision tree autonomous enterprise criterion SME
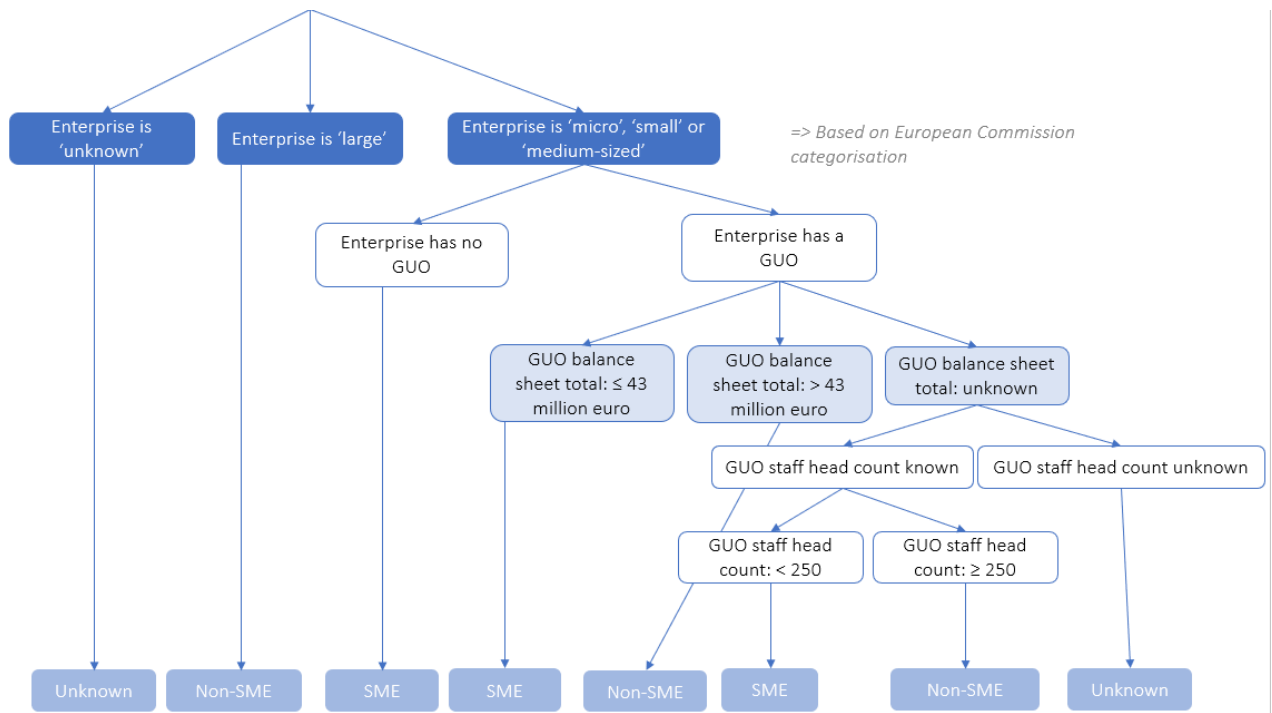
Multinational character. To determine the multinational character of IPR-active enterprises, we constructed a variable once again based on information from Bel-first about the ownership structure of the company (i.e. the global ultimate owner or GUO). If the company has no GUO or if the GUO of the enterprise is also a Belgian enterprise, we categorise the enterprise as Belgian (variable acquires value 0). If the enterprise has a foreign GUO, we categorise the enterprise as part of a foreign company (variable acquires value 1).[12],[13]

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[12] Measured at the time of the study and the development of the variables, i.e. spring - summer 2021
[13] Other elements could also be relevant in determining the multinational character of the enterprise, such as export and proportion of activities abroad. However, since these data are not available, we only considered the multinational character of the GUO.

3.3.   Company performance

The final set of variables relates to company performance benchmarks that provide insights into the performance of the IPR-active companies. These business indicators are not directly available in Bel-first, but can be calculated on the basis of the figures for employment and the company added value figures.

3.3.1   Growth in employment

We started by calculating the growth in employment (in FTE) at the enterprises for the period from 2015 through to 2019. More specifically, we calculated two types of growth, namely Average Annual Growth Rate (AAGR) and Compound Annual Growth Rate (CAGR). We did not include the year 2020 in the calculations due to the possible distortion of the employment figures due to the COVID-19 pandemic.

Average annual growth rate. The annual growth rate was first calculated for successive years for which the number of employees is known. The following formula was used for this purpose:

$$Annual\ growth\ rate = \frac{Number\ of\ employees_{\,t} - Number\ of\ employees_{\,t-1}}{Number\ of\ employees_{\,t-1}}$$

The average for these annual growth rates was then calculated. On each occasion, the average was calculated for the available annual growth rates[14]. If no growth rate is known, the average annual growth rate remains unknown.

Compound annual growth rate. The compound annual growth rate is calculated according to the formula below. Here, on each occasion, the last possible end value (EV) is used (in this case 2019; or 2018 if 2019 was unknown; or 2017 if 2018 was also unknown; etc.) and the first possible start value (SV; in this case 2015; or 2016 if 2015 was unknown; etc.).

$$Compound\ annual\ growth\ rate = (\frac{EV^{\frac{1}{n}}}{SV}) - 1$$

where EV = end value (i.e. number of employees in last known year); with SV = start value (i.e. number of employees in the first known year); where n = number of years (can range from 4 to 1). If no two or more of these values are known for 2019 through to 2015, the compound annual growth rate remains unknown.

For both growth rates, any **outliers** were recorded: extremely high or extremely low growth percentages are often due to major leaps in employment in specific years. For these cases (i.e. enterprises with an AAGR or CAGR ≤ -80%; or AAGR or CAGR ≥ 400%), we determined whether the leaps in numbers of employees per year were attributable to 'legal events'. For the 46 enterprises in the dataset with extremely high or extremely low growth percentages, we discovered that in 11 cases, the leap in

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[14] For example, if two annual growth rates are known, the average is calculated for those two growth rates.

employment was attributable to an occurrence such as an acquisition, merger, absorption or division of the enterprise.[15] In the further analyses, an indication will be given as to whether the outliers attributable to legal events are included or not.

3.3.2   Productivity

Productivity is calculated as the gross added value of a company per employee. The numerator, i.e. the gross added value of a company, is calculated by deducting from the turnover the value of purchased goods and services at a company. More specifically, this is expressed in accounts: 70/74-740-60-61[16]. This variable is directly available in Bel-first. The denominator is the number of employees (in FTE). The **annual productivity** is calculated for the period between 2015 and 2019. This meant that it was only possible to calculate productivity in a given year if the gross added value and the number of employees in that year were both known.

Because productivity in one year may be subject to external/one-off events, we also calculated the **average productivity** for the enterprises for 2015 through to 2019.

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[15] Of the 46 outliers, 32 enterprises were classified as SMEs. Of the 11 outliers attributable to legal events, 4 were classified as SMEs.
[16] The gross added value of a company is expressed in EUR.
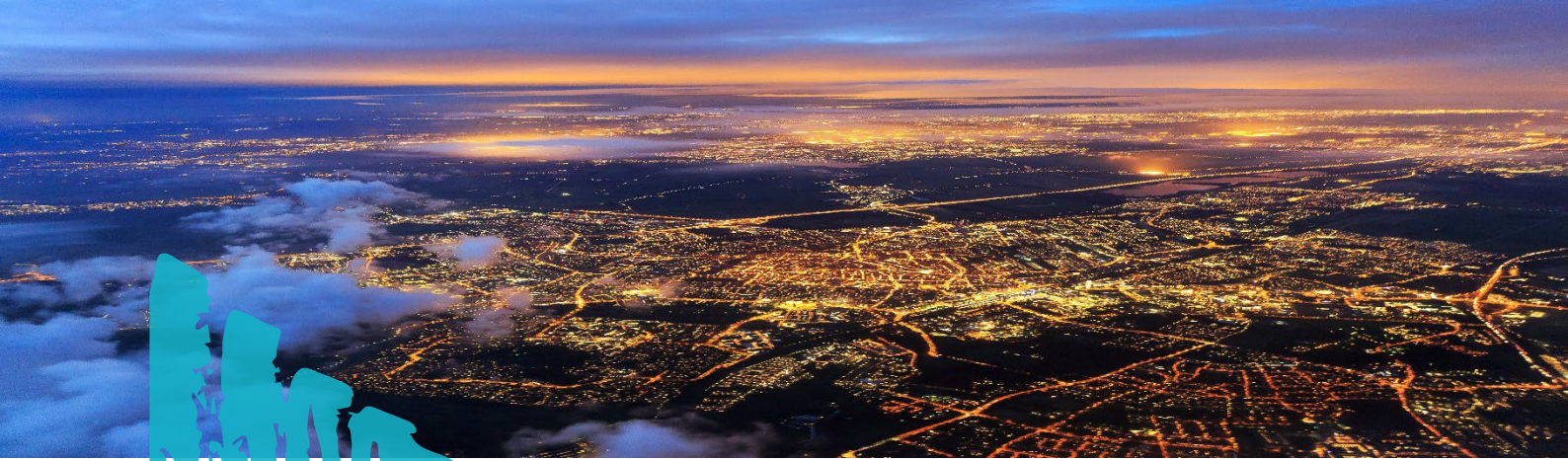
4 / Profile outline of IPR-active enterprises

4.1. The IPR profile of enterprises

In total, we were able to identify 15 193 unique companies that acquired some type of IPR in the period 2010-2019[17]. We first provide an overview of the IPR profile of all enterprises that acquired IPR in that period.

In total, the 15 193 enterprises in our dataset have on average 5.4 intellectual property rights (Table 7).

Table 7 Total IPR per enterprise

Average	s.d.	Min	Max	N
5.4	38.0	1	2 394	15 193

s.d. = standard deviation

Figure 2 shows the distribution of the total number of intellectual property rights held by enterprises in our dataset. This shows that slightly more than half of the companies have a single intellectual property right (i.e. 7737 companies or 50.9%). 2973 companies (or 19.6%) have two property rights, and 1257 (8.3%) have three. 74 companies (or 0.5%) have between 100 and 1000 intellectual property rights and 6 companies (or 0.04%) have more than 1000.

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[17] In the remainder of this report, reference is regularly made to 'all companies with IPR'. It is important to note that wherever used, this refers to companies that acquired IPR in the period 2010 through to 2019.

Figure 2 Distribution of the number of intellectual property rights
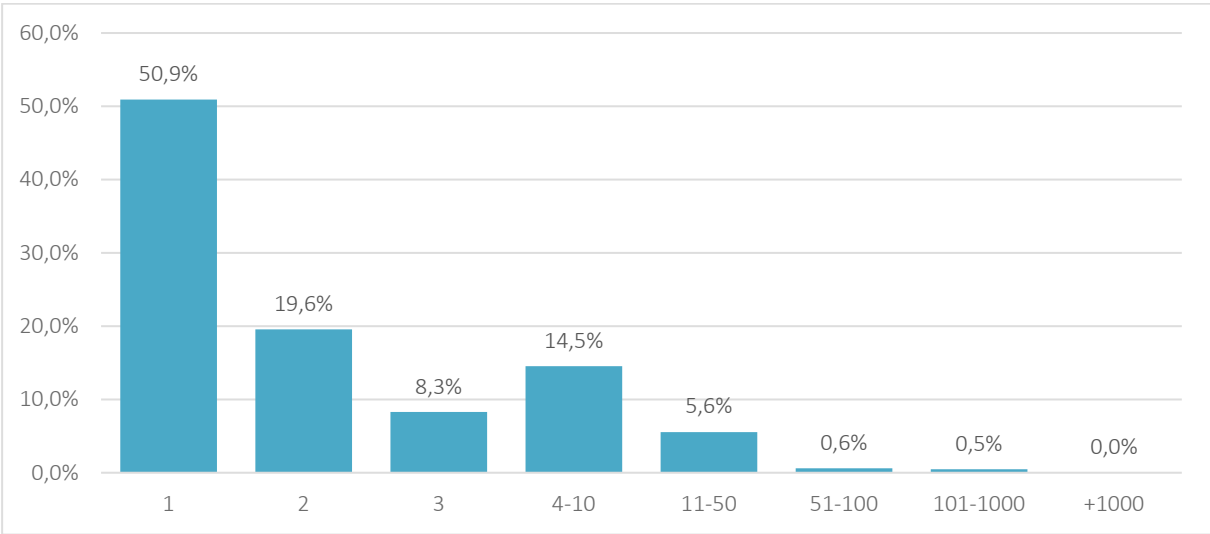
Total, N = 15 193; note, the classes above are unequal.

A breakdown is subsequently made according to the four types of IPR. Below, we provide a summary before discussing the various types in greater detail in the following sections. Figure 3 shows that of the companies in the dataset 90% have at least a single trademark right (i.e. 13634 companies). 17% of the companies have at least a single patent (i.e. 2585 companies) and 7% have at least a single design right (i.e. 1051 companies). Only 26 companies in the dataset have a plant breeders' right.

Figure 3 Various types of IPR
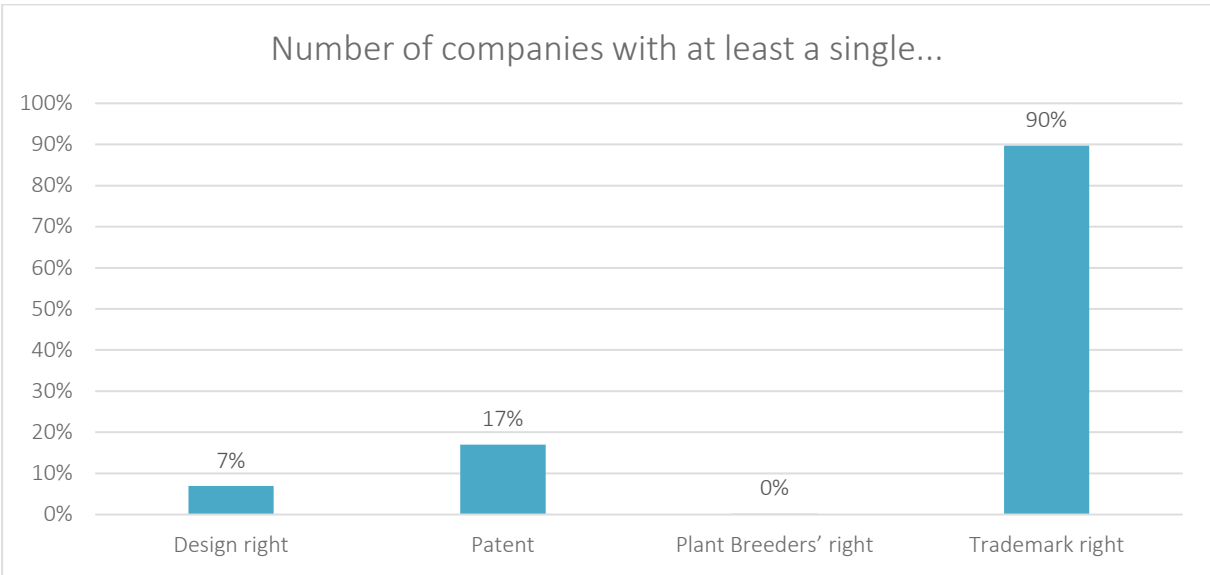
Total number of companies, N = 15 193

4.1.1 Design rights

As shown in Figure 3, 7% or 1051 companies in our dataset have at least a single design right. These companies together hold 9202 design rights. The maximum number of design rights owned by a single company is 867.

Table 8 provides a summary of the design rights according to geographical validity (Belgium, Europe, international). 246 companies have at least a single design right that is valid in Belgium. This coincides with 1.6% of the companies in the complete dataset. 804 companies have at least a single design right valid in Europe (i.e. 5.3% of the companies in the dataset), and 99 companies have at least a single design right that is internationally valid (i.e. 0.7% of the companies in the dataset). We would point out that the 246 companies with a design right in Belgium have a total of 696 design rights in Belgium. This means that a company with a design right in Belgium on average owns 2.8 design rights. The highest number of design rights held by a single company in Belgium is 80. With regard to design rights valid in Europe, 804 companies own a total of 8164 design rights. The highest number of design rights in Europe held by a single company is 865. With regard to international design rights, 99 companies have 342 design rights.

Table 8 Design rights according to geographical validity

	Design right in the Benelux	Design right in Europe	International design rights
Number of companies with at least a single design right (N)	246	804	99
% companies with at least a single design right in dataset	1.6%	5.3%	0.7%
Total number of design rights	696	8164	342
Max. number of design rights at a single company	80	865	57
Average number of design rights per company (according to N)	2.8	10.2	3.5
Standard deviation average number design rights (according to N)	6.5	40.8	6.9

We would also point out that 91% of the companies with at least a single design right has that right for a single geographical area (i.e. either Belgium, Europe or international). 8.7% of the companies have design rights in two geographical categories. 0.3% of the companies with at least a single design right holds that right in all three categories.

4.1.2 Patents

17% or 2585 companies in our dataset have at least a single patent (see Figure 3). These companies together own a total of 29 757 patents. The maximum number of patents held by a single company is 1565.

Table 9 shows a summary of the patents (and not the patent families) according to geographical validity (Belgian, European, PCT and foreign national validity). 1776 companies have at least a single patent valid in Belgium. This coincides with 11.7% of the companies in the complete dataset. 1511 companies have at least a single European patent (i.e. 10.0% of the companies in the dataset). 1064 companies have at least a single patent in a foreign national office (i.e. 7.0% of the companies in the dataset; the majority of these are USPTO patents), and 169 companies (or 1.1% of the companies in the dataset) have at least a single PCT patent.

We would note that the 1776 companies with a patent in Belgium own a total of 5283 patents valid in Belgium. This means that a company with a patent in Belgium on average holds 3 patents. The 1064 companies with a patent in a foreign national office on average hold 11.5 such patents.

Table 9 Patents according to geographical validity

	Belgian Patents	European Patents (EPO)	Foreign national patents	PCT patents
Number of companies with at least a single patent (N)	1 776	1 511	1 064	169
% companies with at least a single patent in dataset	11.7%	10.0%	7.0%	1.1%
Total number of patents	5 283	11 588	12 232	654
Max. number of patents at a single company	330	820	1 160	88
Average number of patents per company (according to N)	3.0	7.7	11.5	3.9
Standard deviation average number patents (according to N)	10.9	37.9	55.0	8.8

We would also point out that 49% of the companies with at least a single patent hold this patent in one of the four above categories. 30% of the companies hold patents in two categories, 18% in three categories and just 3% in all four categories.

4.1.3   Trademark rights

Figure 3 shows that trademark rights are easily the most widely used by IPR-active companies in Belgium: no less than 13 634 companies (or 89.8% of the IPR-active companies) have at least a single trademark right. These companies together have 42 821 trademark rights. The maximum number of trademark rights held by a single company is 771.

Table 10 provides a summary of the use of the trademark rights according to geographical validity (Belgium, Europe, international). 11 699 companies have at least a single trademark right that is valid in Belgium. This coincides with 77.0% of the companies in the complete dataset. 3884 companies have at least a single trademark right valid in Europe (i.e. 25.6% of the companies in the dataset), and 1625 companies have at least a single trademark right that is internationally valid (i.e. 10.7% of the companies in the dataset). We would point out that the 11 699 companies with a trademark right in Belgium have a total of 27 576 trademark rights valid in Belgium. This means that a company with a trademark right in Belgium on average owns 2.4 trademark rights. The highest number of trademark rights held by a single company valid in Belgium is 555. With regard to trademark rights valid in Europe, 3 884 companies own a total of 10 902 trademark rights. The highest number of trademark rights in Europe held by a single company is 161. In respect of international trademark rights, 1 625 companies hold 4 343 trademark rights or on average 2.7 per company.

Table 10 Trademark rights according to geographical validity

	Trademark rights in the Benelux	Trademark rights in Europe	Trademark rights international
Number of companies with at least a single trademark right (N)	11 699	3 884	1 625
% companies with at least a single trademark right	77.0%	25.6%	10.7%
Total number of trademark rights	27 576	10 902	4 343
Max. number of trademark rights at a single company	555	161	370
Average number of trademark rights per company (according to N)	2.4	2.8	2.7
Standard deviation average number trademark rights (according to N)	8.4	6.8	10.0

We would also point out that 78.9% of the companies with at least a single trademark right has that right for a single geographical area (i.e. either Belgium, Europe or international). 16.0% of the companies

have trademark rights in two geographical categories. 5.1% of the companies with at least a single trademark right hold that right in all three categories.

4.1.4   Plant breeders' rights.

Figure 3 shows that a very limited group of 26 companies (or 0.2% of the IPR-active companies) holds at least a single plant breeders' right. Together, these 26 companies have 410 plant breeders' rights. The maximum number of plant breeders' rights held by a single company is 154.

Table 11 provides a summary of the plant breeders' rights valid in Belgium and in Europe. 5 companies have at least a single plant breeders' right that is valid in Belgium. This coincides with 0.03% of the companies in the complete dataset. 23 companies have at least a single plant breeders' right valid in Europe (i.e. 0.15% of the companies in the dataset). We would point out that the 5 companies with a plant breeders' right in Belgium have a total of 9 plant breeders' rights valid in Belgium. This means that a company with a plant breeders' right in Belgium on average owns 1.8 plant breeders' rights. The highest number of plant breeders' rights held by a single company valid in Belgium is 3. With regard to plant breeders' rights valid in Europe, 23 companies own a total of 401 plant breeders' rights. The highest number of plant breeders' rights in Europe held by a single company is 154. These rights are held by the enterprise *PARATY*.

Table 11 Plant breeders' rights according to geographical validity

	Plant breeders' rights in Belgium	Plant breeders' rights in Europe
Number of companies with at least a single plant breeders' right (N)	5	23
% companies with at least a single plant breeders' right	0.03%	0.15%
Total number of plant breeders' rights	9	401
Max number of plant breeders' rights	3	154
Average number of plant breeders' rights (according to N)	1.8	17.4
Standard deviation average number plant breeders' rights (according to N)	0.8	34.7

We also note that 92.3% of the companies with at least a single plant breeders' right (i.e. 24 companies) hold that right for a single geographical area (i.e. either Belgium or Europe). 7.7% (i.e. 2 companies) have plant breeders' rights in the two geographical categories.

4.1.5 Derived summary indicators of IPR activity

4.1.5.1 Total IPR

As stated above, the 15 193 enterprises in our dataset together have 82 190 intellectual property rights. This means that on average, each company in the database has 5.4 intellectual property rights. The maximum number of intellectual property rights held by a single company is 2 394.

4.1.5.2 IPR scope

A second summarising variable, scope, measures how many different types of IPR a company owns. While in theory four types of IPR are studied, the maximum number of types of IPR owned by a single company is three. In other words, not a single company from our dataset owns each of the four types of IPR. On average, a company in the dataset owns 1.13 types of IPR. Figure 4 shows that 13 397 (or 88.2%) of the companies in the dataset own just a single type of IPR; 1 489 (or 9.8%) companies have two different types of IPR and 307 (or 2.0%) own three types.

Figure 4 IPR scope
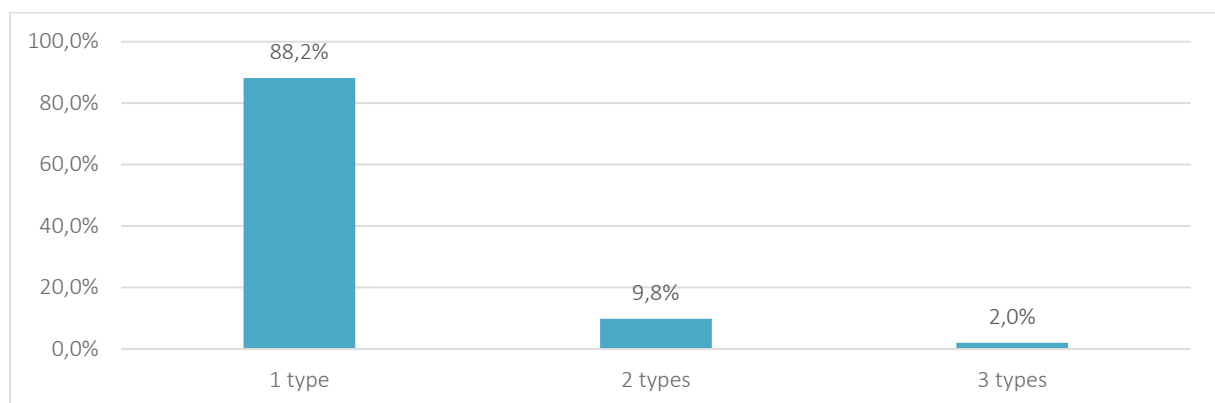
N = 15 193

For the enterprises owning two types of IPR, we studied which combinations occurred most commonly. Figure 5 shows that in most cases, the combination 'patent' and 'trademark right' occurs most commonly (64.8%). The second most frequent combination is design right and trademark right. If we look at the combinations of enterprises with three types of IPR (Figure 6), we see that far and away the most commonly occurring combination is design right, patent and trademark right. This comes as no surprise, since only 26 enterprises in the complete dataset hold a plant breeders' right.

Figure 5 Frequency of combinations of two types of IPR

Patent & Trademark right	64,8%
Design right & Trademark right	28,5%
Design right & Patent	5,8%
Plant breeders' right & Trademark right	0,7%
Patent & Plant breeders' right	0,1%
Design right & Plant breeders' right	0,0%
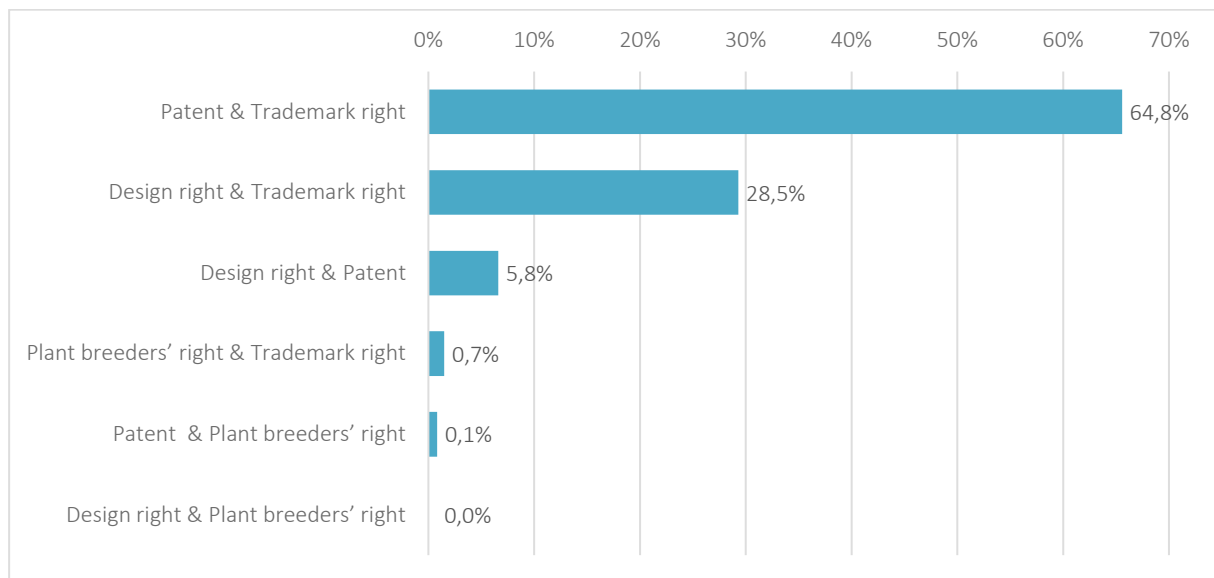
N = 1 489

Figure 6 Frequency of combination of three types of IPR

Design right & Patent & Trademark right	98,4%
Patent & Plant breeders' right & Trademark right	1,3%
Design right & Plant breeders' right & Trademark right	0,3%
Design right & Patent & Plant breeders' right	0,0%
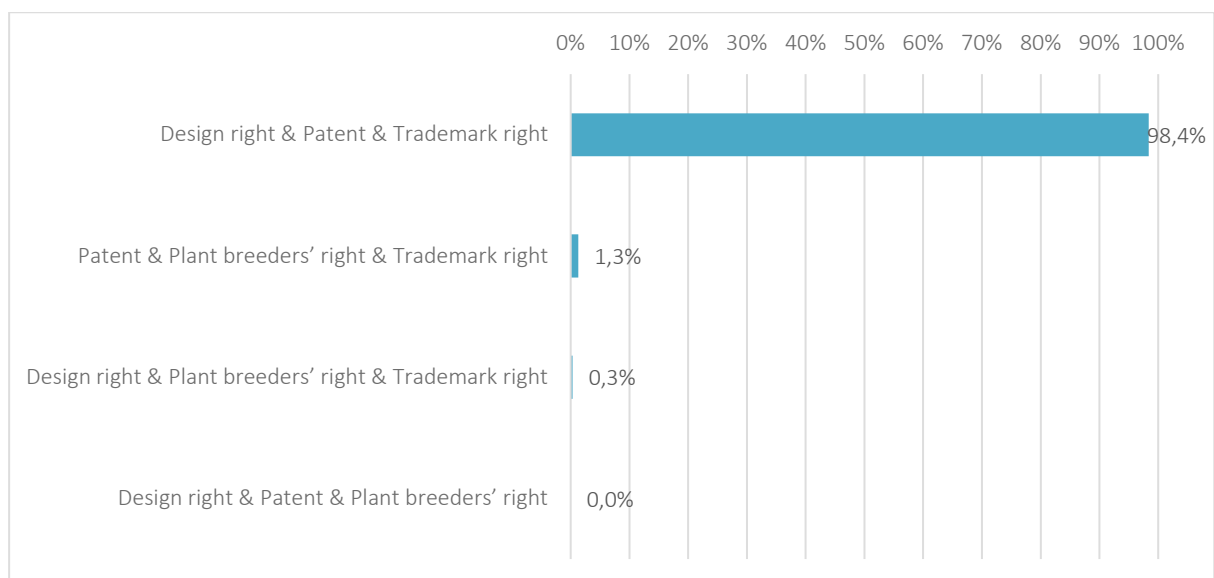
N = 307

4.1.6 IPR Typology

Based on the occurrence of the various IPR types within the group of enterprises studied, a typology was developed for these enterprises, with regard to their IPR portfolios. This was carried out according to a hierarchical clustering (see Figure 7) (Contreras & Murtagh, 2015[18]). In a bottom-up approach of

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[18] Contreras, P. & Murtagh, M. (2015). Hierarchical clustering. In : *Handbook of Cluster Analysis.* Edited by Hennig, C. et al. Chapman and Hall/CRC

this kind, each observation starts in its own basic cluster, and pairs of clusters are combined at each stage, as they rise within the hierarchy.

Figure 7 Agglomerative clustering method
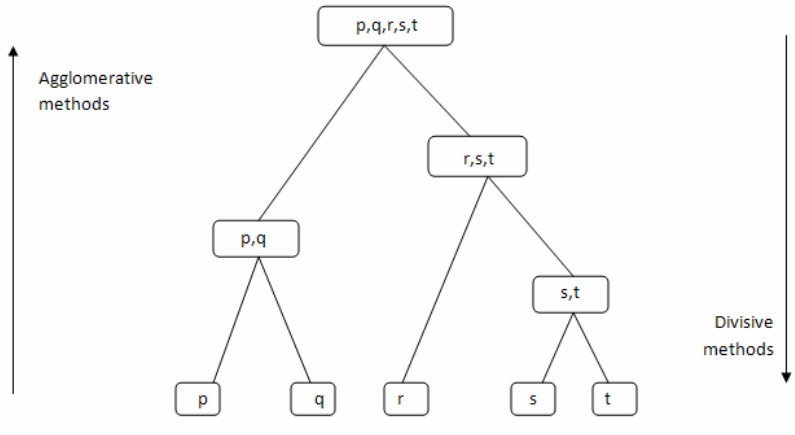
The clusters at the base comprise enterprises with just 1 IPR type. Eight of such single IPR basic clusters are distinguished, whereby a 'single IPR type' consists of the IPR type (trademarks TM; designs DES; patents PAT; plant breeders' rights PL) in combination with the geographical validity (national NAT; international INT[19]). These basic clusters and the number of enterprises within each of them appear in Figure 8.

Figure 8Basis for hierarchical clustering: number of enterprises per single IPR type

8409	1466	476	398	93	132	1	6
TM NAT	TM INT	PAT NAT	PAT INT	DES NAT	DES INT	PL NAT	PL INT

Starting with this basis, the combination of two or more IPR types are mapped out in ascending order, and the number of enterprises in each combination are counted. For the eventual selection of the clusters to be studied in the further analysis, the following criteria applied:

▶ each of the clusters must consist of sufficient enterprises to be analytically meaningful

▶ the total number of enterprises within the selected clusters must represent a sufficiently large proportion of the total number of enterprises in the dataset

▶ the clusters must be mutually exclusive

▶ the clusters must demonstrate sufficient mutual differences in terms of IPR portfolio (scope)

It should be noted that the clusters are based on IPR scope (i.e. which IPR types are combined), whereby the underlying volume of IPR is not taken into account. After all, the aim of the typology is to reflect

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[19] The 'international' dimension comprises both EU and non-EU validity.

differences in terms of IPR behaviour (preferences) and not the related scale/scope (which is driven by the size of the enterprise, R&D investments, etc.).

Table 12 contains a description of which clusters are retained on the basis of the above criteria. The hierarchical cluster diagram is presented in Figure 9: only the retained clusters are shown and each colour represents a separate cluster.

Table 12 Selected IPR clusters

Cluster name	Description	# companies	% companies
TRADEMARKS ONLY NATIONAL	Companies with only trademarks, restricted to the national route (Benelux)	8409	55%
INTERNATIONAL TRADEMARKS	Companies with trademarks, not restricted to the national (Benelux) route	3517	23%
ONLY TRADEMARKS & PATENTS	Companies with only trademarks and patents	758	5%
ONLY PATENTS	Companies with only patents	1226	8%
DESIGNS	Companies with designs (may be combined with patents and/or trademarks)	481	3%
OTHER	All other combinations	802	5%

Figure 9 Hierarchical cluster diagram with number of enterprises per cluster
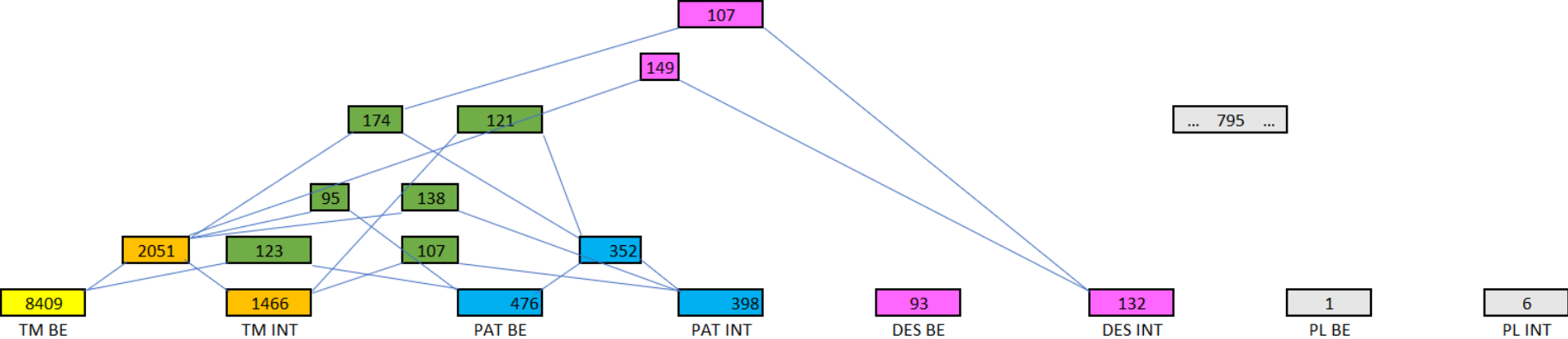
We would point out that the dataset consists of 15 193 Belgian enterprises with at least 1 IPR, acquired in the period 2010-2019, and for which a positive validated match was found in Bel-first. The 5 clusters (excluding the 'Other combinations') in Table 12 cover 95% of these enterprises. The remaining 5% of enterprises are shared over 48 different IPR combinations, and are therefore considered a residual category rather than a separate cluster.

Moreover - and in line with the findings in section 6.1 of this report - it is once again clearly demonstrated that to a considerable extent, trademarks dominate the IPR portfolio of Belgian enterprises: no less than 78% of all enterprises are found in the clusters containing exclusively trademarks (national and/or international).

Annex A.1 reports on an alternative cluster classification whereby the cluster Patents is additionally broken down into national and international validity.

4.2. The characteristics and performance of IPR-active enterprises

Descriptive analyses provide greater insight into the economic characteristics of the Belgian companies active in IPR. We describe the group of companies within each type of intellectual property according to: status, age, sector of activity, location, company size and multinational character. More specifically, in each case, we provide a general overview of what an average company with IPR rights looks like in respect of the characteristic. We then provide insights into the differences for each company characteristic according to the different *types of IPR* owned by the company. We also consider whether and how the company characteristics differ according to the *IPR cluster* to which the enterprises belong (cf. section 6.1.6).

Below we first discuss the status of the complete group of 15 193 companies that acquired IPR between 2010 and 2019. It is important to point out that in the remainder of this report, only those *companies are included that are currently active.*

4.2.1   Status

We start by studying the status of the companies with IPR. It is possible that companies that acquired IPR between 2010 and 2019 are now no longer active[20]. Figure 10 shows that 89% or 13 551 companies are currently still active, 8% (or 1 187 companies) are no longer active. 454 companies or 3% are in a provisional legal situation and the current status of 1 company is unknown.

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[20] At the time of the study and the development of the variables, i.e. spring-summer 2021

Figure 10 Status of companies with IPR
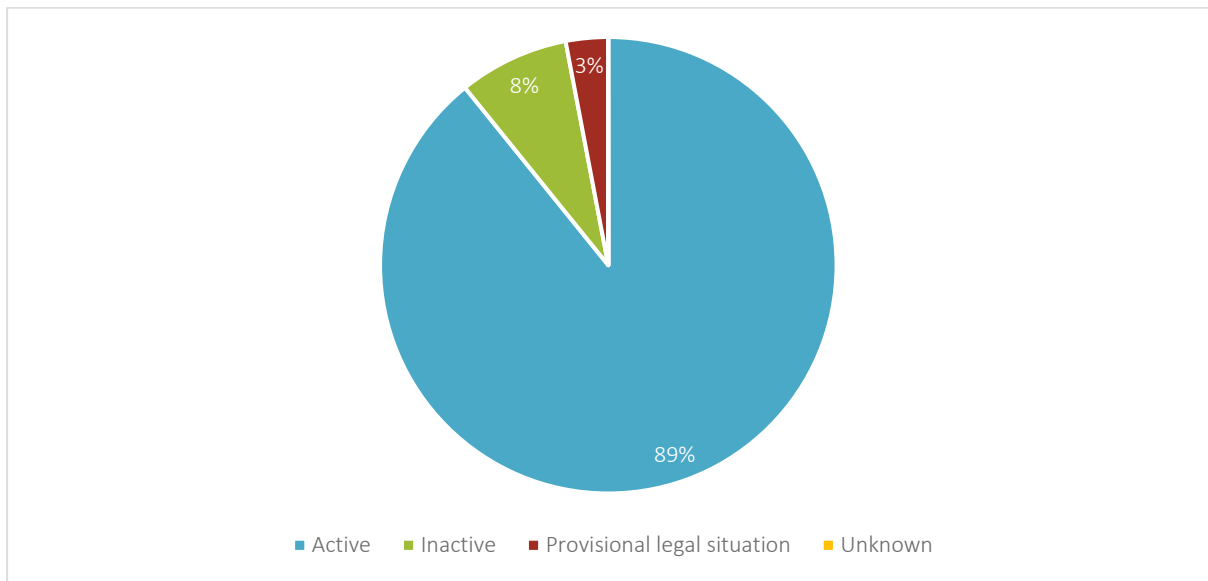
N = 15 193

We then distinguish between the status of the companies according to the various types of IPR they own. Figure 11 shows that 93% of the companies with at least a single design right are still active. For companies with at least a single patent, the share is 90%.

Figure 11 Status according to IPR type
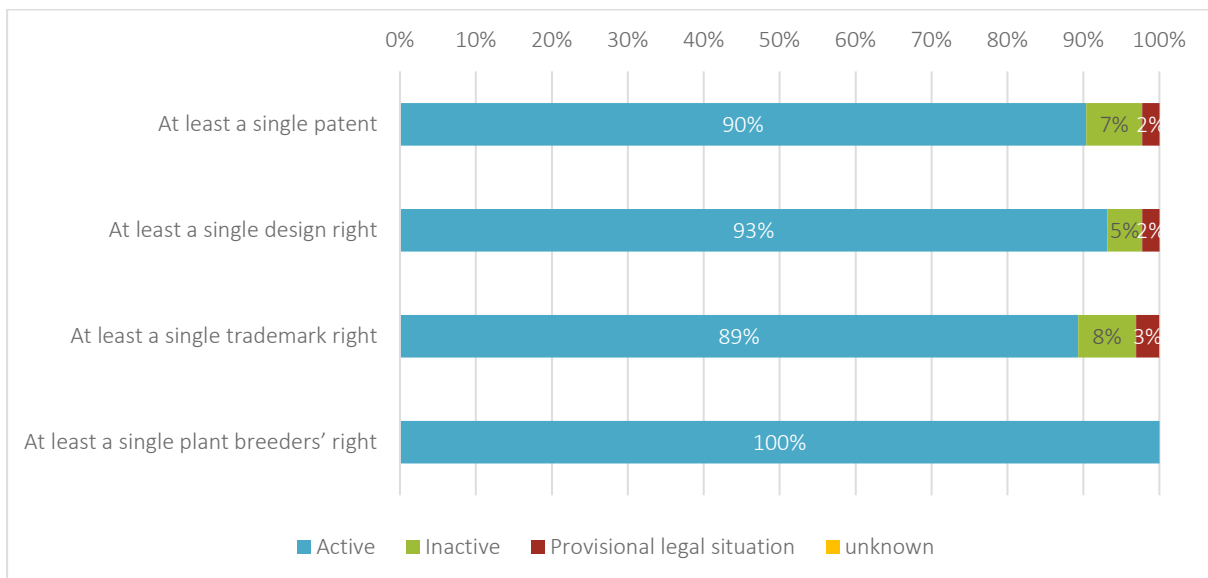
N patents = 2 585; N design rights = 1051; N trademark rights = 13 634; N plant breeders' rights = 26

Below we discuss the company characteristics of the 13 551 companies with IPR that are currently still active.

4.2.2 Age

The average age of the active companies with IPR in our dataset is 20.2 years (s.d. = 16.7; median = 15). The oldest company in the dataset is 202 years old.

Figure 12 shows the number of companies in the various age categories. The majority of companies (i.e. 21%) appear to be in the age category between 5 and 10 years.

Figure 12 Distribution according to age
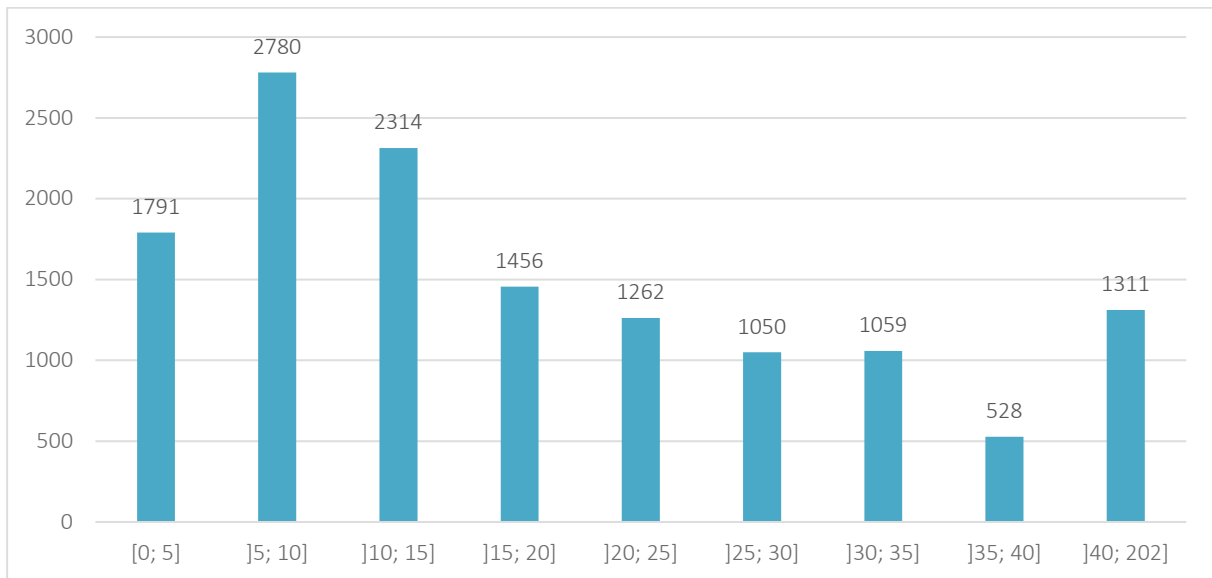
N = 13 551

Figure 13 shows that the companies that have at least a single design right are on average the oldest, at 26.09 years. The group of companies with at least a single trademark right are on average the youngest, with an average age of 19.97 years.

Figure 13 Average age according to IPR type
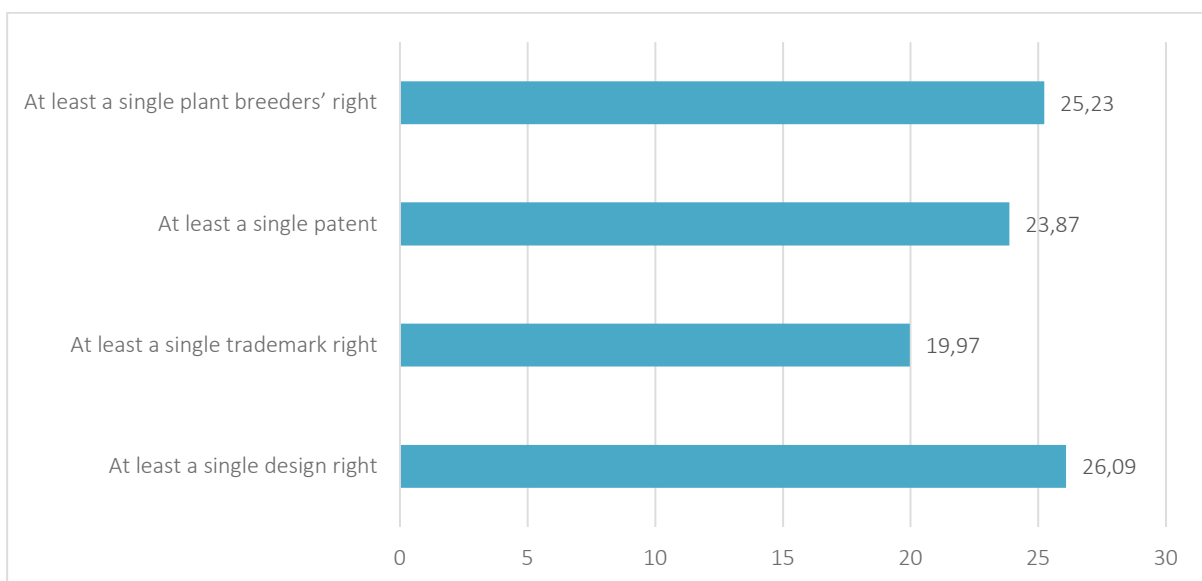
N = 13 551 remember they are not mutually exclusive categories. The average values appear above. The median is respectively (from top to bottom): 22.5; 19; 15; 22

The average age of the companies with a single IPR type is 19.46 years. The average age of companies with two types of IPR is 23.91 years and the average age of a company with 3 types is 31.88 years.

Figure 14 shows the average age of companies for each IPR cluster to which they belong. Companies in the Designs cluster are on average the oldest companies (28 years), those in the National Trademarks cluster are on average ten years younger (18 years). The other clusters are grouped in the age category between the two categories above. A variance analysis (ANOVA) test shows that these age differences between the clusters are significant (ANOVA, $F = 65.99$; $p<0.001$).

Figure 14 Average age according to IPR cluster
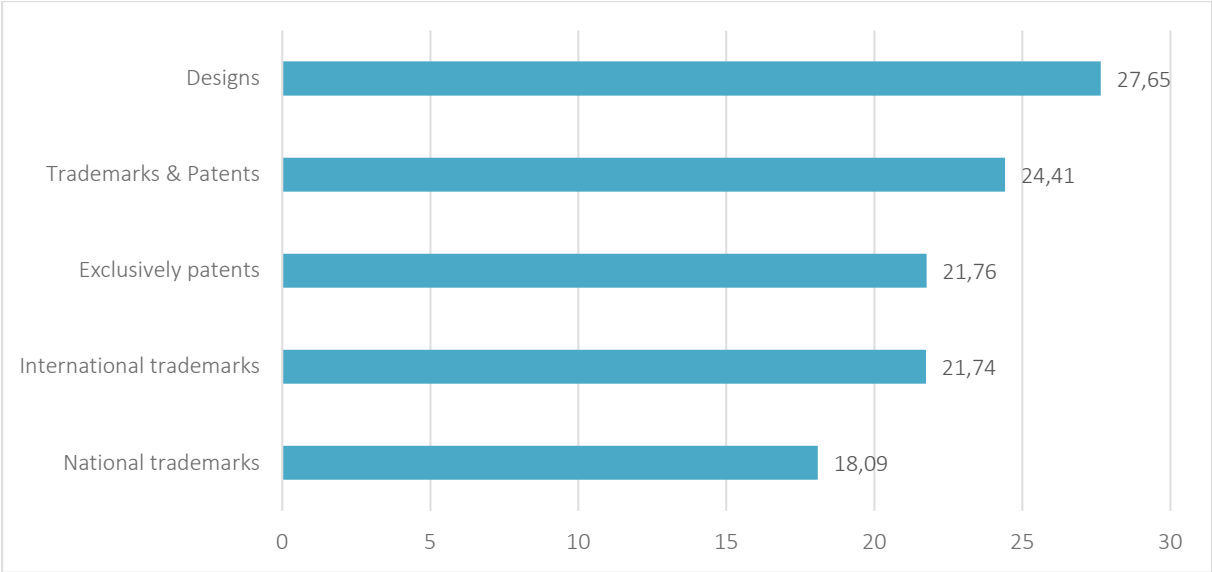
N Designs = 446; N Trademarks & Patents = 702; N Patents = 1073; N International trademarks = 3176; N National trademarks = 7409

4.2.3   Sector

We then studied the sector of activities of the active companies with IPR. Figure 15 provides an overview of the NACE sections for those companies with IPR. 26.6% of the companies with IPR are in the section 'G - wholesale and retail trade'. 17.7% of the companies are in sector 'M - Professional, scientific and technical activities' and 16.4% in sector 'C - Manufacturing'.

If we look in greater detail at the 2-digit numerical NACE code linked to the companies, it becomes clear from Figure 16 that 16.6% of the companies with IPR are in '46 - Wholesale trade, 8.7% in '47 - retail trade' and 8.1% in '70 - activities of head offices; management consultancy activities'.

Figure 15 NACE sections
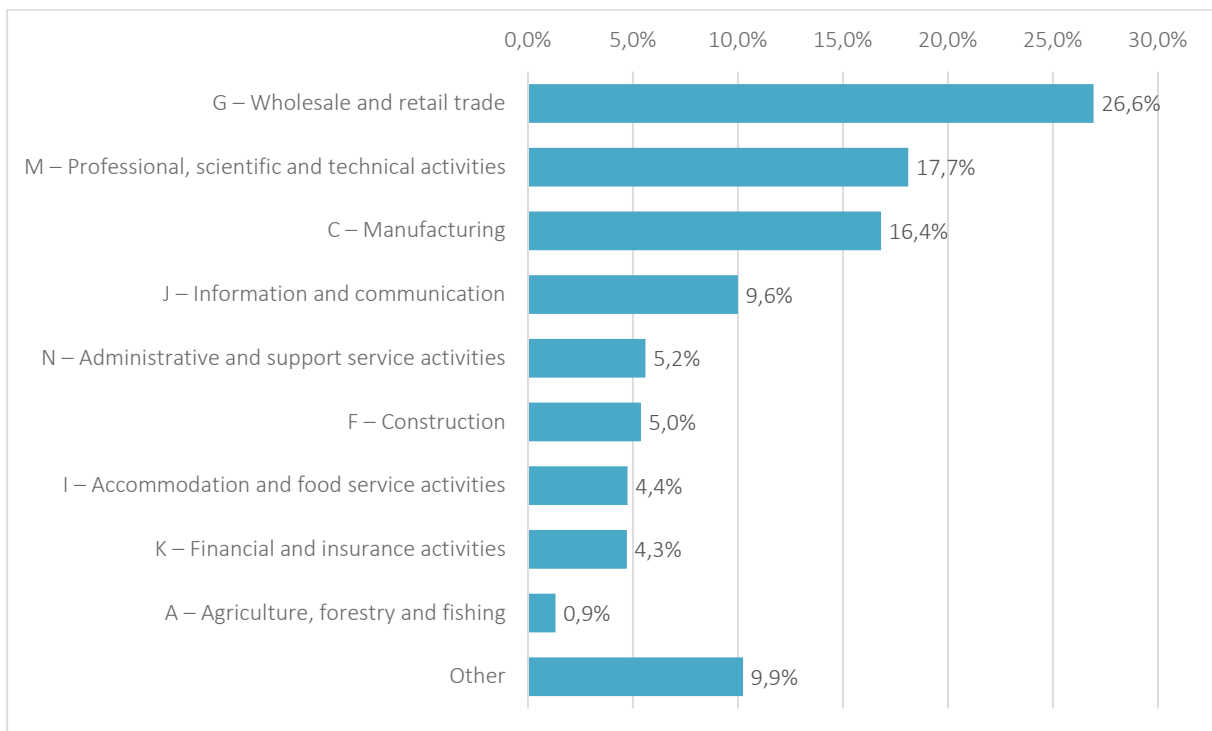
N = 13 289 The NACE code is not available for every enterprise in Bel-first.

By way of comparison, we then considered the distribution of active Belgian companies (with more than 0 employees)[21]. Here we see that 34% is active in sector G, 24% in sector M, 12% in sector C and 8% in sector J.

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[21] Please note, these shares of course depend on what is defined as 'the number of enterprises in Belgium'. To arrive at this denominator, Bel-first is used and a variety of filters applied. More specifically, we searched for 'all companies/associations with accounts'; that are active; that are not public companies or associations or sole traders, and excluded all entities with 0 employees.

Figure 16 NACE 2-digit numerical code
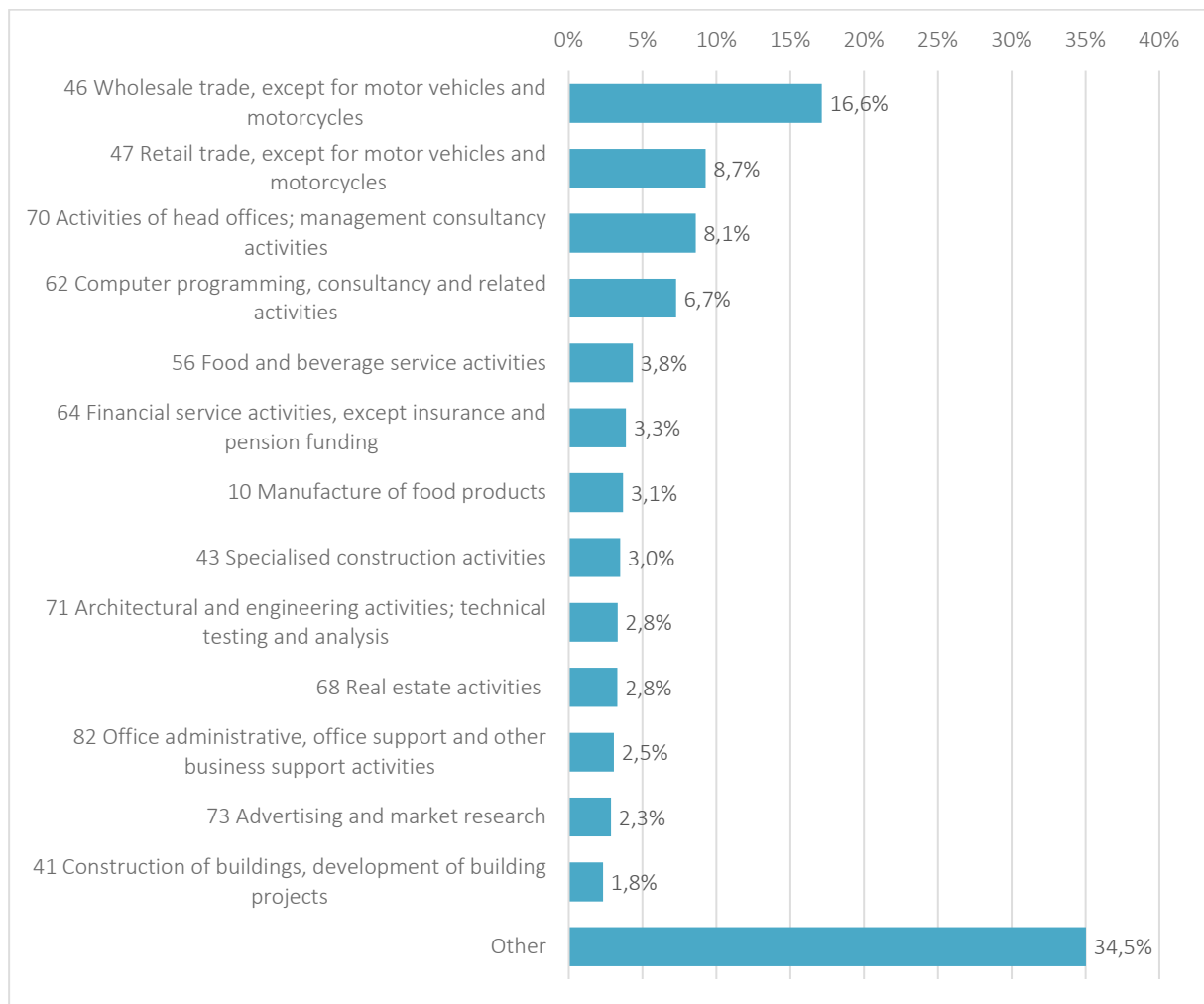
N = 13 289 The NACE code is not provided for every enterprise in Bel-first.

We then describe the group of active companies within each type of intellectual property according to the sector of activity. The results appear in Figure 17. We see that within the group of companies with at least a single patent, 36% are active in the sector 'C - Manufacturing' and 20% within the sector 'M - Professional, scientific and technical activities'. Within the group of companies with at least a single design right, the majority of companies (36%) are also active in the sector 'C - Manufacturing'. Among the companies with at least a single trademark right, we see that 28% of the companies are active in the sector 'G - Wholesale and retail trade', followed by 17% in 'M - Professional, scientific and technical activities'. Of the companies with at least a single plant breeders' right, no less than 65% are in the category 'A - Agriculture, forestry and fishing'.

Figure 17 NACE section according to IPR type
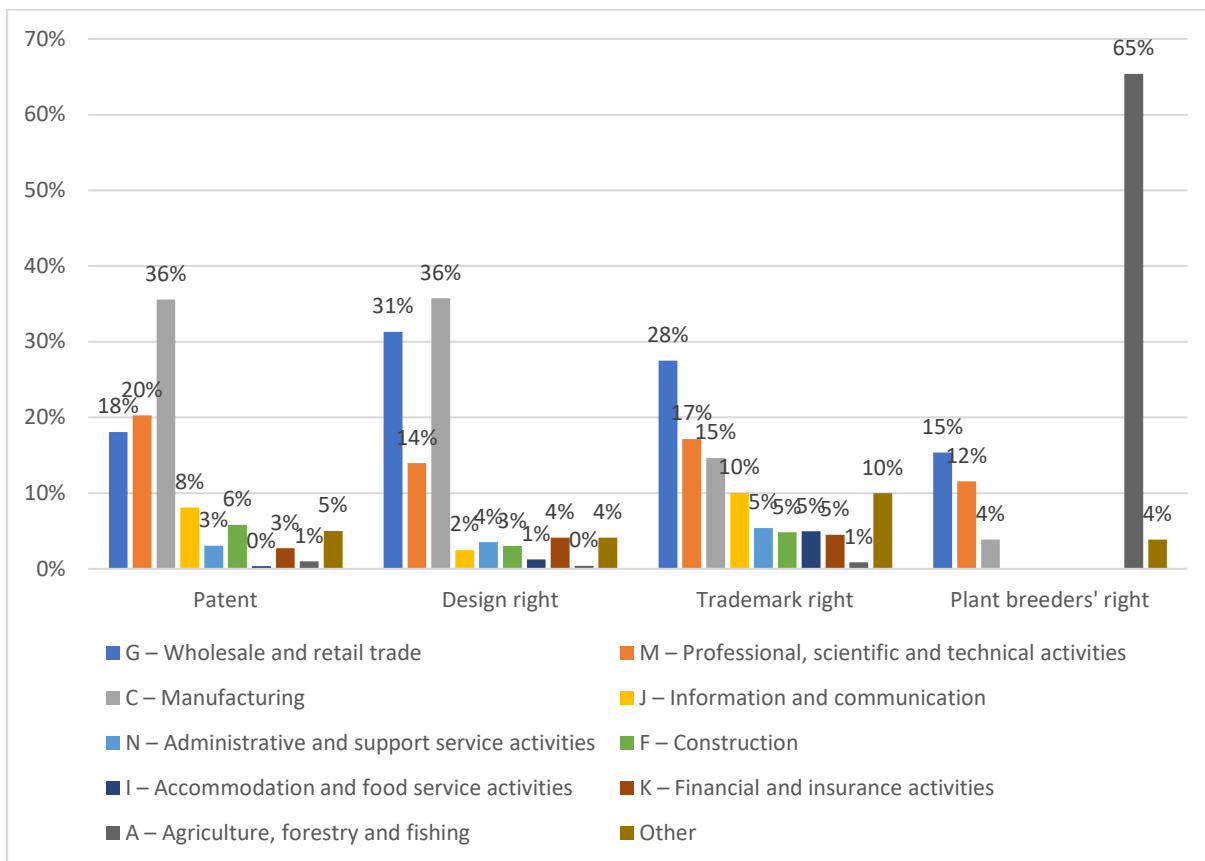
N patents = 2 305; N design rights = 968; N trademark rights = 11 949; N plant breeders' rights = 26.

In Figure 18 finally, we determine whether there is a connection between sectors on the one hand and the IPR clusters on the other.

Figure 18 NACE sections per IPR cluster
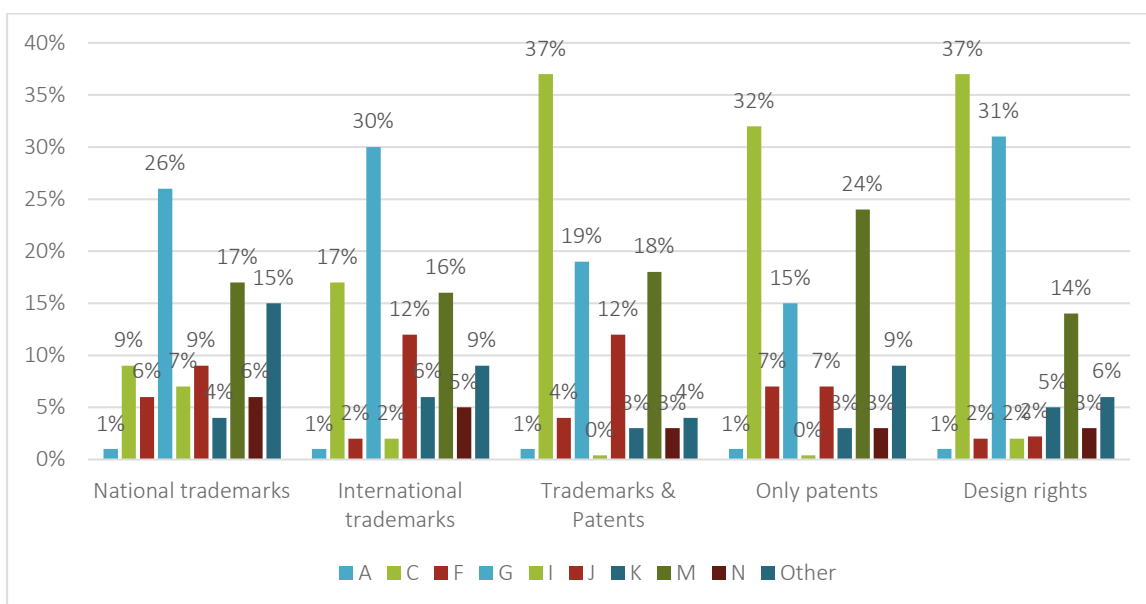
N Designs = 446; N Trademarks & Patents = 702; N Patents = 1073; N International trademarks = 3176; N National trademarks = 7409
The NACE code is not provided for every enterprise in Bel-first.

The accompanying chi squared test ($p < 0.001$) establishes the following observations:

▶ International Trademarks are underrepresented in sectors A (Agriculture, Forestry & Fishing) and F (Construction); they are overrepresented in the sector J (Information & Communication)

▶ National Trademarks are underrepresented in sector C (Manufacturing); they are overrepresented in sectors I (Accommodation and food service activities) and N (Administrative and Support service activities)

▶ Designs are underrepresented in the sectors F (Construction) and J (Information and Communication).

▶ Patents are underrepresented in the sector G (Wholesale and Retail trade); they are overrepresented in sector M (Professional, scientific and technical activities).

4.2.4   Location

Below we show the geographical location of the head offices of the companies with IPR. Figure 19 shows that the head offices of 21% of companies with IPR are based in Antwerp. 16% are based in East Flanders and 15% in Brussels.

Figure 19 Location
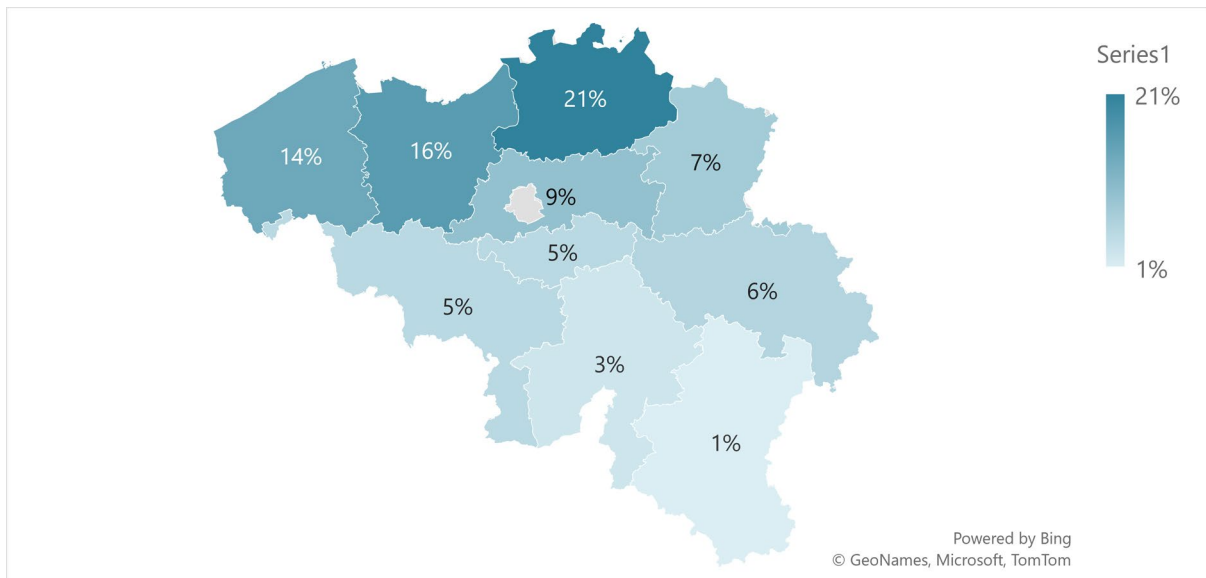
N = 13 551

Figure 20 shows the share of companies with IPR in relation to the total number of companies in the province[22]. It is notable that in percentage terms, Brussels-Capital Region, Walloon Brabant and East Flanders are home to the majority of enterprises with IPR.

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[22] Please note, these shares of course depend on what is defined as 'the number of enterprises in Belgium'. To arrive at this denominator, Bel-first is used and a variety of filters applied. More specifically, we searched for 'all companies/associations with accounts'; that are active; that are not public companies or associations or sole traders; with nacebel section B-J, L, M or N, and excluded all entities with 0 employees.

Figure 20 Share of companies with IPR per province
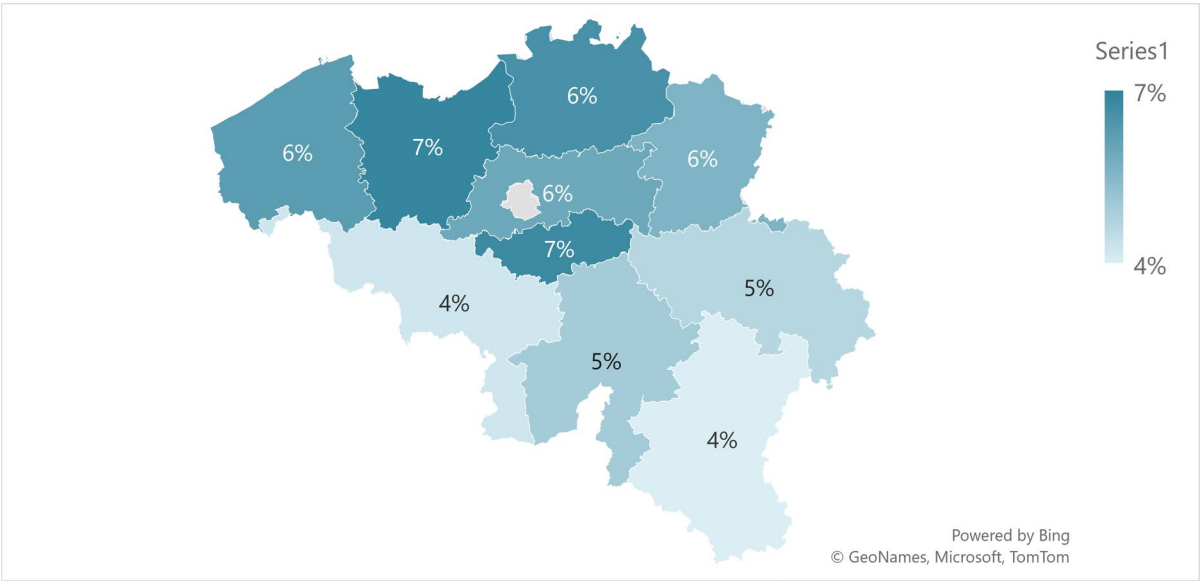
If we then look at the location of enterprises according to the type of IPR they own (Figure 21), we see that 20% of enterprises that hold at least a single patent are based in East Flanders and 19% in Antwerp. 20% of the enterprises with at least a single design right are established in West Flanders and 20% also in Antwerp. 21% of the enterprises that hold at least a single trademark right are based in Antwerp and 16% in East Flanders. No less than 42% of enterprises with a single plant breeders' right are based in East Flanders.

Figure 21 Location according to IPR type

Patent
- Antwerp: 19%
- East Flanders: 20%
- Brussels: 7%
- West Flanders: 16%
- Flemish Brabant: 9%
- Limburg: 10%
- Liege: 6%
- Hainaut: 5%
- Walloon Brabant: 4%
- Namur: 2%
- Luxembourg: 1%

Design right
- Antwerp: 20%
- East Flanders: 17%
- Brussels: 10%
- West Flanders: 20%
- Flemish Brabant: 7%
- Limburg: 7%
- Liege: 7%
- Hainaut: 5%
- Walloon Brabant: 5%
- Namur: 2%
- Luxembourg: 1%

Trademark right
- Antwerp: 21%
- East Flanders: 16%
- Brussels: 15%
- West Flanders: 13%
- Flemish Brabant: 9%
- Limburg: 7%
- Liege: 6%
- Hainaut: 5%
- Walloon Brabant: 5%
- Namur: 3%
- Luxembourg: 1%

Plant breeders' right
- Antwerp: 12%
- East Flanders: 42%
- West Flanders: 15%
- Flemish Brabant: 8%
- Limburg: 15%
- Hainaut: 8%

Legend: Antwerp, East Flanders, Brussels, West Flanders, Flemish Brabant, Limburg, Liege, Hainaut, Walloon Brabant, Namur, Luxembourg

N patents = 2 336; N design rights = 979; N trademark rights = 12 179; N plant breeders' rights = 26

4.2.5 Company size

Figure 22 shows the distribution of the size of the active companies with IPR based on the European Commission definition (see Table 6). We see here that more than half of the companies in our dataset are categorised as 'micro' (i.e. 54%). 21% of the companies are categorised as small and 12% are medium-sized.

Figure 22 Size classification IPR companies
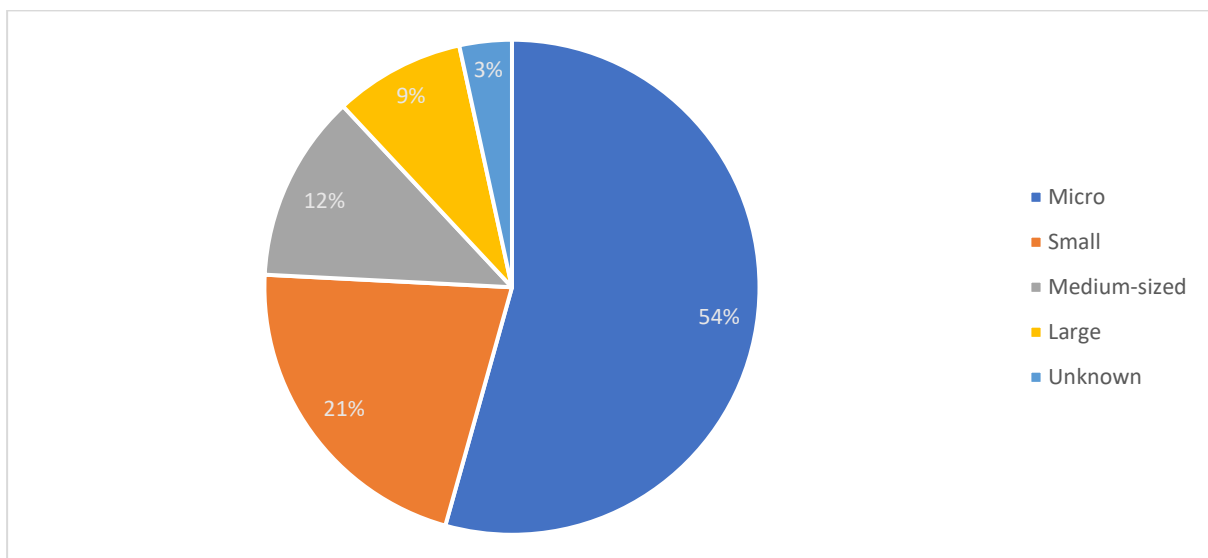
N = 13 551

Figure 23 considers the size classification for each IPR cluster. The majority of companies here are also micro, which is particularly visible within the National Trademarks cluster.

Figure 23 Distribution of company size according to IPR cluster
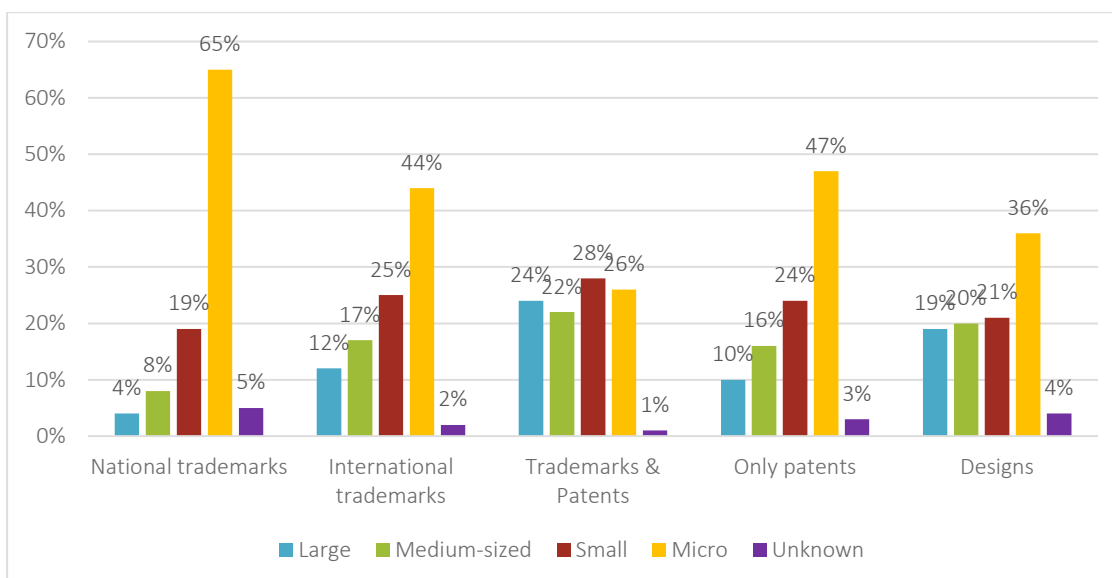
N Designs = 446; N Trademarks & Patents = 702; N Patents = 1073; N International trademarks = 3176; N National trademarks = 7409

As indicated in Section 4.2. 'company size', we first calculated the size classification on the basis of the European Commission definition (see Figure 22). We then determined whether a company is an SME on the basis of the definition from the Flemish government. As well as being classified as micro, small or medium-sized in the previous step, an SME must also satisfy the *'autonomous enterprise criterion'[23]*. Based on these criteria (described in section 4.2.), we created the dummy variable SME[24]. Figure 24 shows that 84% of the companies with IPR in the dataset can be classified as SME, and 16% as non-SME. If we then consider the SMEs themselves, we see that the vast majority are micro companies (i.e. 66%), 24% are small enterprises and 10% are medium-sized enterprises.

Figure 24 SME classification
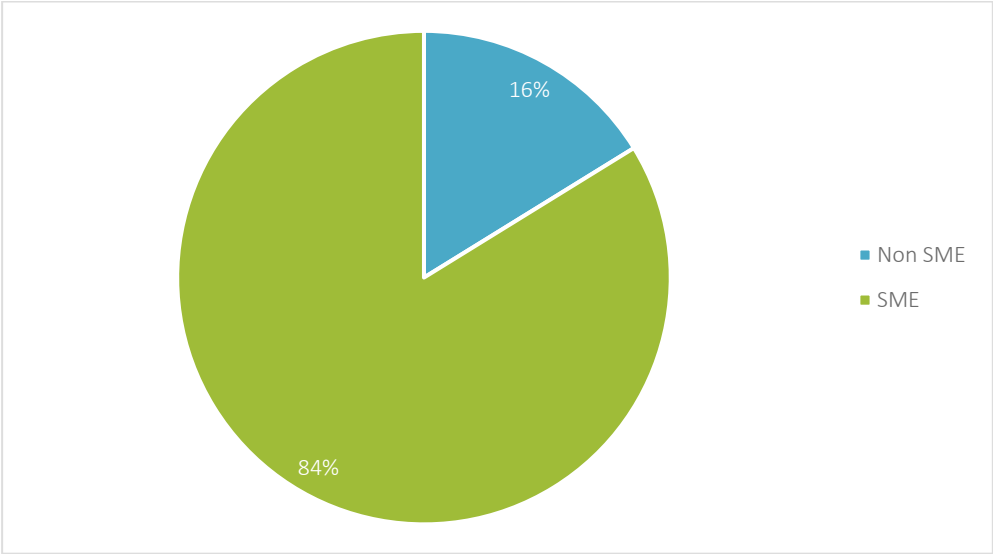
N = 11 947

Figure 25 shows that as a percentage, the group of enterprises that owns at least a single patent includes the fewest SMEs (i.e. 71%). The group of enterprises with at least a single trademark right includes the most SMEs as a percentage (i.e. 84%).

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[23] i.e. not owned by a company that does not satisfy the SME definition

[24] In total there are 779 enterprises (or 7%) of the 10 791 active enterprises that according to the European Commission definition were classified as 'micro', 'small' or 'medium-sized' and which, following application of the autonomous enterprise criterion could NO longer be characterised as SME. In other words, these companies had a 'global ultimate owner' which was classified as 'large' (based on balance sheet total).

Figure 25 Proportion of SMEs according to IPR type
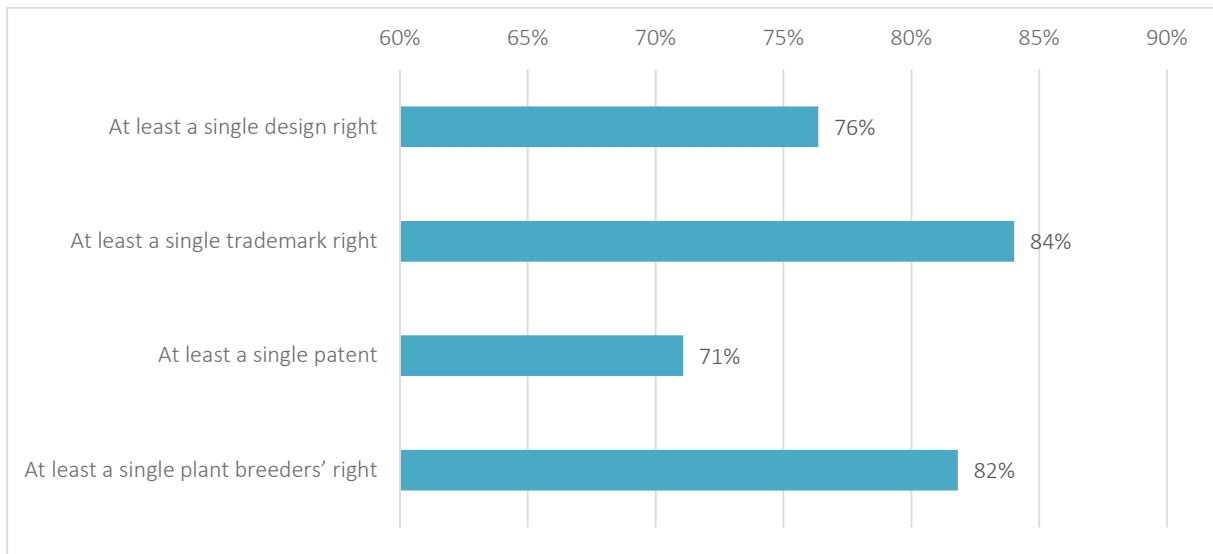
N design right = 867; N trademark right = 10734; N patent = 2 113; N plant breeders' right = 22

Figure 26 involves a similar type of evaluation whereby the share of SMEs is considered for each IPR cluster. In general terms, there is an overrepresentation of SMEs within each of the clusters. This overrepresentation is most pronounced for trademarks, whereby Figure 26 furthermore demonstrates that it is primarily national (Benelux) trademarks within which the role of SMEs is particularly pronounced. In the cluster of enterprises that complement trademarks with patents, the overrepresentation of SMEs is the least pronounced, such that the role of large companies is slightly more prominent in this cluster than in other clusters.

Figure 26 Proportion of SMEs according to IPR cluster
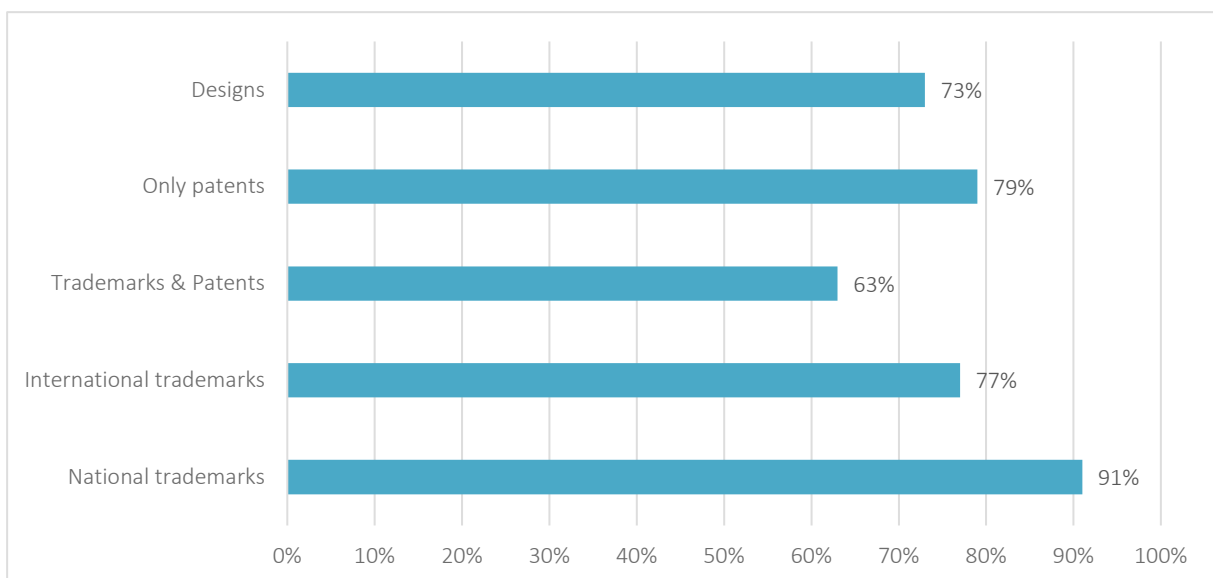
N Designs = 385; N Trademarks & Patents = 648; N Patents = 958; N International trademarks = 2836; N National trademarks = 6451

4.2.6 Multinational character

On the basis of Bel-first data, it is also possible to distinguish between companies that are part of a foreign company or Belgian-owned companies. The latter group then comprises all independent Belgian companies or companies that form part of another Belgian company. Figure 27 shows that 92% of the companies with IPR are Belgian companies and that 8% are part of a foreign company.

Figure 27 Multinational character of businesses
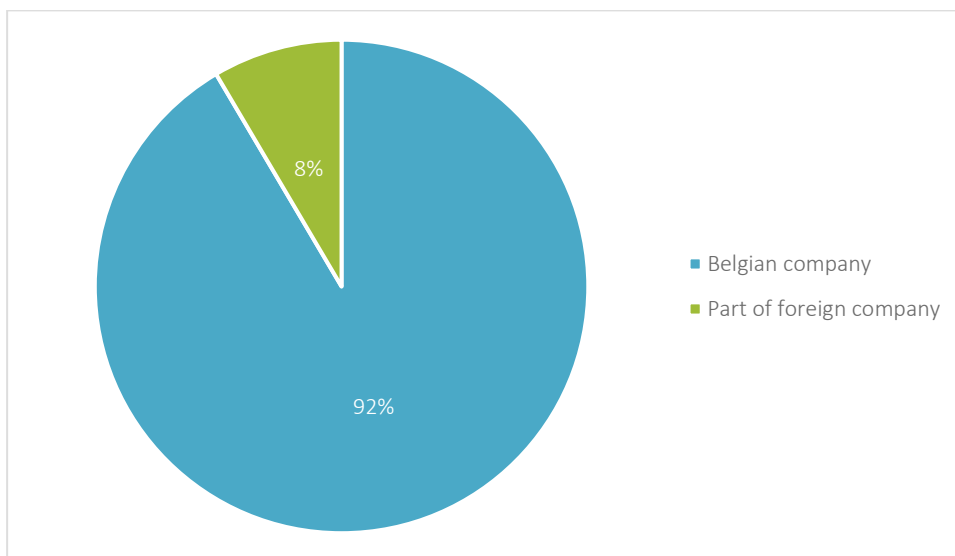
N = 13 318

Figure 28 reveals that IPR-active companies with a foreign global ultimate owner on average make more use of patents and plant breeders' rights than local companies (16% and 15% respectively of enterprises that have at least a single patent or plant breeders' right has a foreign global ultimate owner, as compared with just 8% in the total IPR dataset). The use of trademark and design rights appears to be less influenced by the multinational character of the companies.

Figure 28 Multinational character according to IPR type
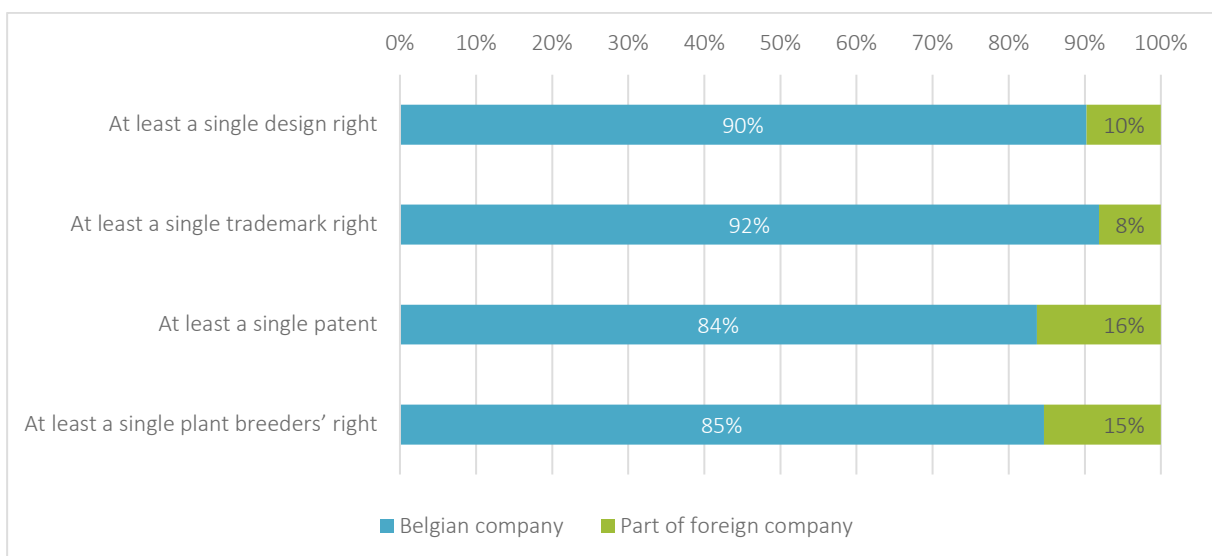
N = 13 318

For internationally active companies, Figure 29 makes a distinction according to the specific validity of the right (Belgian, Benelux, European, International, ...) to identify which procedures are most dominant. The choice of international (and mainly European) validity dominates for companies with a foreign GUO with at least a single design right (Block A), patent (Block B) OR plant breeders' right (Block C). Companies with at least a single trademark right and a foreign GUO on the other hand more often opt for validity in the Benelux countries (Block D).

Figure 29 Enterprises with foreign global ultimate owner

A: Companies with foreign global ultimate owner with at least a single design right:
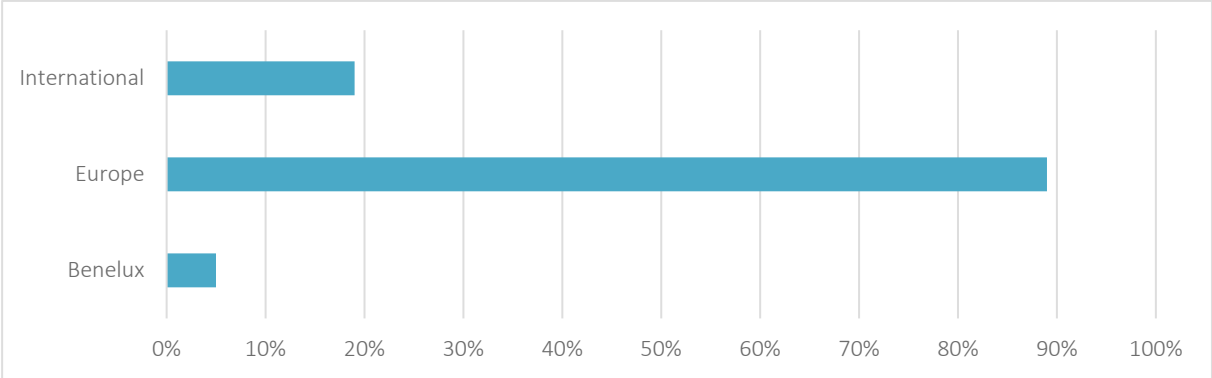
N = 93

B: Companies with foreign global ultimate owner with at least a single patent:
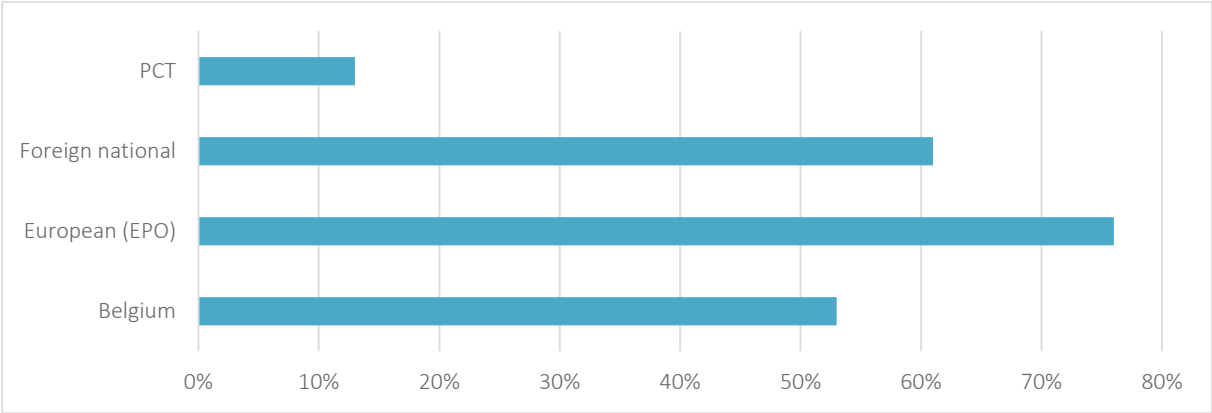
N = 372

C: Companies with foreign global ultimate owner with at least a single plant breeders' right:
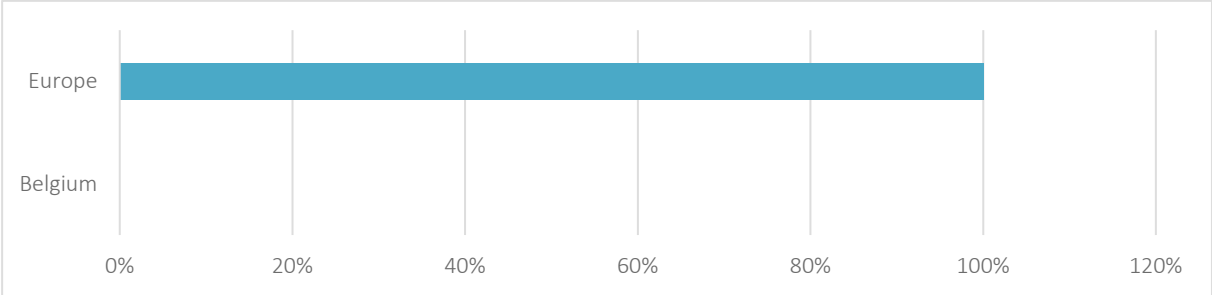
N = 4

D: Companies with foreign global ultimate owner with at least a single trademark right:
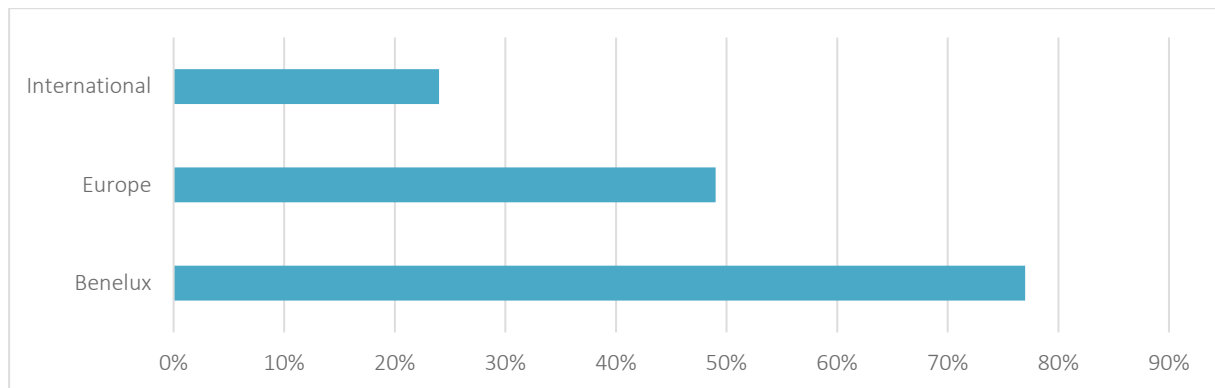
N = 973

4.2.7 Growth in employment

To investigate the relationship between IPR and company performance, we first calculated growth in employment. We calculated the average annual growth rate of the companies with IPR and the compound annual growth rate between 2015 and 2019.

The average annual growth rate for active companies with IPR is 15.7% for the period between 2015 and 2019. The compound annual growth rate is on average 11.5%.[25]

Table 13 Growth based on employees for active companies with IPR (2015 - 2019)

	N	Average	s.d.	Min	Max
Average annual growth rate.	8 211	15.74%	0.48	-90%	1200%
Compound annual growth rate	8 257	11.46%	0.40	-100.00%	1200%

where s.d. = standard deviation, outliers related to legal events such as mergers and acquisitions are removed (see section 5.3.1.).

Figure 30 and Figure 31 show the distribution of the number of companies per category growth rate. Both the Average Annual Growth Rate and the Compound Annual Growth Rate include the vast majority

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[25] Here, the averages are calculated on the basis of all values, excluding the outliers relating to legal events such as mergers and acquisitions (see section 5.3.1.). In the econometric analyses in Section 9, the 1% highest and lowest growers are left out.

of companies in the group of between 0% and 20% growth (4406 or 54% of enterprises and 4721 or 57% of enterprises, respectively).

Figure 30 Histogram showing Average Annual Growth Rate (2015 - 2019)
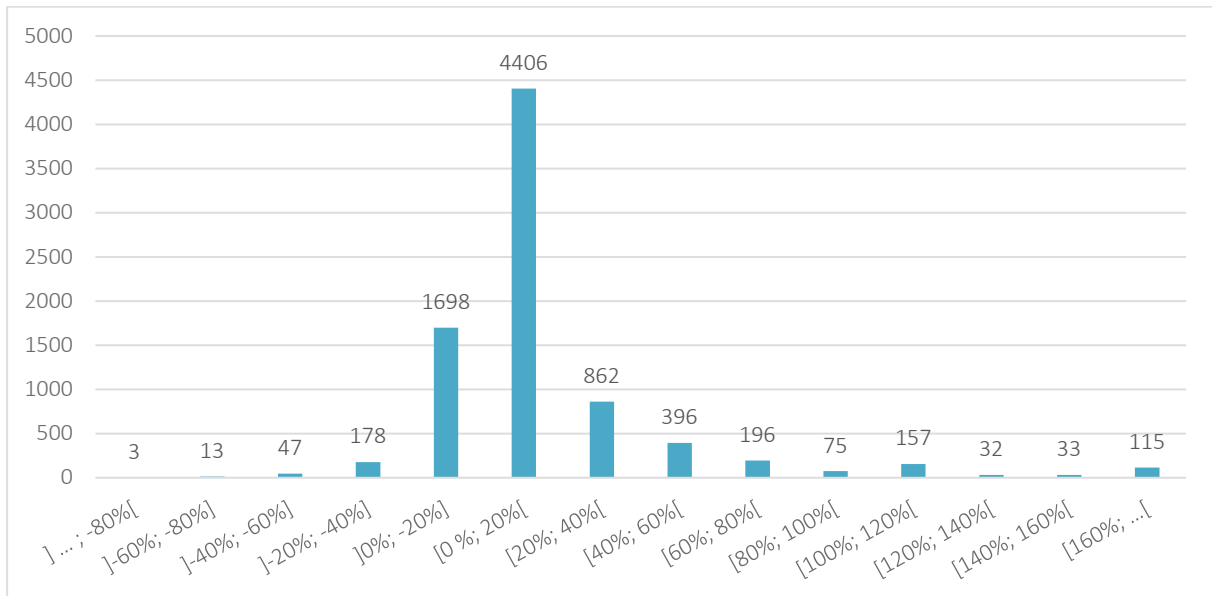
N = 8211, outliers related to legal events - such as mergers and acquisitions - are removed

Figure 31 Histogram Compound Annual Growth Rate (2015 - 2019)
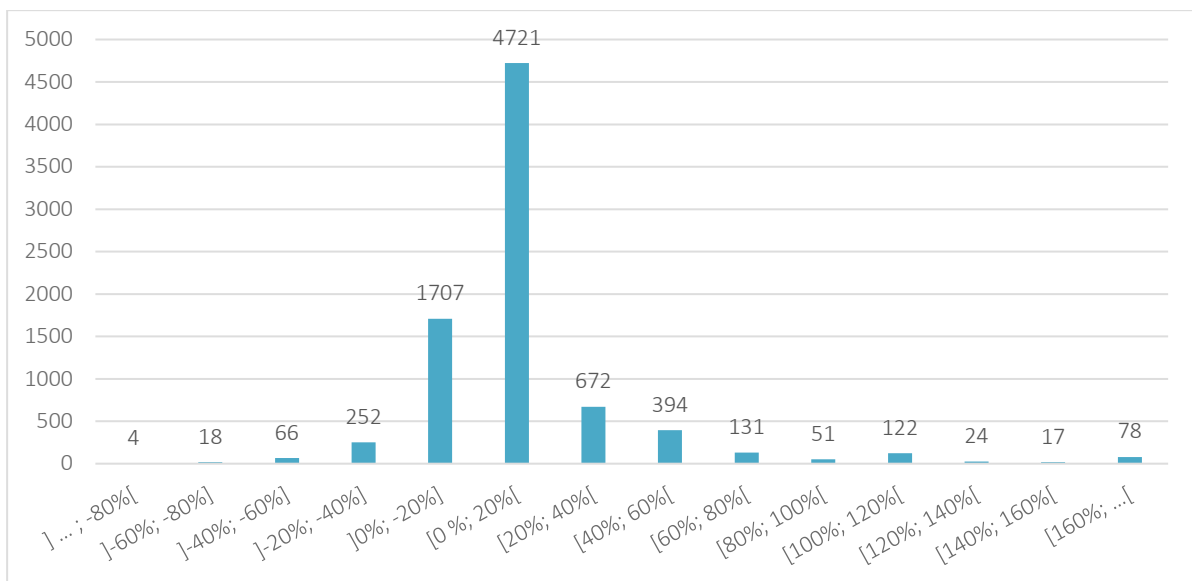
N = 8257, outliers related to legal events - such as mergers and acquisitions - are removed.

Table 14 shows the average and compound annual growth rate for the active SMEs with IPR.

Table 14 Growth according to number of employees for active SMEs with IPR (2015 - 2019)

	N	Average	s.d.	Min	Max
Average annual growth rate	5 257	16.67%	0.48	-90%	1200%
Compound annual growth rate	5 915	11.93%	0.41	-100.00%	1200%

where s.d. = standard deviation, outliers related to legal events removed

We then distinguish between the growth percentages of enterprises according to the various types of IPR they own (own Figure 32). The average annual growth percentage of enterprises with at least a single trademark right is 16.2%. The average annual growth percentage of enterprises with at least a single patent is 14.2%. The growth percentages of enterprises with at least a single design right, for both benchmarks, is lowest.

Figure 32 Growth according to number of employees (2015-2019) according to IPR type and IPR cluster
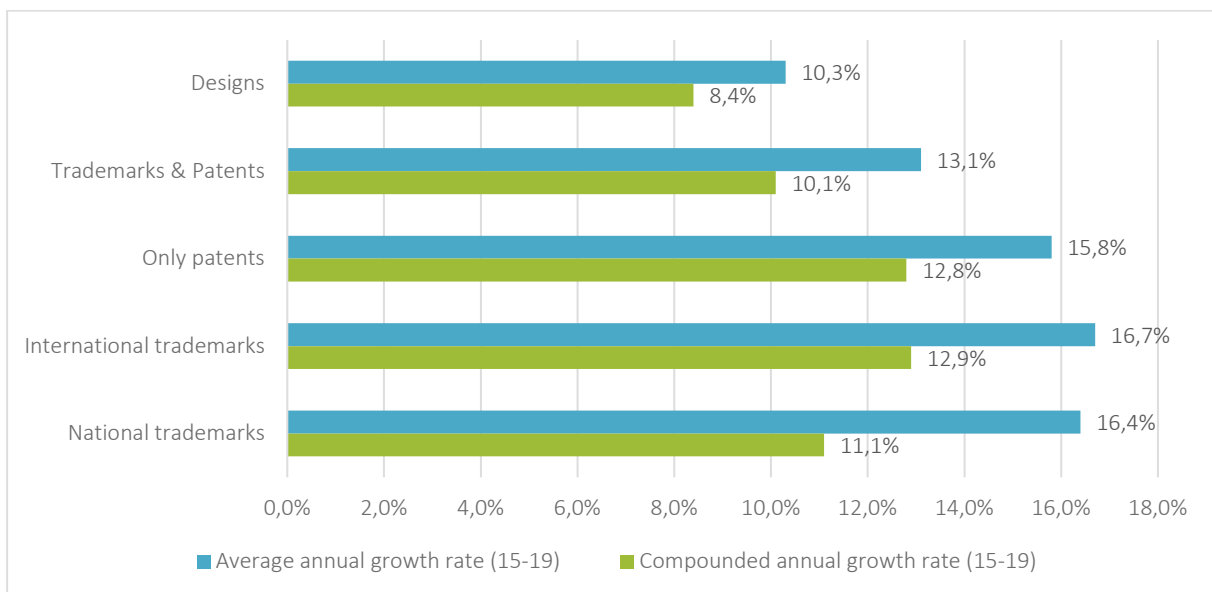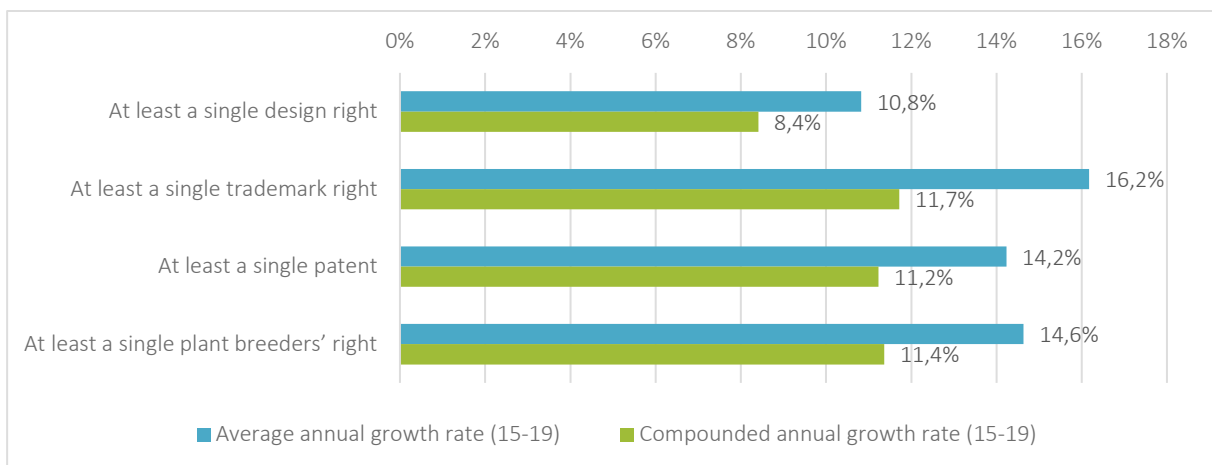
4.2.8 Productivity

In addition to growth, we also studied the added value per employee of the active enterprises with IPR, i.e. company productivity. We calculated this benchmark for the years 2015 through to 2019. Below (in Table 15), we see that the average productivity of the active enterprises with IPR is 114 067,3.[26]

Table 15 Average productivity for active companies with IPR (2015 – 2019)

	N	Average	s.d.	Min	Max
Productivity	8 954	114067.3	583 507	-5259 963	48216 200

s.d. = standard deviation

Figure 33 shows the distribution in the number of companies per productivity category. The bulk of enterprises with IPR fall in the category 50 000€ to 100 000€ productivity (i.e. 3 897 enterprises or 44%).

Figure 33 Histogram showing Average Productivity (2015 - 2019)
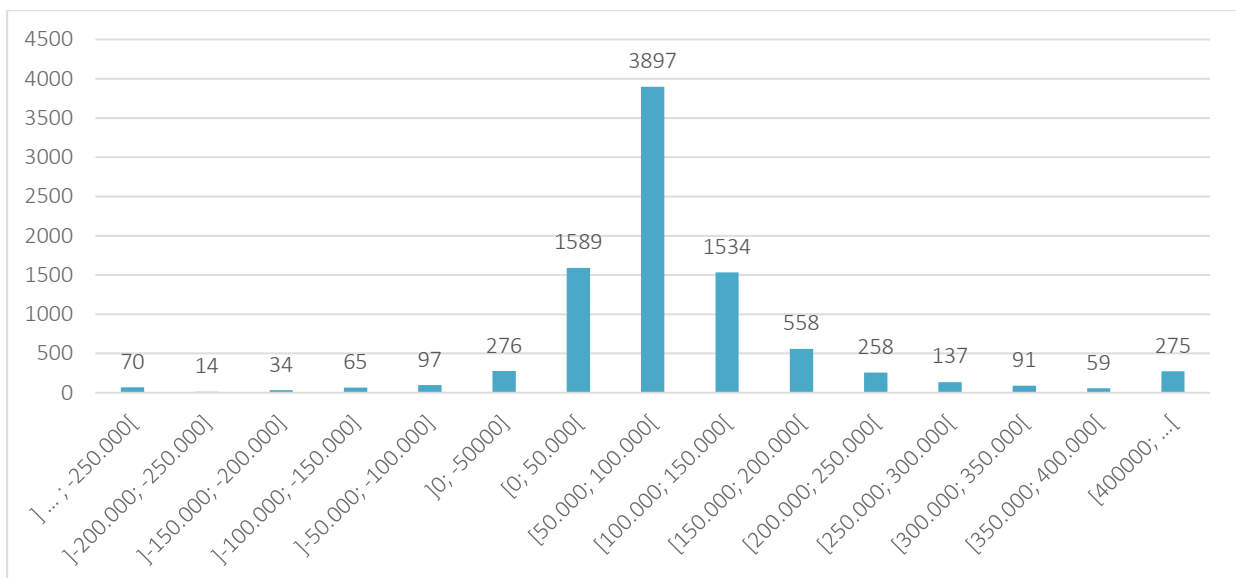
N = 8954

Table 16 shows the average productivity for active SMEs with IPR in the dataset

Table 16 Average productivity for active SMEs with IPR (2015 – 2019)

	N	Average	s.d.	Min	Max
Productivity	6 477	90 616.4	186 396.8	-2887 478	7 179 961

s.d. = standard deviation

We then distinguish between the growth percentages of enterprises according to the various types of IPR they own (Figure 34). The enterprises with at least a single patent, on average demonstrate the

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[26] Here, the averages are calculated on the basis of all values. In the econometric analyses in Section 9, the 1% highest and lowest are left out.

highest productivity (at 152 008,7 €/employee) followed by companies with at least a single design right (at 127 306,1 €/employee).

Figure 34 Average productivity (2015 - 2019) according to IPR type and IPR cluster
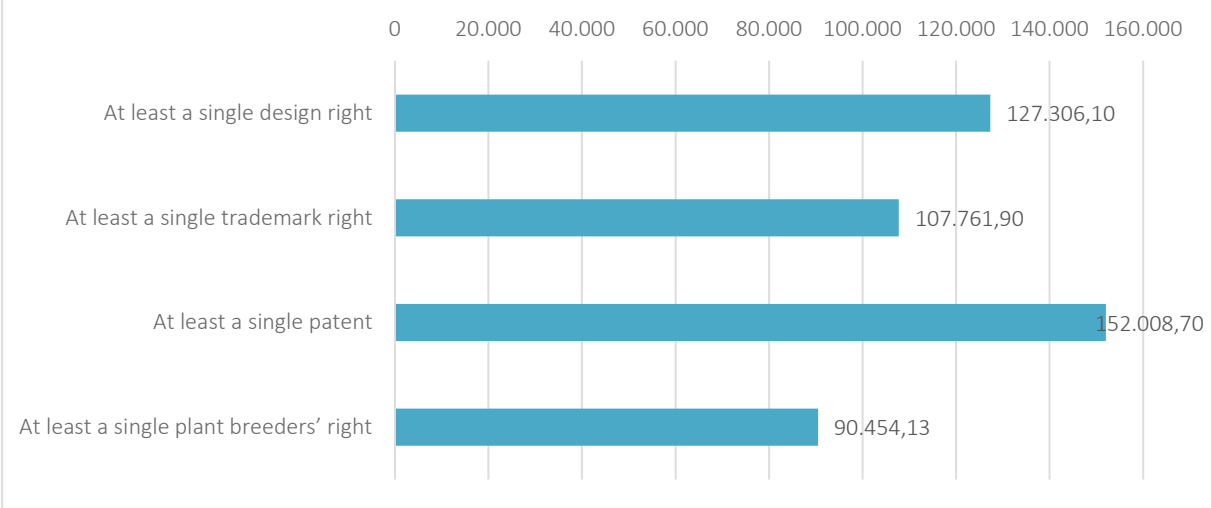
N patents = 730; N design rights = 8054; N trademark rights = 1 774; N plant breeders' rights = 23
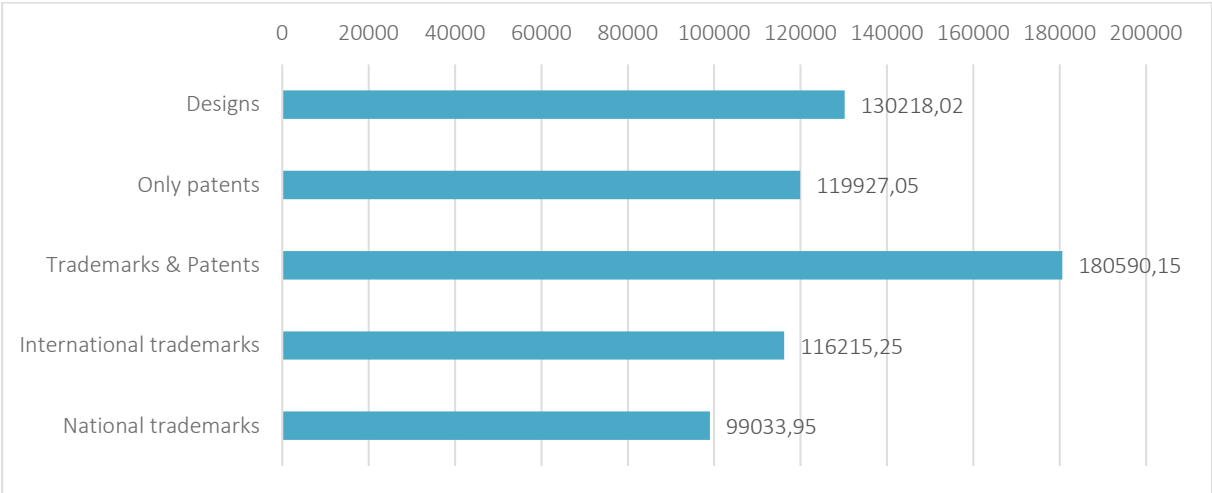
4.3. The relationship between IPR, company characteristics and company performance

The analyses above provide insights into company characteristics and company performance of the active companies that own IPR. In this chapter, we determine *whether there is a relationship between the three types of variables*, namely IPR variables, company characteristics and company performance.

4.3.1 Correlation analyses

We firstly studied the **(pairwise Pearson) correlations** between the different variables. A correlation measures the strength and direction of the relationship between two variables. The Pearson correlation coefficient is the most commonly used correlation coefficient and has a value between -1 and 1 (where -1 = perfect negative relationship, 0 = no relationship, 1 = a perfect positive relationship).

Table 17 shows the correlations between the overarching IPR variables and the company characteristics and company performance. This table reveals that there is a positive correlation between the total number of IPR owned by a company and the age of the enterprise. We also see a positive relationship between active status in sector 'C - Manufacturing' and the total number of IPR. Being an SME appears to have a negative relationship with the number of IPR owned by the enterprise in question. The latter findings are in line with those of Alkaersig et al. (2015). They discovered that larger companies are more active in IPR (patents, trademarks and designs). We also observed a positive relationship between the multinational character of a company and the total number of IPR.

We also see that the IPR scope (i.e. the number of different types of IPR owned by an enterprise) relates positively to the age of the company, 'Sector C (Manufacturing)', the Flemish region and the multinational character of the enterprises. There is a negative correlation between the scope of the IPR and SME status. In other words, on average, SMEs own fewer types of IPR than non-SMEs.

The overarching IPR-related variables, i.e. total IPR and IPR scope, show no strong relationships with the two growth rate variables. All we see is a slight negative relationship between total IPR and the average annual growth rate. However, we do see a positive relationship between total IPR of a company and that company's productivity.

The variable SME has a slight positive correlation with the two growth rates and slight negative correlation with productivity. We also observe that the age of a company has a negative correlation with the growth rates.

Table 17 Pairwise Pearson Correlations between IPR, company characteristics and company performance

Variables	(1) total IPR	(2) IPR scope	(3) Average annual growth rate	(4) Compound annual growth rate	(5) Productivity
(1) total IPR	1.000				
(2) IPR scope	0.251*	1.000			
(3) Average annual growth rate	-0.023*	-0.016	1.000		
(4) Compound annual growth rate	-0.019	-0.004	0.915*	1.000	
(5) Productivity	0.075*	0.011	-0.023*	-0.027*	1.000
(6) Age	0.130*	0.130*	-0.233*	-0.226*	0.035*
(7) Sector section G	-0.013	-0.015	-0.064*	-0.059*	-0.007
(8) Sector section M	-0.004	-0.023*	0.039*	0.033*	-0.001
(9) Sector section C	0.081*	0.203*	-0.064*	-0.051*	-0.014
(10) Sector section J	-0.021*	-0.035*	0.090*	0.097*	-0.012
(11) Sector section N	-0.017	-0.038*	0.013	0.002	-0.003
(12) Sector section 'Other'	-0.029*	-0.095*	0.032*	0.020	0.031*
(13) Region: Flanders	-0.006	0.064*	-0.031*	-0.016	0.015
(14) Region: Wallonia	-0.001	-0.011	-0.007	-0.018	-0.024*
(15) Region: Brussels	0.010	-0.073*	0.052*	0.044*	0.008
(16) SME	-0.166*	-0.170*	0.055*	0.045*	-0.081*
(17) Multinational character	0.117*	0.099*	-0.052*	-0.041*	0.037*

*** p<0.01, ** p<0.05, * p<0.1

Correlation coefficients higher than or equal to 0.1 or lower than or equal to -0.1 are shown in green.

The outliers in the growth rates that were attributable to legal occurrences were not included here.

Table 18 shows the correlations between owning or not owning a particular IPR type, and the company characteristics and company performance. Owning a design right in the IPR portfolio has a slight negative correlation with the growth rate variables. Owning a trademark right, on the other hand, has a positive correlation with the average annual growth rate, but negative with productivity. Owning at least a single patent in the IPR portfolio has a positive correlation with productivity.

Table 18 Pairwise Pearson Correlations between types of IPR, company characteristics and company performance

Variables	(1) Design right (dummy)	(2) Trademark right (dummy)	(3) Patent (dummy)
(1) Design right (dummy)	1.000		
(2) Trademark right (dummy)	-0.180*	1.000	
(3) Patent (dummy)	0.151*	-0.595*	1.000
(4) Average annual growth rate	-0.031*	0.026*	-0.016
(5) Compound annual growth rate	-0.023*	0.019	-0.003
(6) Productivity	0.007	-0.032*	0.032*
(7) Age	0.099*	-0.037*	0.101*
(8) Sector section G	0.030*	0.065*	-0.088*
(9) Sector section M	-0.028*	-0.044*	0.030*
(10) Sector section C	0.146*	-0.143*	0.236*
(11) Sector section J	-0.068*	0.041*	-0.023*
(12) Sector section N	-0.021*	0.023*	-0.045*
(13) Sector section 'Other'	-0.075*	0.056*	-0.101*
(14) Region: Flanders	0.026*	-0.040*	0.080*
(15) Region: Wallonia	0.006	-0.008	-0.008
(16) Region: Brussels	-0.041*	0.062*	-0.098*
(17) SME	-0.057*	0.018*	-0.160*
(18) Multinational character	0.013	-0.039*	0.127*

*** p<0.01, ** p<0.05, * p<0.1

Correlation coefficients higher than or equal to 0.1 or lower than or equal to -0.1 are shown in green.

The outliers in the growth rates that were attributable to legal occurrences were not included here.

4.3.2   Regression analyses

We then conducted regression analyses to determine the relationship between the characteristics of the enterprise, the IPR of the enterprises and the company performance. While correlation analyses consider the relationship between two variables, regression analyses simultaneously study the influence of all variables in the model. In these regression analyses, we only studied the currently active enterprises. It is important to note that the data here relate to the group of active companies with at least a single IPR.

Table 19 summarises the regression results for the dependent variables relating to the IPR of enterprises. These regression results therefore provide insights into which company characteristics are related to the IPR variables. The first two models (model 1 to 2) in which the dependent variables 'Total IPR' and 'IPR scope' are studied, show that the age of an enterprise has a positive relationship with the total IPR and IPR scope. In other words, older companies with at least a single IPR own more intellectual property rights in absolute terms, but also own more types of IPR. At the same time, we observe that SMEs have fewer intellectual property rights and fewer different types of IPR in their IPR portfolio. Compared with the reference category 'sector G - Wholesale and retail trade', companies in sector C (Manufacturing) have more intellectual property rights and more different types of IPR. However, enterprises in the sectors J (Information and communication), N (Administrative and support service activities) and 'Other' have fewer IPR and fewer different types of IPR. IPR-active companies in Brussels and Wallonia have fewer different types of IPR in their IPR portfolio.

Models 3, 4 and 5 in Table 19 show which company characteristics of IPR-active companies have an influence on the number of design rights, patents and trademark rights in the enterprise's IPR portfolio. We see that older IPR-active companies own more design rights, patents and trademark rights, while SMEs own fewer. Enterprises in sectors M, J, N and 'Other' generally speaking have fewer design rights in their IPR portfolio than enterprises in sector G. Enterprises in sectors M and C have more patents in their portfolio than enterprises in sector G. Sectors N and 'Other' also reveal a negative relationship with the number of trademark rights, compared with the reference category, sector G. There is also a positive relationship between the number of patents owned by an IPR-active enterprise and the multinational character of that enterprise. IPR-active enterprises in Brussels, compared with the reference category Flanders, own more trademark rights in their IPR portfolio.

Table 19 Regression results, IPR-related dependent variables

	(1) Total IPR		(2) IPR scope		(3) Number of Design rights		(4) Number of trademark rights		(5) Number of patents	
Age [c]	1.021***	(0.279)	0.0506***	(0.0105)	1.048*	(0.470)	0.662***	(0.137)	1.582**	(0.610)
SME	-1.490***	(0.137)	-0.128***	(0.0131)	-1.039**	(0.327)	-1.260***	(0.0844)	-2.224***	(0.255)
Sector M [a]	0.353	(0.222)	0.00651	(0.00963)	-1.388**	(0.429)	-0.00779	(0.107)	1.473**	(0.492)
Sector C [a]	0.530**	(0.165)	0.132***	(0.0116)	0.126	(0.313)	0.101	(0.0995)	1.321***	(0.383)
Sector J [a]	-0.385*	(0.193)	-0.0239*	(0.0107)	-2.908***	(0.563)	-0.0968	(0.0819)	-0.434	(0.500)
Sector N [a]	-0.616**	(0.193)	-0.0476***	(0.0133)	-1.493**	(0.570)	-0.375***	(0.0890)	-0.817	(0.508)
Sector Other [a]	-0.384*	(0.180)	-0.0522***	(0.00835)	-1.707***	(0.479)	-0.179*	(0.0755)	-0.397	(0.482)
Multinational	0.391	(0.200)	0.00452	(0.0180)	0.670	(0.445)	-0.133	(0.159)	0.701*	(0.280)
Wallonia [b]	0.0538	(0.150)	-0.0278***	(0.00825)	-0.349	(0.249)	-0.0302	(0.0662)	0.234	(0.295)
Brussels [b]	0.302	(0.229)	-0.0597***	(0.00805)	0.545	(0.636)	0.257**	(0.0996)	0.360	(0.429)
_constant	1.210*	(0.482)	0.189***	(0.0204)	-0.666	(0.892)	1.184***	(0.236)	-1.137	(1.086)
N	11 691		11 691		11 691		11 691		11 691	
	Poisson regression		Poisson regression		Poisson regression		Poisson regression		Poisson regression	

Robust standard errors between brackets
* $p<0.05$, ** $p<0.01$, *** $p<0.001$
[a] Reference category = Section G (Wholesale and retail trade)
[b] Reference category = Flanders Region
[c] Logarithm of the values

We then conducted regression analyses to study the influence of intellectual property rights owned by an IPR-active company and the other company characteristics on the performance of that company (i.e. growth and productivity).

Table 20 shows the relationship on the one hand between the total IPR owned by an IPR-active company, and the IPR scope (i.e. the number of different types of IPR held by an enterprise in its portfolio) and, on the other, the performance indicators. The total number of IPR held by an IPR-active enterprise reveals a positive relationship with the productivity of the enterprise. The IPR scope (i.e. the number of different types of IPR held by an enterprise in its portfolio) relates positively to growth (CAGR). In other words, companies with a broader IPR scope achieved slightly higher compound growth between 2015 and 2019 than companies with a narrower IPR scope.

Table 20 Regression results: influence of overarching IPR indicators on performance

	(1) Growth (AAGR) 2015-2019		(2) Growth (CAGR) 2015-2019		(3) Productivity 2015 - 2019	
Independent variables						
Total IPR	-0.000	(0.000)	-0.000	(0.000)	815,0***	(138.9)
IPR scope	0.0218	(0.012)	0,0250*	(0.010)	-17631.1	(15750.8)
Control variables						
Age [c]	-0.503***	(0.0196)	-0.431***	(0.0163)	53548.2*	(24253.5)
SME	-0.0333*	(0.0157)	-0.0330*	(0.0131)	-107701.0***	(20794.7)
Sector M [a]	0.0139	(0.0175)	0.00160	(0.0146)	11201.0	(22450.3)
Sector C [a]	0.0279	(0.0151)	0.0269*	(0.0126)	-31799.2	(20030.7)
Sector J [a]	0.0856***	(0.0206)	0.0733***	(0.0171)	-7262.9	(26368.9)
Sector N [a]	0.0275	(0.0255)	-0.00320	(0.0213)	5219.3	(33235.1)
Sector Other [a]	0.0314*	(0.0146)	0.0129	(0.0121)	45740.3*	(18894.2)
Multinational	-0.0315	(0.0208)	-0.0166	(0.0174)	-13560.6	(27677.9)
Wallonia [b]	-0.0104	(0.0134)	-0.0230*	(0.0111)	-29723.2	(17426.9)
Brussels [b]	0.0458**	(0.0160)	0.0290*	(0.0133)	-2155.5	(20535.8)
_constant	0.792***	(0.0370)	0.662***	(0.0308)	148 014.2**	(46833.0)
	linear regression		linear regression		linear regression	
N	7 515		7 559		8 143	
Adj. R²	0.10		0.10		0.01	

***$p < .001$, **$p < .01$, *$p < .05$,
Standard errors between brackets
Only active companies included; the outliers attributable to legal events for the growth benchmarks are not included.
[a] Reference category = Section G (Wholesale and retail trade)
[b] Reference category = Flanders Region
[c] Logarithm of the values

If the same analysis is repeated for the SMEs in our dataset (Table 21), we observe that the more intellectual property rights IPR-active SMEs own, the higher their productivity. We also observe that the more different IPR types an IPR-active SME owns, the higher its growth (both AAGR and CAGR).

Table 21 Regression results: influence of overarching IPR indicators on SME performance

	(1) Growth (AAGR) 2015-2019		(2) Growth (CAGR) 2015-2019		(3) Productivity 2015 - 2019	
Independent variables						
Total IPR	-0.00	(0.00)	-0.00	(0.00)	670.6*	(293.0)
IPR scope	0.043**	(0.016)	0.041**	(0.013)	-11 731.5	(6282.2)
Control variables						
Age [c]	-0.529***	(0.0229)	-0.456***	(0.0192)	55334.7***	(8414.4)
Sector M [a]	0.00951	(0.0196)	-0.00129	(0.0164)	10105.2	(7469.4)
Sector C [a]	0.0342	(0.0178)	0.0337*	(0.0149)	-12567.6	(7007.3)
Sector J [a]	0.120***	(0.0237)	0.101***	(0.0198)	-8272.9	(9009.2)
Sector N [a]	0.0279	(0.0296)	-0.0118	(0.0248)	9985.8	(11450.8)
Sector Other [a]	0.0316	(0.0166)	0.0121	(0.0139)	18026.7**	(6382.6)
Multinational	-0.000572	(0.0580)	0.0188	(0.0488)	2721.1	(22118.9)
Wallonia [b]	-0.0136	(0.0152)	-0.0299*	(0.0127)	-17146.4**	(5866.8)
Brussels [b]	0.0371*	(0.0189)	0.0237	(0.0158)	-10036.8	(7176.8)
_cons	0.767***	(0.0373)	0.641***	(0.0312)	33 506.7*	(13804.7)
	linear regression		linear regression		linear regression	
N	5856		5900		6451	
Adj. R²	0.10		0.10		0.01	

***p < .001, **p < .01, *p < .05,
Standard errors between brackets
Only active companies included; the outliers attributable to legal events for the growth benchmarks are not included.
[a] Reference category = Section G (Wholesale and retail trade)
[b] Reference category = Flanders Region
[c] Logarithm of the values

We then repeated the above regression analyses, but then with IPR clusters (as opposed to Scope) as independent variables (Table 22). In other words, we considered the influence of belonging to the various IPR clusters on the three performance benchmarks studied, while carrying out controls for the other company characteristics. We observed a higher growth rate (CAGR) for the cluster 'International trademarks', as compared with the cluster 'National trademarks'. The cluster 'Only patents' shows higher productivity. When we considered the group of SMEs, in Table 23, we see that the clusters 'International trademarks', 'Only patents', and 'Designs' all reveal a higher growth rate (CAGR) as compared with the cluster 'National trademarks'. The cluster with International trademarks also reveals higher productivity than the cluster with exclusively National trademarks.

Table 22 Regression results: influence of IPR clusters on performance

	(1) Growth (AAGR) 2015-2019		(2) Growth (CAGR) 2015-2019		(3) Productivity 2015 - 2019	
Independent variables						
C2 International trademarks [d]	0.0154	(0.0129)	0.0226*	(0.0107)	10900.1	(16784.7)
C3 Only patents [d]	0.0233	(0.0218)	0.0341	(0.0181)	6840.1	(28743.4)
C4 Trademarks & Patents [d]	0.00526	(0.0206)	0.0152	(0.0172)	81491.9**	(26751.2)
C5 Designs [d]	0.0318	(0.0284)	0.0451	(0.0237)	20642.0	(37603.7)
C6 Other combinations [d]	0.0216	(0.0220)	0.0270	(0.0183)	21763.9	(29057.0)
Control variables						
Age [c]	-0.503***	(0.0196)	-0.431***	(0.0163)	57906.7*	(24317.0)
SME	-0.0325*	(0.0158)	-0.0308*	(0.0131)	-113534.7***	(20902.3)
Sector M [a]	0.0143	(0.0176)	0.0015	(0.0146)	8282.7	(22599.7)
Sector C [a]	0.0280	(0.0154)	0.0252*	(0.0128)	-40534.8*	(20384.3)
Sector J [a]	0.0849***	(0.0207)	0.0721***	(0.0172)	-9566.4	(26477.6)
Sector N [a]	0.0289	(0.0256)	-0.0008	(0.0213)	5938.9	(33339.4)
Sector Other [a]	0.0333*	(0.0147)	0.0158	(0.0122)	46422.9*	(19062.8)
Multinational	-0.0317	(0.0208)	-0.0171	(0.0174)	-9704.2	(27778.1)
Wallonia [b]	-0.0105	(0.0134)	-0.0229*	(0.0111)	-27955.3	(17457.5)
Brussels [b]	0.0450**	(0.0161)	0.0286*	(0.0133)	5734.6	(20624.3)
_cons	0.809***	(0.0347)	0.677***	(0.0289)	121041.7**	(43710.6)
	linear regression		linear regression		linear regression	
N	7 515		7 559		8 143	
Adj. R²	0.10		0.10		0.01	

***p < .001, **p < .01, *p < .05,
Standard errors between brackets
Only active companies included; the outliers attributable to legal events for the growth benchmarks are not included.
[a] Reference category = Section G (Wholesale and retail trade)
[b] Reference category = Flanders Region
[c] Logarithm of the values
[d] Reference category = cluster 'National trademarks'

Table 23 Regression results: influence of IPR clusters on SME performance

	(1) Growth (AAGR) 2015-2019		(2) Growth (CAGR) 2015-2019		(3) Productivity 2015 - 2019	
Independent variables						
C2 International trademarks [d]	0.0241	(0.0149)	0.0355**	(0.0125)	15925.6**	(5749.5)
C3 Only patents [d]	0.0424	(0.0282)	0.0505*	(0.0235)	-5813.2	(10985.4)
C4 Trademarks & Patents [d]	0.0216	(0.0245)	0.0283	(0.0205)	16159.8	(9394.8)
C5 Designs [d]	0.0649	(0.0352)	0.0758*	(0.0296)	5635.8	(13804.0)
C6 Other combinations [d]	0.0373	(0.0258)	0.0399	(0.0216)	-4854.8	(10148.7)
Control variables						
Age [c]	-0.530***	(0.0230)	-0.458***	(0.0192)	55874.6***	(8421.3)
Sector M [a]	0.00939	(0.0197)	-0.00154	(0.0165)	9733.5	(7514.1)
Sector C [a]	0.0323	(0.0181)	0.0303*	(0.0152)	-14468.4*	(7114.4)
Sector J [a]	0.119***	(0.0238)	0.0995***	(0.0199)	-9268.4	(9044.1)
Sector N [a]	0.0309	(0.0297)	-0.00761	(0.0249)	10951.6	(11461.3)
Sector Other [a]	0.0350*	(0.0168)	0.0172	(0.0140)	19948.0**	(6436.9)
Multinational	-0.00472	(0.0580)	0.0137	(0.0487)	3519.2	(22110.9)
Wallonia [b]	-0.0139	(0.0152)	-0.0299*	(0.0127)	-16716.6**	(5866.6)
Brussels [b]	0.0362	(0.0190)	0.0227	(0.0158)	-10033.5	(7194.9)
_cons	0.803***	(0.0335)	0.672***	(0.0280)	17091.5	(12185.4)
	linear regression		linear regression		linear regression	
N	5 856		5 900		6 451	
Adj. R²	0.10		0.11		0.01	

***p < .001, **p < .01, *p < .05,
Standard errors between brackets
Only active companies included; the outliers attributable to legal events for the growth benchmarks are not included.
[a] Reference category = Section G (Wholesale and retail trade)
[b] Reference category = Flanders Region
[c] Logarithm of the values
[d] Reference category = cluster 'National trademarks'

4.4.   Conclusions

The IPR profile of enterprises. In total, we were able to identify 15 193 unique companies that acquired some type of IPR in the period 2010-2019. On average, these companies own 5.4 intellectual property rights. Slightly more than half of the companies in the dataset however, own only a single intellectual property right. 90% of the companies in the dataset have at least a single trademark right, 17% of the companies own at least a single patent, 7% at least a single design right and just 26 companies (0%) in the data set have a plant breeders' right.

If we consider validity, it can be concluded that for the use of design rights, patents and plant breeders' rights, the dominant choice is in favour of international (and mainly European) validity. In this respect, trademark rights stand out from the other types due to a pronounced focus on local validity (in particular in the Benelux countries). This observation in fact continues to apply if focused exclusively on companies with a foreign GUO.

A bottom-up clustering of companies based on the composition of their IPR portfolios (in terms of scope and not of volume), resulted in 5 identifiable clusters. A comparison of company characteristics within these different clusters, leads to the following 'stereotyping':

Cluster	Company stereotype
National trademarks	Relatively young (18 years), micro enterprise, active in Antwerp within the trade or services sector.
International trademarks	Micro enterprise (22 years), active in Antwerp within the trade or services sector or in the Information & Communication sector.
Trademarks & Patents	SME or large company (24 years), active in Antwerp or East Flanders within the manufacturing sector.
Only patents	Micro company (24 years), active in Antwerp or East Flanders within the scientific-technical sector.
Designs	Relatively old (28 years) micro enterprise, active in Antwerp or West Flanders, within the manufacturing or trade sector.

The characteristics of IPR-active enterprises. Of all enterprises in the dataset that acquired some type of IPR between 2010 and 2019, at present 89% are still active. The average age of these enterprises is 20 years (median 15 years). On average, the enterprises with at least a single design right (or enterprises in the cluster 'designs') are oldest. The majority of enterprises with IPR are active in the sector 'Wholesale and retail trade'. If we consider the distribution per IPR cluster, we see that in the clusters 'National trademarks' and 'International trademarks', the highest percentage of companies are active in 'Wholesale and retail trade'. In the clusters 'trademarks & patents', 'only patents' and 'designs', more enterprises are active in the sector Manufacturing than in other sectors. Moreover, 84% of enterprises with IPR in the dataset are SMEs, while 16% can be classified as large enterprises. The subgroup enterprises with the largest share of SMEs are those enterprises with at least a single trademark right. The enterprises with at least a single patent have the lowest share of SMEs. With regard to the clusters,

enterprises in the cluster 'National trademarks' represent the largest proportion of SMEs. Finally, we note that 92% of enterprises with IPR can be classified as Belgian companies. 8% are part of a foreign company. IPR-active companies with a foreign global ultimate owner on average make more use of patents and plant breeders' rights than Belgian companies.

The performance of IPR-active enterprises. The average annual growth rate for active enterprises with IPR is 15.7% for the period between 2015 and 2019. The compound annual growth rate is on average 11.5%. As a rule, companies with at least a single trademark right achieve the highest growth rate, while companies with at least a single design right the lowest. We also observed that average productivity of the active enterprises with IPR amounts to 114 067 euro per employees; among SMEs, average productivity is 90 616 euro per employee. Enterprises with at least a single patent on average demonstrate the highest productivity, and enterprises with at least a single plant breeders' right the lowest. If we consider the clusters, we see that the cluster 'only patents' shows the highest productivity followed by 'designs', while the cluster 'national trademarks' achieves the lowest productivity.

The relationship between IPR, company characteristics and company performance. We first assessed which company characteristics have a relationship with the IPR variables, namely total number of IPR or IPR scope (i.e. the number of different IPR types owned by a company). The first observation is that the age of an enterprise has a positive relationship with the total IPR and IPR scope. In other words, older companies with at least a single IPR own more intellectual property rights in absolute terms, but also own more types of IPR. At the same time, we observe that SMEs have fewer intellectual property rights and fewer different types of IPR in their IPR portfolio. Compared with enterprises active in the sector 'Wholesale and retail trade', companies in the sector 'Manufacturing' have more IPR and more different types of IPR. However, enterprises in the sectors 'Information and communication', 'Administrative and support service activities' and 'Other' have fewer IPR and fewer different types of IPR (than enterprises in 'Wholesale and retail trade').

Secondly, we studied the influence of IPR on the performance of the IPR-active company. The total number of IPR held by an IPR-active enterprise reveals a positive relationship with the productivity of the company. IPR scope also has a positive relationship with growth (CAGR). In other words, companies with a broader IPR scope achieved higher compound growth between 2015 and 2019 than companies with a more focused IPR portfolio.

5 / The share of IPR-active companies in the Belgian economy

This chapter analyses the share of active enterprises in the Belgian economy, that acquired IPR between 2010 and 2019 (N = 13 551). The analysis focuses on their contribution to total employment and added value in Belgium in 2019.

These IPR-active companies are compared with and positioned in relation to active Belgian enterprises/associations that recorded and published their accounts. In total, 474 315 enterprises that acquired no IPR between 2010 and 2019 satisfied these criteria. Via Bel-first, we gathered data about these active enterprises with and without IPR concerning their gross added value, staff head count and balance sheet total in 2019. It is important to note that these data are not published for all enterprises and that the figures depend heavily on which companies are considered Belgian companies[27]. These figures must therefore be interpreted with caution.

In addition to the description of the complete set of enterprises with IPR as compared with the Belgian active enterprises (without IER), we also offer a number of preliminary insights for the subset of small and medium-sized companies. However, unlike in the other chapters, we consider the SME definition here by classifying enterprises with a balance sheet total of less than 43 million euros as small or medium-sized. We chose this option because using all criteria for classifying Belgian, active enterprises as SMEs (as described in chapter 5.2.), demands a disproportionate volume of data, in order to be applied to the complete sample of 474 315 active Belgian companies.

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[27] If we wish to study the share of Belgian companies that acquired IPR between 2010 and 2019 in the Belgian economy, the share depends heavily on the effectively chosen denominator. This was discussed in Section 6.2.4. Location. If we calculate the share of IPR-active companies according to the 474 315 enterprises that did not acquire IPR between 2010 and 2019, the share amounts to 3%. However, if we calculate the share on the basis of the filtered denominator, as specified in Section 6.4.2., we arrive at a share of 6% (filtered denominator: all companies/associations with accounts'; that are active, that are not public companies or associations or sole traders; with nacebel section B-H, L, M or N and excluding all entities with 0 employees). Below we continue according to the denominator of 474 315 enterprises that acquired no IPR between 2010 and 2019. This is because the calculations are made on the basis of figures about staff head count and added value and because of the many enterprises that do not publish accounts, many enterprises are no longer included in the denominator.

5.1. Employment

Firstly we show the importance of companies active in IPR according to their percentage contribution to total employment in Belgium.

Table 24 shows that companies that acquired IPR between 2010 and 2019 on average employed more staff in 2019 than Belgian companies that acquired no IPR in that period. More specifically, the companies with IPR employ on average 75.8 employees, while Belgian companies without IPR employ on average 14.8 people. This difference is statistically significant (t-test, t=22.5, p < 0.001) and confirms earlier findings about the leverage effect of IPR (EPO & EUIPO, 2021, cf. Section 3.2).

We then studied the share of the IPR-active companies in total employment in Belgium. It can be concluded from Table 24 that enterprises with IPR represent 23.7% of total employment in Belgium in 2019, whereas they only represent a fraction of the total company population[28].

Table 24 Total and average employment 2019

	Total employment in 2019	Average employment in 2019	s.d.	N
Enterprises without IPR	1 981 742	14.8	195.3	134 188
Enterprises with IPR	617 094	75.8	598.4	8 137

Note: It should be noted that many enterprises do not publish employee numbers.

If we conduct the same analysis for enterprises with a balance sheet total below 43 million euro (as a proxy for SMEs), it should be noted that here too, average employment rates in SMEs with IPR are higher than for SMEs without IPR (Table 25). SMEs with IPR account for 11.0% of total employment in 2019 by SME in Belgium, while they represent just 5% of the SME population[29].

Table 25 Average employment 2019 small and medium-sized companies (according to balance sheet total)

	Average employment in 2019	s.d.	N
Enterprises without IPR	10.6	147.1	131 980
Enterprises with IPR	23.3	60.9	7 304

Note: It should be noted that many enterprises do not publish employee numbers.

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[28] Calculations here on the basis of available data (N). On the basis of the number of available data concerning employment in 2019, we can state that companies with IPR represent 5.7% of the total Belgian company population.

[29] Calculations here on the basis of available data (N). On the basis of the number of available data concerning employment in 2019, we can state that SMEs with IPR represent 5.2% of the total SME population.

5.2. Gross added value (per employee)

We secondly show the importance of IPR-active companies according to gross added value.

Table 26 shows that enterprises with IPR in 2019 on average achieved higher gross added value than Belgian companies without IPR. Enterprises with IPR on average achieve added value of 6 422 917 in 2019, while Belgian companies without IPR on average achieve 442 176,7 euro added value. This difference is statistically significant (t-test, t=45.7, p < 0.001) and confirms earlier findings about the leverage effect of IPR (EPO & EUIPO, 2021, cf. Section 3.2).

Table 26 Average gross added value 2019

	Average gross added value in 2019	s.d.	N
Enterprises without IPR	442 176.7	9 937.7	428 257
Enterprises with IPR	6 422 917	683775.7	12 659

Based on the fact that the above tables tell us that enterprises with IPR on average employ more people, we studied the average gross added value per employee in 2019 (the productivity of an enterprise). Table 27 shows that the average gross added value per employee or the average productivity is also higher for enterprises with IPR than enterprises without IPR. The difference is once again significant (t-test, t = -2.7, p<0.05) and also confirms earlier findings about the leverage effect of IPR (EPO & EUIPO, 2021, cf. Section 3.2).

Table 27 Average productivity 2019 (i.e. gross added value per employee)

	Average productivity in 2019	s.d.	N
Enterprises without IPR	99 914.3	533 774.9	134 177
Enterprises with IPR	116 611.5	596 186.9	8 137

Note: It should be noted that many enterprises do not publish employee numbers.

We then conducted analyses for enterprises with a balance sheet total below 43 million euro (as a proxy for SMEs). The share of active small and medium-sized enterprises with IPR (according to balance sheet total) in the total gross added value of small and medium-sized enterprises in 2019 amounts to 11.2%.

Among small or medium-sized enterprises (according to balance sheet total) the average productivity of enterprises with IPR is higher than in enterprises without IPR (Table 28). This difference is statistically significant (t-test, t = -3.5, p<0.05).

Table 28 Average productivity 2019 small and medium-sized companies (according to balance sheet total)

	Average productivity in 2019	s.d.	N
Enterprises without IPR	92 209.5	157 193.2	131 969
Enterprises with IPR	98 904.6	214 479.6	7 304

Note: It should be noted that many enterprises do not publish employee numbers.

5.3. Conclusions

In this chapter we studied the share of active enterprises that acquired IPR between 2010 and 2019, in the Belgian economy. We see that companies that acquired IPR between 2010 and 2019 on average employed more staff in 2019 than Belgian companies that acquired no IPR in that period. We see that enterprises with IPR represent 23.7% of total employment in Belgium in 2019, whereas they only represent a fraction of the total company population.

We would further note that enterprises with IPR in 2019 on average achieved higher gross added value than Belgian companies without IPR. Also if we study the average gross added value per employee in 2019, the same trend emerges. The average productivity (i.e. gross added value per employee) for companies with IPR amounts to 116 611,5, as compared with 99 914 euros for enterprises without IPR.

6 / A comparison between IPR-active SMEs and IPR-active large enterprises

Since the focus of this study is on IPR-active SMEs, in this chapter, we present the differences between currently active SMEs and non-SMEs that acquired IPR between 2010 and 2019. Figure 24 showed that 84% of active companies with IPR in the dataset can be classified as SMEs (in other words 10 012 enterprises in the dataset are SMEs and 1 935 are not; the remaining companies are 'unknown' and are therefore not included ('missing')). Below we discuss the differences between SMEs and non-SMEs in terms of IPR profile, company characteristics and company performance.

6.1. IPR profile of SMEs versus IPR profile of non-SMEs.

Table 29 shows that there is a major difference in the total number of intellectual property rights between SMEs and non-SMEs. Whereas SMEs on average have 3 IPR, large companies on average have 22.

Table 29 Comparison SMEs and non-SMEs with regard to total IPR

	Average	s.d.	Min	Max	N
SME	3.0	7.4	1	275	10 012
Non-SME	22.1	102.5	1	2394	1 935

s.d. = standard deviation

Figure 35 compares SMEs and non-SMEs in the dataset with regard to the distribution of the number of intellectual property rights owned by the enterprises. In terms of percentages, 53% of SMEs have just a single intellectual property right, whereas only 24% of the group of non-SMEs have just a single IPR. In terms of percentage, the non-SMEs therefore more often have more than a single IPR than SMEs. No single SME has more than 275 intellectual property rights.

Figure 35 Comparison SMEs and non-SMEs with regard to distribution of number of IPR
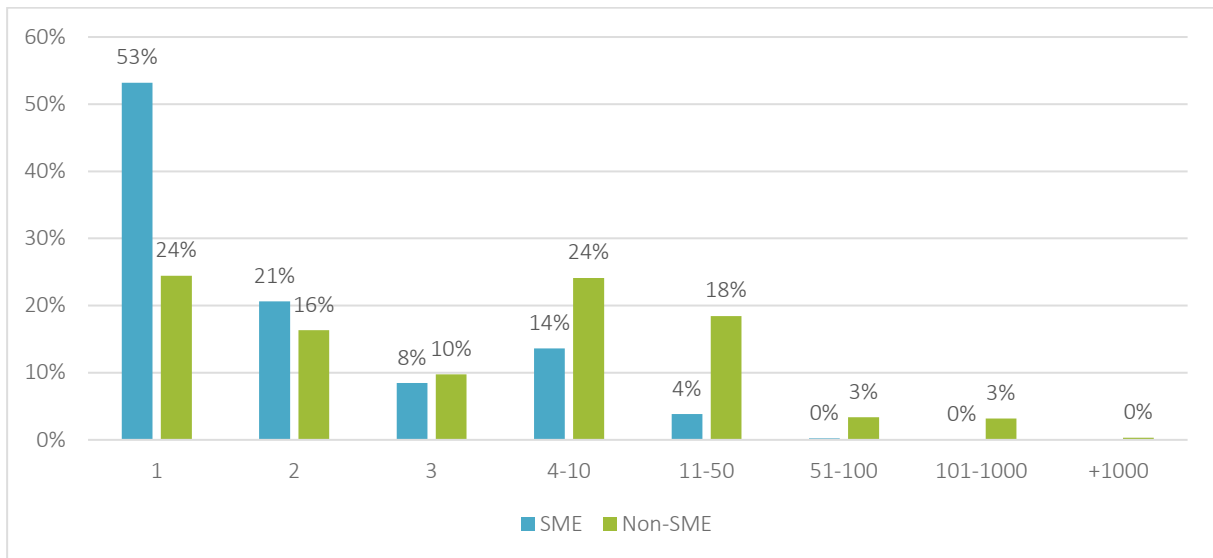
Total SMEs, N = 10 012; Total non-SMEs, N = 1 935; note, the classes above are not equal.

Figure 37 shows the distribution of SMEs and non-SMEs according to the IPR cluster to which the enterprise belongs. The share of SMEs is highest for enterprises in the cluster 'National trademarks' and lowest in the cluster 'Trademarks and patents'.

Figure 36 Distribution of SMEs and non-SMEs according to IPR cluster
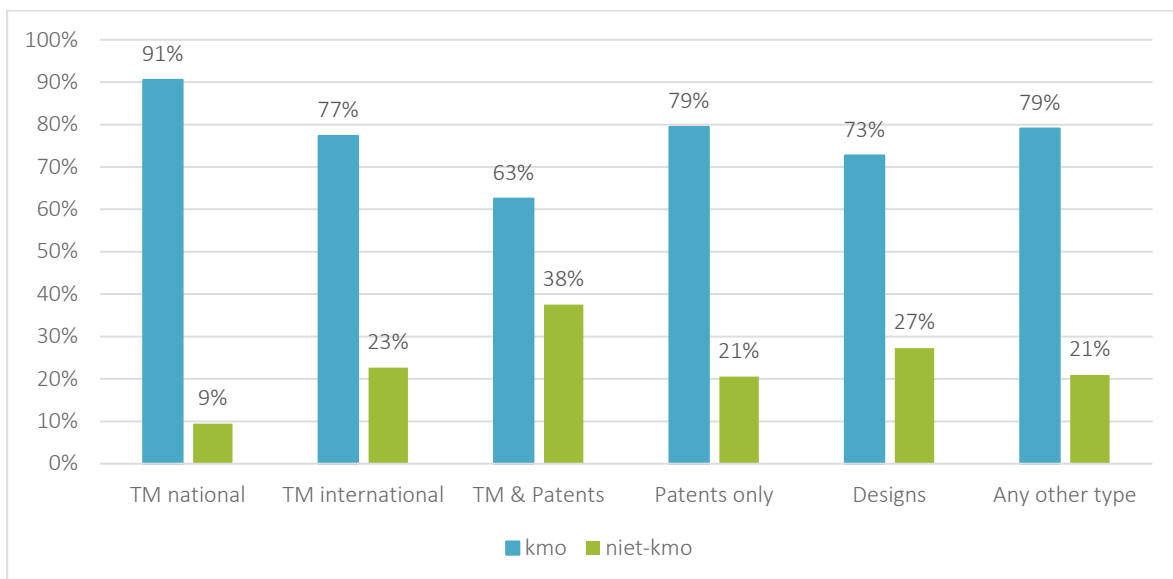
6.1.1 Design rights

7.2% or 979 active companies in our dataset have at least a single design right[30]. Of the SMEs in the dataset, 6.6% have at least a single design right as compared with 10.6% from the group of non-SMEs in the dataset.

Table 30 shows the difference between design rights valid in Benelux, Europe and internationally, for SMEs and non-SMEs. Whereas in terms of percentage, more SMEs have at least a single design right in Benelux, in terms of percentage, the non-SMEs have more design rights valid in Europe and internationally. The SMEs with at least a single design right in Benelux on average have 3.1 design rights. The non-SMEs with at least a single design right in Benelux on average have slightly fewer (2.7).

Table 30 Design rights according to geographical validity and SME or not

	Design right in the Benelux		Design right in Europe		International design rights	
	SME	Non-SME	SME	Non-SME	SME	Non-SME
Number of companies with at least a single design right (N)	179	19	500	183	35	37
% companies with at least a single design right in the group of companies[a]	1.8%	1.0%	5.0%	9.5%	0.4%	1.9%
Max number of design rights	80	7	174	865	16	57
Average number of design rights (according to N)	3.1	2.7	6.6	23.1	3.2	5.1
Standard deviation average number design rights (according to N)	7.5	2.1	16.2	79.0	3.6	10.4

[a] The term 'group of companies' refers either to the complete group of active SMEs in the dataset or the complete group of active non-SMEs in the dataset.

6.1.2 Patents

17% or 2 336 active companies in our dataset have at least a single patent[31]. Of the SMEs in the dataset, 15% have at least a single patent. For the group of non-SMEs in the dataset, the number is higher, i.e. 31.6%.

Table 31 shows the occurrence of the different levels of validity of patents within the group SMEs and non-SMEs. In terms of percentage, more enterprises in the group non-SMEs have patents valid in Belgium, Europe and abroad than enterprises in the group SMEs. The SMEs with at least a single patent also on average have fewer patents than the non-SMEs.

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[30] Note that this deviates slightly from the figures reported in section 6.1.1. because here only the active companies are included.
[31] Note that this deviates slightly from the figures reported in section 6.1.2. because here only the active companies are included.

Table 31 Patents according to geographical validity and SME or not

	Patent BE		Patent EP		Patent foreign		Patent INTL	
	SME	Non-SME	SME	Non-SME	SME	Non-SME	SME	Non-SME
Number of companies with at least a single patent (N)	1 092	399	811	436	535	352	58	87
% companies with at least a single patent in the group of companies[a]	10.9%	20.6%	8.1%	22.5%	5.3%	18.2%	0.6%	4.5%
Max number of patents	23	330	67	820	136	1160	33	88
Average number of patents (according to N)	1.8	7.0	2.2	20.7	2.9	28.5	2.0	5.6
Standard deviation average number patents (according to N)	1.8	22.2	3.9	68.5	7.6	92.9	4.3	11.4

[a] The term 'group of companies' refers either to the complete group of SMEs in the dataset or the complete group of non-SMEs in the dataset.

6.1.3 Trademark rights

89.9% (or 12 179) of the active enterprises in our dataset have at least a single trademark right[32]. Of the SMEs in the dataset, 90.1% have at least a single trademark right. The percentage for the group non-SMEs in the dataset is slightly lower, i.e. 88.6%.

Table 32 shows the difference between trademark rights valid in Benelux, Europe and internationally, for SMEs or non-SMEs. Whereas in terms of percentage, more SMEs have at least a single trademark right in Benelux, in terms of percentage, the non-SMEs have more trademark rights valid in Europe and internationally. This is in line with the observations for the other types of IPR. The SMEs with at least a single trademark right in Benelux on average have 1.8 trademark rights. This is fewer than the non-SMEs with at least a single trademark right in Benelux.

Table 32 Trademark rights according to geographical validity and SME or not

	Trademark right in the Benelux		Trademark right in Europe		Trademark right international	
	SME	Non-SME	SME	Non-SME	SME	Non-SME
Number of companies with at least a single trademark right (N)	7 817	1 405	2 324	873	872	489

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[32] Note that this deviates slightly from the figures reported in section 6.1.3. because here only the active companies are included.

% companies with at least a single trademark right in the group of companies[a]	78.1%	72.6%	23.2%	45.1%	8.7%	25.3%
Max number of trademark rights	169	399	100	161	17	370
Average number of trademark rights (according to N)	1.8	6.1	2.0	5.7	1.7	4.8
Standard deviation average number trademark rights (according to N)	3.1	17.1	3.0	12.9	1.6	17.7

[a] The term 'group of companies' refers either to the complete group of SMEs in the dataset or the complete group of non-SMEs in the dataset.

6.1.4   Plant breeders' rights.

Only 26 active companies (or 0.19%) has at least a single plant breeders' right[33]. Of the SMEs in the dataset, 0.18% have at least a single plant breeders' right. For the group of non-SMEs in the dataset, the number is slightly higher i.e. 0.21%.

Given the small number of observations in the groups SMEs and non-SMEs with at least a single plant breeders' right, it is neither meaningful nor reliable to produce a summary table.

6.1.5   IPR scope

The summary variable IPR scope measures how many different types of IPR a company owns. 87.6% of the active enterprises in the dataset own at least a single type of IPR, 10.2% own 2 types and 2.2% three types.[34]

Figure 37 shows that in terms of percentage, 90% of active SMEs in the dataset own one type of IPR as compared with 75% of non-SMEs in the dataset. In terms of percentage, the non-SMEs therefore own more different types of IPR than the SMEs.

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[33] Note that this deviates slightly from the figures reported in section 6.1.4. because here only the active companies are included.
[34] Note that this deviates slightly from the figures reported in section 6.1.5.2. because here only the active companies are included.

Figure 37 Distribution SMEs and non-SMEs in terms of IPR scope
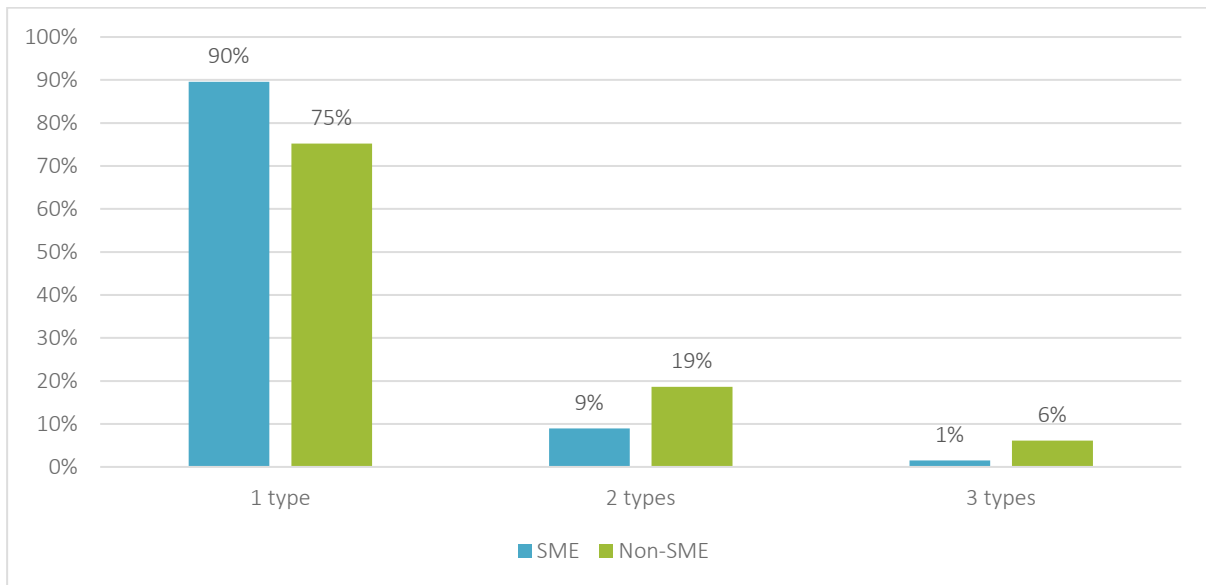
Total SMEs, N = 10 012; Total non-SMEs, N = 1 935

6.2. The characteristics and performance of SMEs versus non-SMEs with IPR

6.2.1 Company characteristics

Age. The average age of active SMEs with IPR is 18.7 years as compared with the age of active non-SMEs with IPR at 33.7 years.

Sector. If we consider the sectors in which SMEs and non-SMEs with IPR are active, we see in Figure 38 that 28% of SMEs are active in sector G (Wholesale and retail trade), 19% in sector M (Professional, scientific and technical activities), and 15% in C (Manufacturing). The non-SMEs with IPR are most active in sector C (Manufacturing), i.e. 28%.

Figure 38 Distribution of SMEs and non-SMEs according to sector
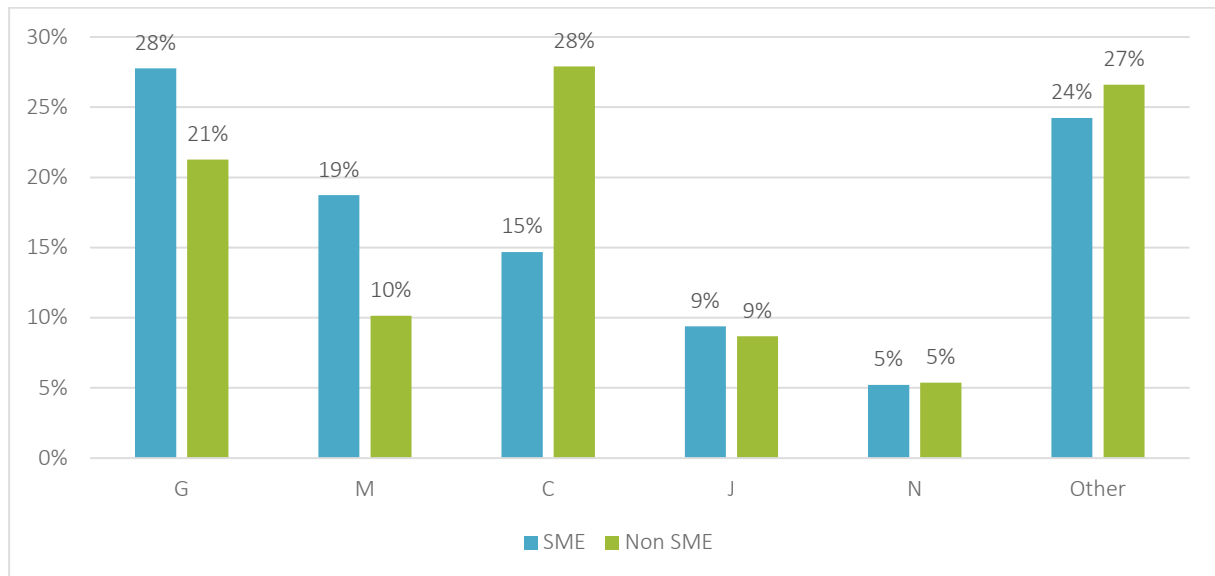
Total SMEs, N = 9 831; Total non-SME, N = 1 913

Location. We observe no major differences in terms of location of SMEs and large companies with IPR. 67% of the IPR-active SMEs are based in Flanders, 19% in Wallonia and 14% in the Brussels-Capital Region.

Figure 39 Geographical location of SMEs versus non-SMEs
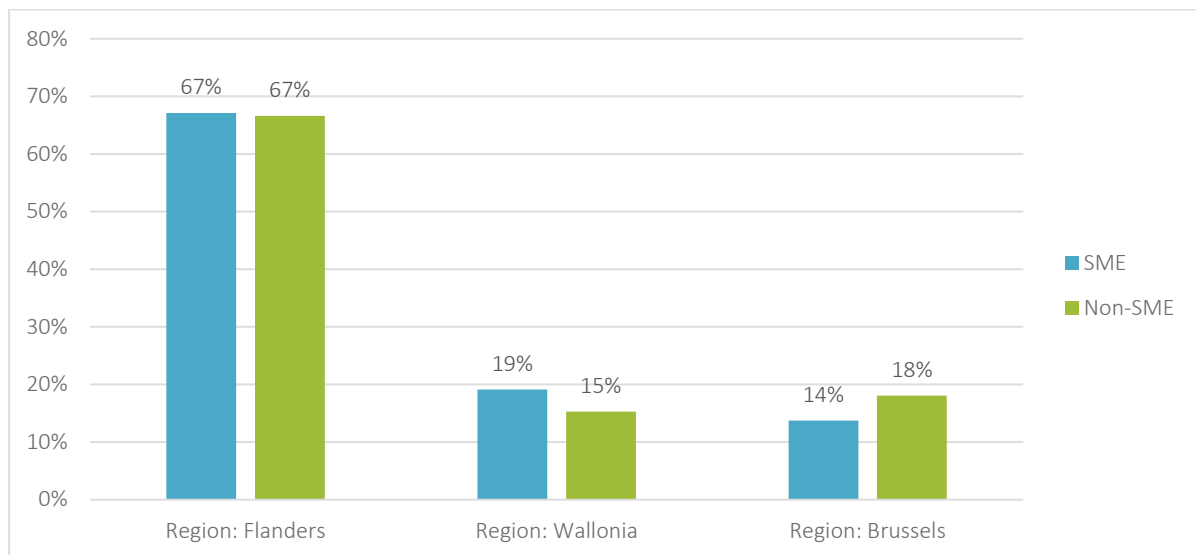
Total SMEs, N = 10 012; Total non-SME, N = 1 935

Multinational character. There is a major difference in multinational character between SMEs with IPR and non-SMEs with IPR. More specifically, only 1% of IPR-active SMEs has a multinational character, as compared with 41% among IPR-active non-SMEs.

6.2.2   Growth in employment

Table 33 shows that the average annual growth rate for IPR-active SMEs is considerably higher than the average annual growth rate for IPR-active non-SMEs. These differences are statistically significant (t-test, t=-4.8, p>0.001).

Table 33 Average annual growth rate (AAGR) for SMEs and non-SMEs with IPR

	Average	s.d.	N
SME	16.7%	0.48	5 871
Non-SME	10.5%	0.42	1 707

Outliers attributable to 'legal events' such as mergers and acquisitions not included

Table 34 also shows that the compound annual growth rate for IPR-active SMEs is higher than for IPR-active non-SMEs. This difference is also statistically significant (t-test, t= -3.9, p<0.001).

Table 34 Compound annual growth rate (CAGR) for SMEs and non-SMEs with IPR

	Average	s.d.	N
SME	11.9%	0.41	5 915
non-SME	7.7%	0.34	1 707

Outliers attributable to 'legal events' such as mergers and acquisitions not included

These results confirm past findings regarding a greater leverage effect of IPR among SMEs than among large companies (EPO & EUIPO, 2019a; Andries & Faems, 2013, cf. Section 3.2).

6.2.3   Productivity

Table 35 finally shows that the average productivity (defined as the gross added value per employee) between 2015 and 2019 is significantly higher among active non-SMEs with IPR than active SMEs with IPR (t-test, t=7.4, p<0.001).

Table 35 Average productivity for SMEs and non-SMEs with IPR

	Average	s.d.	N
SME	90 415	2 311	6 474
non-SME	210 948	30 288	1 742

6.3. Conclusions

In this chapter, we discuss the differences between (active) SMEs and non-SMEs that acquired IPR between 2010 and 2019. 84% of active companies with IPR in the dataset could be classified as SMEs. The share of SMEs is highest for enterprises in the cluster 'National trademarks' and lowest in the cluster 'Trademarks and patents'.

Whereas SMEs on average have 3 IPR, large companies on average have 22. Of the SMEs in the dataset, 6.6% have at least a single design right as compared with 10.6% from the group of non-SMEs in the dataset. Of the SMEs in the dataset, 15% have at least a single patent. For the group of non-SMEs in the dataset, the number is higher, i.e. 31.6%. Of the SMEs in the dataset, 90.1% have at least a single trademark right. The percentage for the group non-SMEs in the dataset is slightly lower, i.e. 88.6%. Of the SMEs in the dataset, 0.18% have at least a single plant breeders' right. For the group of non-SMEs in the dataset, the number is slightly higher i.e. 0.21%. Furthermore, in terms of percentage, the non-SMEs own more different types of IPR than the SMEs.

Concerning company characteristics, the average age of active SMEs with IPR is 19 years as compared with the average age of active non-SMEs with IPR at 34 years. We see that SMEs are most often active in the sector Wholesale and retail trade, while non-SMEs are most commonly active in the sector Manufacturing. There is a major difference in multinational character between SMEs with IPR and non-SMEs with IPR. More specifically, only 1% of IPR-active SMEs has a multinational character, as compared with 41% among IPR-active non-SMEs.

Concerning performance, we see that both annual growth rates for IPR-active SMEs are considerably higher than of IPR-active non-SMEs. These results confirm past findings regarding a greater leverage effect of IPR among SMEs than large companies. Finally, we note that the average productivity (measured as the gross added value per employee) between 2015 and 2019 is significantly higher among active non-SMEs with IPR than among active SMEs with IPR.

7 / The influence of owning or not owning IPR

The intention of this chapter is to chart out the impact of activity in the field of IPR on company performance. Because this question is counterfactual in nature and assumes a causal connection (*'How would the company have performed if it had not acquired any IPR?'),* we must separate the differences in performance caused by IPR from other possible underlying factors. There is for example a suggestion that more productive companies are more likely to apply for IPR. To correct for such selection effects, in this chapter we make use of matching, one of the canonical methods of counterfactual analysis. In a matching analysis, for each company that acquired IPR in the study period between 2010 and 2019, we identified an equivalent ('control') company that did not acquire IPR in that period. If the control companies are well selected, the difference in performance between companies with IPR and control companies summarises the effect of owning IPR. Unlike in the analyses presented earlier, the focus in this case is on owning versus not owning IPR. Just like in previous chapters, we assess performance on the basis of growth and productivity. In these analyses, we estimate both the general impact of IPR ownership and the impact according to IPR cluster.[35] We also discuss in greater depth the differences in growth and productivity effects between SMEs and large companies.

Below we first briefly explain the matching method. This is followed by the results, which start with descriptive differences in growth and productivity between companies with (one or more, or one or more types of) IPR and the control companies. We then further underpin these relationships with regression analyses.

7.1. Method

In this analysis, we match companies with IPR to companies without IPR by selecting for each IPR-active company a control company from the same NACE section, which is also equivalent in terms of size and age. Moreover, we also match according to past productivity.[36] We measure the matching variables size and productivity ten years ago, in 2012[37], and we measure performance between 2015 and 2019. These

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[35] See section 6.1.6. for a description of the IPR typology employed.
[36] An alternative analysis without matching according to productivity in 2012 did not result in qualitatively different conclusions.
[37] 2012 is the earliest possible year for which we are able to gather Bel-first data.

time differences make it less likely that the observed results are exclusively attributable to selection effects. We determine company size on the basis of balance sheet total, and growth on the basis of compound annual growth rate in employment between 2015 and 2019 (CAGR). We determine productivity according to added value per employee, in 2012 for the matching, with the average between 2015 and 2019 as the outcome.

One possibly important other matching variable is investment in R&D or innovation. If this is included, the effect of IPR on performance can be estimated for a certain level of R&D or innovation. Because the information is only available for a limited set of (large, quoted) companies, however, it is not possible to include this in the analysis. All results must hence be interpreted with the possibility that companies with and without IPR may differ in terms of R&D expenditure. As a consequence, the estimated effects on performance in this analysis should rather be viewed as upper limits.[38]

For this analysis, we take as a basis the set of IPR-active companies that have both the status active and that are at least 10 years old (6 119 companies[39]). The potential control enterprises are all active, Belgian companies that submit and publish their accounts, and that are at least 10 years old (310 094 companies). Following removal of the control companies with missing values in the relevant matching variables, 107 739 potential control companies remain.

To compile the control group, we made use of propensity score matching. Propensity score matching awards a propensity score to every company with IPR and to every potential control company, that represents the probability that the company could attract IPR. The matching is then not based on every variable, but on this propensity score. This also avoids the problem of the difficulty of identifying precise counterparts for every IPR company, if matching is based on multiple variables. Econometric theory has demonstrated that this is equivalent to matching for individual variables (Rosenbaum and Rubin, 1983). To guarantee that each control company is selected from the correct NACE section, this procedure was carried out within the individual NACE sections.

The procedure resulted in 6 119 companies with IPR, and 6 119 control companies. The control companies comprise 5 683 unique companies, of which a number are linked to multiple companies with IPR. The statistical analyses below correct for the fact that some of the companies occur repeatedly in the data (Lechner, 2001). The data were then checked for outliers and other statistical problems. Firstly, observations were left out if located in the highest or lowest percentile of outcome variables[40]. Moreover, observations with negative productivity in 2012, or average negative productivity for the period 2015-2019, were left out. This reduces the probability that the results identified are attributable to non-representative outliers or data errors. In this way, 440 companies with IPR and 386 control companies were omitted from the analysis. Another 682 companies with IPR and 933 control companies could not be further investigated, because not all the necessary information was available for the regression analysis.

The final dataset consists of 4 997 companies with IPR and 4 800 control companies. The final sample of companies with IPR consists of companies with an average age of 31 years, with a balance sheet total of approx. 51 million euro in 2012, and 103 290 euros added value per employee in 2012. Companies

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[38] For an analysis of public companies that includes R&D but with a focus on quoted companies and patents, see also Hall et al. (2005).
[39] These are all companies for which the necessary (matching) variables are also known.
[40] Note that outliers are dealt with differently here than in the previous chapters.

in manufacturing, wholesale and retail trade, and scientific and technical activities are more heavily represented, and together represent 68% of the sample. Annex A.2 discusses in more depth the quality of the matches, and presents different ways of carrying out the assessment. The annex also presents detailed overview statistics of the final sample.

7.2.   Results

7.2.1   Descriptive results

By way of introduction, we first present a descriptive analysis of the relationship between IPR and performance, by comparing average performance between companies with any type of IPR and the matched control companies. In the next section, we determine whether these results are robust if we further check for other factors that could absorb any remaining correlations between having IPR and the performance benchmarks. This is important, since both growth and productivity are heavily influenced by environmental factors, that for example can vary widely between sectors.

Table 36 compares average growth and productivity between companies with IPR and control companies. In line with past studies that concluded that IPR deliver a leverage effect in terms of growth and productivity (EPO & EUIPO, 2019a, 2021), companies with IPR on average achieve a compound annual growth rate in employment of 2.9%.[41] This growth rate is on average 2.5 percentage points higher than among companies in the control group, which achieved a growth rate of only 0.4% (p<0.01). Companies with IPR are also on average more productive than companies in the control group: companies with IPR on average generate 104,788 euro added value per employee, as compared with 95,228 euro for companies in the control group. The difference of 9,561 euro, which amounts to 10% of the productivity of the control group, is statistically significant (p<0.01).

If we conduct the same analysis for SMEs and large companies, within both groups, we arrive at very similar conclusions for growth. For productivity, however, differences emerge. Whereas SMEs with IPR achieve on average 7,378 euro higher productivity (8.4% of the productivity of SMEs in the control group, p<0.01), the impact for large companies is negative. More surprisingly, at 133,844 euro, the productivity of large companies with IPR is 21,017 euro or 15.7% lower than for large companies in the control group at 154,861 euro (p<0.01). This finding is in line with past work that revealed that the leverage effects of IPR are greater among SMEs than large companies (Andries & Faems, 2013; EPO & EUIPO, 2019a, 2021). In the regression analysis, we assess whether these differences remain robust when we also check for other variables.

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[41] This growth is lower than reported in the previous chapters. Whereas the previous reported growth relates to all companies with IPR, the focus here is on an accurate comparison between companies with and without IPR. For that reason, companies with exceptional growth are more likely to be conservatively removed from the data, which automatically lowers the average.

Table 36 Average growth and productivity per IPR ownership

	Growth (CAGR) [%]			Productivity [EUR]		
	Control	IPR	Difference	Control	IPR	Difference
All companies	0.004	0.029	0.025***	95,228	104,788	9,561***
Observations	*4,800*	*4,997*		*4,800*	*4,997*	
SMEs	0.004	0.029	0.025***	87,352	94,730	7,378***
Observations	*4,240*	*3,712*		*4,240*	*3,712*	
Large companies	0.003	0.029	0.026***	154,861	133,844	-21,017***
Observations	*560*	*1,285*		*560*	*1,285*	

Average compound annual growth rate (CAGR) in employment, 2015-2019, and average productivity (added value per employee), 2015-2019, for companies with IPR compared with the control group. The difference reflects the difference between companies with and without IPR. Significant differences on the basis of t-test with Lechner (2001) correction for repeat sampling are marked: *** p < 0.01, ** p < 0.05, * p < 0.10.

Table 37 considers in greater depth the different types of IPR by making the same comparison within each IPR cluster. In this analysis, companies with a specific combination of IPR types are compared with the control group relevant for those companies. It should be remembered that in the smaller clusters, remaining differences between control companies with IPR ownership and control companies can be magnified, because for certain companies, no adequate control companies were identified, or because certain clusters contain a more diverse group. In each IPR cluster, companies with that type of IPR demonstrate significantly higher growth in employment than the control companies. The differences are comparable across the majority of clusters, and range from 2.0 to 3.1 percentage points. Only companies that combine trademarks and patents achieve a significantly higher average growth rate, 4.6 percentage points more than that of the relevant control companies. Previous studies also determined in that framework that companies experience greater positive effects if they combine different types of IPR, since these reinforce their competitive position and are able to generate complementarity (EPO & EUIPO, 2019; EUIPO, 2020).

Table 37 Average growth and productivity per IPR cluster

	Growth (CAGR) [%]			Productivity [EUR]		
	Control	IPR	Difference	Control	IPR	Difference
National trademarks	0.005	0.025	0.020***	92,590	92,220	370
Observations	*2,223*	*2,319*		*2,223*	*2,319*	
International trademarks	0.01	0.03	0.028***	98,660	113,830	15,168***
Observations	*1,250*	*1,323*		*1,250*	*1,323*	
Trademarks and patents	-0.005	0.041	0.046***	98,372	131,154	32,781***
Observations	*349*	*351*		*349*	*351*	
Only patents	0.002	0.025	0.023***	90,913	116,699	25,785***
Observations	*413*	*414*		*413*	*414*	
Designs	0.005	0.027	0.022**	101,989	117,956	16,966*
Observations	*222*	*236*		*222*	*236*	
Other combinations	-0.004	0.026	0.031***	97,440	104,497	7,057
Observations	*343*	*354*		*343*	*354*	

Average compound annual growth rate (CAGR) in employment, 2015-2019, and average productivity (added value per employee), 2015-2019, for companies in different IPR clusters as compared with relevant control groups. The difference reflects the difference between companies with and without IPR. Significant differences on the basis of t-test with Lechner (2001) correction for repeat sampling are marked: *** p < 0.01, ** p < 0.05, * p < 0.10.

The differences in productivity are more varied. Companies with only national (Benelux) trademarks are almost precisely as productive as the relevant control companies (IPR: 92,220, control: 92,590). There is also no significant difference between companies with other combinations and the relevant control companies. Although the average difference amounts to 7,057 euro, 7.2% of the productivity of the control group, the difference is not statistically significant (p>0.10). The differences are greater for the remaining clusters. For example, companies with designs are 16,966 euro more productive than the relevant control companies (16.6%, p<0.10), and companies with international trademarks are 15,168 euro more productive (15.4%, p<0.01). The difference increases even further for companies that own patents; they are 25,785 euro more productive than the relevant control group (28.4%, p<0.01). The difference in productivity is greatest for companies that combine trademarks and patents: they are 32,781 euro more productive than the relevant control group (33.3%, p<0.01).

Table 38 reports these differences for SMEs. The growth effects are comparable with the previous results, and range from 1.9 to 3.0 percentage points for SMEs with only national trademarks, national and international trademarks, only patents and other combinations (p<0.01). As was the case for the complete sample, SMEs that combine patents and trademarks achieve higher growth, here 5.0 percentage points higher than that of the relevant control group (p<0.01). The only major difference between the SME sample and the full sample is that SMEs that own designs do not achieve systematically stronger growth than the relevant control group, in this descriptive analysis. Although the average difference at 1.7 percentage points is in line with the previous differences, this effect is not statistically significant (p>0.10). This can probably be explained by the low number of companies in this cluster (195 companies with designs, 153 control companies).

Table 38 Average growth and productivity per IPR cluster: SMEs

	Growth (CAGR) [%]			Productivity [EUR]		
	Control	IPR	Difference	Control	IPR	Difference
National trademarks	0.005	0.024	0.019***	86,486	86,404	82
Observations	*1,995*	*1,956*		*1,995*	*1,956*	
International trademarks	0.007	0.037	0.030***	89,265	102,927	13,663***
Observations	*1,091*	*897*		*1,091*	*897*	
Trademarks and patents	-0.007	0.042	0.050***	93,842	113,350	19,508**
Observations	*291*	*168*		*291*	*168*	
Only patents	0.002	0.031	0.029***	83,112	105,598	22,485***
Observations	*365*	*227*		*365*	*227*	
Designs	0.007	0.024	0.017	88,748	102,234	13,486*
Observations	*195*	*153*		*195*	*153*	
Other combinations	-0.003	0.026	0.029***	84,141	101,037	16,896***
Observations	*303*	*261*		*303*	*261*	

In line with the previous results, SMEs with only national (Benelux) trademarks are not more productive than the relevant control companies. Also in line with the previous analysis is the fact that the differences in productivity are greatest for SMEs with international trademarks (13,664 euro or 15.3% more than the relevant control group, p<0.01), SMEs with both trademarks and patents (19,508 euro or 20.8%, p<0.05), and SMEs with only patents (22,485 euro or 27.1%, p<0.01). SMEs with designs are on average 13,486 euro more productive than the relevant control companies, although the difference is only slightly statistically significant (13.5%, p<0.10). Unlike the complete sample, SMEs that own other combinations of IPR are on average more productive than their relevant control companies; they are 16,896 euro more productive (20.1%, p<0.01).

Table 39 focuses on large companies. It should be noted that the number of companies with IPR and control companies is considerably lower than in the previous analyses. As compared with the previous analyses, this makes it more difficult to detect significant differences. Notwithstanding this limitation, significant differences in growth are observed. Large companies that use only national trademarks, or national and international trademarks, on average grow 2.4 and 2.5 percentage points more respectively, than the relevant control groups (p<0.01 and p<0.05, respectively). Large companies that combine trademarks and patents also grow 3.3 percentage points more than the control group (p<0.05), but large companies that only use patents do not (1.0 percentage point, p>0.10). Large companies that use design rights and large companies that use other combinations show higher growth, as compared with the relevant control groups, than the previous clusters, with 4.0 and 4.5 percentage points respectively (both p<0.01).

Table 39 Average growth and productivity per IPR cluster: large companies

	Growth (CAGR) [%]			Productivity [EUR]		
	Control	IPR	Difference	Control	IPR	Difference
National trademarks	0.008	0.032	0.024***	146,002	123,557	-22,445**
Observations	*228*	*363*		*228*	*363*	
International trademarks	0.000	0.025	0.025**	163,117	136,777	-26,340*
Observations	*159*	*426*		*159*	*426*	
Trademarks and patents	0.006	0.039	0.033**	121,101	147,498	26,397*
Observations	*58*	*183*		*58*	*183*	
Only patents	0.004	0.014	0.010	150,235	139,143	-11,092
Observations	*48*	*137*		*48*	*137*	
Designs	-0.008	0.032	0.040***	197,619	146,935	-50,684
Observations	*27*	*83*		*27*	*83*	
Other combinations	-0.017	0.028	0.045***	198,181	114,207	-83,974***
Observations	*40*	*93*		*40*	*93*	

If we compare the productivity of large companies with IPR with that of the control groups, negative differences also emerge. The greatest difference occurs in the cluster with other combinations. In that cluster, companies with IPR are 83,974 euro less productive than the control group (73.5%, p<0.01).[42] The differences are considerably smaller, but negative and statistically significant, for large companies that only hold national trademarks (22,445 euro, 18.2%, p<0.05), and large companies with national and international trademarks (26,340 euro, 19.3%). However, the final difference is only slightly significant (p<0.10). Large companies with only patents and large companies with design rights on average achieve lower productivity than the control companies, but those differences are not statistically significant (p>0.10). The only cluster with a positive difference is the cluster in which trademarks are combined with patents. Large companies in this cluster are 26,397 euro more productive than the relevant control group. However, this effect is only slightly statistically significant (21.8%, p<0.10).

7.2.2   Regression analyses

7.2.2.1   Method

The descriptive analysis has documented positive growth and productivity differences for the complete sample and for SMEs, whereby the effect varied according to the IPR cluster. For large companies, similar growth differences have been documented, but more often with negative productivity differences. In the following analysis, on the basis of regressions, we determine whether these effects are robust if we also check for the characteristics of the companies in the samples. It is after all the case that companies with different ages, balance sheet totals and ex-ante productivity demonstrate differences in growth and productivity prospects. In addition, growth and productivity are typically different in different sectors. Corrections are made for these aspects in the regression analysis. As was the case in the previous analyses, the sector indicators are grouped in 6 broader classes.[43] Moreover, in this analysis, we introduce additional controls for the region in which the company is located (Flanders, Wallonia, Brussels), and whether or not the company has a multinational character. This corrects for the possibility that small remaining differences in these factors between the set of companies with IPR and the control companies could distort the estimates.

In the following tables, the key variable is IPR. This variable indicates the difference in growth or productivity between companies with (any or all types of) IPR and the control group, if the other factors are kept constant. In models marked with 'all', the variable IPR indicates the difference in growth or productivity between companies with IPR and the complete control group. In the remaining models, the variable IPR indicates the difference in growth or productivity between companies with IPR in the indicated cluster and the control companies relevant for that group. As outlined above, when interpretating these results, it must be kept in mind that it is not possible to check for R&D or innovation

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[42] This very large difference must however be interpreted with the small comparison groups in mind: the possibility cannot be excluded that a small number of high values here acquire considerable weight, thereby distorting the averages. If the medians are compared, the difference is reduced to 20,688 euro or 20.7% (IPR: 100,051 euro, control group: 120,739 euro).

[43] The matching was conducted with the complete set of NACE sections.

spending. The coefficient therefore only summarises the effect of IPR ownership and differences in innovation spending, and should therefore be viewed as an upper limit.

In the first set of regressions, we consider the compound annual growth rate of the company as a dependent variable. The interpretation of the key variable IPR, which indicates ownership of IPR or a specific type of IPR, is then reproduced in percentage points. In a second set of regressions, productivity is taken as the dependent variable. We have modelled the natural logarithm for productivity, $\ln$ (productivity), in order to be able to interpret the key variable as an elasticity. We then repeat the analyses for SMEs and large companies, in order to be able to contrast the results between the two groups.

7.2.2.2　Complete sample

Table 40 presents the results in relation to growth and the complete sample. Model 1 shows the effect of IPR if no other variables are controlled for. In this model, companies with IPR achieve 2.5 percentage points more growth than the control companies ($p < 0.01$). This effect remains robust in model 2, where the control variables are added (2.6 percentage points, $p < 0.01$). The control variables also indicate that older and larger companies grow more slowly, but more productive companies (in 2012) grow faster. In comparison to the reference sector G (Wholesale and retail trade), companies in NACE section C (Manufacturing) and J (Information and communication) achieve faster growth.

The remaining columns indicate that the growth effects of IPR in the different IPR clusters are similar, at between 1.9 and 3.2 percentage points. The effect is significant in each group at a level of significance of at least 95%. The impact is greatest for companies that combine trademarks and patents: in comparison with the relevant control group, these companies grow 5.1 percentage points faster ($p < 0.01$). Although the impact of the control variables themselves varies across the models, it is less meaningful to interpret these, since they are partly driven by specific dynamics in the different sub samples.

Table 41 shows the impact of IPR ownership on average productivity. If other variables are not controlled for, in model 1, there is a high positive productivity differential of 13.9% between companies with IPR and the control group (p<0.01). When controlling for the other variables, however, this effect disappears and the coefficient falls to zero (-0.003, p>0.10). The control variables indicate that younger companies are more productive, as are larger companies and multinational companies. Companies in NACE sections M (Professional, scientific and technical activities) and J (Information and communication) demonstrate higher productivity than companies in the reference section G (Wholesale and retail trade). Companies located in Wallonia and Brussels are on average less productive than companies in the reference group (Flanders). The strongest predictor for productivity, however is productivity: companies that were 1% more productive at the moment of the matching are on average 0.557% more productive between 2015 and 2019.

The remaining columns show that the productivity effect of IPR differs considerably across the various clusters. Companies that have only national (Benelux) trademarks (model 3) are 3% less productive than the relevant control companies (p<0.05). This could indicate that these companies focus too heavily on local markets or invest only in IPR in order to deliver specific signals to the market or for example shareholders. Companies with national and international trademarks (column 4) are not more or less productive than the relevant control group. Companies that combine trademarks and patents, on the other hand, are 8.3% more productive than the relevant control companies (p<0.05). For the other clusters, namely companies with only patents (column 6), companies with designs (model 7) and other combinations (model 8), no statistically significant productivity differences are detected between companies with the type of IPR and the relevant control groups.

In that connection, the analysis revealed that IPR relates robustly to growth effects, but that only companies that combine trademarks and patents enjoy positive productivity effects. Companies with only national trademarks are in fact less productive. This confirms earlier findings that demonstrate positive effects of a broader scope (in terms of content and geographical coverage) of IPR (EPO & EUIPO, 2019 cf. section 3.2). In the next section, we assess to what extent these effects are driven by SMEs and large companies.

Table 40 Impact of IPR on growth (CAGR) 2015-2019

IPR characteristics	(1) All	(2) All	(3) National trademarks	(4) International trademarks	(5) Trademarks & Patents	(6) Only patents	(7) Designs	(8) Other combination
IPR	0.025***	0.026***	0.022***	0.029***	0.051***	0.019**	0.023**	0.032***
	(0.002)	(0.003)	(0.004)	(0.005)	(0.011)	(0.008)	(0.010)	(0.009)
Ln(Age)		-0.024***	-0.022***	-0.024***	-0.031***	-0.032***	-0.018*	-0.024**
		(0.003)	(0.004)	(0.005)	(0.009)	(0.008)	(0.011)	(0.010)
Ln(Balance sheet total '12)		-0.002***	-0.002**	-0.004**	-0.005**	0.002	-0.002	-0.003
		(0.001)	(0.001)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)
Ln(Productivity '12)		0.015***	0.013***	0.017***	0.015**	0.016**	0.018**	0.019***
		(0.002)	(0.003)	(0.004)	(0.007)	(0.008)	(0.007)	(0.007)
Multinational		-0.001	0.002	-0.006	0.014	-0.014	-0.012	0.000
		(0.004)	(0.007)	(0.007)	(0.012)	(0.011)	(0.012)	(0.014)
Sector: M		0.001	0.001	0.004	-0.008	-0.003	0.005	-0.003
		(0.004)	(0.006)	(0.008)	(0.020)	(0.015)	(0.018)	(0.017)
Sector: C		0.007**	0.006	0.007	0.016	-0.000	0.010	-0.006
		(0.003)	(0.005)	(0.005)	(0.011)	(0.011)	(0.011)	(0.009)
Sector: J		0.012*	0.008	0.026**	-0.026	0.010	0.006	-0.024
		(0.006)	(0.009)	(0.011)	(0.024)	(0.024)	(0.039)	(0.028)
Sector: N		0.008	0.010	0.006	-0.009	0.012	0.017	0.018
		(0.006)	(0.009)	(0.013)	(0.028)	(0.023)	(0.056)	(0.025)
Sector: Other		0.004	0.006	0.004	-0.002	0.012	-0.001	-0.010
		(0.003)	(0.004)	(0.007)	(0.013)	(0.014)	(0.019)	(0.013)
Region: Wallonia		0.001	0.000	0.001	0.009	0.003	0.008	-0.008
		(0.003)	(0.004)	(0.005)	(0.012)	(0.008)	(0.011)	(0.009)
Region: Brussels		0.000	-0.000	-0.003	-0.005	0.029*	-0.016	0.009
		(0.004)	(0.006)	(0.007)	(0.014)	(0.017)	(0.016)	(0.012)
Intercept	0.004**	0.030**	0.035*	0.033	0.065	0.019	-0.002	0.018
	(0.002)	(0.013)	(0.019)	(0.023)	(0.039)	(0.042)	(0.046)	(0.044)

Observations	9797	9797	4542	2573	700	827	458	697
R-square	0.012	0.035	0.024	0.046	0.083	0.053	0.045	0.061

*** p < 0.01, ** p < 0.05, * p < 0.10. Linear regression. Cluster-robust standard errors between brackets. Outliers not included. Reference categories: Sector G, Flemish region. The variable IPR estimates the difference in growth between companies with IPR, or companies in specific IPR clusters, and the relevant control group. Columns 1 and 2 make no distinction between the different types of IPR. Columns 3 to 8 focus respectively on the effects of the various IPR clusters. These are only national trademarks (3); trademarks including international trademarks (4); trademarks together with patents (5); only patents **(6); only designs (7); and other combinations of IPR (8).**

Table 41 Impact of IPR on average productivity (2015-2019)

IPR characteristics	(1) All	(2) All	(3) National trademarks	(4) International trademarks	(5) Trademarks & Patents	(6) Only patents	(7) Designs	(8) Other combination
IPR	0.139***	-0.003	-0.030**	0.018	0.083**	0.019	0.053	-0.001
	(0.013)	(0.010)	(0.015)	(0.019)	(0.040)	(0.035)	(0.045)	(0.038)
Ln(Age)		-0.067***	-0.060***	-0.074***	-0.047	-0.045	-0.038	-0.122**
		(0.012)	(0.017)	(0.019)	(0.038)	(0.037)	(0.052)	(0.052)
Ln(Balance sheet total '12)		0.059***	0.070***	0.048***	0.038***	0.058***	0.041***	0.045***
		(0.004)	(0.008)	(0.007)	(0.013)	(0.011)	(0.014)	(0.013)
Ln(Productivity '12)		0.557***	0.518***	0.583***	0.561***	0.599***	0.586***	0.634***
		(0.022)	(0.038)	(0.023)	(0.061)	(0.049)	(0.068)	(0.034)
Multinational		0.063***	0.034	0.085***	0.036	0.048	0.053	0.205***
		(0.017)	(0.028)	(0.031)	(0.046)	(0.048)	(0.075)	(0.060)
Sector: M		0.087***	0.085***	0.078**	0.056	0.093	0.139	0.170***
		(0.017)	(0.024)	(0.032)	(0.086)	(0.071)	(0.091)	(0.057)
Sector: C		0.009	0.008	-0.017	0.057	0.026	-0.090*	0.068
		(0.012)	(0.019)	(0.022)	(0.050)	(0.053)	(0.049)	(0.047)
Sector: J		0.087***	0.084***	0.098***	0.044	0.004	0.165	0.195**
		(0.020)	(0.029)	(0.033)	(0.083)	(0.095)	(0.187)	(0.081)
Sector: N		0.018	-0.024	0.038	0.243**	-0.033	-0.074	0.351***
		(0.023)	(0.030)	(0.039)	(0.110)	(0.112)	(0.168)	(0.091)
Sector: Other		0.001	0.009	0.027	-0.051	-0.002	-0.136	0.069
		(0.014)	(0.018)	(0.030)	(0.060)	(0.058)	(0.087)	(0.055)
Region: Wallonia		-0.066***	-0.077***	-0.050**	-0.022	-0.104***	-0.133***	0.031
		(0.012)	(0.018)	(0.022)	(0.042)	(0.039)	(0.047)	(0.040)
Region: Brussels		-0.035**	-0.031	-0.061**	0.021	-0.138**	0.018	0.073
		(0.018)	(0.025)	(0.031)	(0.072)	(0.060)	(0.093)	(0.114)
Intercept	4.323***	1.750***	1.817***	1.748***	1.795***	1.509***	1.745***	1.598***
	(0.010)	(0.097)	(0.162)	(0.117)	(0.271)	(0.238)	(0.334)	(0.170)

Observations	9797	9797	4542	2573	700	827	458	697
R-square	0.012	0.494	0.460	0.517	0.500	0.540	0.574	0.508

*** p < 0.01, ** p < 0.05, * p < 0.10. Linear regression. Cluster-robust standard errors between brackets. Outliers not included. Reference categories: Sector G, Flemish region. The variable IPR estimates the difference in productivity between companies with IPR, or companies in specific IPR clusters, and the relevant control group. Columns 1 and 2 make no distinction between the different types of IPR. Columns 3 to 8 focus respectively on the effects of the various IPR clusters. These are only national trademarks (3); trademarks including international trademarks (4); trademarks together with patents (5); only **patents (6); only designs (7); and other combinations of IPR (8).**

7.2.2.3   SMEs versus large companies

In this section, we focus on the differences between SMEs and large companies. We estimate the effect of IPR separately for the two groups, so that the different growth and productivity dynamics can be better understood.

Table 42 presents the impact of IPR on the growth of SMEs and large companies. Each cell presents the coefficient of IPR for the company type (SME or large company) and for each IPR in general or each IPR cluster.[44] We first discuss the results for SMEs. The broad growth effect of IPR for SMEs is similar to that of the complete sample and is estimated at 2.5 percentage points (model 1, p<0.01). The effects are comparable with those reported for the complete sample (

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[44] The full results are available in Table 46 and 47 in Annex A.2.

Table 40), with mainly significant growth effects between 2.1 and 3.1 percentage points. The total effect of IPR for SMEs is estimated at 2.5 percentage points (model 1, p<0.01). Unlike the full sample, for SMEs that own designs, no significant growth effect is identified (model 6, 1.7 percentage points, p>0.10).

Table 42 Impact of IPR on growth (CAGR) 2015-2019: SMEs and large companies

IPR characteristics	(1) All	(2) National trademarks	(3) International trademarks	(4) Trademarks & Patents	(5) Only patents	(6) Designs	(7) Other combination
SMEs	0.025***	0.021***	0.030***	0.052***	0.021**	0.017	0.031***
	(0.003)	(0.004)	(0.006)	(0.015)	(0.009)	(0.012)	(0.010)
Observations	*7952*	*3951*	*1988*	*459*	*642*	*348*	*564*
Large companies	0.024***	0.018*	0.022*	0.038***	0.008	0.050***	0.041**
	(0.006)	(0.009)	(0.011)	(0.014)	(0.015)	(0.017)	(0.019)
Observations	*1845*	*591*	*585*	*241*	*185*	*110*	*133*

*** p < 0.01, ** p < 0.05, * p < 0.10. **Linear regression.** Table summarises regression results for SMEs and large companies. Each cell represents the coefficient of (all or types of) IPR for that sample. The coefficient represents the difference in growth between SMEs (or large companies) with IPR, or companies in specific IPR clusters, and the relevant control group. Control variables for size, age, past productivity, sector, region, and multinational are included. The full results are available in Table 46 and Table 47 in Annex A.2. Cluster-robust standard errors between brackets. Outliers not included. Column 1 makes no distinction between the various types of IPR; Columns 2 to 7 focus respectively on the effects of the various IPR clusters. These are only national trademarks (2); trademarks including international trademarks (3); trademarks together with patents (4); only patents (5); only designs (6); and other combinations of IPR (7).

While the broad growth effect of IPR for large companies is estimated as similar to that for the complete sample and SMEs, at 2.4 percentage points (model 1, p<0.01), the effects of different types of IPR are more varied. For example, large companies that only own patents (model 6) experience no significant growth bonus (0.8 percentage points, p>0.10), while this was the case for the complete sample and for SMEs. At the same time, large companies that only own national trademarks (model 2) or only national and international trademarks (model 3) experience only weak significant growth, as compared with the relevant control groups (national trademarks: 1.8 percentage points, p<0.10; national and international trademarks: 2.2 percentage points, p <0.10). The growth effects are greater and more clearly significant for large companies that combine trademarks and patents (model 4, 3.8 percentage points, p<0.01). Large companies that also own designs (model 6, 5.0 percentage points, p<0.01) and large companies that own other combinations of IPR (model 7, 4.1 percentage points, p<0.05). These differences suggest that it is possibly more important for large companies to combine IPR types in order to guarantee growth effects. This is not the case for SMEs.

Table 43 focuses on productivity effects of IPR on SMEs and large companies.[45] For SMEs, the effect of IPR (model 1) is insignificant (p>0.10), as is also the case for the complete sample. The majority of IPR clusters also generate no significant productivity effects for SMEs. This is the case for SMEs with only national trademarks (model 2), SMEs with national and international trademarks (model 3), SMEs with trademarks and patents (model 4), SMEs that only own patents (model 5) and other combinations of IPR (model 7). Only SMEs that also own designs show a weak significant association with higher productivity (9.3%, p<0.10).

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[45] The full results are available in Table 48 and Table 49 in Annex A.2

Table 43 Impact of IPR on average productivity (2015-2019): SMEs and large companies

IPR characteristics	(1) All	(2) National trademarks	(3) International trademarks	(4) Trademarks & Patents	(5) Only patents	(6) Designs	(7) Other combination
SMEs	0.004	-0.019	0.013	0.075	0.048	0.093*	0.030
	(0.011)	(0.016)	(0.021)	(0.055)	(0.040)	(0.050)	(0.045)
Observations	*7952*	*3951*	*1988*	*459*	*642*	*348*	*564*
Large companies	-0.076***	-0.140***	-0.033	0.077	-0.076	-0.068	-0.198**
	(0.025)	(0.044)	(0.040)	(0.057)	(0.070)	(0.108)	(0.077)
Observations	*1845*	*591*	*585*	*241*	*185*	*110*	*133*

*** p < 0.01, ** p < 0.05, * p < 0.10. **Linear regression.** Table summarises regression results for SMEs and large companies. Each cell represents the coefficient of (all or types of) IPR for that sample. The coefficient represents the difference in growth between SMEs (or large companies) with IPR, or companies in specific IPR clusters, and the relevant control group. Control variables for size, age, past productivity, sector, region, and multinational are included. The full results are available in Table 48 and Table 49 in Annex A.2. Cluster-robust standard errors between brackets. Outliers not included. Column 1 makes no distinction between the various types of IPR; Columns 2 to 7 focus respectively on the effects of the various IPR clusters. These are only national trademarks (2); trademarks including international trademarks (3); trademarks together with patents (4); only patents (5); only designs (6); and other combinations of IPR (7).

Whereas the effect of IPR is insignificant for the complete sample and SMEs, it is significantly negative for large companies. Large companies with IPR are 7.6% less productive than large companies in the control group (model 1, p<0.01). This effect is driven by two IPR clusters. Firstly, large companies that own only national trademarks are 14.0% less productive than the relevant control companies (p<0.01). This could indicate that large companies with an excessive focus on local markets are not able to convert this focus into productivity. It is also possible that this option is more often chosen by less performant companies, or by companies that focus less if at all on the development of productivity-boosting technologies. Secondly, large companies that use other combinations are 19.8% less productive than the relevant control companies (model 7, p<0.05). The other clusters - national and international trademarks (model 3), trademarks and patents (model 4), only patents (model 5) and designs (model 6) show no significant productivity effects.

7.3. Conclusions

This chapter disentangles the impact of IPR on growth and productivity by means of a matching analysis. Companies with IPR are linked to comparable control companies, in order to quantify the difference in growth and productivity. An important note here is that the identified effects likely represent upper limits, because in this analysis, it is not possible to control for spending on R&D or innovation. The estimated effects are therefore the combined result of IPR ownership and possibly remaining differences in spending on R&D or innovation between companies with IPR and the control group. Follow-up studies could further distinguish between the effects of IPR ownership and the effect of R&D investments by focusing on companies for which the R&D spending is known, for example companies that have submitted replies to national R&D surveys.

The analysis reveals a robust impact of IPR on growth. Companies that acquired IPR in the studied period experience compound growth in employment between 2015 and 2019 that is approximately 2.5

percentage points higher than the growth achieved by the control group. These effects are comparable for the various clusters of IPR, and for SMEs and large companies. However, in this analysis, SMEs do not experience stronger growth effects in the cluster designs, and large companies experience no or weak growth effects in the clusters national trademarks and international trademarks. For large companies, it therefore appears to be important to combine types of IPR in order to access growth effects.

The analysis did not confirm a broader impact of IPR on average productivity between 2015 and 2019 - measured on the basis of added value per employee. In fact, negative productivity effects are shown for companies owning only national trademarks. This is driven by large companies, that experience strong negative productivity growth in this cluster. This could indicate that large companies in this sector focus excessively on local markets, that this IPR strategy is more likely to be followed by less performant companies, or that companies in this cluster do not aim for productivity growth through technology development. Companies with trademarks and patents are more productive in the complete sample, although this effect is not specific to SMEs or large companies. Among SMEs, too, no broadly supported productivity effects were identified. Only SMEs in the cluster designs show slightly significant higher productivity. The absence of broad productivity effects indicates that - both for SMEs and large companies - it is not a simple matter to achieve higher productivity. At the same time, this conclusion should be refined: in the majority of clusters the productivity of SMEs with IPR remains comparable with that of the control group, while the analysis also reveals that SMEs with IPR achieve stronger growth. Since it is no easy matter to retain productivity in a context of expansion and growth, the conclusion of constant productivity could be interpreted in a more positive light.

8 / General conclusion

Summary of findings

Small and Medium-sized Enterprises (SMEs) make a fundamental contribution to innovation and economic growth. Given the potential of intellectual property rights (IPR) as catalysts for research and development, the FPS Economy and the BOIP wish to create a clear understanding of IPR activities within the Belgian corporate landscape; with a specific focus on the role of SMEs. The findings of this study are instrumental for the design of a customised approach aimed at sensitising Belgian SMEs to the use of various types of IPR.

The structure of this study involved two phases. In phase one, data were gathered about the presence of the various types of IPR among Belgian companies in the period 2010 to 2019. The types of IPR considered are trademark rights, patents, design rights and plant breeders' rights. The resultant list of 15 193 Belgian companies active in IPR was linked to Bel-first, for the extraction of company statistics that make it possible to determine company size and performance. The data thus generated were placed in a database at company level; IPR data were combined with data relating to company size (based on the distinction between micro, small, medium-sized and large enterprises) and company performance. Details of the approach employed in this phase and their relationship to previous efforts are described in Report 1 of this study: "Accompanying Report to database "Corporate IP in Belgium".

In phase two, analyses were elaborated on the basis of the created database. The analytical report contains details of these analyses. Based on descriptive statistics and econometric analyses, the relationship between company size and IPR profiles is analysed, with a view to determining the extent to which different IPR profiles relate to differences in terms of company performance. In these analyses, the difference between SMEs and large companies is specifically considered. Here we summarise the key findings.

A profile sketch of IPR-active enterprises in Belgium reveals that their IPR portfolios are rather limited in size. Half of the companies holds just a single IP right, and only 6% of companies have more than 10 IP rights in their name. In terms of scope, too, the portfolios of Belgian enterprises are limited: almost 90% of the companies holds just a single type of IPR. It will come as no surprise that the IPR portfolios of older and larger companies are more extensive in terms of size and scope than those of younger companies and SMEs. There is a clearly visible overrepresentation of trademark rights in the Belgian IPR landscape. Coverage in terms of geographical validity differs according to the IPR type. For design rights and plant breeders' rights, the focus is clearly on European validity, while the coverage for trademark rights is more manifestly national (i.e. via Benelux trademark). For patents, there is a more balanced distribution between national and international validity areas.

IPR-active companies in Belgium are relatively old, with an average age of 20 years. On average, holders of design rights are older than holders of other IPR types. The sector 'Wholesale and retail trade' is most widely represented within IPR-active companies in Belgium. This is primarily driven by the large proportion of holders of trademark rights, prominent within this sector. Holders of patents and designs are also clearly present within the industrial (Manufacturing) sector.

No less than 84% of IPR-active companies in Belgium are SMEs. SMEs have a very large share in particular among holders of trademark rights. This heavy overrepresentation of SMEs is slightly less pronounced among holders of patents. IPR-active SMEs are on average 19 years old, while among large companies, the average is considerably older, at 34 years. The SMEs are above all active within the Retail and wholesale trade, while most of the large companies are active within the Manufacturing sector.

The observations suggest a leverage effect of IPR, not only for individual company performance but also for the Belgian economy as a whole. The size of the IPR portfolio is related to productivity within a company, while the scope of the portfolio relates to growth. This leverage effect for company performance is particularly pronounced for SMEs as compared with large companies. Enterprises with IPR are also responsible for 23.7% of total employment in Belgium (2019), while they represent only a small fraction of the total company population. Moreover, IPR-active companies in Belgium generate higher gross added value per employee than Belgian companies without IPR.

The leverage effect of IPR on growth is particularly confirmed by a comparative analysis of IPR-active companies with comparable companies without IPR. The results indicate that the presence of IPR goes hand in hand with additional growth: companies with IPR achieve growth in employment approximately 2.5 percentage points higher than companies without IPR. Whereas for SMEs this effect relates both to scale and scope (of the IPR portfolio), for large enterprises, the scope of the portfolio seems to relate above all to growth.

Caveats

If one relies on IPR as a basis for evaluating the innovative contribution of SMEs (and large companies), a number of other considerations must be taken into account. The following caveats apply first and foremost to patents, but can be expanded to include IPR in general. Firstly, the propensity to acquire IPR between companies of different size varies in a non-random manner. To acquire and retain IPR, resources are needed (including budget and expertise). The registration of an IPR (depending on the type and procedure to be followed) is generally speaking a costly affair, in particular when enforcement of that right in the event of an infringement or dispute is taken into account. Small and medium-sized enterprises generate less internal cashflow and are faced with higher thresholds for external financing. As a result, they experience greater financial restrictions than their larger counterparts (Czarnitzki & Hottenrott, 2010). Moreover, as a rule, they do not have access to the legal and management expertise of internal IP specialists, for the correct evaluation of the options available in the field of intellectual property registration (Blind et al, 2006). For that reason, SMEs tend to opt for alternative acquisition strategies (Jensen and Webster, 2006; Rothwell & Dodgson, 1992; Arundel, 2001; Hall et al., 2014). On the other hand, SMEs have specific motivations for protecting their developments. They may experience a greater need for strategic alliances in production and marketing, whereby the presence of intellectual property rights can assist them in realising effective contracts (Jensen and Webster, 2006). Moreover, intellectual property rights can be used as a 'value signal', both for potential clients and for future investors (Blind et al., 2006; Hsu & Ziedonis, 2008; de Rassenfosse, 2012). Empirical studies suggest that the interaction between barriers and incentives is not an issue in which one of the two consistently outweighs the other. Research by Brouwer and Kleinknecht (1999) for example reveals that the likelihood of a company having at least a single patent increases more than proportionally with the

number of employees. However, if a company has several patent applications, the number of applications rises less proportionally to the company size. The existence of a conditional relationship between company size and IPR calls for caution in interpreting the findings in this context.

Moreover, this study explains relationships between IPR profiles and company performance, but this association provides no information about any causal relationship between the two. The uncovered relationship can work like a two-way street. On the one hand, a higher level of activity in IPR can result in improved financial performance. On the other hand, companies may increasingly seek refuge in IPR, as a consequence of growth in performance.

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ANNEXES

A.1 / Report showing alternative clustering

Description of clusters

Table A1 describes which clusters were retained. The hierarchical cluster diagram is presented in Figure A1: only the retained clusters are shown and each colour represents a separate cluster.

Table A1 Selected IPR clusters

Cluster name	Description	# companies	% companies
TRADEMARKS ONLY NATIONAL	Companies with only trademarks, restricted to the national route (Benelux)	8409	55%
INTERNATIONAL TRADEMARKS	Companies with only trademarks, not restricted to the national (Benelux) route	3517	23%
ONLY TRADEMARKS & PATENTS	Companies with only trademarks and patents	758	5%
INTERNATIONAL PATENTS	Companies with only patents, not restricted to the national route	750	5%
ONLY NATIONAL PATENTS	Companies with only patents, restricted to the national route	476	3%
DESIGNS	Companies with designs (may be combined with patents and/or trademarks)	481	3%
OTHER	All other combinations	802	5%

Figure A1 Hierarchical cluster diagram with number of enterprises per cluster
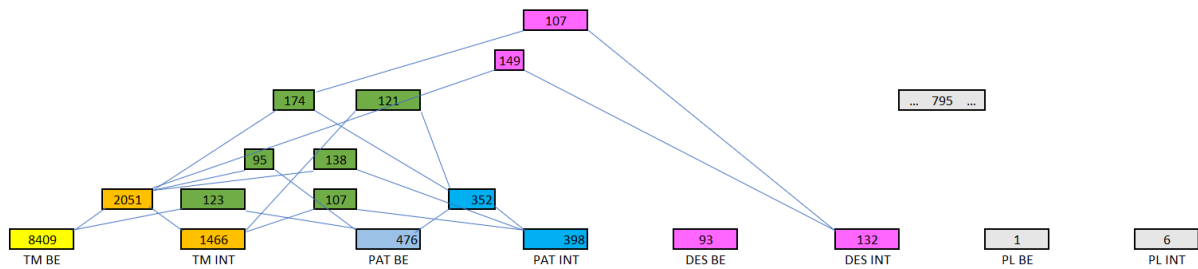
We would point out that the dataset consists of 15 193 Belgian enterprises with at least 1 IPR, acquired in the period 2010-2019, and for which a positive validated match was found in Bel-first. The 6 clusters (excluding the 'Other combinations') in Table A1 cover 95% of these enterprises. The remaining 5% of enterprises are shared over 48 different IPR combinations, and are therefore considered a residual category rather than a separate cluster.

Moreover it is once again clear that to a considerable extent, trademarks dominate the IPR portfolio of Belgian enterprises: no less than 78% of all enterprises are found in the clusters containing only trademarks (national and/or international). In respect of trademarks, the national (Benelux) route is mainly chosen, while for patents, the international route is chosen relatively more often.

Characteristics according to cluster

Status

We start by studying the status of the companies with IPR. It is possible that companies that acquired IPR between 2010 and 2019 are now no longer active[46]. Figure A2 shows that 89% or 13 551 companies are currently still active, 8% (or 1 187 companies) are no longer active. 454 companies or 3% are in a provisional legal situation and the current status of 1 company is unknown.

Figure A2 Status of companies with IPR
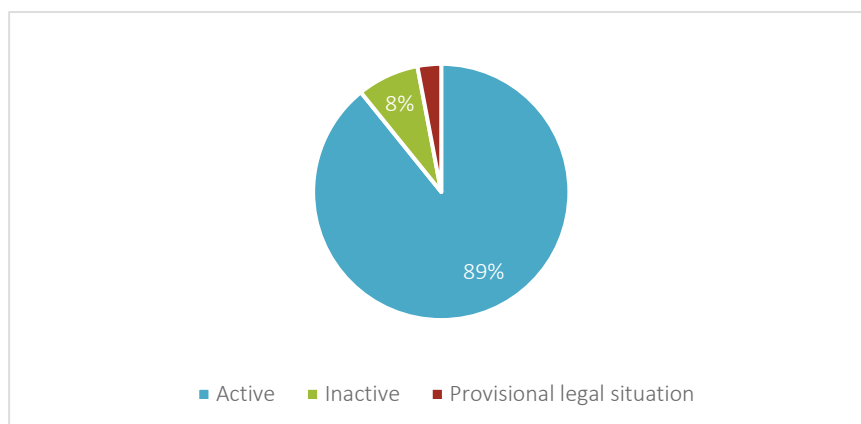
N = 15 193

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[46] At the time of the study and the development of the variables, i.e. spring-summer 2021

We then distinguish between the status of companies according to the cluster in which they appear. Figure A3 shows that companies with a narrow scope (only patents or only trademarks) have remained proportionally less active. For trademark-focused companies, this lower survival rate is particularly pronounced if they have exclusively a national focus (i.e. via Benelux trademark). For patent-focused companies, on the other hand, the lower survival rate is slightly more pronounced if they have an international scope.

Figure A3 Status according to IPR type
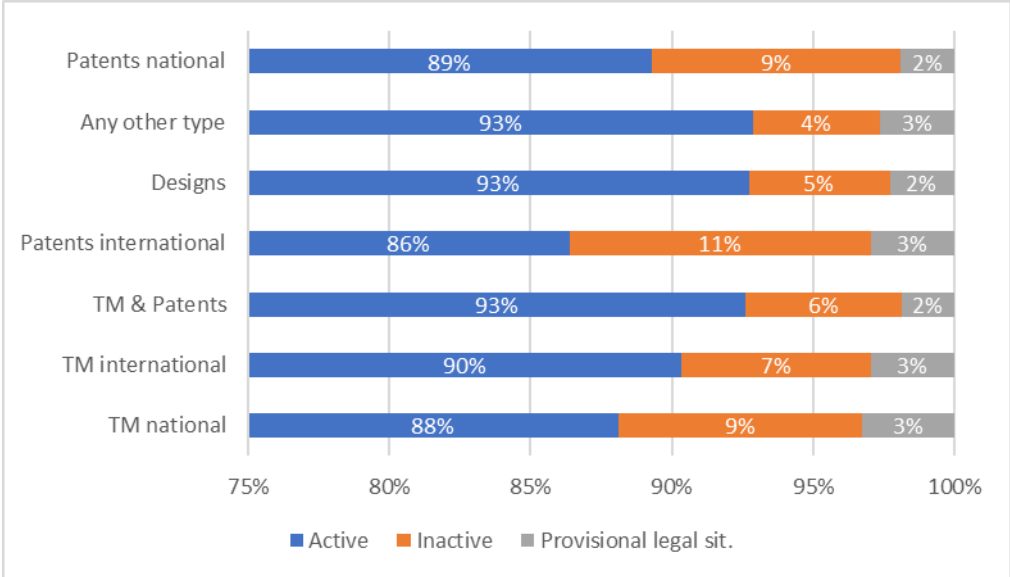
Below we discuss the company characteristics of the 13 551 companies with IPR that are currently still active.

Age

Figure A4 shows the average age of the enterprises for each IPR cluster to which they belong. Companies in the Designs cluster are on average the oldest companies (28 years), those in the National Trademarks cluster are on average ten years younger (18 years). The other clusters are grouped in the age category between the two categories above. An analysis of variance (ANOVA) test shows that these age differences between the clusters are significant (ANOVA, F = 55.39; p<0.001).

Figure A4 Average age according to IPR cluster
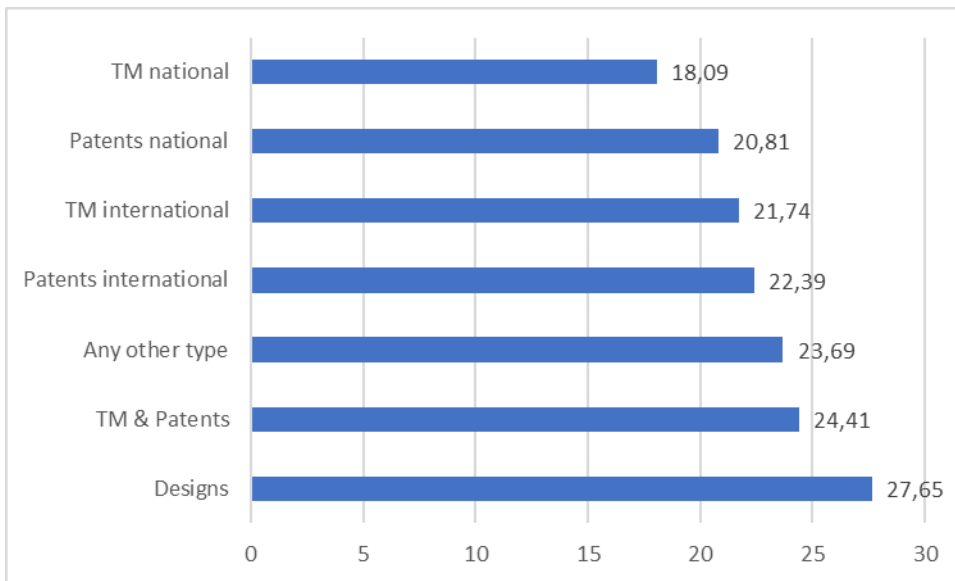
N = 13 551

Sector

In Figure A5, we consider the sector breakdown for each of the IPR clusters. For the clusters with a trademark focus (national or international), Wholesale and retail trade enjoy a more prominent presence. This sector is relatively underrepresented in the clusters with patents. Within the clusters with no trademark focus, the Manufacturing sector is more prominently represented. Above all within the cluster with international patents, the presence of sector M (Professional, scientific and technical activities) is particularly noticeable.

Figure A5 Sector distribution within IPR clusters
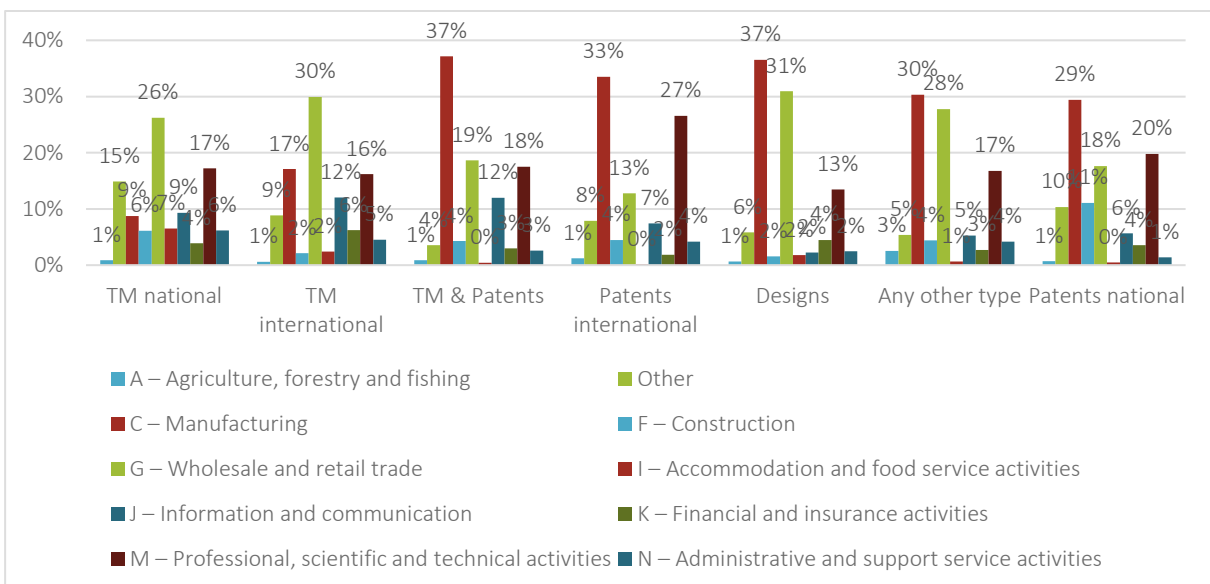
N = 13 551

Location

Figure A6 provides an indication of the provincial distribution of each of the IPR clusters. Antwerp and East Flanders generally account for the largest proportions. For the clusters around Trademarks (national and international), Brussels also stands out more prominently than in the other clusters. Within the cluster National patents, East Flanders is particularly well represented, as is West Flanders. Within International patents, Antwerp continues to occupy the largest share. For the cluster Designs, West Flanders takes a more prominent role (also in combination with Antwerp).

Figure A6 Provincial spread per IPR cluster
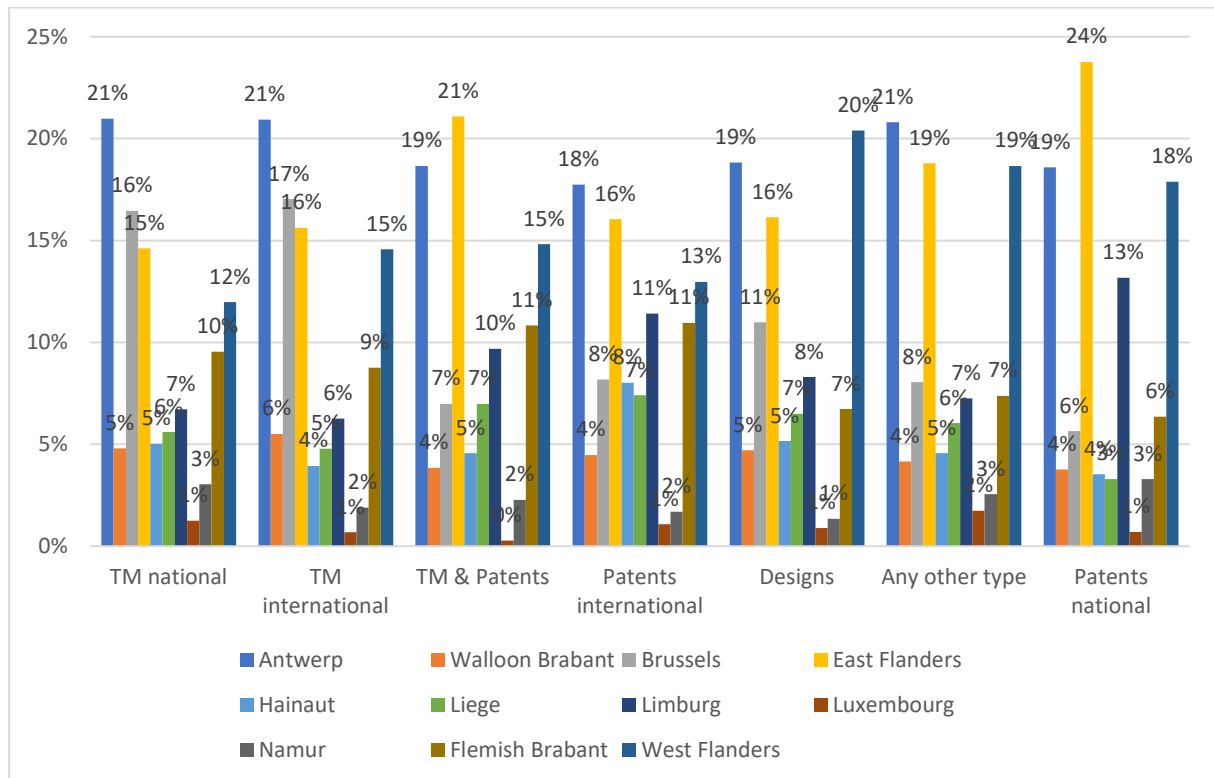
N = 13 551

Company size

In Figure A7, the companies are divided according to company size, in each IPR cluster. Micro companies are strongly represented across all clusters, a situation that is slightly more pronounced among clusters with a national focus. In general, large companies are proportionally poorly represented. An exception is the cluster Trademarks & Patents, where the share of large companies is relatively higher. This applies to a lesser extent to the cluster Designs.

Figure A7 Distribution of company size per IPR cluster
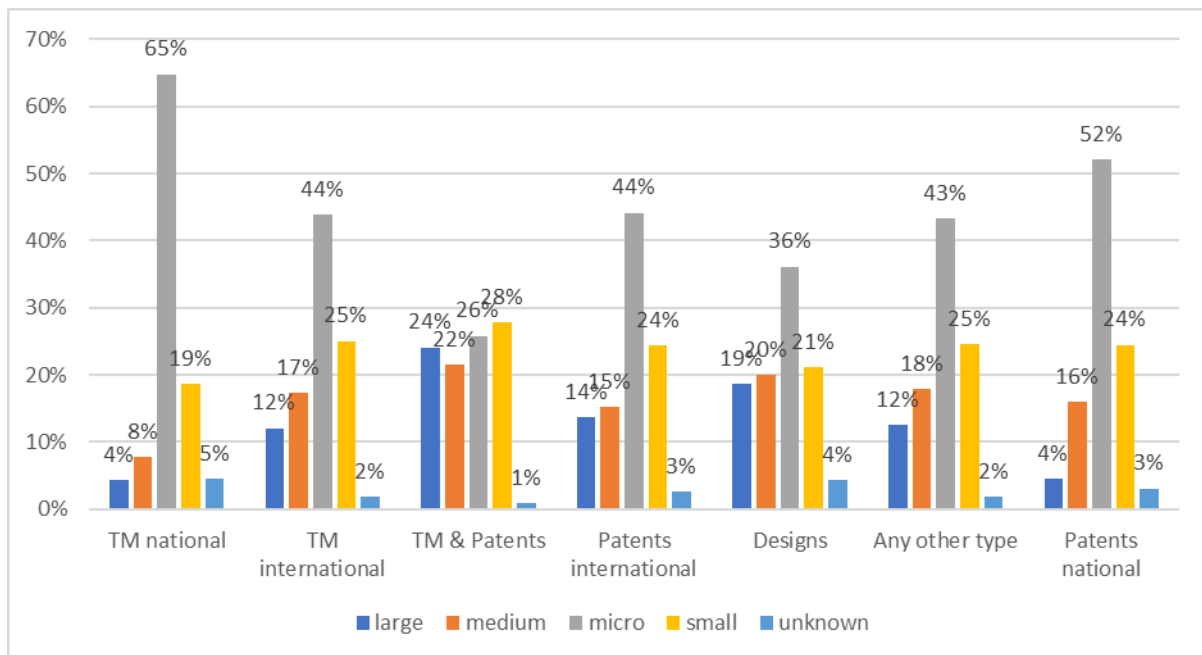
N = 13 551

Figure A8 zooms in on the proportion of SMEs[47] per IPR cluster. In general terms, there is an overrepresentation of SMEs within each of the clusters. This overrepresentation is most pronounced for the clusters focused on national protection (for trademarks and patents). Within the cluster that combines Trademarks & Patents, the overrepresentation of SMEs is the least pronounced, such that the role of large companies is slightly greater here than in other clusters. These figures suggest that the share of large companies grows (or the overrepresentation of SMEs declines) according to the increase in scope in IPR types and in geographical validity.

Figure A8 Proportion of SMEs per IPR cluster
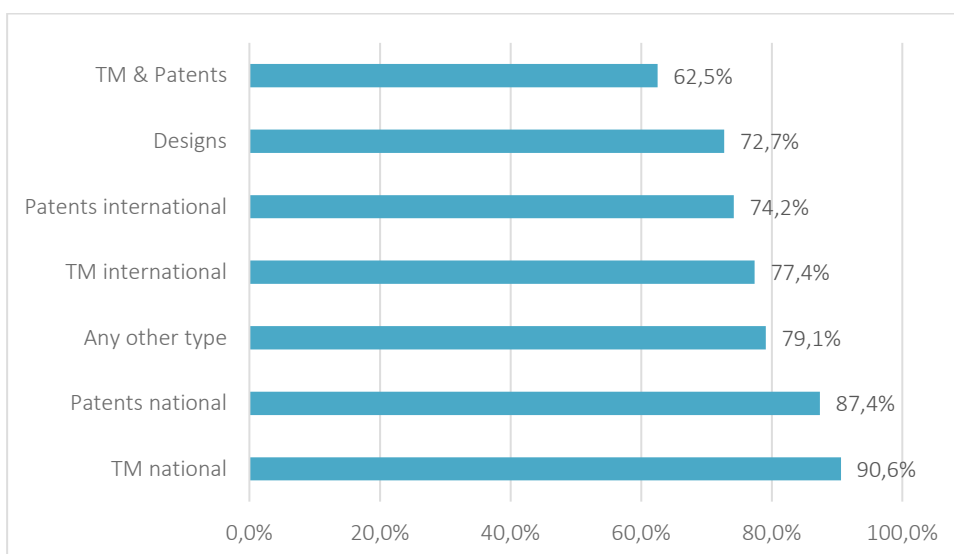
N = 13 551

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[47] These figures take account of the independence criterion.

Multinational character

Figure A9 reflects the presence of companies that form part of multinational enterprises per IPR cluster. Within the clusters with a national focus, multinational enterprises are least well represented. The clusters with international patents and with Trademarks & Patents contain proportionally the largest number of companies that form part of a multinational enterprise.

Figure A9 Multinational character per IPR cluster
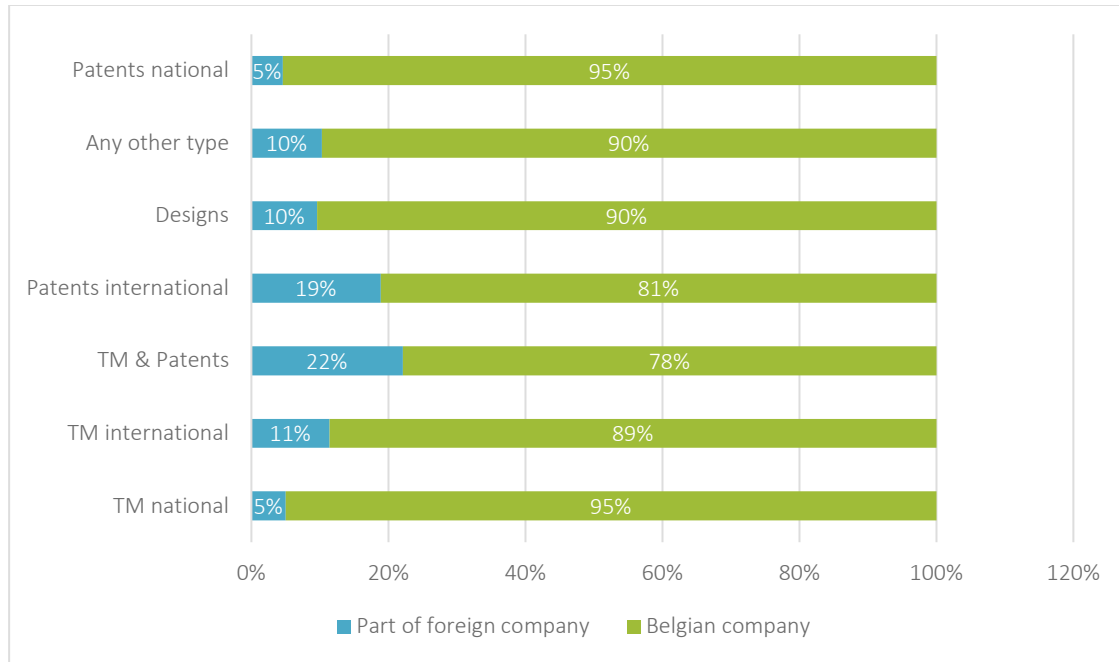
N = 13 551

Cluster synthesis

Based on the comparison of company characteristics within the various clusters, the following stereotyping can be produced:

Cluster	Company stereotype
National trademarks	Relatively young (18 years), micro enterprise, active in Antwerp within the trade or services sector.
International trademarks	Micro enterprise (22 years), active in Antwerp within the trade or services sector or in the Information & Communication sector.
Trademarks & Patents	SME or large company (24 years), active in Antwerp or East Flanders within the manufacturing sector.
National patents	Micro company (21 years), active in East Flanders, Antwerp or West Flanders within the manufacturing sector.
International patents	Micro company (22 years), active in Antwerp or East Flanders within the Manufacturing or Scientific/technical activities sector.
Designs	Relatively old (28 years) micro enterprise, active in Antwerp or West Flanders, within the manufacturing or trade sector.

The additional breakdown in the Patents cluster into National and International scope makes it possible to zoom in on the differences between the two. The distribution of sectors within the two clusters is equivalent, as is the average age of the companies within the two clusters. In terms of location, we see a relatively higher representation in East and West Flanders in the cluster with National patents. In the cluster International patents, the share of inactive companies is slightly higher than within the patent cluster with exclusively national focus. It comes as no surprise that the international patent cluster includes more companies that form part of a multinational enterprise, and more large companies, than the cluster National patents.
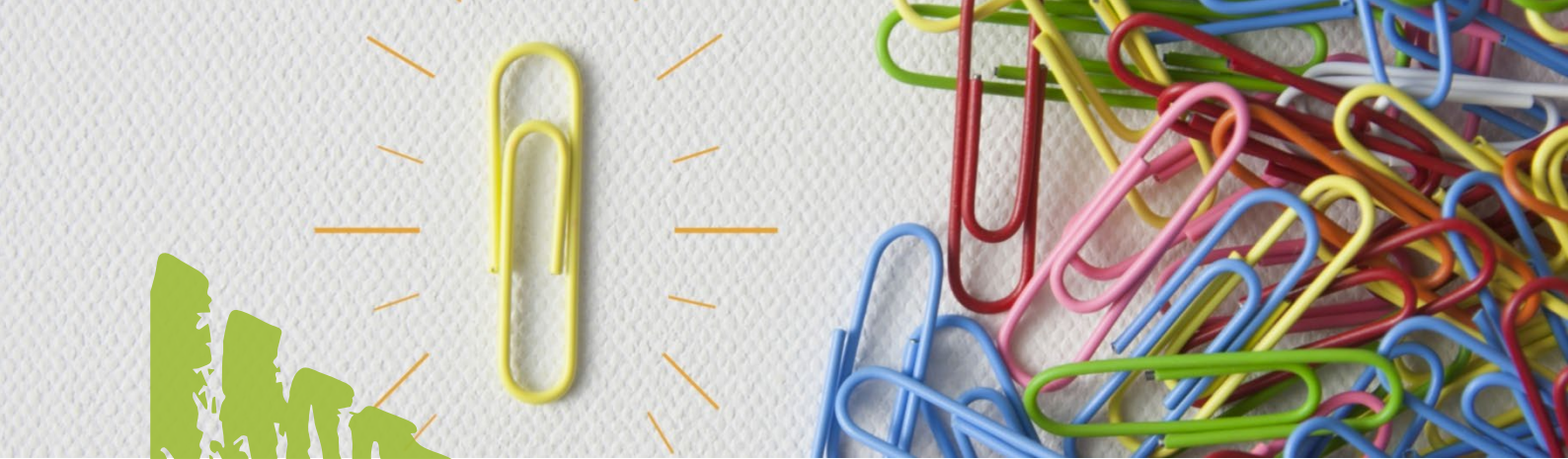
A.2 / Additional material Chapter 9

This appendix presents additional material for chapter 9. Firstly, the quality of the propensity score matching is further estimated. There are several different methods for that process. The differences between the control groups can be estimated according to the multivariate method, by means of regressions. These are presented in section 2.1. Alternatively, the distributions of the propensities can be studied. These are shown in section 2.2. Section 2.3 then presents additional overview statistics for the final sample. Section 2.4 presents the full versions of the abbreviated regression tables from section 7.2.2.3.

2.1 Group differences

As described in section 0, in a propensity score matching, two samples are balanced on the basis of an estimated propensity score. That propensity score is calculated according to a regression, which relates to the probability of a company appearing in the discussion group (here: companies with IPR) to the matching variables opposite in the set of potential controls. To eliminate section effects, control companies are then selected that have a similar propensity score to the companies in the discussion group. To guarantee that each control company comes from the correct sector, this exercise is carried out at the level of NACE sections.

It is also possible to determine the quality of the matching by means of these regressions: if the probability that a company is allocated to the discussion group following matching can no longer be explained by the matching variables, the samples for these variables are in balance. Table 44 presents the results of this regression before and after matching. Although the matching took place within each NACE section, we present the results taking in all the sections by way of illustration.

Table 44 Regression of IPR ownership for matching variables, pre and post matching

	(1) Pre matching	(2) Post matching
Age	0.012***	-0.001
	(0.001)	(0.001)
Balance sheet total'12	0.000***	0.000
	(0.001)	(0.000)
Productivity '12	0.000**	0.001*
	(0.000)	(0.000)
Sector: B	-0.069	-0.045
	(0.477)	(0.717)
Sector: C	1.369***	-0.037
	(0.132)	(0.209)
Sector: D	1.044***	-0.263
	(0.350)	(0.662)
Sector: E	1.111***	-0.160
	(0.200)	(0.309)
Sector: G	-0.539***	-0.028
	(0.139)	(0.220)
Sector: F	0.535***	-0.043
	(0.130)	(0.208)
Sector: H	-0.691***	-0.010
	(0.167)	(0.267)
Sector: I	-0.268*	-0.043
	(0.147)	(0.233)
Sector: J	1.418***	0.053
	(0.139)	(0.223)
Sector: K	0.118	-0.088
	(0.148)	(0.242)
Sector: L	-0.234	-0.131
	(0.162)	(0.267)
Sector: M	0.609***	-0.136
	(0.139)	(0.214)
Sector: N	0.444***	-0.071
	(0.142)	(0.226)
Sector: O	0.228	-0.366
	(0.483)	(0.732)
Sector: P	-0.760***	0.140
	(0.256)	(0.402)
Sector: Q	-1.537***	-0.270
	(0.193)	(0.302)
Sector: R	0.377**	-0.021
	(0.167)	(0.274)
Sector: S	-0.863***	-0.030
	(0.188)	(0.297)
Intercept	-3.612***	0.057
	(0.130)	(0.208)
Design	Logit	Logit
Observations	113,857	9,797
Pseudo R-square	0.062	0.002
Model Significance	Chi2(21) = 2,960.73	Chi2(21) = 8.74
(p)	(0.000)	(0.9911)

*** p<0.01, ** p<0.05, * p<0.10. Independent variable: IPR company (0/1). Outcomes shown are coefficients. Cluster-robust standard errors between brackets. Outliers not included. Sector A: reference category.

Column 1 in Table 44 shows the situation pre-matching. The model is overall significant (Chi2(21) = 2,960.73, p<0.01), which suggests that the matching variables are informative for explaining the difference between companies with IPR and control companies. The coefficients in the model indicate that companies are more likely to be present in the set with IPR, if they are older, larger or more productive. There are also significant differences across the sectors. Companies in sectors C, D, E and I are most likely to own IPR.

Column 2 in Table 44 describes the situation post matching and following data cleansing. The model is no longer overall significant Chi2(21) = 8.74, and no longer explains significant levels of variance. Companies that are more productive are slightly more likely to own IPR, but this difference is only slightly significant (p>0.10). Given that the explanatory capacity of the model has essentially become zero, we conclude that the discussion group and the control group can no longer be statistically differentiated, post-matching.

2.2 Propensities

Another way of assessing the quality of the matching is to study the propensity scores. If post-matching the propensity scores of the companies in the discussion group and the control group still match, the exercise is considered a success, and the set of chosen control companies can be seen as a good control group. In that connection, it is also important that potential control companies actually exist for all companies in the discussion group, i.e. companies in the potential control group with the same propensity score. This is described in literature as the existence of 'common support'.

Figure 40 shows the situation pre matching. Here there is common support, since the scope of the propensity scores of potential control companies (black line, 'No IPR') covers the complete scope of the propensity scores of companies with IPR (Red line, 'IPR'). The two distributions are nonetheless very different: Companies with IPR, as expected, typically have a higher propensity than potential control companies.

Figure 41 shows the distribution of propensities post-matching and following data cleansing. In line with the above described regression analysis, there is a solid overlap between companies with IPR and the selected control companies, which suggests that the two groups are statistically comparable in the matching dimensions.
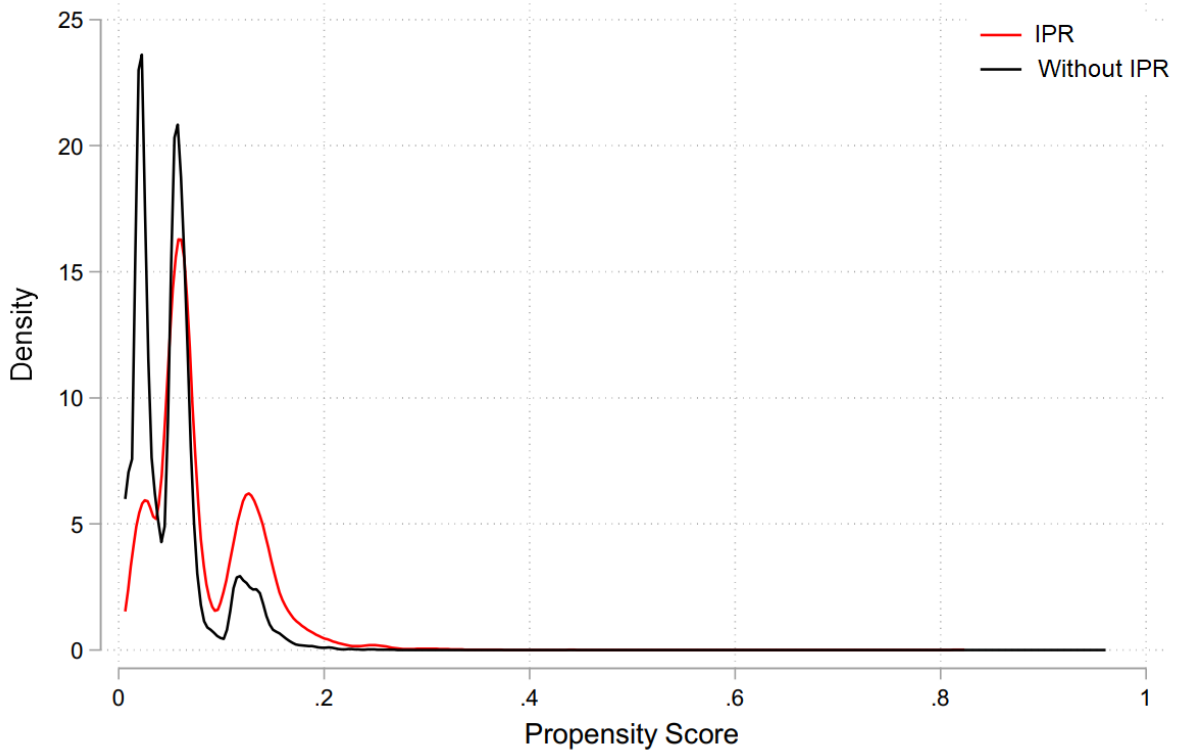
Figure 40 Estimated propensity score of IPR owners and potential control companies
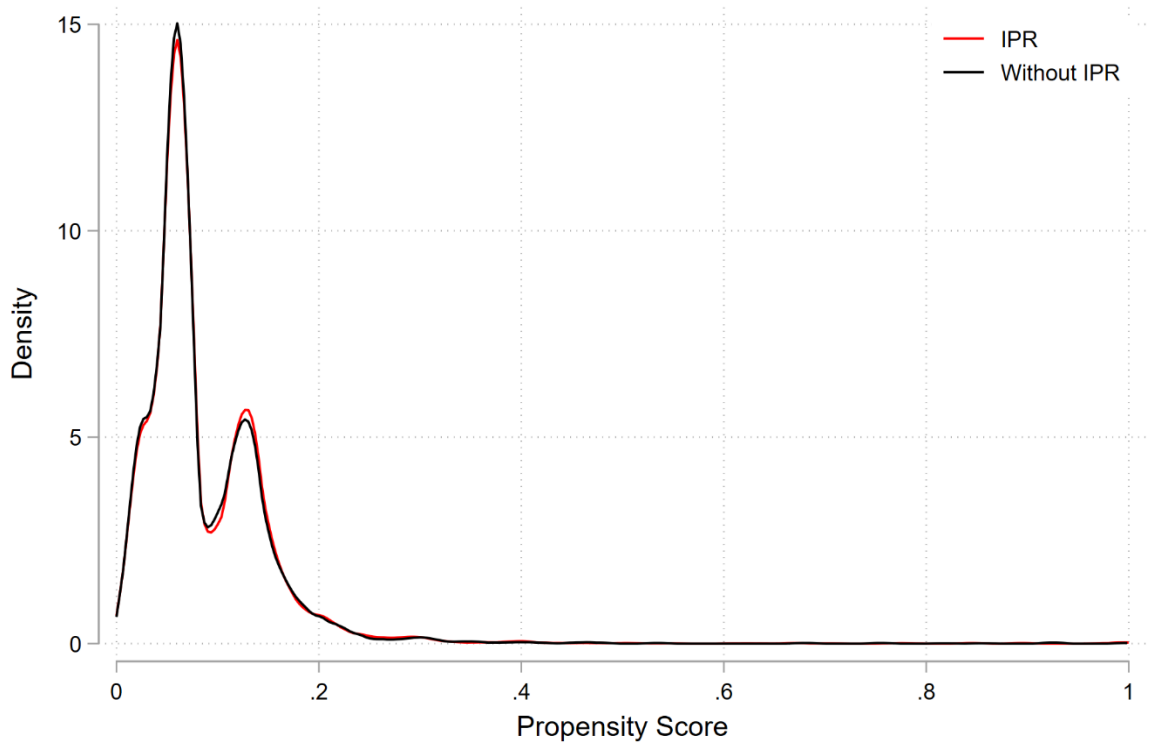
Figure 41 Estimated propensity score of IPR owners and selected control companies

2.3   Final sample

Table 45 shows the averages of companies with and without IPR in each dimension of the matching, post matching and following further data cleansing. Whereas the previous analyses already demonstrated that the matching statistically balanced the groups, this table provides a further overview of the distribution of the sample and the characteristics of the companies in the analysis. Companies in the analysis, both companies with IPR and control companies, are on average 31 years old. Companies with IPR, at the moment of the matching (2012), had slightly higher balance sheet totals, at approx. 51 million euro, than the companies in the control group, with balance sheet totals of approx. 34 million euro. On average, they also achieved a higher added value per employee (8,690 euro) as compared with companies in the control group (IPR: 103,290 euro, control group: 94,600 euro).

The sectoral composition of the sample is also relevant. Sector C (Manufacturing), G (Wholesale and retail trade) and M (Professional, scientific and technical activities) are most heavily represented, at 25%, 32% and 11% respectively of the observations in the control group. The analysis represents no companies in sectors B (Mining and quarrying), D (Electricity, gas, steam and air conditioning supply), O (Public administration and Defence, compulsory social security) and P (Education), since these do not occur in the set of companies with IPR.

Table 45 Overview of statistics of matching variables, post-matching

	No IPR	IPR	Difference
Age	30.74	30.62	0.12
Balance sheet total '12 (000 euro)	33714.5	51759.16	-18044.66*
Productivity '12 (000 euro)	94.6	103.29	-8.69***
Sector: A	0.01	0.01	0.00
Sector: B	0.00	0.00	0.00
Sector: C	0.25	0.25	0.00
Sector: D	0.00	0.00	0.00
Sector: E	0.01	0.01	0.00
Sector: F	0.06	0.06	0.00
Sector: G	0.32	0.32	0.00
Sector: H	0.01	0.01	0.00
Sector: I	0.03	0.03	0.00
Sector: J	0.06	0.06	-0.01
Sector: K	0.03	0.03	0.00
Sector: L	0.01	0.01	0.00
Sector: M	0.12	0.11	0.01
Sector: N	0.05	0.05	0.00
Sector: O	0.00	0.00	0.00
Sector: P	0.00	0.00	0.00
Sector: Q	0.01	0.01	0.00
Sector: R	0.01	0.01	0.00
Sector: S	0.01	0.01	0.00
Observations	4800	4997	9797
Table shows average for each group and difference between groups. Significant differences on the basis of t-test with Lechner (2001) correction for repeat sampling are marked: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.			

2.4   Complete regression results SMEs and large companies

This section presents the full versions of Table 42 and Table 43. Table 46 and Table 47 present the full versions of the regression reports in Table 42. Table 48 and Table 49 present those for Table 43.

Table 46 Impact of IPR on growth (CAGR) 2015-2019: SMEs

IPR characteristics	(1) All	(2) National trademarks	(3) International trademarks	(4) Trademarks & Patents	(5) Only patents	(6) Designs	(7) Other combination
IPR	0.025***	0.021***	0.030***	0.052***	0.021**	0.017	0.031***
	(0.003)	(0.004)	(0.006)	(0.015)	(0.009)	(0.012)	(0.010)
Ln(Age)	-0.025***	-0.022***	-0.021***	-0.041***	-0.036***	-0.025*	-0.028**
	(0.003)	(0.004)	(0.006)	(0.013)	(0.010)	(0.014)	(0.012)
Ln(Balance sheet total '12)	-0.004***	-0.005***	-0.006**	-0.004	0.001	0.001	-0.006
	(0.001)	(0.002)	(0.002)	(0.005)	(0.004)	(0.005)	(0.004)
Ln(Productivity '12)	0.019***	0.015***	0.023***	0.019**	0.028***	0.015*	0.023***
	(0.003)	(0.004)	(0.005)	(0.009)	(0.008)	(0.009)	(0.008)
Multinational	-0.001	0.002	0.013	-0.078	-0.002	-0.108***	0.009
	(0.013)	(0.018)	(0.021)	(0.069)	(0.047)	(0.024)	(0.033)
Sector: M	-0.006	-0.004	-0.004	-0.014	-0.021	-0.007	-0.006
	(0.005)	(0.007)	(0.009)	(0.025)	(0.016)	(0.020)	(0.018)
Sector: C	0.007**	0.008	0.011*	0.010	-0.002	0.004	-0.008
	(0.003)	(0.005)	(0.006)	(0.013)	(0.012)	(0.012)	(0.010)
Sector: J	0.018**	0.015	0.028**	-0.017	0.034	-0.024	-0.031
	(0.007)	(0.010)	(0.012)	(0.032)	(0.023)	(0.019)	(0.035)
Sector: N	0.000	-0.002	0.011	-0.019	-0.004	0.008	0.003
	(0.007)	(0.009)	(0.014)	(0.032)	(0.028)	(0.082)	(0.028)
Sector: Other	0.002	0.006	0.004	-0.014	0.004	-0.009	-0.025
	(0.004)	(0.005)	(0.009)	(0.015)	(0.015)	(0.021)	(0.016)
Region: Wallonia	0.001	0.000	0.003	0.001	0.003	0.007	-0.013
	(0.003)	(0.004)	(0.006)	(0.015)	(0.010)	(0.014)	(0.011)
Region: Brussels	0.003	0.001	-0.000	-0.006	0.035	-0.006	0.015
	(0.005)	(0.007)	(0.009)	(0.019)	(0.022)	(0.020)	(0.012)
Intercept	0.028*	0.040*	0.009	0.076	-0.004	0.024	0.041
	(0.015)	(0.021)	(0.029)	(0.050)	(0.051)	(0.061)	(0.055)
Observations	7952	3951	1988	459	642	348	564
R-square	0.036	0.026	0.049	0.084	0.078	0.036	0.070

*** p < 0.01, ** p < 0.05, * p < 0.10. **Linear regression.** Cluster-robust standard errors between brackets. Outliers not included. Reference categories: Sector G, Flemish region. The variable IPR estimates the difference in growth between SMEs with IPR, or SMEs in specific IPR clusters, and SMEs in the relevant control group. Column 2 makes no distinction between the various types of IPR; Columns 2 to 7 focus respectively on the impact of the various IPR clusters. These are only national trademarks (2); trademarks including international trademarks (3); trademarks together with patents (4); only patents (5); only designs (6); and other combinations of IPR (7).

Table 47 Impact of IPR on growth (CAGR) 2015-2019: Large companies

IPR characteristics	(1) All	(2) National trademarks	(3) International trademarks	(4) Trademarks & Patents	(5) Only patents	(6) Designs	(7) Other combination
IPR	0.024***	0.018*	0.022*	0.038***	0.008	0.050***	0.041**
	(0.006)	(0.009)	(0.011)	(0.014)	(0.015)	(0.017)	(0.019)
Ln(Age)	-0.021***	-0.017**	-0.031***	-0.020*	-0.022**	0.000	-0.021
	(0.005)	(0.008)	(0.009)	(0.011)	(0.011)	(0.015)	(0.014)
Ln(Balance sheet total '12)	-0.004**	-0.005*	-0.001	-0.012***	0.007	-0.010**	-0.001
	(0.002)	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)	(0.006)
Ln(Productivity '12)	0.004	0.011*	0.001	0.002	-0.011	0.025*	0.003
	(0.004)	(0.006)	(0.006)	(0.011)	(0.012)	(0.015)	(0.014)
Multinational	-0.010**	-0.016*	-0.010	0.005	-0.004	-0.008	-0.003
	(0.005)	(0.009)	(0.009)	(0.012)	(0.014)	(0.014)	(0.016)
Sector: M	0.037***	0.040**	0.036*	0.010	0.096**	0.055	-0.016
	(0.011)	(0.017)	(0.019)	(0.024)	(0.042)	(0.034)	(0.040)
Sector: C	0.005	-0.004	-0.006	0.031	0.025	0.029	-0.001
	(0.006)	(0.013)	(0.010)	(0.021)	(0.029)	(0.019)	(0.019)
Sector: J	-0.005	-0.027	0.020	-0.040	0.006	0.025	0.004
	(0.012)	(0.019)	(0.020)	(0.033)	(0.049)	(0.059)	(0.036)
Sector: N	0.032**	0.064***	-0.020	0.045**	0.063	0.034	0.086*
	(0.014)	(0.019)	(0.025)	(0.020)	(0.044)	(0.035)	(0.049)
Sector: Other	0.008	-0.001	0.003	0.020	0.053*	0.010	0.034*
	(0.007)	(0.011)	(0.013)	(0.024)	(0.030)	(0.042)	(0.020)
Region: Wallonia	0.006	0.003	-0.004	0.029*	0.002	0.016	0.017
	(0.006)	(0.012)	(0.011)	(0.015)	(0.016)	(0.015)	(0.015)
Region: Brussels	-0.007	-0.008	-0.014	0.004	0.009	-0.007	-0.017
	(0.008)	(0.012)	(0.014)	(0.019)	(0.027)	(0.033)	(0.030)
Intercept	0.093***	0.074*	0.128***	0.168**	0.034	-0.051	0.055
	(0.025)	(0.044)	(0.043)	(0.072)	(0.099)	(0.071)	(0.077)
Observations	1845	591	585	241	185	110	133
R-square	0.061	0.090	0.069	0.169	0.105	0.245	0.131

*** p < 0.01, ** p < 0.05, * p < 0.10. **Linear regression.** Cluster-robust standard errors between brackets. Outliers not included. Reference categories: Sector G, Flemish region. The variable IPR estimates the difference in growth between large companies with IPR, or large companies in specific IPR clusters, and large companies in the relevant control group. Column 2 makes no distinction between the various types of IPR; Columns 2 to 7 focus respectively on the impact of the various IPR clusters. These are only national trademarks (2); trademarks including international trademarks (3); trademarks together with patents (4); only patents (5); only designs (6); and other combinations of IPR (7).

Table 48 Impact of IPR on average productivity (2015-2019): SMEs

IPR characteristics	(1) All	(2) National trademarks	(3) International trademarks	(4) Trademarks & Patents	(5) Only patents	(6) Designs	(7) Other combination
IPR	0.004	-0.019	0.013	0.075	0.048	0.093*	0.030
	(0.011)	(0.016)	(0.021)	(0.055)	(0.040)	(0.050)	(0.045)
Ln(Age)	-0.089***	-0.068***	-0.129***	-0.088	-0.024	-0.048	-0.144**
	(0.014)	(0.019)	(0.021)	(0.054)	(0.046)	(0.057)	(0.066)
Ln(Balance sheet total '12)	0.077***	0.083***	0.080***	0.059**	0.040**	0.040*	0.058***
	(0.006)	(0.010)	(0.009)	(0.024)	(0.016)	(0.021)	(0.017)
Ln(Productivity '12)	0.531***	0.499***	0.542***	0.560***	0.610***	0.526***	0.604***
	(0.026)	(0.045)	(0.027)	(0.080)	(0.057)	(0.071)	(0.035)
Multinational	0.033	-0.028	0.108	0.113	-0.120	0.243	0.134
	(0.053)	(0.073)	(0.106)	(0.151)	(0.186)	(0.193)	(0.115)
Sector: M	0.099***	0.105***	0.099***	0.031	0.069	0.104	0.171***
	(0.019)	(0.026)	(0.033)	(0.102)	(0.079)	(0.097)	(0.062)
Sector: C	0.014	0.029	-0.016	0.098*	0.030	-0.141***	0.061
	(0.014)	(0.021)	(0.024)	(0.055)	(0.060)	(0.053)	(0.054)
Sector: J	0.102***	0.106***	0.116***	0.009	-0.056	-0.324***	0.218***
	(0.023)	(0.033)	(0.039)	(0.103)	(0.111)	(0.083)	(0.077)
Sector: N	0.057**	0.020	0.073	0.270**	0.022	-0.161	0.385***
	(0.025)	(0.032)	(0.045)	(0.120)	(0.144)	(0.229)	(0.103)
Sector: Other	0.017	0.019	0.049	-0.007	0.005	-0.072	0.109*
	(0.015)	(0.019)	(0.034)	(0.066)	(0.064)	(0.087)	(0.063)
Region: Wallonia	-0.071***	-0.076***	-0.053**	-0.042	-0.117***	-0.151***	0.024
	(0.013)	(0.019)	(0.023)	(0.057)	(0.045)	(0.053)	(0.045)
Region: Brussels	-0.044**	-0.043	-0.056	0.013	-0.177***	-0.046	0.021
	(0.021)	(0.028)	(0.036)	(0.096)	(0.069)	(0.107)	(0.133)
Intercept	1.800***	1.824***	1.872***	1.781***	1.510***	2.060***	1.697***
	(0.112)	(0.180)	(0.133)	(0.361)	(0.281)	(0.368)	(0.204)
Observations	7952	3951	1988	459	642	348	564
R-square	0.449	0.427	0.487	0.445	0.483	0.524	0.462

*** p < 0.01, ** p < 0.05, * p < 0.10. Linear regression. Cluster-robust standard errors between brackets. Outliers not included. Reference categories: Sector G, Flemish region. The variable IPR estimates the difference in productivity between SMEs with IPR, or SMEs in specific IPR clusters, and SMEs in the relevant control group. Column 2 makes no distinction between the various types of IPR; Columns 2 to 7 focus respectively on the impact of the various IPR clusters. These are only national trademarks (2); trademarks including international trademarks (3); trademarks together with patents (4); only patents (5); only designs (6); and other combinations of IPR (7).

Table 49 Impact of IPR on average productivity (2015-2019): Large companies

IPR characteristics	(1) All	(2) National trademarks	(3) International trademarks	(4) Trademarks & Patents	(5) Only patents	(6) Designs	(7) Other combination
IPR	-0.076***	-0.140***	-0.033	0.077	-0.076	-0.068	-0.198**
	(0.025)	(0.044)	(0.040)	(0.057)	(0.070)	(0.108)	(0.077)
Ln(Age)	-0.005	-0.033	0.074*	0.004	-0.076	0.003	-0.049
	(0.024)	(0.046)	(0.044)	(0.042)	(0.059)	(0.112)	(0.065)
Ln(Balance sheet total '12)	0.029***	0.039***	-0.002	0.026*	0.063***	0.011	0.016
	(0.007)	(0.013)	(0.013)	(0.015)	(0.021)	(0.023)	(0.024)
Ln(Productivity '12)	0.623***	0.572***	0.655***	0.568***	0.571***	0.790***	0.712***
	(0.028)	(0.049)	(0.042)	(0.080)	(0.091)	(0.081)	(0.086)
Multinational	0.061***	0.027	0.092**	0.044	0.032	0.023	0.160**
	(0.021)	(0.038)	(0.038)	(0.054)	(0.057)	(0.088)	(0.075)
Sector: M	0.063	-0.018	0.018	0.171	0.171	0.262	0.288**
	(0.047)	(0.064)	(0.096)	(0.127)	(0.122)	(0.223)	(0.124)
Sector: C	-0.011	-0.154***	-0.021	-0.008	-0.041	0.052	0.122
	(0.027)	(0.057)	(0.046)	(0.101)	(0.098)	(0.104)	(0.088)
Sector: J	0.010	-0.049	0.020	0.104	-0.033	0.193	-0.022
	(0.042)	(0.074)	(0.059)	(0.153)	(0.177)	(0.220)	(0.194)
Sector: N	-0.114**	-0.225***	-0.005	0.034	-0.210	0.023	0.191
	(0.047)	(0.074)	(0.083)	(0.136)	(0.177)	(0.363)	(0.138)
Sector: Other	-0.063*	-0.021	-0.020	-0.170	-0.124	-0.504*	-0.066
	(0.037)	(0.060)	(0.063)	(0.128)	(0.109)	(0.268)	(0.112)
Region: Wallonia	-0.025	-0.051	-0.010	0.018	-0.050	-0.058	0.016
	(0.030)	(0.061)	(0.056)	(0.063)	(0.069)	(0.109)	(0.063)
Region: Brussels	0.025	0.046	-0.004	0.031	-0.015	0.021	0.346*
	(0.036)	(0.053)	(0.060)	(0.112)	(0.101)	(0.254)	(0.200)
Intercept	1.596***	1.879***	1.430***	1.731***	1.839***	0.993	1.413***
	(0.148)	(0.271)	(0.256)	(0.304)	(0.427)	(0.629)	(0.374)
Observations	1845	591	585	241	185	110	133
R-square	0.527	0.532	0.521	0.501	0.590	0.642	0.630

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. **Linear regression.** Cluster-robust standard errors between brackets. Outliers not included. Reference categories: Sector G, Flemish region. The variable IPR estimates the difference in productivity between large companies with IPR, or large companies in specific IPR clusters, and large companies in the relevant control group. Column 2 makes no distinction between the various types of IPR; Columns 2 to 7 focus respectively on the impact of the various IPR clusters. These are only national trademarks (2); trademarks including international trademarks (3); trademarks together with patents (4); only patents (5); only designs (6); and other combinations of IPR (7).

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