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DETERMINANTS OF INTELLECTUAL PROPERTY RIGHTS IN EU REGIONS

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INTRODUCTION

The aim of this thesis is to analyse and compare the different innovation profiles of EU-14 countries at regional level.

Usually, the literature refers to the group of EU-15 countries, which corresponds to those countries belonging to the European Union prior to the accession of the "Eastern" candidates, occurred in 2004. In this case, taking into account the recent exit-process undertaken by the United Kingdom, reference is made with respect to the EU-14 cluster, that excludes UK and includes the following "Western-European" countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and Sweden.

In this work, the regions' innovation profile is determined by their performances in terms of the major Intellectual Property Rights (IPRs): Patents, Trademarks and Designs, each one representing an indicator of different typologies of invention or innovation.

In recent years, the linkage between innovation and economic growth has been extensively studied and most of the achieved results suggest a positive correlation between these two variables.

IPRs are considered one of the possible outputs of the innovation process, therefore their extent and variation should affect the economic development of firms, regions and countries.

For this reason, evaluating the innovation profile of EU-14 regions could provide an additional element able to explain their different economic performances.

Furthermore, this work takes into account a set of collateral elements and variables that are involved in order to try to assert to what extent they influence the innovation profile of the European regions and consequently their economic growth.

Understanding which variables are the most successful in positively affecting regional innovation, is crucial to orientate national and local policy-makers so that they can direct funds, financial supports and subsidies in the most efficient way to foster the economic growth of their reference area.

This thesis is organized in the following chapters.

Chapter 1 provides a description of the IPRs included in this work: patents, trademarks and designs. The distinctive features of them, the different advantages and disadvantages that characterize their utilization, the different registration processes and also the different roles played by these IPRs in explaining innovation and economic outcomes will be examined. This Chapter also contains a review of some empirical findings available in the existing literature.

Chapter 2 contains an extensive empirical analysis performed with the aim of investigating the innovation scenario existing in western Europe. This analysis is carried out by considering the trend of IPRs in the EU-14 aggregate and also the performance of its different regions. The empirical investigation will be undertaken by performing both static regional rankings and dynamic analysis.

Chapter 3 provides a description of the dependent and the explanatory variables included in the subsequent econometric analysis.

The econometric regressions will be performed in Chapter 4, where it will be possible to achieve some interesting results. First of all, the regional per-capita GDP has a positive and significant impact on all the IPRs. There is a positive correlation between patents and R&D activities, while the latter is not relevant for the other IPRs. The role of sectorial variables varies moving from one IPR to another, while tertiary education turns out to be relevant for trademarks and designs but not for patents.

CHAPTER 1. INTELLECTUAL PROPERTY RIGHTS

According to the World Intellectual Property Organization (WIPO), Intellectual Property Rights (IPRs) represent creations of people's minds; such creations may assume different appearances like for example inventions, literary and artistic works, designs, symbols or names and images used in commerce.

Over the years, the relevance of intellectual creations intensified and consequently a specific regulation was created. The result is that nowadays IPRs are protected by law, giving rights to people over their creative outcomes. These rights give to individuals or organizations an exclusivity over the use of their creation and they also enable them to earn recognition and financial benefits from what they create. In particular, the rights conferred when registering and IPR are: the right of prevent others from making, using, selling or infringing those creations protected by the IPR, in those countries where the IPR is granted; also, it is conferred the possibility of selling the IPR or conclude licensing contracts.

The main purpose of the IPRs regulation is to ensure the correct trade-off between the private interests of inventors or creators and the public interest. This system aims to foster and facilitate "knowledge spill-overs" so that the benefits provided by the intellectual creations can be exploited also by other individuals and/or other companies; in the meanwhile, the IPRs regulation is meant to protect inventors' interests encouraging them to continue their innovative creation process. Indeed, if the invention is not protected by an IPR, the inventor or other third parties cannot benefit from it, there are no economic or industrial advantages in this situation because the invention is not widespread. The registration of the IPR is the crucial step that allows the invention to become innovation, that means to widespread the profits and the benefits among the population through the commercialization or the industrial utilization of the invention.

When focusing on the process of registration of the IPR there are three main roles that must be differentiated: the Inventor, who must be a physical person and that is the progenitor of the creation; the Proprietor, who is usually a legal person (company or firm) and that is the owner of the rights granted by the registration of the IPR; the Legal representative (IPR attorney), that is the person who legally represents the other two actors in all the procedures undertaken to register the IPR. Those professionals that can suit this role are enrolled in a special list held by the EUIPO or by attorneys-at-law.

In general, the inventor and the owner of the IPR are different identities, otherwise, when the inventor and the proprietor are the same entity it is called an “individual patent”.

It is important that all these players consider the main crucial issues when deciding if register the IPR or not. These issues could be for example related to the better combination of IPRs to register, to the commercial necessity of registering an IPR, to the total cost of registering the IPR respect to the expected return on investments, to the adequate timing to apply for the registration, to the utility of the IPR linked to the creation to protect and for example to the possibility that the registered IPR would resist future legal challenges.

According to the World Trade Organization (WTO), IPRs are commonly divided into the following main categories:

- Copyright and rights related to copyrights: these are the rights recognized to authors, performers or producers of literary and artistic works.

In the European system, they protect and reward also the creative work of software developers.

- Industrial property rights: inside this category are included the protection of distinctive signs (Trademarks), of inventions (Patents) and industrial designs (Registered designs).

Rights included in this category aim to ensure fair competition, inform and protect consumers and protect the outcomes of the investment made by inventors.

This work will be mainly focused on those IPRs that are supposed to have the largest impact on the economic performances of companies, regions and countries: *Patents*, *Trademarks* and *Registered Designs*.

In Table 1, a general overview of what introduced above is presented, in order to introduce their role in the innovation scenario.

Table 1: Patents, trademarks and designs overview: measurement area, points of strength and points of weakness

IPR	Measurement Area	Points of Strength	Points of Weakness
Patents	- technological novelties or improvements - technological specialization of countries	- reliable measure of technological innovation - identification of knowledge domain - one-to-one relation with technological novelties	- not able to capture innovative activities when innovations are not technological in nature - not all patents become innovations - existence of different propensity to patent - presence of strategic patenting
Trademarks	- marketing innovation - consumer-oriented specialization of countries - indicator calculated for the service industry	- good indicator of marketing innovation - indicator used for low-tech manufacturing industries - possible measure of innovation in creative industry	- the relation with the introduction of a new product or service is not guaranteed - the same trademark can be applied for different sectors
Design Registrations	- design innovation - industry specialization	- possible indicator of industrial structural specialization of countries - able to capture the portion of non-technological innovation not captured by other IPRs.	- multiple applications can be counted as one application (design regulation) - possibility of strategic behaviour not reflecting innovation

Source: Filippetti, Gkotsis, Vezzani and Zinilli (2019)

1.1 Patents

"A Patent is an exclusive right granted for an invention, product or process, that provides a new way of doing something or offers a new technical solution to a problem" (WIPO International Portal).

Patents have been by far one of the most exploited measures of invention and innovation, used to study this phenomenon both at a national, regional, industry or firm level.

Patents offer several advantages when using them to study innovation. They are a reliable measure of inventive activity, because data are largely available and because they are comparable across countries and over time (Archibugi, 1992). In addition, they represent "the only observable manifestation of inventive activity with a well-grounded claim for universality" (Trajtenberg, 1990).

However, it is important to stress the fact that not all the innovations are represented by patents, that not all the R&D activities end with the registration of a patent and, most importantly, that not all the registered patents do effectively have a concrete introduction into the market (as a product or a process). This last aspect is even more significant if the rise of the "strategic patenting" phenomenon is considered, resulting in the increasing tendence of registering patents for competitive strategies (both defensive and aggressive reasons) and not for real "innovation reasons".

In the literature there are many different theories and opinions characterized by different concepts and nuances for what concerns the role of patents as an indicator of innovation.

However, the most suitable and common choice, that will be privileged in this thesis, is to consider patents as indicators of technological innovation. This is sustained for example by Archibugi: “Patents are outcome which have a proprietary nature and are likely to generate business applications; in other words, they are more likely to reflect technological rather than scientific activities” (Archibugi 1992, p. 357).

Patents are considered the tangible outputs of knowledge creation and diffusion in productive activities; indeed, they are used to introduce new goods, services or production processes. This is the main reason why this specific intellectual property right is selected to represent and measure the technological progress of countries, regions and firms.

It is also relevant to focus on the legal and bureaucratic process that is necessary to undertake in order to register a patent; to this purpose it is proposed a summary of the procedure requested to apply for a patent at an international level.

One of the first choices that the inventor has to make is related to the institution to select in order to undertake the patent applications; the two main possible procedures to apply for a patent at an international level are: the European Patent Office (EPO), which operates according to the rules settled by the European Patent

Convention (EPC), or the procedure established by the Patent Co-operation Treaty (PCT). Choosing among them depends on the typology of the invention, on the financial funds available for the applicant and many other variables.

Both these two procedures are legal processes characterized by strict timetables and deadlines. First of all, it is patentable only an invention that is new to the world (Novelty requirement) and previously undisclosed, characterized by a not obvious inventive step (Innovativeness requirement) and capable of industrial application (Applicability requirement). There are some inventions that cannot be patented in Europe, as for example computer software (that can be protected only by copyrights), business methods or mere ideas not reduced to practice.

In this study it will be reported only the EPO procedure; instead, the PCT procedure, that differentiates for costs, deadlines and bureaucratic steps, will be resumed in Figure A (Appendix).

According to the EPO website the process could be structured in the following main steps:

1. Preparing the documentation for the application. The requested documents are: the details of the applicant, a description of the invention, claims, eventual drawings and an abstract regarding the invention. The applications to the EPO can be filled in English, French or German. Also, a fee must be paid at the moment of presentation of the application.

2. If the documentation presented seems correct, a filling date is given to the application; this is also known as “priority date”. The importance of the priority date is that in the following 12 months to that date, the inventor can request for patent protection (over the same invention) in other European countries considering as filling date for all of them the priority date of the first application to the EPO. This means that the inventor disposes of one year to decide how many countries he/she wants to include in the patent protection. After filing there is a first “formalities examination” to ensure that the documentation is correct and complete.
3. Receipt of the search report, which includes prior documents related to the invention and, often, an initial opinion regarding the patentability of the invention.
4. Within 18 months after the priority date, the application is published. The invention is now visible from other people in public databases and this step functions as “prior art”, the proof against any future patent applications from other inventors regarding similar inventions.
5. After the publication of the application the inventor has six months to decide if he wants to continue the application procedure. The decision of not continue a patent application procedure could be based for example on a negative search report, this decision is called “withdraw”. In this phase the inventor must decide also which countries to include in the patent protection. Depending on the

number of countries selected, different designation fees must be paid. The number of countries in which a patent protection is required for the same invention is called “Patent family”.

6. If the inventor decides to continue the procedure, the EPO undertakes a “substantive examination” through which it is verified if the invention and the application satisfies the requirements of the EPO. Usually there are three EPO examiners that undertake the examination, in order to guarantee the maximum objectivity.
7. If the examiners decide to grant the patent, after verifying that all the fees have been paid, the decision is reported in the European Patent Bulletin; the decision to grant the patent enters into force on the date of publication. The period that goes form the date of the initial applications and the date of publication of the grant could be equal to four or five years.
8. After the final approbation of the application, the patent must be validated in each designated country, within a specific time limit, at each national patent office. If it is not the case, the patent is not enforceable in those countries and therefore is quite useless (usually, countries request the translation of the patents in order to be granted at a national level). Thus, there is not an international institution that allows to register a patent at an international level simultaneously; instead, the EPO operates as an actor of centralization of the procedures necessary to register the patent and as a “facilitator” of the

registration of the patent protection also at a national level. This situation is due to the fact that it does not exist a European patent, but instead it does exist a European procedure to validate a patent in Europe.

9. Within nine months after the grant is reported in the public bulletin, the granted patent can be opposed by third parties. Statistically, almost the 10% of patents grants are subject to opposition. The notice of opposition will be examined again by three EPO examiners (one of them is the examiner in charge of the first examination). This is the opposition procedure that operates according to the rules settled by the EPO; after these nine months a granted patent can be challenged only in national courts by classic legal procedures. At this point, the opposition procedure becomes a patent litigation and has nothing to do respect to the EPO rules because it follows the legal system that is into force in each national country, with all the regular levels of judgment. This also means that each ruling in a certain country will not have any effects on the patents registered for the same invention in other countries. This situation creates the conditions to give to the third part that applies for opposition, a strong incentive to challenge an invention during the opposition period, because later it would be definitely more expensive and difficult. This incentive is strengthened by the fact that the cost for an EPO opposition varies from 10.000€ to 50.000€ while the cost of a legal patent litigation in Europe could vary from 50.000€ to 500.000€ depending on the complexity of the case.

An eventual acceptance of the opposition application by the EPO can be appealed, as all the others EPO decisions, by the inventor and other third parties. The possible results of the EPO examination against a patent opposition could be: a rejection (21% of the cases), meaning that the patent is confirmed to be valid; an emendation (30% of the cases), the patent remains valid but some changes or some reductions to patent's claims must be applied; a revocation (38% of the cases), the patent is no longer valid; in some cases, the opposition could be closed without a decision (10% of the cases).

1.2 Trademarks

"A trademark is a distinctive sign capable of distinguishing the goods or services provided by a specific enterprise (or person) from those of other competitors" (WIPO International Portal).

Trademarks have been less employed to measure innovation if compared to patents; however, their use has been growing over time.

According to Wilkins (1992) the development of modern big corporations and multinationals, in particular the US ones, is the turning point that led to greater attention to brand names. With the birth of modern corporations, the international economic system passed from small dimensions of both sellers and buyers with a direct contact between them, to a situation where there is a significant separation between these two players through the intermediation of distribution chains. In this kind of economic environment large companies and multinationals cannot exploit their characteristic economies of scale and scope without a strong brand name and a legal protection of trademarks: "the name, the brand, the reputation and the trademark of companies become intangible property rights that require legal support" (Wilkins, 1992, p. 66-95). At this point trademarks started to become crucial instruments for companies to remain competitive in national and international markets.

At the beginning, the predominant usage of trademarks was linked to products' names, where these instruments were mainly employed to signal the quality of goods and to distinguish them from similar items produced by competitors.

In the last decades the market attended a radical change of direction with an increasing trend regarding trademarks applied to the service sector. Companies and scholars started to understand that trademarks are more suitable indicator, and instruments, of innovation when referring to the service industry. This is due to the fact that developed countries are more and more characterized by a "servitization" process (Filippetti, Gkotsis, Vezzani, Zinilli, 2019). Indeed, the economic literature confirmed this trend by documenting and associating the growth of per-capita GDP to the increasing share of services in terms of GDP and total employment.

Hence, the role of the service sector for innovation is becoming more and more significant, above all if we consider the so-called Knowledge Intensive Business Services (KIBS) represented by those service companies that provide knowledge input mainly to the business process of other organizations (Filippetti, Gkotsis, Vezzani, Zinilli, 2019).

The increasing use of trademarks by companies is also due to the fact that they remain the best entrepreneurial tool to undertake differentiation strategies which, nowadays, probably represent the most effective approach used by enterprises. As it is valid for patents, it is important to stress the fact that also trademarks can be used for strategic reasons: companies may register trademarks to increase visibility, to marginally differentiate their services or to discourage potential new entrants (Hipp and Grupp, 2005). This phenomenon is even more clear by considering the fact that trademarks are commonly registered to protect service innovations that are characterized by the attribute of intangibility. This means that the inventions protected by trademarks are not limited by the requirement of materiality as it usually happens with the majority of the invention protected by patents.

According to Ramello (2006, p.549), it is possible to distinguish among three categories of trademarks: a "Fanciful trademark" when it consists of novel signs that do not have any pre-existing meaning; an "Arbitrary trademark" when it does have a previous direct meaning but it is used in such a specific field that there is no possibility of confusion; a "Suggestive trademark" when it refers, even if indirectly, to some property of the product that it is linked to.

In all these cases, it is for the capability of conveying information and facilitating purchase decisions that trademarks are reinforced with legal protection.

Therefore, like in the previous situation, also for trademarks it is relevant to analyse the process to undertake in order to register this typology of IPR in Europe.

First of all, all kind of signs (words, devices, digits or shapes) can be registered as trademarks. The basic requirements are that the public authorities must be able to determine the object of the protection clearly and precisely and the creation must satisfy the requirements of novelty, distinctiveness and lawfulness. There are several typologies of trademarks that can be registered according to the features of the creation covered by the protection: product marks, service marks, figurative marks, colour marks, sound marks, multimedia marks and many others.

A European trademark grants to the proprietor the exclusive rights over a creation in all current and future member states of the EU through a single registration obtained with a unique application. The European trademark is valid for ten years and can be renewed for subsequent periods of 10 years. Hence, this is the first crucial difference respect to the situation obtained for patents, because here it does exist a European trademark and therefore there is a unique registration procedure to protect the creation all over the European countries, while for patents different steps are necessary (see the previous section).

The application form for a European trademark is available online, on the EUIPO website and the basic fee for the online application is 850€, while for the paper form the basic fee is 1.000€.

The registration process for a European trademark registered with the EUIPO includes the following main steps:

1. The first thing to do when deciding to register a trademark is to check the availability of the protection for a certain creation. If the trademark is available, hence it is possible and convenient to continue with the application.
2. The application for registering a European trademark can be filed regardless of whether a prior national trademark exists and, viceversa, if the application for a European trademark is not accepted the conversion of the application into an application at national levels is still possible. The application must contain a representation of the trademark and a list of the goods and/or services to be covered by the mark. These goods and services must be classified according to the "Nice classification" that divides the goods and the services into 45 different categories/classes. In the application form must be provided the details of the entity that will become the sole proprietor of the trademark. In this case, the owner of the trademark could be an individual or a company. (Applications to the EUIPO can be filed in French, English, Italian, Spanish and German)
3. After presenting the application form, it starts the examination period. At first the EUIPO checks that the application contains all the mandatory and basic

information required plus the payment of the basic fee that must be made within one month from the filing date. Then the office will check if the goods and services are correctly classified and if their nature has been clearly indicated. After that, it starts an examination on absolute grounds, meaning that the trademark is analysed in order to state if it is distinctive or not. If there are some problems, related to an error or to an objection, the applicant receives an official communication and has two months to remedy any deficiencies and reply. Instead, if everything is ok the EUIPO will proceed with the publication of the application.

4. From the date of publication of the application, it starts the opposition period, during which any third parties can present opposition (it costs around 300€ to present an opposition instance); the opposition period lasts for three months. The first reason that triggers a trademark opposition is related to an earlier right over the creation, this is the case of the 20% of the trademark applications; another reason that can provoke a trademark opposition is when a third part considers that the application should not be accepted for infringing the "absolute ground requirements". When a trademark is opposed, a proper opposition procedure begins and the trademark is examined and evaluated again until a decision is taken.
5. At the end of the opposition period, if none presented an opposition or if the oppositions presented have been rejected, the trademark is registered and the

registration is published. At this point, the proprietor of the trademark can apply the recognized symbol "®", in order to show that the trademark is registered.

6. Any parties adversely affected by a final decision can file an appeal through an online form on the EUIPO website.

A particularity of trademarks organization is that it exists a peculiar regulation also for what concerns the utilization of the trademark once it has been registered. Indeed, the right granted by the registration allows the proprietor to build brand recognition in the market and to distinguish the offered goods or services from those of competitors. The economic utility and benefits of a registered trademark are widespread when it goes into force concretely; this is the reason why if an owner of a registered trademark does not use it, any third parties can challenge the trademark for non-use. The existing regulation establishes that an EU trademark must be put into genuine use within the five years following its registration. This is a clear example of how the existing regulation provides different kinds of incentives to the proprietor in order to make him/her concretely using its trademark.

1.3 Registered Design

"An Industrial Design represents the creating activity of achieving a formal or ornamental appearance for a mass-produced item. It may consist of the shape, the materials, the patterns, the lines or the colour of a certain product which are necessary to satisfy both the need to appeal visually to potential customers and the need to perform its intended function efficiently” (WIPO International Portal).

From the previous definition, it is possible to state that a registered design provides a protection for both the aesthetic and the functional aspects of a product; this means that a design has to be new and original in order to be a valid IPRs.

Design registrations are relatively less employed as a measure of innovation if compared to the previous two IPRs; however, also in this case it is evident an increasing trend both for the employment of designs by enterprises and also for their relevance when studying innovation.

According to the Community Innovation Surveys (CIS), firms characterized by an advanced innovative profile are recently making a greater use of design rights than non-innovating firms (Livesey and Moultrie, 2008) which is a trend also observable for patents and trademarks. However, unlike the latter two, design protection is the only IPR that is used more intensively among innovating firms both in “low-tech” and “high-tech” industries (Mairesse and Mohnen, 2004). The concept introduced above is crucial when analysing the role of designs in the innovation scenario: this kind of IPR seems to be the most “flexible” among the three intellectual property rights considered in this work; indeed, designs are widespread both in high-tech firms, producing advanced and new technologies, and also among low-tech industries, producing non technological items such as for example clothes or footwear. This flexibility makes designs a ductile IPR suitable for different kinds of firms and different sectors; this is mainly due to the fact that this IPR protects the appearance of products, no matter the technological characteristics involved in them.

Another peculiar feature observable when studying the design system is that the substantive requirements for protection are not examined prior to registration; indeed, designs are assumed to be valid until successfully challenged, either by an invalidity proceeding or by a counterclaim in infringement proceedings. Non-examination increases uncertainty about the validity of designs and leaves room for strategic registrations activities that influence the quality of registered design. (Filitz, Henkel, Tether, 2015)

As done for the previous IPRs, it is proposed an analysis of the registration process for industrial designs.

A European design grants to the proprietor the exclusive rights over a creation in all current and future member states of the EU through a single registration obtained with a unique application. The European design is valid for five years and can be renewed for a maximum of 25 years by subsequent periods of 5 years a time. Hence, also in this case it is fundamental to point out the crucial difference with respect to patents, because also in this case it does exist a European design and therefore there is a unique registration procedure to protect the creation all over the European countries, while for patents different steps are requested, as explained before.

The application form for a European design is available online on the EUIPO website, and the basic fee for the online application is around 350€, amount that could vary according to the features of the application.

The registration process for a European design registered with the EUIPO includes the following main stages:

1. Also in this instance the first fundamental step is to check the availability of the protection. In this case it is even more important because designs operate on a "first-come" basis; this means that if someone else has already registered or disclosed the same design or a similar one, it is not available for a new registration. Searching if there are registered or disclosed designs that may enter into conflict is a proper activity in order to save money and time. If the result of the search tells that the design is available, it is possible to proceed with the application.
2. The design application must contain to which products the design applies to. The specification of products should include a clear indication of their nature and their classification according to the "Locarno classification", a specific international classification for industrial designs.

   The peculiarity of the design application is that it is possible to file several designs in the same application as long as the "unity of class requirement" is respected, which means that all the designs to protect and included in the same application must belong to the same "Locarno class" (the only exception is for ornamentation).

In the application form must be provided the details of the entity that will become the sole proprietor of the design. In this case, the owner of the design could be an individual or a company. (Applications to the EUIPO can be filed in French, English, Italian, Spanish and German)

3. After presenting the application form it starts the examination undertaken by the EUIPO. If the application has been filed online, the process is extremely rapid respect to the other IPRs, indeed most of the online filling are registered within a couple of days. The examination carried out by UIPO examiners is twofold. The first one regards the formal requirements, that are for example a not clear representation of the product linked to the design, inconsistent views, not completed payments of the fees, errors in the indication of the products and so on. The second is a substantive examination through which the examiners establish if the design in question is a real design, that is if it represents the appearance of the product. In addition, the examiners evaluate if the design contains an element, or more elements, that go against public policy and morality. If there are some problems, related to an error or to an objection, the applicant receives an official communication consisting in a deficiency letter. At this point, the applicant has the possibility to withdraw, to amend the representation of the design or to present observations.

What is fundamental to point out is that the EUIPO will not verify the novelty requirement of the designs presented in the application. This activity can be requested by third parties only after the registration of the design.

4. At the end of the examination period, if no problems are detected or if the applicant solved all the issues, the design will be registered. It will be also published in the Community Design Bulletin. If the applicant asked to defer the design, its representation will not be published.
5. At this point, when the design has been registered, any third parties can request that the design is declared invalid. To this purpose a specific process begins, it is called "invalidity procedure" carried on by the EUIPO (A registered design can be attacked also before the national courts). The main reasons for invalidation are linked to the novelty requirement or to the lacking of individual character. The invalidity procedure may end with an amicable settlement of the parties or with a decision undertaken by the EUIPO. If the EUIPO accepts the invalidation request, the design is declared to be invalid and it is deemed to never have existed. In this case the owner pays costs to the opponent, typically around 750€. If the design is confirmed to be valid, the opponent must pay the costs sustained for the procedures, around 400€.
6. Anyway, parties adversely affected by a final decision of EUIPO can file an appeal request.

1.4 <u>IPRs as economic assets</u>

This section analyses an alternative role played by IPRs, that is less eye-catching when speaking about innovation but instead is crucial for its circulation. Indeed, IPRs are the outputs of innovation processes and, as such, they represent real forms of investment both for economic and non-economic entities; hence, they are proper economic assets. In this sense, "IPRs commercialisation could be defined as the process of bringing the IPRs to the market in order for them to be exploited in return for business profits and benefits" (AANZFTA, 2019, p.6). In other words, the commercialisation of IPRs refers to doing business with these, allowing technology and knowledge to be shared and enabling IPRs holders to obtain commercial gains (Chandra and Liaqat, 2019).

From these definitions it is possible to understand that the role played by IPRs as economic assets is not secondary, but instead it allows to pursue the same crucial objective: transferring technology and knowledge among various organizations (in this case by turning an innovation into a commercial product, service or process) with the purpose of creating a harmonized and innovative economy (Chandra and Liaqat, 2019).

In addition, this topic must be treated because it has to do with the management of IPRs after their registration and consequently has to do with the managerial and entrepreneurial skills in the field of innovation. To a certain extent, this could also be another relevant variable that could differentiate the innovation performances of a certain region from the others: not only focusing on the input of the innovation process but also focusing on the management of IPRs at the end of the innovation processes.

According to the European Commission (2013), there are several ways to transfer knowledge on the market; anyway, it is often exchanged through contractual mechanisms, that can be divided in three categories:

- Exploitation of IPRs: in this category are included the License, the Assignment and the Spin-off.
- R&D Collaborations: in this category are included the Consultancy, the R&D Contract, the Consortium Agreement and the Joint Venture.
- Supplementary Agreements: in this category are include the Non-disclosure Agreement and the Material Transfer Agreement.

The first category is the one that is most related with the real commercialisation of IPRs and consequently is the one that is going to be analysed in depth.

The first commercialisation tool is the License agreement, that is a "contract under which the holder of the IPRs (licensor) grants permission for the use of its IPRs to another person (licensee), within the limits set by the provisions of the contract" (European Commission, 2013, p.5). It could be that this kind of contract is a "standalone agreement" or it could be involved in larger partnerships such as for example franchising. The advantages of the license are that the holder of the IPR can decide the fields of the technology to share with the licensee and through the license he/she is able to obtain additional economic benefits linked to licensing fees. The second possible commercialisation tool is the Assignment agreement, which is "a permanent transfer of ownership of an IPR (Patents, trademarks or designs) from one party (the assignor) to another party (the assignee). The latter becomes the new owner of the IPR" (European Commission, 2013, p.6). Hence, the assignment agreement is the tool that allows the transfer of the title of the IPR, reflecting the equivalent contract for selling agreements in the case of tangible assets. Thus, in this case the knowledge transfer tool does not involve the utilization of the IPR, but instead it affects its property. Probably the assignment is the best option from the economic point of view, because it allows to the assignor an immediate cash-flow return (usually they are once-off lump payments), in contrast with licence agreements that usually are settled on the basis of periodic payments of royalties. In addition, the assignor has no longer responsibilities or risks related to the management of the IPR, because the ownership is completely transferred to the buyer; this means that it shows also an inferior risk respect to the previous tool.

Another mechanism used to transfer knowledge and commercialise intellectual properties rights are the Spin-offs, that are "separate companies established/bought in order to bring to the market some technologies developed by a parent organisation" (European Commission, 2013, p.6). This is viewed as a good alternative to the previous two options; in this case, the main reason to start a spin-off is to create a specific mediator between the research environment and the industries in order to commercially exploit intangible assets and create new economic value. This option is preferred when the technology is at an early stage of development or when the commitment and personality of the actors that will manage the spin-off are particularly incentivizing.

In all the options selected to transfer knowledge and IPRs, the risk of commercialisation is another aspect that must be considered. The impact of the commercialisation risk varies according to the commercialisation tool selected, to the nature of the IPR and to the underlying arrangement.

The evaluation of commercialisation risks must be undertaken before to start a similar process in order to avoid the possibility of disclosing confidential information with another economic player, maybe a potential competitor, without managing to conclude the deal.

1.5 Empirical evidence across regions

In this section it is provided a brief overview of some empirical results that are widespread in literature regarding the different findings obtained when studying the role of IPRs at regional level.

This analysis is important when considering the concept of "interregional heterogeneity", indicating the fact that no two regions are identical; they differ along socioeconomic, political, structural and institutional lines (Rodríguez-Pose and Wilkie, 2018, p.5). In practice, these differences can relate with several factors of innovation capacity that, according to Rodríguez-Pose and Wilkie, include: the supply and quality of human capital (Crescenzi, 2005), the skills composition of labour workforce (Storper and Scott, 2009), the agglomeration of economic activity and the knowledge-related externalities (Duranton and Puga, 2004), the capacity to absorb non-local knowledge (Bathelt, Malmberg and Maskell, 2004) and local institutions and their quality (Rodríguez-Pose and Di Cataldo, 2015). Thus, there are significant differences among the factors that affect innovation depending on the context in which this process takes place; from this assumption it is not surprising that regions will tend to show also different results in many areas, including the innovation field.

For what concerns patents as outputs of innovation, Rodríguez-Pose and Wilkie (2018) argue that a crucial role as determinant of innovation is played by R&D expenditure. According to them, this is the "natural input" of the innovation processes for what concerns patents and also the only one for which there are reliable and comparable data at regional level. Nevertheless, they also sustain that R&D investments are strictly linked with the "generation and absorption of economically useful knowledge" (Audretsch and Feldman, 2004). The peculiarity of the work carried out by Rodríguez-Pose and Wilkie is that they consider not only R&D expenditure as a whole, but they also differ among R&D in business enterprise, R&D in higher education and R&D in government sector. This decision is taken because each sub-category of R&D expenditure is considered to be an indicator of a particular kind of innovation: business R&D is more suitable to explain the generation of new goods and services or higher quality of outputs and production processes (Guellec and Van Pottelsberghe de la Potterie, 2004, p.355); Instead higher education and government R&D are more linked with scientific and basic knowledge or with the expansion of the stock of knowledge available for society (Guellec and Van Pottelsberghe de la Potterie, 2004, p.356). The result of their work was that only business and higher education R&D expenditure are statistically significantly linked to regional innovative output in terms of patent applications.

From the work of Rodríguez-Pose and Wilkie there are also econometric inferences regarding the positive correlation emerging between regional patenting activity and the availability of skilled human capital (tertiary educational attainment), the population density and the youthfulness of population. According to them, the unemployment rate does not play any significant role in this examination.

The same outcomes are substantially confirmed by a previous study carried out by Crescenzi, Rodríguez-Pose and Storper in 2007. In this work they performed a similar analysis and obtained the following econometric evidence for what concerns Europe: the extent of patenting activity relies on the R&D inputs, on socio-economic environments and on the attraction and availability of highly skilled workforce. In addition, in this work resulted to be relevant also the proximity to other innovative areas and the capacity to assimilate and transform inter-regional knowledge spillovers into innovation (Crescenzi, Rodríguez-Pose and Storper, 2007, p.703).

For what concerns trademarks, one important reference is the study carried out by Brahem, El Harbi and Grolleau in 2013. They performed some empirical and econometric analysis to investigate the factors that determine the registrations of trademarks for what concerns clothing industries in Tunisia, thus referring to a low-tech sector. The outcome obtained by this work is that trademark registrations are influenced by: the level of market-diversification of the firms, the degree and the predisposition of companies toward product innovation, the amount of investments made by companies in advertising, the investment made in increasing the quality of the offered products and also by the willingness to face financial risks.

Another relevant study is the one performed by Webster and Hensen in 2004. They conducted a research on the factors that stimulate companies to register a trademark. Among the economic factors influencing the registration of trademarks they included: the growth of per-capita GDP, that resulted to be significant in their econometric regressions; the explanation behind this result is that when the population becomes wealthier, there is a demand shift and firms respond to this changes through product differentiation; one of the most important way to conquer product differentiation is by registering trademarks through which the company signals to consumers the distinction of its products respect to the competitors 'ones. They obtained significance also for what concerns a variable indicating the predisposition of economic sectors for product imitation; the explanation they provide is that when there are higher possibilities for a product or a service to be imitated, it arises the necessity for companies to emerge from the competitors and it is possible to achieve so through trademarks. For what concerns the role of R&D expenditure Webster and Hensen did not propose a unique point of view; for example, they quoted Allegrezza and Guard-Rauch (1999) that sustained a positive correlation between trademarks and R&D expenditures. But they also cited Loundes and Rogers (2003) that sustained a negative correlation among these two variables; in this second case, the explanation has to do with the fact that companies invest in R&D in the early stages of innovation while instead trademarks are usually registered at the end of the innovation cycle, once a product/service has been launched and proven in the market (Webster and Hensen, 2004).

Among the factors influencing the registration of trademarks, Webster and Hensen also collocated the strong increase of service marks. Indeed, they argued that the industries driving the development of trademarking activity are perdonminantely service-based. With the expansion of the service sector, the result was that trademark registrations related to services were much stronger than the registrations of goods trademarks (Webster and Hensen, 2004).

For what concerns designs, it seems to exist a lack of sources in the literature regarding the factors that determine the trend of this IPR. Indeed, the vast majority of literature documents including designs, consider them in the role of “explanatory variables” in order to study their impact in influencing other variables.

CHAPTER 2. PROFILE OF EU-14 REGIONS IN TERMS OF IPRs

This chapter, analyses the IPRs profile of the EU-14 regions. These regions belong to the following countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and Sweden. The codification of EU-14 regions is available in Table B (Appendix).

Investigating and evaluating the innovation profile of European regions is crucial because, as stressed in the previous chapter, it seems to exist a significant linkage between the degree of innovation and the extent of economic growth both across countries and regions. Indeed, in recent decades both scholars and policy-makers reserved particular attention to the analysis of IPRs and their macroeconomic effects.

This examination is necessary because among the papers, works and studies regarding the linkage between innovation and economic development, it is appreciable a certain variability of conclusions. Table C (Appendix) contains a resume of the different results about this topic.

Summing up, IPRs are widely believed to play a crucial role in encouraging innovation, fostering technological process and stimulating economic growth (Barro and Sala-i-Martin, 2004). This general conclusion is mainly due to the fact that IPRs are considered the most efficient tools to manage the relationship between creators and consumers, allowing the latter to exploit the benefit of innovations and, in the meanwhile, reward and protect creators for their ideas.

If the importance of IPRs is widely sustained by academics, the majority of them also support the idea that IPRs are not equally effective in any country, region and in any kind of surrounding environment.

Among the others, Chu, Cozzi and Galli (2014) conclude that the effects of IPRs on the economy is stage-dependent. They have shown that at an early development stage, it could be optimal for national governments to weaken IPRs protection in order to reduce the barriers for the transfer of knowledge and consequently promote imitation from foreign agents. Instead, in more advanced development stages, national government tend to reinforce IPRs protection in order to preserve national inventors and intensify domestic innovation.

With that been said, it is possible to say that there is a positive and direct impact of IPRs on innovation and consequently economic growth, but the scope and the magnitude of this impact are strongly influenced by structural characteristics, development level and openness of the analysed economies (Neves, Afonso, Silva and Sochirca, 2021).

To strengthen this theoretical concept, it is useful to mention the fact that the most innovative countries and the most innovative firms turned out to have performed better during the 2008 economic crisis (Archibugi et al., 2013; Archibugi and

Filippetti, 2011). This is a clear example of how innovation is able to influence and determine the economic performances of a country, a region or a certain company.

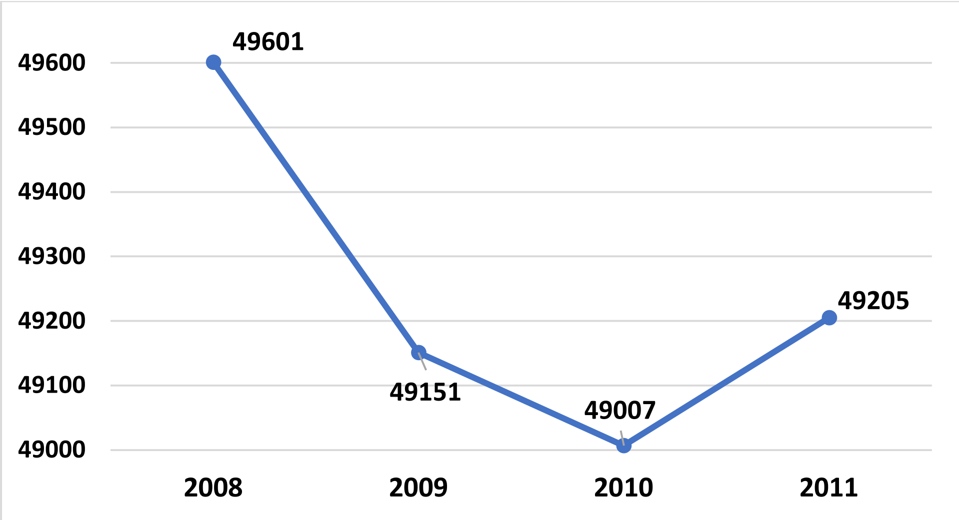
2.1 <u>Trends in Patents, Trademarks and Designs</u>

This section focuses on the evolution of the three considered IPRs during the period ranging between 2008 and 2014. The analysis will show the different patterns of change affecting patents, trademarks and designs with the purpose of providing a general overview of the IPRs environment in western Europe.

This analysis is carried out by using the Eurostat database; it is important to specify that even if the considered period is 2008-2014, data for patents are only available for the period 2008-2011. It is also important to point out an important distinction about the data used in this thesis: when speaking about patents, reference is made to patent applications; instead, when speaking about trademarks or designs, reference is made to their registrations.

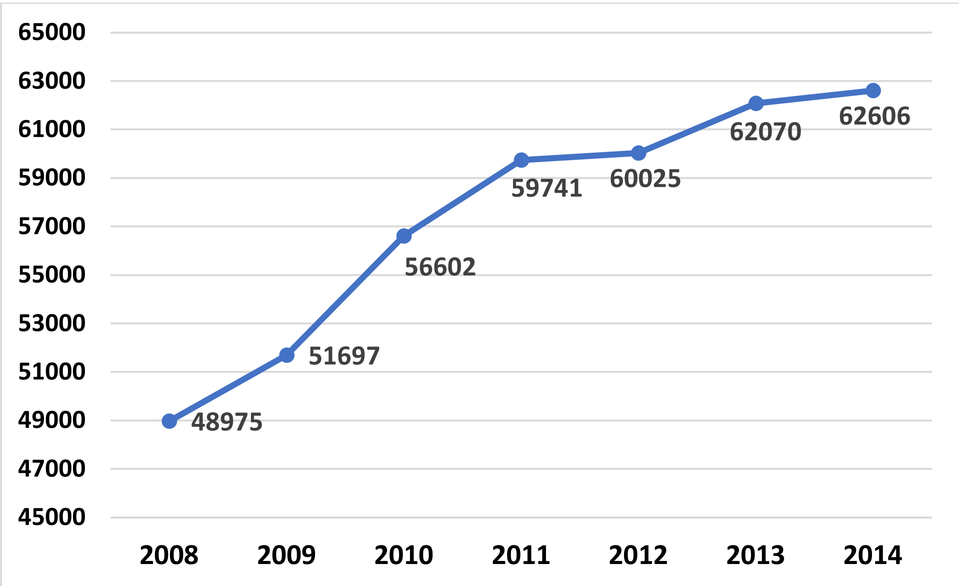
The following figures show the general trend of the three IPRs when considering all the registrations carried out in all the 14 countries. This general overview allows to understand the basic performance of patents, trademarks and designs in the considered period.

Figure 1: Patent applications in EU-14 for the period 2008-2011



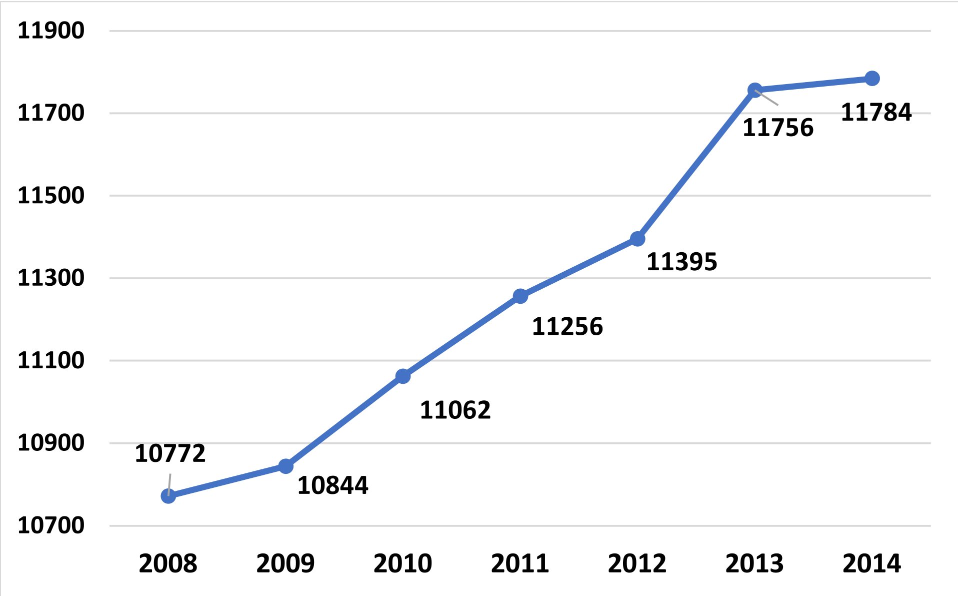
Source: Author's elaboration using the Eurostat Database

Figure 2: Trademark registrations in EU-14 for the period 2008-2014



Source: Author's elaboration using the Eurostat Database

Figure 3: Design registrations in EU-14 for the period 2008-2014



Source: Author's elaboration using the Eurostat Database

From the previous figures it is possible to appreciate the different trend existing between the considered IPRs when analysing the whole EU-14 as a unit.

The performance of patents is the only one that marked a slightly negative trend for the considered period (2008-2011), with a compound annual growth rate (CAGR) of -0,2 % for the same period.

The CAGR is calculated by dividing the number of applications/registration of the last reference year by the number of the first reference year; then this result is elevated to one divided by the number of years of the considered period; this second result is diminished by one and expressed in percentage format.

This result suggests that patents were the IPR that most suffered the impact of the economic crisis, although a certain recovery is appreciable already in 2011.
Instead, trademarks' performance was the one that registered the best outcome with a CAGR of +3,57 % for the period 2008-2014. It is visible from the figure that the number of trademark registrations increased constantly during the considered period (2008-2014), result that probably suggests a crucial change in the utilization of this kind of IPR at an international level.
Also for what concerns designs it is visible a positive trend with a CAGR of +1,26% for the considered period (2008-2014). As in the case of trademarks, also for designs it is appreciable a continuous increase even if with a lower growth rate.

2.2 Concentration of Innovation among EU regions – Absolute Dimension

This paragraph shifts the focus to the "regional level", meaning that each European region is now considered as a unit.
In this case, Table 2 represents a picture of the ten best performers when considering the absolute number of patents applications for each region. The table also indicates the portion of total applications covered by each performer and also the cumulative impact of the ten best performers respect to the totality.
As it is visible, the top performers are exactly the same both in 2008 and in 2011 with limited changes in the order. The best performer is Ile de France (France) but

there is an important presence of German regions (6 out of 10). The only Italian region is Lombardia which classified seventh in 2008 and ninth in 2011.

Table 2: Cumulative percentage of patent applications covered by the best ten performing regions in 2008 and 2011.

2008	Region	Share over the total	Cumulative % covered
1°	Ile de France	6,38%	*6,38%*
2°	Oberbayern	4,91%	*11,29%*
3°	Stuttgart	4,81%	*16,10%*
4°	Rhône-Alpes	3,34%	*19,44%*
5°	Noord-Brabant	3,06%	*22,50%*
6°	Düsseldorf	2,89%	*25,39%*
7°	Lombardia	2,76%	*28,15%*
8°	Darmstadt	2,66%	*30,81%*
9°	Karlsruhe	2,59%	*33,41%*
10°	Köln	2,42%	*35,82%*
2011	**Region**	**Share over the total**	**Cumulative % covered**
1°	*Ile de France*	6,14%	*6,14%*
2°	*Stuttgart*	4,83%	*10,97%*
3°	*Oberbayern*	4,81%	*15,78%*
4°	Rhône-Alpes	3,63%	*19,40%*
5°	Noord-Brabant	3,32%	*22,72%*
6°	Darmstadt	2,71%	*25,43%*
7°	Düsseldorf	2,71%	*28,14%*
8°	Karlsruhe	2,60%	*30,74%*
9°	Lombardia	2,47%	*33,20%*
10°	Köln	2,24%	*35,45%*

Source: Author’s elaboration using the Eurostat Database

The following table exhibits the same analysis carried out for trademarks, considering 2008, 2011 and 2014 as reference years. In contrast with the previous situation, for trademarks it is possible to appreciate a certain degree of heterogeneity when comparing the ten best performers in the different reference years.

Table 3: Cumulative percentage of trademark registrations covered by the best ten performing regions in 2008, 2011 and 2014.

2008	Region	Share over the total	Cumulative % covered
1°	Oberösterreich	6,10%	*6,10%*
2°	P. Aut. Trento	4,88%	*10,98%*
3°	Dytiki Ellada	4,13%	*15,11%*
4°	Campania	3,59%	*18,70%*
5°	Åland	3,33%	*22,02%*
6°	Östra Mellansverige	2,72%	*24,74%*
7°	Oberfranken	2,39%	*27,13%*
8°	Iles Balears	2,28%	*29,42%*
9°	Lazio	2,26%	*31,68%*
10°	Umbria	2,23%	*33,91%*
2011	**Region**	**Share over the total**	**Cumulative % covered**
1°	Ile de France	6,12%	*6,12%*
2°	Oberbayern	4,02%	*10,13%*
3°	Lombardia	3,94%	*14,08%*
4°	Cataluña	3,75%	*17,82%*
5°	Com. de Madrid	3,03%	*20,85%*
6°	Düsseldorf	2,75%	*23,60%*
7°	Darmstadt	2,25%	*25,86%*
8°	Stuttgart	2,18%	*28,04%*
9°	Köln	2,04%	*30,08%*
10°	Luxembourg	1,93%	*32,01%*
2014	**Region**	**Share over the total**	**Cumulative % covered**
1°	Ile de France	5,72%	*5,72%*
2°	Lombardia	4,13%	*9,86%*
3°	Cataluña	4,06%	*13,92%*
4°	Oberbayern	3,65%	*17,57%*
5°	Com. de Madrid	3,20%	*20,78%*
6°	Düsseldorf	2,41%	*23,19%*
7°	Luxembourg	2,12%	*25,31%*
8°	Berlin	2,10%	*27,41%*
9°	Veneto	2,05%	*29,46%*
10°	Stuttgart	2,01%	*31,47%*

Source: Author's elaboration using the Eurostat Database

In 2008 the best performer is Oberösterreich (Austria). Nevertheless, in the same year it is appreciable the "predominance" of Italian regions with four positions out of ten: Prov. Autonoma di Trento, Campania, Lazio and Umbria.

In 2011 the best performer is Ile de France (France). In this instance the Italian predominance is substituted by a wide presence of German regions (5 out of 10); the only Italian region is Lombardia that was not present among the ten best performers in the previous period.

In 2014 the best performer is again Ile de France. The German predominance seems to persist (4 out of 10); for what concerns Italy, in 2014 Lombardia and Veneto are both among the top ten performers, placing respectively second and ninth.

The following table reports the developing patterns for what concerns design registrations in 2008, 2011 and 2014.

Table 4: Cumulative percentage of design registrations covered by the best ten performing regions in 2008, 2011 and 2014.

2008	Region	Share over the total	Cumulative % covered
1°	Ile de France	5,42%	*5,42%*
2°	Lombardia	4,67%	*10,09%*
3°	Stuttgart	3,90%	*13,99%*
4°	Cataluña	3,19%	*17,18%*
5°	Veneto	3,16%	*20,35%*
6°	Oberbayern	3,05%	*23,39%*
7°	Arnsberg	2,70%	*26,10%*
8°	Rhône-Alpes	2,39%	*28,49%*
9°	Düsseldorf	2,34%	*30,82%*
10°	Com. Valenciana	2,21%	*33,04%*

2011	Region	Share over the total	Cumulative % covered
1°	Ile de France	5,85%	*5,85%*
2°	Lombardia	4,53%	*10,38%*
3°	Cataluña	3,13%	*13,50%*
4°	Stuttgart	3,12%	*16,62%*
5°	Oberbayern	3,10%	*19,72%*
6°	Veneto	2,98%	*22,70%*
7°	Düsseldorf	2,47%	*25,17%*
8°	Noord-Brabant	2,38%	*27,55%*
9°	Emilia-Romagna	2,31%	*29,86%*
10°	Arnsberg	2,13%	*31,99%*
2014	**Region**	**Share over the total**	**Cumulative % covered**
1°	Ile de France	5,74%	*5,74%*
2°	Lombardia	4,16%	*9,90%*
3°	Stuttgart	3,54%	*13,45%*
4°	Oberbayern	3,03%	*16,48%*
5°	Veneto	3,02%	*19,50%*
6°	Emilia-Romagna	2,36%	*21,87%*
7°	Cataluña	2,27%	*24,14%*
8°	Com. Valenciana	2,05%	*26,19%*
9°	Düsseldorf	2,04%	*28,22%*
10°	Noord-Brabant	1,99%	*30,22%*

Source: Author's elaboration using the Eurostat Database

In this situation the first reference year is characterized by the preponderance of German regions (4 out of 10), together with Italian regions (Lombardia and Veneto) and Spanish regions. Nevertheless, in 2008 the best performer was again Ile de France. Moving from 2008 to 2011 the situation remains pretty much similar, with the same best performer and a vast presence of German regions followed by three Italian regions: Lombardia, Veneto and Emilia Romagna.

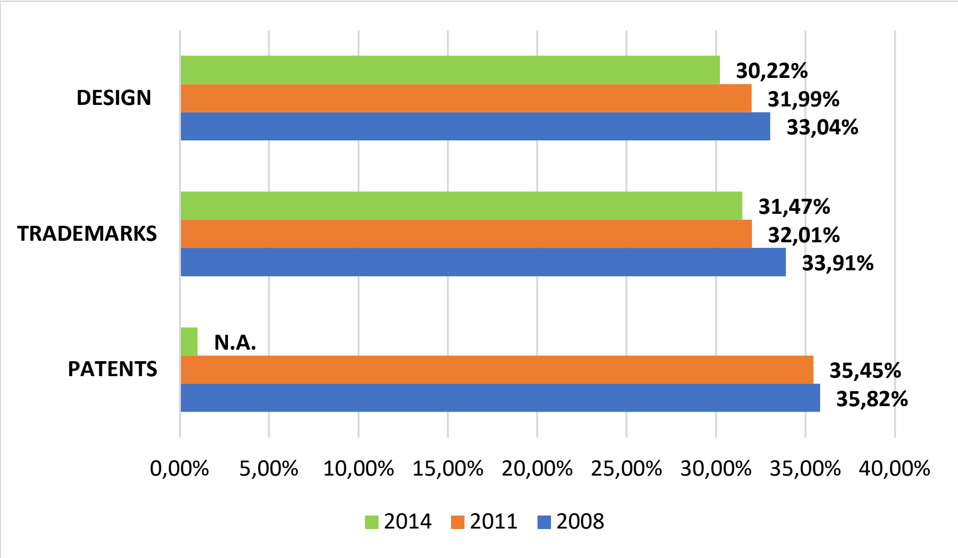
In 2014 the best performer is again Ile de France, with the remaining best regions distributed among Germany, Spain and Italy. In the latter country Lombardia managed to reach the second position, Veneto ranked fifth and Emilia Romagna classified sixth.

The following figure presents the cumulative impact over the total amount of each IPR covered by the first ten performing regions in each reference year.

As it is visible, patents seem to be the IPR with the highest concentration among the best performers; indeed, the first ten regions reported almost the 35% of the total patent applications both in 2008 and 2011. For what concerns the other two IPRs the ten best performers registered a lower impact over the total, around 33% in both cases.

Another significant observation is that, moving from 2008 to the following reference years, the cumulative impact of the best performers gradually diminishes. This means that, in the considered period, the concentration among the best reduces in favour of a more equitable distribution of the IPRs registrations/applications among regions.

Figure 4: Overview of the cumulative percentage covered by the first ten regions for each IPR



Source: Author's elaboration using the Eurostat Database

2.3 <u>Concentration of Innovation among EU regions – Relative Dimension</u>

This section deepens the analysis of the development of IPRs at a regional level by considering at the same time two variables: the first one is the intensity per million people of each IPR in the final year. It is the total amount of IPR registered/applied in a certain region divided by the total population of that region in millions. The second variable is the growth of the IPR intensity during the whole considered period, obtained through the compound annual growth rate (*CAGR*), calculated as explained in the previous section. The purpose of this examination is to consider both a static variable as expression of a single year (the final one) and a dynamic variable as expression of the variation occurred during the considered period. This is the reason why in the following tables are reported both the ranking "A", related to the IPR's intensity in the final year, and the ranking "B", related to its growth during the period. The final ranking is composed by the best performing regions in terms of both rankings.

The following table shows the situation for patent applications.

Table 5: Best performing regions considering simultaneously their patent intensity in 2011 and the growth of patent intensity over the period 2008-2011

Region	Patent Intensity	Rank (A)	Patent Intensity Growth	Rank (B)	Final Rank
Vorarlberg	716	**1°**	6,47%	**19°**	**1°**
Midtjylland	335	**17°**	10,30%	**12°**	**2°**
Oberpfalz	472	**8°**	4,63%	**30°**	**3°**
Åland	202	**39°**	82,09%	**1°**	**4°**
Limburg	247	**30°**	6,65%	**18°**	**5°**
Oberösterreich	288	**22°**	4,98%	**27°**	**6°**
Friuli-Venezia Giulia	200	**40°**	8,87%	**13°**	**7°**
Noord-Brabant	665	**2°**	1,51%	**54°**	**8°**
Mittelfranken	573	**4°**	1,58%	**52°**	**9°**
Prov. Vlaams-Brabant	265	**25°**	3,77%	**31°**	**10°**

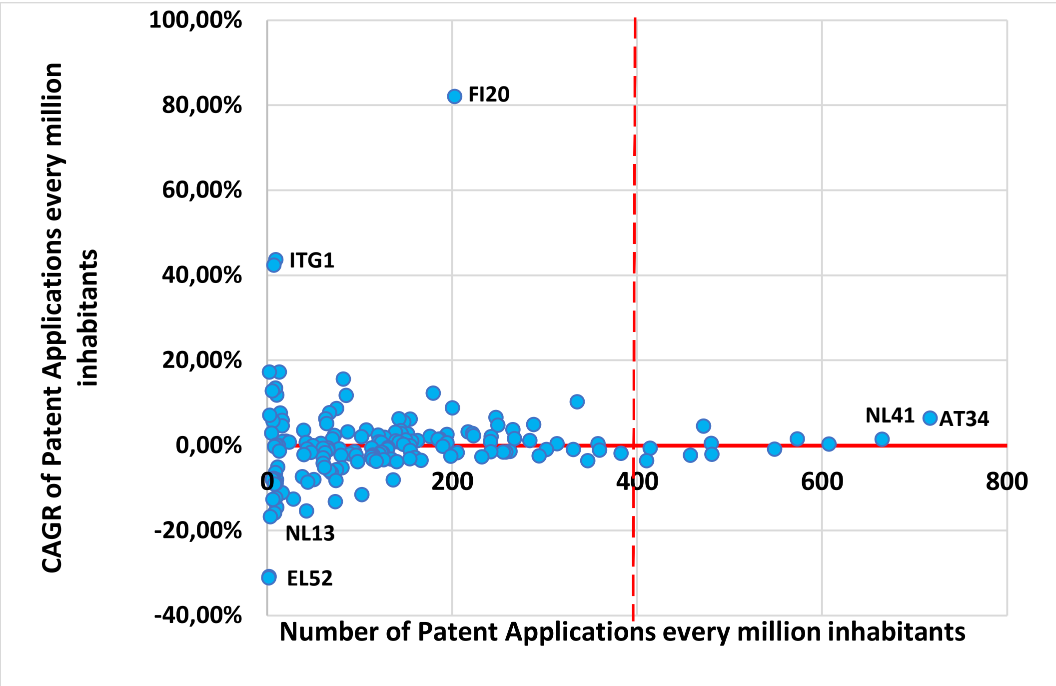
Source: Author's elaboration using the Eurostat Database

As it is visible, in this case the situation is characterized by a certain degree of heterogeneity with regions belonging to seven different countries that managed to enter this classification.

The best performer of this classification is Vorarlberg (Austria) especially thanks to its first position in terms of patent intensity (Rank A). Instead, in terms of growth of patent intensity during the period 2008-2011, the best performer is Åland (Finland) with a massive increase of around +82 %; this region placed fourth in the overall rank. Italy registers one region only, Friuli Venezia Giulia which manages to rank seventh.

Figure 5 describes the distribution of the whole sample of regions on a graph obtained by considering the number of patent applications every million inhabitants (Patent intensity) on the X-axis and the CAGR of patent intensity on the Y-axis. Each blue-dot represents one region.

Figure 5: Distribution of regions according to their patent intensity in 2011 and the growth rate of the same variable during the period 2008-2011



Source: Author's elaboration using the Eurostat Database

For what concerns the X-Axis, almost the totality of the regions is concentrated in the left section of the graphic, corresponding to a situation with a patent intensity lower than 400. This graphical result is sustained by the fact that the average patent intensity in 2011 is 143. On the other hand, when focusing on the Y-Axis, the situation seems to be equally distributed: the majority of the regions registered a negative CAGR of patent intensity for the period 2008-2011 (51%) resulting in the bottom-left quadrant, while the other half of the sample showed a positive CAGR and placed in the top-left quadrant. This substantial balance is supported by the fact that the average CAGR of Patent Applications for the period 2008-2012 is -0,2%.
The worst outcome in this case is represented by Ipeiros (Greece) which registered a patent intensity of 1 in 2011 and a CAGR of patent intensity for the period 2008-2011 of -31,06%. As said before, the unit with the highest CAGR is Åland, followed by Molise with a CAGR of +43,74%.
Only few regions are located in the right section; here particular attention must be paid to Vorarlberg (Austria) which records the highest patent intensity in 2011 with the huge result of 716 followed by Noord-Brabant (Netherlands) with a patent intensity of 665 in 2011.

The same analysis is carried out for trademarks, taking into account both the trademark intensity in 2014 and its CAGR for the period 2008-2014.

Table 6 reports the best ten performers when considering the previous two variables at the same time.

In this case, the best performing regions are concentrated in Austria, followed by Germany and Italy that reported two regions each. In particular, Italy enters the classification with Prov. Autonoma di Bolzano that classified first and Valle d'Aosta that ranked second.

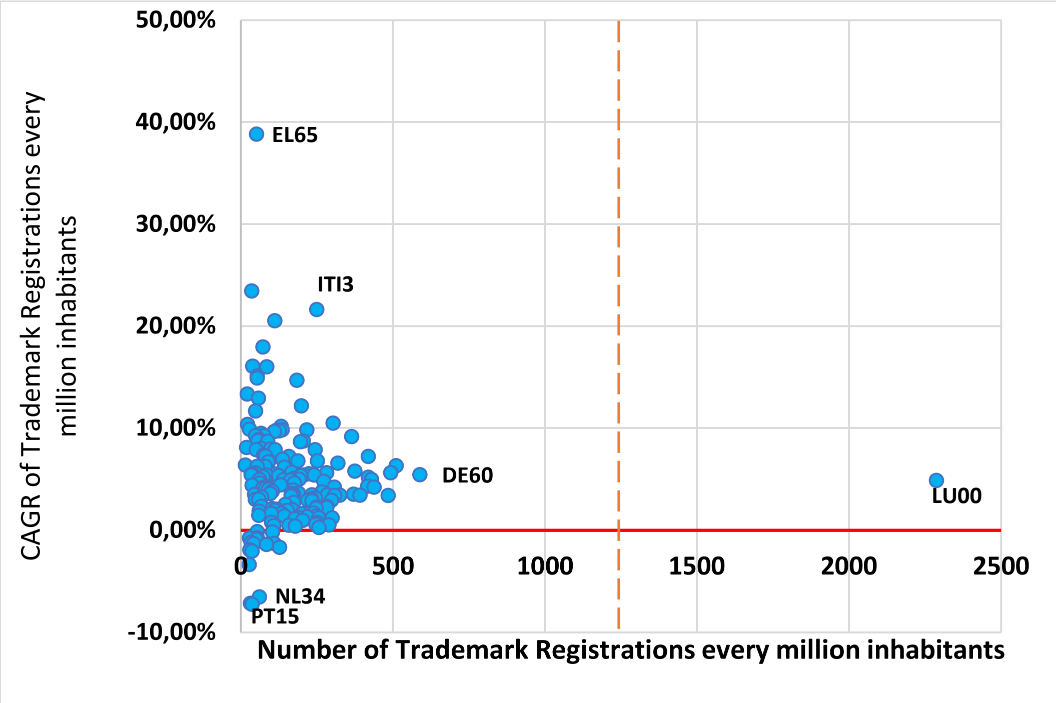
Table 6: Best performing regions considering simultaneously their trademark intensity in 2014 and the growth of trademark intensity over the period 2008-2014

Regions	Trademark Intensity	Rank (A)	Trademark Intensity Growth	Rank (B)	Final Rank
P. Aut. Bolzano	302	**20°**	10,48%	**15°**	**1°**
Valle d'Aosta	249	**35°**	21,61%	**3°**	**2°**
Berlin	364	**15°**	9,18%	**27°**	**3°**
Åland	419	**9°**	7,23%	**41°**	**4°**
Stockholm	510	**4°**	6,32%	**49°**	**5°**
Salzburg	492	**5°**	5,62%	**57°**	**6°**
Hamburg	588	**2°**	5,44%	**62°**	**7°**
Oberösterreich	319	**17°**	6,57%	**47°**	**8°**
Tirol	374	**13°**	5,79%	**53°**	**9°**
Murcia	216	**48°**	9,84%	**19°**	**10°**

Source: Author's elaboration using the Eurostat Database

Figure 6 exhibits the distribution of regions considering on the X-axis the number of trademark registrations every million inhabitants in 2014 and the CAGR of trademark intensity over the period 2008-2014.

Figure 6: Distribution of regions according to their trademark intensity in 2014 and the growth rate of the same variable during the period 2008-2014



Source: Author’s elaboration using the Eurostat Database

Similarly to what has been found for patents, also the previous figure detects a very high degree of regions concentration in the left section of the chart. Nevertheless, in contrast with the patent situation, the majority of the regions are placed in the top-left quadrant, above the X-axis. This suggests that almost the totality of the considered regions (91%) registered a positive CAGR of trademark intensity during the period 2008-2014. This graphical result is confirmed by the fact that the average CAGR of trademark registrations of the entire EU-14 was +3,57%, making trademarks the IPR that grew more in the considered period (2008-2014). Instead, the average trademark intensity in 2014 for the EU-14 was 173.

The worst performer in this case is Algarve (Portugal) which exhibits a trademark intensity of 36 and a CAGR of the same variable for the period 2008-2014 of -7,27%. The best performer in terms of CAGR of trademark intensity is Voreio Aigaio (Greece) which recorded a +38,81% in the considered period. Instead, the best performer in terms of trademark intensity is Luxembourg with a huge result of 2287. In this case, it is important to take into account the size of Luxembourg, in terms of its restricted population, that facilitates similar outcomes when speaking about relative-data calculations. Anyway, it is interesting to specify that neither Luxembourg or Voreio Aigaio entered the top ten classification because both did not have a very high performance in one of the two considered variables.

The following table completes the analysis for what concerns design registrations. In this case the final rank is characterized by a strong presence of Austrian regions (3 out of 10), similar to the findings obtained for trademarks. Also, a significant presence is registered for Belgium and Italy with two regions each. The latter, enters the top ten classification with Umbria that ranked second and Emilia Romagna that classified eighth.

Table 7: Best performing regions considering simultaneously their design intensity in 2014 and the growth of design intensity over the period 2008-2014

Regions	Design Intensity	Rank (A)	Design Intensity Growth	Rank (B)	Final Rank
Luxembourg	189	1°	9,02%	15°	**1°**
Umbria	56	29°	27,33%	2°	**2°**
Länsi-Suomi	50	38°	11,79%	8°	**3°**
Tirol	104	2°	4,03%	45°	**4°**
Hamburg	72	17°	5,78%	30°	**5°**
Brabant Wallon	66	21°	6,44%	27°	**6°**
Oberösterreich	96	7°	4,35%	42°	**7°**
Emilia-Romagna	60	25°	6,71%	26°	**8°**
Vlaams-Brabant	47	45°	11,67%	9°	**9°**
Vorarlberg	93	9°	3,35%	49°	**10°**

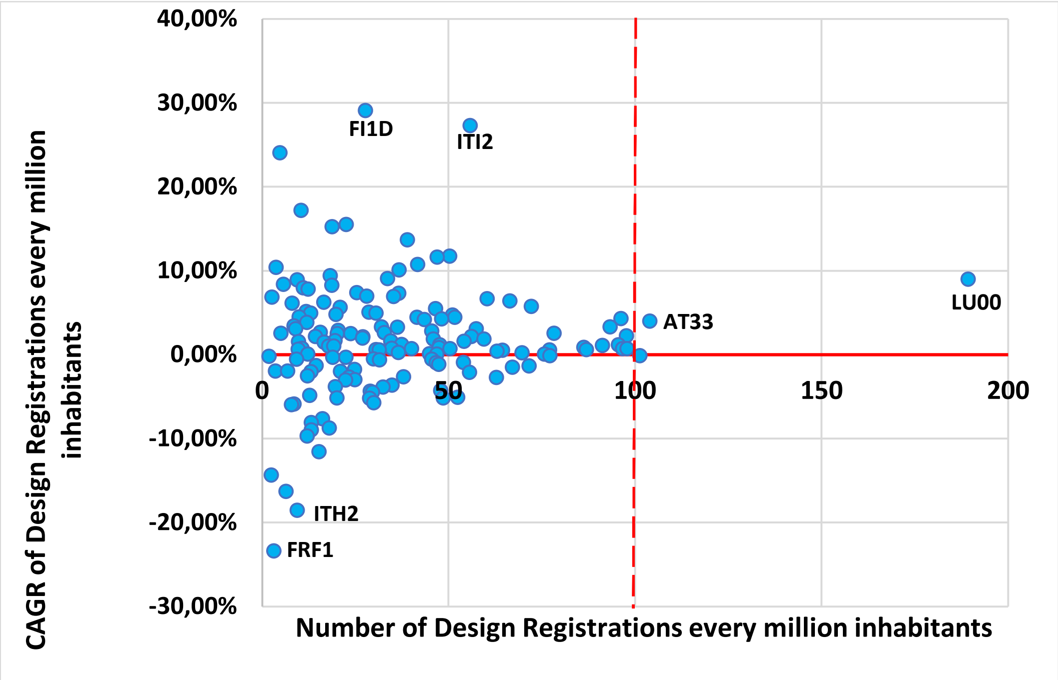
Source: Author's elaboration using the Eurostat Database

Figure 7 represents the distribution of regions considering the number of design registrations every million inhabitants on the X-axis and the CAGR of design intensity for the period 2008-2014 on the Y-axis.

According to this graphical outcome, the situation for designs seems to be the most heterogenous among the three considered IPRs, both in terms of absolute intensity and in terms of CAGR. This means that there is not a high degree of concentration but rather a certain dispersion of regions. The majority of blue-dots are located in the top-left and in the bottom-left quadrant, while only a few regions are distributed in the right side of the graphic; indeed, the average design intensity in 2014 is *36*. Moving to the CAGR of design intensity, the majority of the regions registered a positive trend (66%) and this situation is confirmed by the fact that the design registrations in EU-14 increased by +1,26% in the period 2008-2014.

The worst performer in this scenario is Corse (France) with a design intensity in 2014 of 3 and the lowest CAGR of design intensity corresponding to a -23,35% for the period 2008-2014. The best performer in terms of design intensity is again Luxembourg, as in the trademark situation. Instead, the region that registered the highest increase of design intensity during the period 2008-2014 was Pohjois-ja Itä-Suomi (Finland) with the CAGR of +29,13%.

Figure 7: Distribution of regions according to their design intensity in 2014 and the growth rate of the same variable during the period 2008-2014



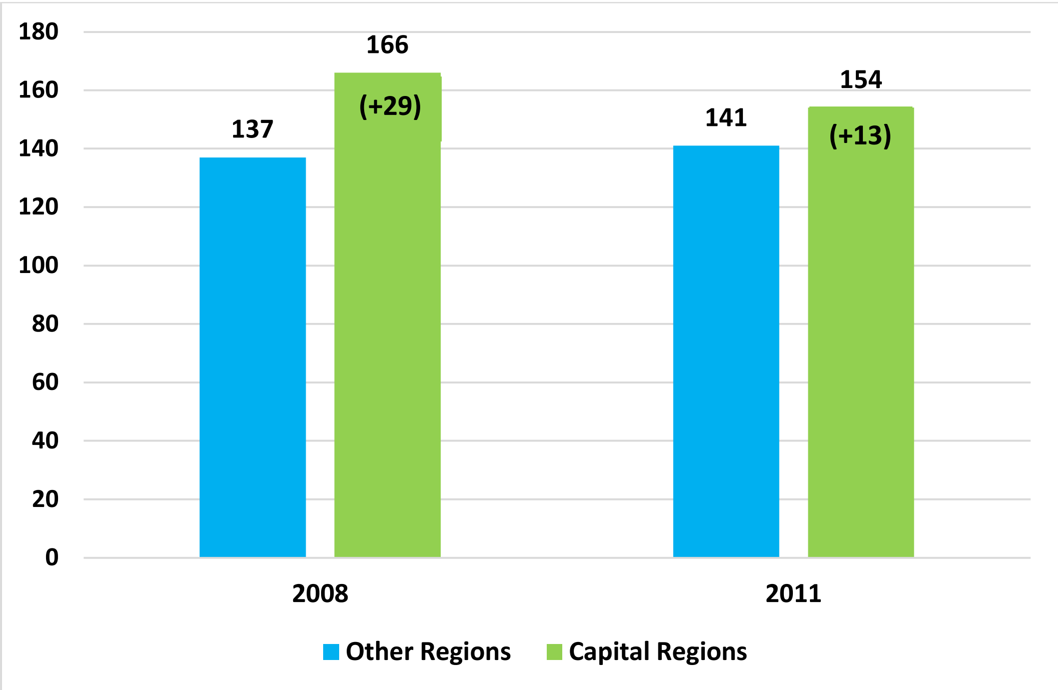
Source: Author’s elaboration using the Eurostat Database

2.4 IPRs in Capital Regions and Other Regions

In the previous section the differences that arise when analysing data in absolute terms or in relative terms have been explained.

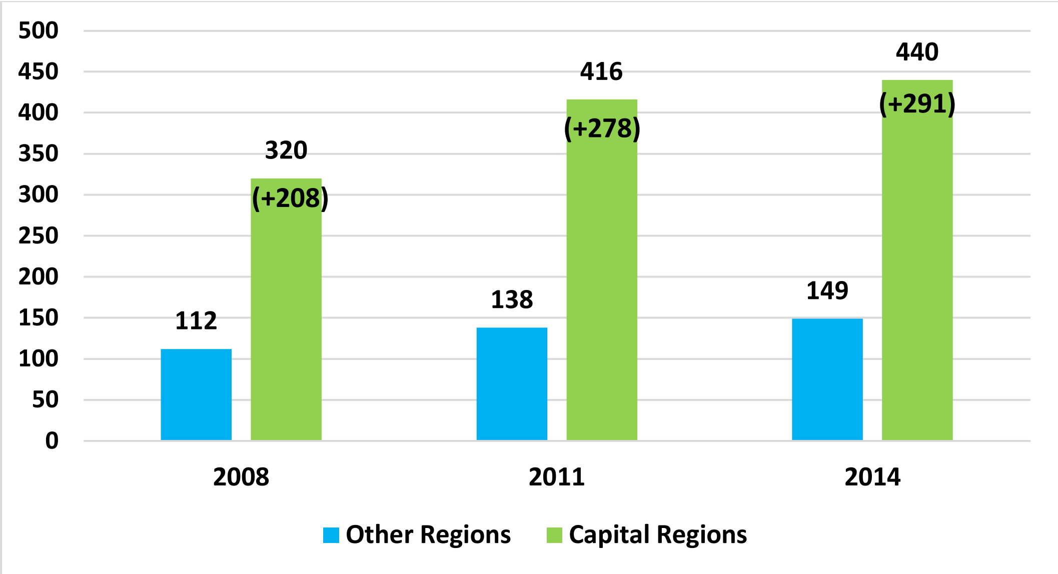
Anyway, it is clear that certain differences do exist when comparing the largest regions with the others. In order to examine this topic, figures 8, 9 and 10 outline the existing differences between the capital regions and the other regions. The capital regions are those regions that include the capital cities of the fourteen European countries considered in this study.

Figure 8: Average patent intensity in capital regions and in other regions



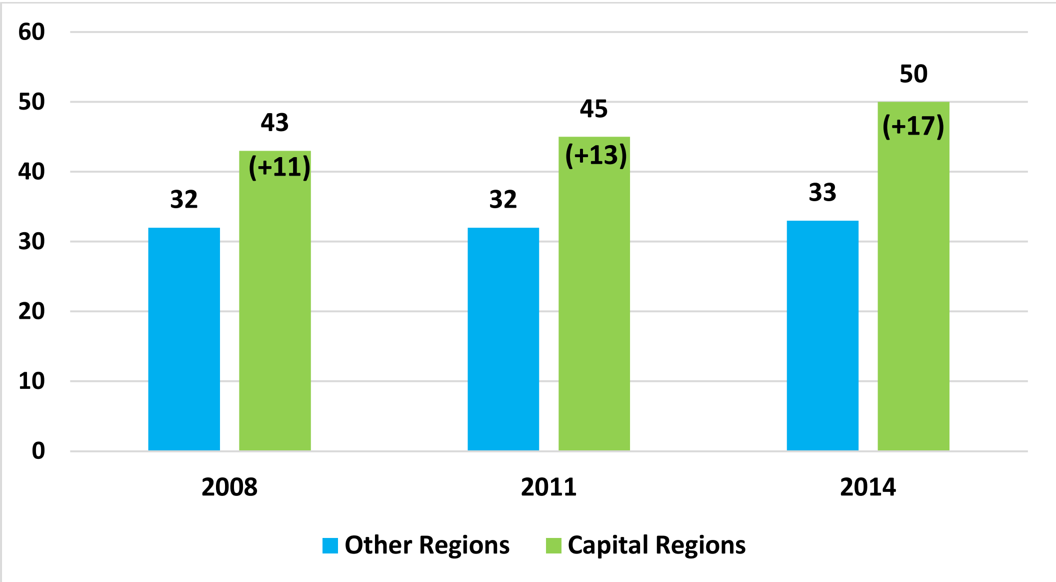
Source: Author's elaboration using the Eurostat Database

Figure 9: Average trademark intensity in capital regions and in other regions



Source: Author's elaboration using the Eurostat Database

Figure 10: Average design intensity in capital regions and in other regions



Source: Author's elaboration using the Eurostat Database

The average IPR intensity was computed by considering at first all the regions except the capital ones and subsequently by considering only the capital regions. The main outcome is that the average IPR intensity registered among the capital regions is higher respect to the one resulting in other regions. This finding is confirmed in each reference year and it is valid for all the three IPRs.

Trademarks are the IPR that exhibit the largest difference between the average intensity in capital regions and the one in other regions. In addition, the gap in terms of average trademark intensity increases during the considered period, passing from an average difference of 208 in 2008 to an average distance of 291 in 2014. This outcome means that moving from 2008 to 2014 the gap existing between the average trademark intensity in capital regions and the one in other regions increased by 10%. The other two IPRs are characterized by less significant distances.

For what concerns designs, also in this case the gap in terms of average design intensity increases during the considered period, passing from an average difference of 11 in 2008 to an average distance of 17 in 2014. In this case, the gap existing between the average design intensity of capital regions and the one of other regions increased by a 16%. When focusing on patents, it is important to point out the fact that this is the only IPR that shows a reduction of its applications recorded in capital regions respect to other regions: moving from 2008 to 2011 the difference existing between the average patent intensity in capital regions and the one in other regions decreased by -12%.

However, this analysis seems to confirm the predominance and the impact of capital regions also in terms of intellectual property rights. These regions are characterized by higher populations, largest dimensions, highest concentration of multinationals and large companies. Also, capital regions are usually characterized by a higher propension to digitalization, technological sectors and advanced communication infrastructure which are elements that make these areas more attractive and more prolific. Therefore, capital cities and capital regions appear to be the economic leaders of countries also in the IPRs environment.

2.5 The changing innovation profiles of European Regions

Analysing the relative performance of regions in terms of IPRs is crucial in order to understand the economical tendency of a certain area; for example: “a region with better patent performances compared to others could be considered as a region more oriented towards technological development and could be considered as a high-tech region” (Filippetti, Gkotsis, Vezzani, Zinilli, 2019 – p.22) or “ a region relatively stronger in trademark is more oriented to the soft kind of knowledge beyond the technological one” (Filippetti, Gkotsis, Vezzani, Zinilli, 2019 – p.22). Therefore, studying and examining the relative outcome of regions in terms of patents, trademarks and designs is useful to map the evolution of regional competences and regional innovation profiles over a certain period of time.

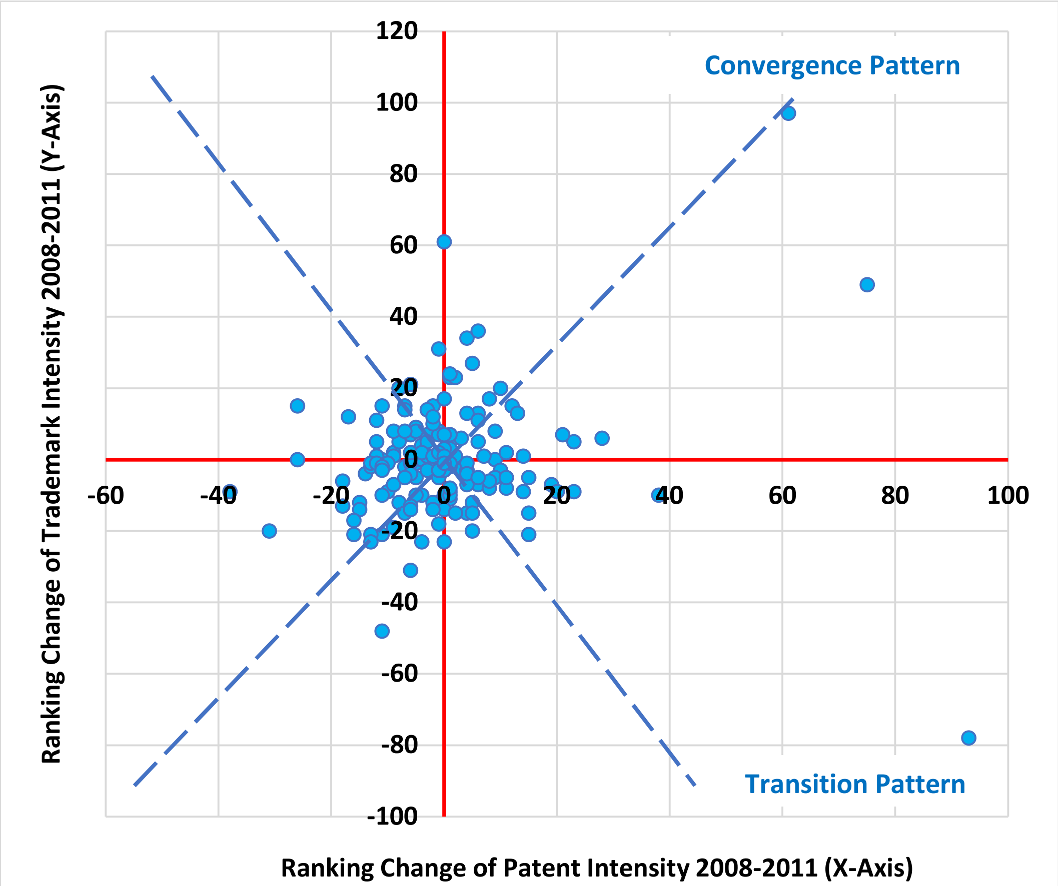
For that purpose, in the following section are proposed three charts showing the evolution of innovation profiles of EU-14 regions in the period 2008-2014. In these charts patent applications, trademark registrations and design registrations are used as indicators to discover the predominant trends of innovation among regions. These three indicators are not considered in their absolute form; indeed, the IPRs' intensities (IPRs' absolute values relativized by the regional population in millions) are used.

The process carried out to obtain these maps is the following: firstly, EU-14 regions were ranked according to their patent intensity, trademark intensity and design intensity for three reference years (2008, 2011 and 2014). After that, the change in the ranking between each reference year was calculated; the outcome of this second step consists of a number, which could be positive or negative, expressing the ranking positions conquered (positive number) or lost (negative number) by each region according to each one of the three indicators. At the end, the change in the ranking for two different indicators are used simultaneously to build the following graphs. By plotting these two variables it is possible to subdivide the regions in four main quadrants: the top-right quadrant indicating a ranking improvement in both the indicators; the bottom-right quadrant indicating a ranking decrease of the indicator on the Y-axis and a ranking improvement of the indicator on the X-axis; the top-left quadrant indicating ranking improvement of the indicator on the Y-axis and a ranking decrease of the indicator on the X-axis and the bottom-left quadrant indicating a ranking decrease in both the indicators.

In addition, the next three graphs are characterized by two oblique lines that represent the two main patterns detectable from this kind of study: a convergence pattern, represented by the oblique line going from the bottom-left quadrant to the top-right quadrant. Along the convergence line (and in the corresponding quadrants) it is possible to find out those regions characterized by a similar trend in terms of both the indicators analysed; these regions improved their performances in both the IPRs intensities or, alternatively, they worsened their performances in both the indicators analysed. A transition pattern, represented by the oblique line going from the bottom-right quadrant to the top-left quadrant. Along the transition line (and in the corresponding quadrants) it is possible to find out those regions which reflect a transition from one IPR to another one, recognizable by the fact that their performances increased for one indicator but decreased for the other one.

Figure 11 represents the graphical outcome obtained by considering on the X-axis the change in the ranking for patent in the period 2008-2011 and on the Y-axis the change in the ranking for trademarks in the same period.

Figure 11: Ranking change for patent intensity and trademark intensity in the period 2008-2011



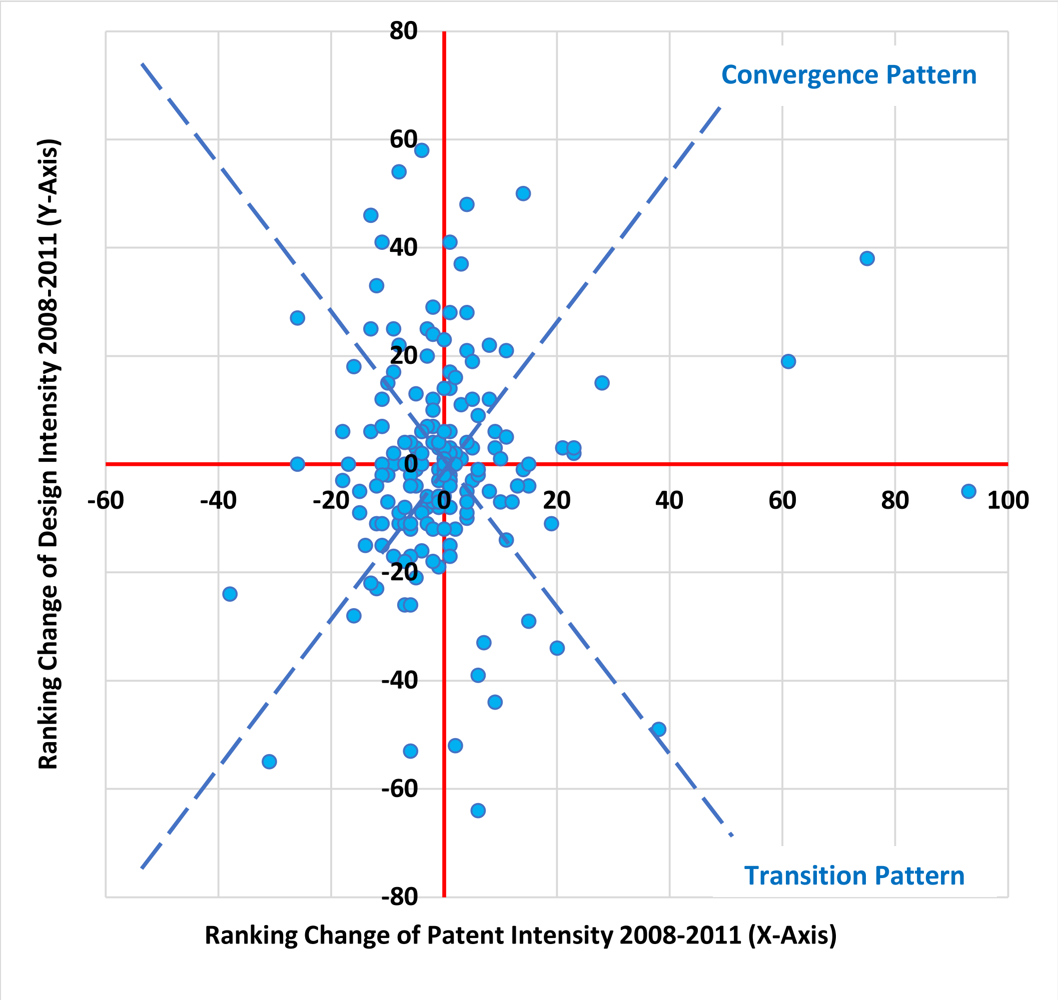
Source: Author's elaboration using the Eurostat Database

Thus, for the period 2008-2011, by analysing together the ranking position change of patents and trademarks, the outcome is that the 51% of regions belong to the convergence pattern while the remaining part belongs to the transition pattern; hence, there is a balanced equilibrium between the two categories. But the most significant observation is that the 56% of the regions belonging to the convergence pattern registered a negative converging trend, worsening their performances both in terms of patent intensity and trademark intensity. This means that these regions decreased and weakened their efforts and investments in innovation for what concerns patent applications and trademark registrations.

Figure 12 shows the graphical scenario obtained by considering on the X-axis the change in the ranking for patent in the period 2008-2011 and on the Y-axis the change in the ranking for design in the same period.

For what concerns the period 2008-2011, by analysing together the ranking position change of patents and designs, the outcome is that there is certain balancing between the two categories, with almost a half of the regions (52%) belonging to the convergence pattern and the remaining part belonging to the transition pattern; as well as the previous situation, an important observation is that in this case the 53% of the regions belonging to the convergence pattern showed a negative converging trend, decreasing their performances both in terms of patent intensity and design intensity. This means that the majority of these regions experienced a collapse of the contribution to the innovation sector, worsening their performances in terms of patents and designs.

Figure 12: Ranking change for patent intensity and design intensity in the period 2008-2011

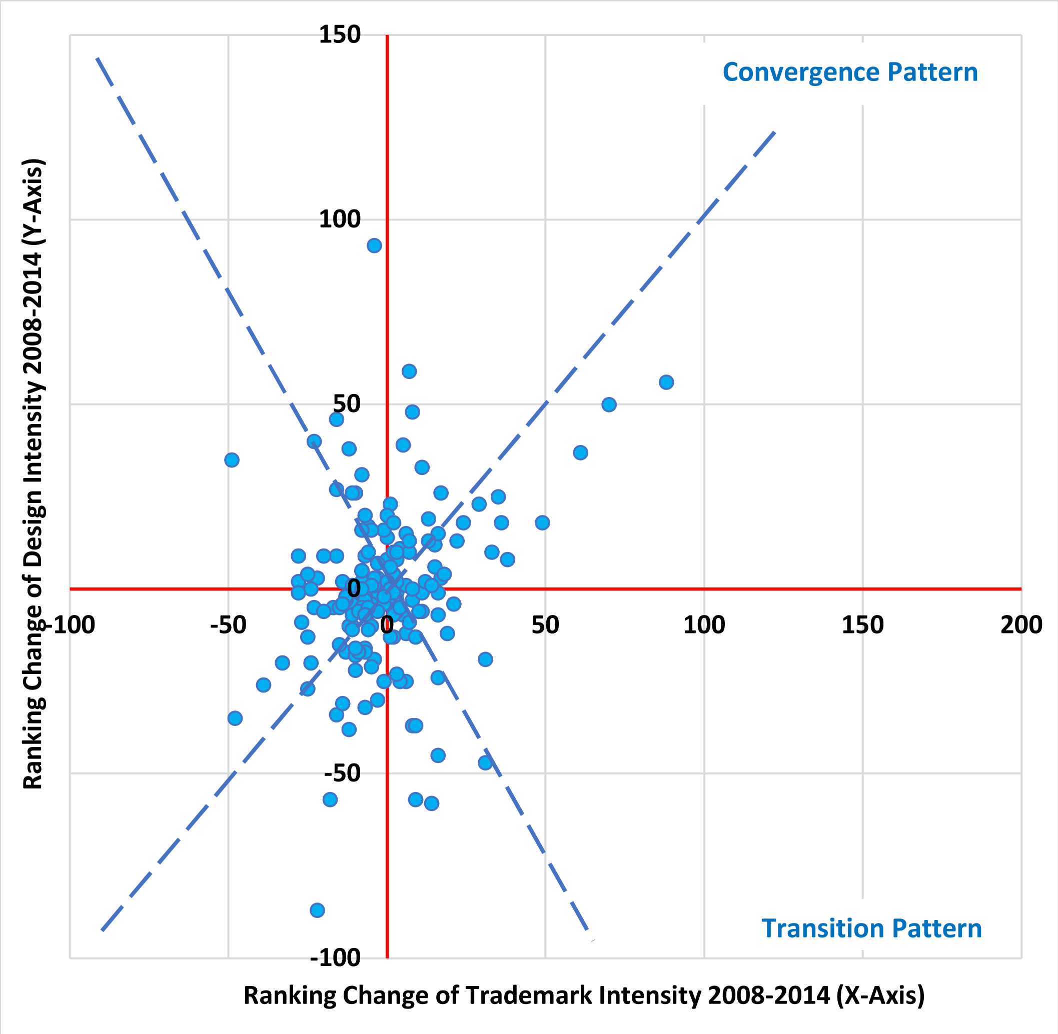


Source: Author's elaboration using the Eurostat Database

Figure 13 provides the graphical result obtained by considering on the X-axis the change in the ranking for trademarks in the period 2008-2014 and on the Y-axis the change in the ranking for designs in the same period. As patents' data for the period

2011-2014 are not available, in this case there is a mutual and direct comparison between trademarks and designs in order to analyse the whole period, instead of using patents as a benchmark-indicator to analyse the different situations.

Figure 13: Ranking change for trademark intensity and design intensity in the period 2008-2014



Source: Author's elaboration using the Eurostat Database

Therefore, for the period 2008-2014, when analysing together the ranking position change of trademark intensity and design intensity, the main outcome is that the 63% of regions belongs to the convergence pattern while the remaining part belongs to the transition pattern; hence, the majority of regional samples registered a converging performance for what concerns the indicators analysed. The first evidence is that when considering the whole period, a larger portion of regions records a convergence pattern indicating a homogeneity of the IPRs management in the long period. The most significant observation in this case is that among the regions belonging to the convergence pattern, the 58% of them reported a negative converging trend. Hence, when focusing on trademarks and designs, the outcome is that the majority of the regions decreased their efforts and investments in this category of innovation also for the period 2008-2014.

From the analysis above it is possible to conclude that over the period 2008-2014, by investigating the innovation profile of European regions a general trend of convergence seems to emerge. This means that the majority of European regions experienced the same development pattern for what concerns the considered IPRs. In addition, this trend seems to reinforce over the long-period (Figure 13). Unfortunately, the existing convergence turned out to be negative for all the combinations, meaning that EU-14 regions decreased their efforts in innovation in terms of patents, trademarks and designs during the period 2008-2014.

CHAPTER 3. MAIN DETERMINANTS OF THE EU-14 REGIONS PERFORMANCE IN TERMS OF IPRs

This study aims to analyse the performance of EU-14 regions in terms of IPRs. In particular the aim is to understand the main factors that influence and determine the utilization of Patents, Trademarks and Designs and the correlation among them.

In order to do so, the following section describes the dependent and independent variables that will be considered in the econometric and empirical analysis carried on to answer this question.

3.1 Dependent Variables

As explained before, this study is focused in understanding the functioning of IPRs and in particular patents, trademarks and designs. Therefore, these are going to be the dependent variables of the following empirical analysis. It is important to remember that when speaking about patents, reference is made to patent applications; instead, when speaking about trademarks and designs, reference is made to trademark and design registrations.

In order to avoid results bias linked to the different population sizes of the regions considered in the study, the dependent variables will be used in their "intensity format" instead of their absolute values. This means that the original data for each region (absolute number of regional applications for patents and absolute number of regional registrations for trademarks and designs) are divided by the total population of that area and then multiplied by 1 million. In this way, the dependent variables used in the empirical analysis will be "relativized" and the results will be reliable.

3.2 Explanatory Variables

- R&D Expenditure: this is the most important explanatory variable and the most significantly connected with the main variables. The R&D activity could be considered as a measure of innovation. This is the preliminary step of a complex process that, at the end, concretizes with the registration of IPRs. In the current economic environment R&D activity is one of the most important elements for companies to remain competitive, improve productivity, increase margins and anticipate customer demands or trends. Nevertheless, it is important to remind that R&D activity is a process expected to contribute to the long-term profitability with the implication of no-immediate payoff and uncertain returns on investment (ROI), a factor that could influence the propensity of companies to invest in innovation.

  In this work it will be considered the regional R&D expenditure, which corresponds to the percentage of regional GDP spent by both public and private agents in research and development activities.

- Employment Rate: employment rates are measures of the extent to which available labour resources are being used in a certain area (OECD - Website). In general, they are calculated by comparing the employed population and the population in working age. The employment rate is a crucial variable to consider when analysing the economic state of health of a certain area, since higher employment rates mean that there is a high degree of utilization of the available factors of production in a certain country or region. Employment rates are influenced by economic cycles, government policies and social dynamics. In this work, this variable is expressed as a percentage and refers to the portion of population from 15 to 64 years old (working age), that works in remunerated employments.
- Population with Tertiary Education: the population with tertiary education is commonly defined as those people who have successfully completed the highest level of education, usually third-level studies (OECD – Website). Tertiary studies include universities, technical training institutes, research laboratories and any kind of post-secondary education. In recent years, due to the continuous technological progress and also to globalisation, the advanced-education level of countries has become a crucial factor able to influence the labour market and the economic situation of countries; a process of re-shaping of the needs of labour markets is visible worldwide and the demand for workers with a wider knowledge base and more specialised skills is continuing to rise. In this study,

this variable is expressed as a percentage referred to those people from 25 to 64 years old that have successfully completed their tertiary studies.

- Regional Per-Capita GDP: as it is commonly known "the gross domestic product is the total monetary or market value of all the finished goods and services produced within a country's border and in a specific time period" (Investopedia - Website). This means that GDP is an indicator, an approximation measure of the domestic production and for this reason it functions as a comprehensive scorecard of a certain country's economic health. This study utilizes the GDP in purchasing power standards (PPS) in order to eliminate the differences in price levels between different countries and regions. In this paper GDP is expressed in "regional per-capita format", that is the average GDP held by each individual of a certain region (in the econometric analysis the natural-logarithm of this variable will be employed).
- Index for manufacturing activities and Index for professional, scientific and technological activities: The utilization of these variables is meant to provide to the empirical analysis elements that are highly distinctive for different countries and different regions. Indeed, these two variables could be considered as "structural" because they describe the core of the business of a certain area. These two variables are supposed to assume different values moving from one region to another even if belonging to the same country, according to the different historical and social factors, economic market features and

government policies that distinguish one region to another one. In order to analyse the linkage with the IPRs utilization, two structural variables were selected: one for manufacturing activities and the other for those activities that are commonly referred to the tertiary sector (PST activities). In this study, they are expressed as percentages, referring to the portion of enterprises or units that operate in the manufacturing, or in the PST sector, respect to the total existing enterprises of a certain region.

Table D (Appendix) proposes a brief summary of the data-trend regarding the explanatory variables considering the performances of the fourteen European regions together.

CHAPTER 4. ECONOMETRIC ANALYSIS AND EVIDENCE

The empirical analysis performed in this study is an econometric regression; in particular, in order to satisfy the requirements of the data used in the study, the one conducted is a Panel Data regression.

The Panel data regression is a particular kind of econometric model that combines both cross-sectional data and time-series data: cross-sectional data are those data collected by registering a characteristic of many subjects at the same point in time; time-series data are those data collected by recording a characteristic of a certain subject over several time periods. Thus, while in the first case there is a certain variety of subjects, in the other case there is variety of time. The result is that, being a combination of the two previous models, the panel data model is built by collecting data recording a characteristic of many subjects over several time periods.

The basic formulation of the Panel model is the following:

$$\boldsymbol{y_{it} = \alpha_i + \beta x'_{it} + \varepsilon_{it}}$$

As it is visible, the dependent variable “y” is characterized both by the “i” indicating the variety of subjects and the “t” indicating the variety of time periods. The dependent variable is explained by the intercept “α” for “i” subjects, plus the parameter “β” multiplied by a set of independent variables “x” for “i” subjects at “t” time periods, plus the error element ε for “i” subjects at “t” time periods.

In this formulation, the role of the intercept is crucial. This element, also called "individual effect", is the one that contains the different individual characteristics belonging to each individual. These characteristics are the ones that are able, even if not observed, to explain the existing heterogeneity among different units. In addition, the main feature of the intercept "α" is that it doesn't vary over time; thus, the intercept explains those fundamental characteristics that do not vary over time, but which are able to differentiate each individual from the other ones. Thanks to this element, it is possible to explain the reasons why the dependent variable of every individual differs from the others, apart from the effects of the explanatory variables.

Depending by the role and the interpretation of the intercept, it is possible to perform two different estimation models:

- Fixed Effects Model: in this case the intercept "α" is considered as a parameter that can be estimated with the standard estimation techniques. This means that no assumptions on this element are made, neither regarding their distribution or their magnitude. Here only the "Within variability" is taken into account, that is the variability of data referred to the differences existing within the observations regarding the same individual.

  To the aim of estimating "β", the fixed effects model considers only how and how much the dependent and the independent variables vary within the individual observations, without taking into account all the information coming from the differences between one individual and the others.

It is also important to point out that the fixed effects estimator does not work when operating with time-invariant variables (a variable that doesn't change within the individual observations during time).

- Random Effects Model: in this case the intercept "α" is considered as a random variable that is not observable; two assumptions are made regarding this variable: the intercept must have a variance and its mean must be equal to zero. In this model it is important to analyse the features of the intercept, that are its distribution and its magnitude.

  In this case, the model will consider in addition to the "Within variability" also the "Between variability", that is the variability of data referred to the differences between one individual and the others. The result is that this model works also with time-invariant variables.

  The fundamental requirement that must be satisfied in this case is that the covariance between the independent variables and the intercept must be null. This means that none of the observable characteristics x can be correlated to any individual unobservable characteristic α.

Ultimately, the panel model built in this study could be considered as a "short panel". A panel is defined short when the number of subjects and observations (n) are much larger than the time series (t). In this case the heterogeneity of the regression will be linked to the presence of several observed subjects, rather than to the length of the observation period (as in the case of long panels).

4.1 Results for Patents

Before starting the analysis of the results for patents, it is necessary to introduce an additional panel model that has been adopted because of its particular suitability with respect to the characteristics of the data regarding patents, in particular the length of the considered time period.

This new model is called the Between Panel Model. This model uses the group-averages of the explanatory variables to compute the regression. This means that the between estimator exploits the cross-sectional dimension of the data, that corresponds to the differences between units, by regressing the individual averages of y on the individual averages of x plus a constant. This regression takes place through the classic estimation model known as Ordinary Least Squares (OLS). In this case, the model completely omits to consider the time-period, the observations in each group are averaged over time and, consequently, the model doesn't consider the within variation.

Table 8 shows the results of the 1° model performed to study patent intensity. This first model is a Between model that, as explained before, was selected because of its particular suitability respect to the available dataset for patents.

Table 8: Patent intensity 1° Model - Between Model

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−1395.49	312.938	−4.459	<0.0001	***
RDExpenditure	44.4241	7.68419	5.781	<0.0001	***
EmploymentRate	3.90806	1.28293	3.046	0.0028	***
TertiaryEducation	−1.04462	1.18189	−0.8839	0.3784	
ln_Percapita_GDP	108.303	34.9297	3.101	0.0024	***
Manufacturing	5.54491	2.98473	1.858	0.0654	*
PST	3.74680	1.36454	2.746	0.0069	***
CapitalRegion	−41.4367	31.9411	−1.297	0.1968	

Mean dependent var	145.8649	S.D. dependent var	144.7160
Sum squared resid	1045710	S.E. of regression	89.34494
R-squared	0.638175	Adjusted R-squared	0.618841
F (7, 131)	33.00760	P-value(F)	4.48e-26
Log-likelihood	−817.5709	Akaike criterion	1651.142
Schwarz criterion	1674.618	Hannan-Quinn	1660.682

In this case, all the variables that resulted to be significant, also showed a positive correlation with patent intensity.

In particular, R&D expenditure, employment rate, per-capita GDP and the structural index for PST activities registered a high level of significance. Instead, the structural index for manufacturing activities reported a lower significance level respect to the other one.

The variable related to tertiary education and the dummy variable for the capital region, resulted to be not significant in explaining the trend of the dependent variable.

Table 9 shows the results of the 2° model performed to study patent intensity. This second model is a Random Effects Model.

Table 9: Patent intensity 2° Model – Random Effects Model (GLS)

	Coefficient	*Std. Error*	*z*	*p-value*	
const	−1276.75	214.824	−5.943	<0.0001	***
RDExpenditure	23.2644	5.03562	4.620	<0.0001	***
EmploymentRate	3.74179	1.00631	3.718	0.0002	***
TertiaryEducation	−0.955778	0.871987	−1.096	0.2730	
ln_Percapita_GDP	110.415	24.5916	4.490	<0.0001	***
Manufacturing	−1.70899	0.502384	−3.402	0.0007	***
PST	2.43620	0.695421	3.503	0.0005	***
CapitalRegion	−55.1963	31.3868	−1.759	0.0786	*

Mean dependent var	127.5069	S.D. dependent var	134.5160
Sum squared resid	2791317	S.E. of regression	87.56971
Log-likelihood	−2182.166	Akaike criterion	4380.332
Schwarz criterion	4411.662	Hannan-Quinn	4392.776
rho	−0.186310	Durbin-Watson	0.897462

'Between' variance = 7810.08
'Within' variance = 385.033
mean theta = 0.85668

Joint test on named regressors -
Asymptotic test statistic: Chi-square (7) = 159.271
with p-value = 4.56605e-31

Breusch-Pagan test -
Null hypothesis: Variance of the unit-specific error = 0
Asymptotic test statistic: Chi-square (1) = 100.111
with p-value = 1.44121e-23

Hausman test -
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square (6) = 62.0771
with p-value = 1.70165e-11

In this case R&D expenditure, employment rate, per-capita GDP, the variable linked to manufacturing activities, the variable linked to PST activities and the dummy variable for capital regions resulted to be significant in explaining the trend of patent intensity. All these variables showed a high significance level except for the dummy variable for capital regions that registered a low level of significance. In addition, while R&D expenditure, employment rate, per-capita GDP and PST activities confirm their positive correlation respect to the dependent variable, the structural index for manufacturing activities and the dummy for capital regions reported a negative correlation respect to patent intensity.

Also in this case the variable for tertiary education turned out to be not significant in explaining the trend of patent applications.

In order to complete the study regarding patent intensity other two models were performed; they are appreciable in table E and table F (Appendix). These models are not specifically analysed because their outcomes substantially confirm the results proposed by the previous models.

4.2 <u>Results for Trademarks</u>

Table 10 shows the results of the 1° model performed to study trademark intensity. This is a Fixed-effects Model. Since it is a fixed-effects estimation, both the capital region dummy and the country dummies are excluded because they are time-invariant.

Table 10: Trademark intensity 1° Model - Fixed-effects Model

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−1423.66	323.473	−4.401	<0.0001	***
RDExpenditure	−10.9576	6.70060	−1.635	0.1026	
EmploymentRate	−2.10079	1.15510	−1.819	0.0695	*
TertiaryEducation	5.58703	0.995901	5.610	<0.0001	***
ln_Percapita_GDP	153.315	36.4340	4.208	<0.0001	***
Manufacturing	1.46373	0.690828	2.119	0.0346	**
PST	1.13683	0.933226	1.218	0.2237	

Mean dependent var	164.6631	S.D. dependent var	209.0325
Sum squared resid	529958.9	S.E. of regression	32.39481
LSDV R-squared	0.981595	Within R-squared	0.198177
LSDV F(154, 505)	174.8936	P-value(F)	0.000000
Log-likelihood	−3143.643	Akaike criterion	6597.287
Schwarz criterion	7293.584	Hannan-Quinn	6867.175
rho	0.312149	Durbin-Watson	0.951353

Joint test on named regressors -
Test statistic: F(6, 505) = 20.8025
with p-value = P(F(6, 505) > 20.8025) = 7.87743e-22

Test for differing group intercepts -
Null hypothesis: The groups have a common intercept
Test statistic: F(148, 505) = 107.744
with p-value = P(F(148, 505) > 107.744) = 0

In this case the variables that resulted to be significant are: employment rate, tertiary education, per-capita GDP and the structural index for manufacturing activities. Tertiary education and per-capita GDP turned out to be highly significant, the employment rate registered a low level of significance and the variable for manufacturing activities reported a medium level of significance.

While the other variables registered a positive correlation with trademark intensity, the employment rate resulted to be negatively correlated respect to the dependent variable.

In this case, both R&D expenditure and the variable related to PST activities were found to be not significant in detecting the trend of trademark intensity.

Table 11 shows the results of the 2° model performed to study trademark intensity. Also this one is a Fixed-effects Model and, as explained before, both the capital region dummy and the country dummies are omitted.

With regard to this model, the variables that turned out to be significant are: tertiary education with a high degree of significance, R&D expenditure, per-capita GDP and the dummy variable for 2014 with a medium level of significance and the structural index for manufacturing activities with a low level of significance.

R&D expenditure registered a negative correlation respect to trademark intensity while the other variables showed a positive correlation with the dependent variable.

The coefficient of the dummy variable for the year 2014 means that the results for trademark intensity in that year are around twenty points higher respect to the reference year, that in this case is 2008.

In this model, both the employment rate and the variable related to PST activities resulted to be not significant in explaining the changes of trademark intensity.

Table 11: Trademark intensity 2° Model - Fixed-effects Model (with Time dummies)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−1067.04	418.510	−2.550	0.0111	**
RDExpenditure	−13.9979	6.83219	−2.049	0.0410	**
EmploymentRate	−1.00085	1.40744	−0.7111	0.4773	
TertiaryEducation	3.44940	1.33239	2.589	0.0099	***
ln_Percapita_GDP	117.103	46.7729	2.504	0.0126	**
Manufacturing	1.27854	0.713824	1.791	0.0739	*
PST	1.09851	0.945494	1.162	0.2459	
dt_2	−1.84464	5.96848	−0.3091	0.7574	
dt_3	2.19977	6.62838	0.3319	0.7401	
dt_4	5.05560	6.85452	0.7376	0.4611	
dt_5	1.02070	7.76934	0.1314	0.8955	
dt_6	9.67337	8.49425	1.139	0.2553	
dt_7	20.6058	9.30919	2.213	0.0273	**

Mean dependent var	164.6631	S.D. dependent var	209.0325
Sum squared resid	517921.0	S.E. of regression	32.21673
LSDV R-squared	0.982013	Within R-squared	0.216390
LSDV F(160, 499)	170.2736	P-value(F)	0.000000
Log-likelihood	−3136.061	Akaike criterion	6594.122
Schwarz criterion	7317.373	Hannan-Quinn	6874.458
rho	0.314041	Durbin-Watson	0.952042

Joint test on named regressors -
Test statistic: F(6, 499) = 4.60332
with p-value = P(F(6, 499) > 4.60332) = 0.000145451

Test for differing group intercepts -
Null hypothesis: The groups have a common intercept
Test statistic: F(148, 499) = 108.538
with p-value = P(F(148, 499) > 108.538) = 1.48264e-307

Wald joint test on time dummies -
Null hypothesis: No time effects
Asymptotic test statistic: Chi-square(6) = 11.5981
with p-value = 0.0715597

Also in this case, to terminate the econometric analysis regarding trademark intensity other two models were performed; they are appreciable in Table G and Table H (Appendix). These models are two Random-Effects Models that are not specifically analysed because their outcomes are substantially coherent with the results obtained in the previous models.

4.3 Results for Designs

Table 12 provides the results of the 1° model performed to study design intensity. This is a Fixed-effects Model and therefore excludes the country dummies and the capital region dummies.

Table 14: Designs Intensity 1° Model - Fixed-effects Model

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−185.234	83.1882	−2.227	0.0264	**
RDExpenditure	−2.62409	1.69855	−1.545	0.1230	
EmploymentRate	0.187938	0.333370	0.5638	0.5732	
TertiaryEducation	0.971991	0.268127	3.625	0.0003	***
ln_Percapita_GDP	18.9432	9.52432	1.989	0.0473	**
Manufacturing	−0.280643	0.173489	−1.618	0.1064	
PST	−0.290974	0.237710	−1.224	0.2215	

Mean dependent var	33.25011	S.D. dependent var	27.94545
Sum squared resid	30068.77	S.E. of regression	7.990011
LSDV R-squared	0.937698	Within R-squared	0.069500
LSDV F(147, 471)	48.22378	P-value(F)	6.5e-215
Log-likelihood	−2080.154	Akaike criterion	4456.308
Schwarz criterion	5111.667	Hannan-Quinn	4711.069
rho	0.239348	Durbin-Watson	1.101005

Joint test on named regressors -
Test statistic: F(6, 471) = 5.86326
with p-value = P(F(6, 471) > 5.86326) = 6.51916e-06

Test for differing group intercepts -
Null hypothesis: The groups have a common intercept
Test statistic: F(141, 471) = 21.2717
with p-value = P(F(141, 471) > 21.2717) = 1.52379e-139

In this instance, only two variables resulted to be relevant in explaining the trend of design intensity.

The first one is tertiary education that is highly significant and shows a positive correlation with the dependent variable.

The other relevant variable is the natural logarithm of the per-capita GDP, that was found to be moderately significant with a correlation with design intensity that is confirmed to be favourable also in this situation.

Here, R&D expenditure, the employment rate and both the structural indexes are not significant.

Table 13 exhibits the results of the 2° model performed to study design intensity. This is a Random-effects Model. In this case the time-dummies have been used for the regression but are not included in the results because not significant.

In addition, a further model was performed to complete the analysis for design intensity; it is visible in Table I (Appendix). This is a random-effects model that is not analysed because its outcomes substantially confirm the previous results.

Table 13: Design intensity 2° Model - Random-effects Model (GLS) (with country dummies - with time dummies used for regression but not included)

	Coefficient	*Std. Error*	*z*	*p-value*	
const	−366.641	65.9045	−5.563	<0.0001	***
RDExpenditure	−0.672539	1.11618	−0.6025	0.5468	
EmploymentRate	0.300995	0.272245	1.106	0.2689	
TertiaryEducation	0.736336	0.267523	2.752	0.0059	***
ln_Percapita_GDP	36.7838	7.51637	4.894	<0.0001	***
Manufacturing	−0.218141	0.174810	−1.248	0.2121	
PST	−0.216851	0.235373	−0.9213	0.3569	
CapitalRegion	−14.6931	6.19660	−2.371	0.0177	**
DCountry_Austria	10.8345	9.02488	1.201	0.2299	
DCountry_Belgium	−19.8527	8.26301	−2.403	0.0163	**
DCountry_Denmark	2.56757	9.87869	0.2599	0.7949	
DCountry_Finland	−14.9605	9.91689	−1.509	0.1314	
DCountry_Germany	−6.43416	7.15855	−0.8988	0.3688	
DCountry_Greece	−8.93687	10.1554	−0.8800	0.3789	
DCountry_Ireland	−27.5095	14.9173	−1.844	0.0652	*
DCountry_Italy	0.842506	8.69498	0.09690	0.9228	
DCountry_Luxembourg	68.8585	19.2544	3.576	0.0003	***
DCountry_Netherlands	−14.5067	7.89276	−1.838	0.0661	*
DCountry_Portugal	−1.83561	10.9075	−0.1683	0.8664	
DCountry_Spain	−18.3975	8.19114	−2.246	0.0247	**

Mean dependent var	33.25011	S.D. dependent var	27.94545
Sum squared resid	200975.2	S.E. of regression	18.39408
Log-likelihood	−2668.109	Akaike criterion	5388.218
Schwarz criterion	5503.349	Hannan-Quinn	5432.974
rho	0.239757	Durbin-Watson	1.099814

'Between' variance = 249.771
'Within' variance = 63.8027
mean theta = 0.742796
corr(y,yhat)^2 = 0.58416
Joint test on named regressors -
 Asymptotic test statistic: Chi-square(19) = 228.202
 with p-value = 7.76498e-38

Wald joint test on time dummies -
 Null hypothesis: No time effects

Asymptotic test statistic: Chi-square(6) = 8.27998
with p-value = 0.218301

Breusch-Pagan test -
Null hypothesis: Variance of the unit-specific error = 0
Asymptotic test statistic: Chi-square(1) = 533.896
with p-value = 4.01253e-118

Hausman test -
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(6) = 42.7618
with p-value = 1.30012e-07

After performing this model, the variables that were found to be significant are the one related to tertiary education and per-capita GDP with a high level of significance, and the dummy variable for capital regions with a medium level of significance. The latter variable showed a negative correlation respect to design intensity while the first two were positively correlated with the dependent variable. From this regression also several dummy variables for countries turned out to be significant in explaining the variation of design intensity, even if with different degrees of significance. In this case, the reference country is France. Belgium, Ireland, Netherlands and Spain registered lower results for design intensity respect to the reference country while Luxembourg reported a higher coefficient respect to France.

4.4 Analysis of the Results

In this section the econometric evidence obtained through the previous models are examined.

Before to start the analysis, it is important to point out a specification related to the several typologies of models performed in this study. Among the Between Panel Model, the Fixed-Effects Model and the Random-Effects Model there are important differences that have been introduced at the beginning of this Chapter. Therefore, also for what concerns the outcomes of the models, and their interpretation, there are some meaningful differences: among the three kinds of models the fixed-effects model is the one that provides the higher reliability of the results. In this case, it is possible to establish a causal relation between the explanatory variables and the dependent variables; this relation is supposed to be reliable. In the other two cases, there are some interferences that may lead to results bias; in these situations, it is not correct to consider a proper causal relation among the explanatory and the dependent variable because it would not be completely reliable.

What is possible to do with these models is to consider the results as additional information that can be useful to confirm, to reject or to amend some assumptions sustained by the reliable models. Thus, the inferences obtained from the econometric regression should be viewed as "exploratory in nature" and are points of departure for further research and examination as they are "standalone" conclusions.

For what concerns patents, one of the most important variables is certainly R&D expenditure. Indeed, it resulted to be strongly significant in all the models performed to study the trend of patent intensity, except for model 4. In addition, this variable showed in all these cases a positive coefficient, meaning a favourable correlation with patents. Another crucial variable is the natural logarithm of GDP per-capita that turned out to be moderately or highly significant in all the models computed. Also in this case the coefficient for this variable is always positive and consequently the impact on patent intensity is confirmed to be beneficial also with a considerable magnitude (high coefficient). For what concerns the employment rate, there is not a certain outcome because this variable sometimes resulted to be significant (models 1 and 2) and sometimes resulted to be not significant (model 3 and 4); what is possible to say is that this variable does not appear as a characteristic element of the development of patent intensity. The variable related to tertiary education was found to be significant only in two models (models 3 and 4) out of the four performed to study the trend of patent intensity. In these two situations, this variable showed a negative coefficient; therefore, the third-level education is not significant or has a negative correlation respect to patents. This means that this variable, even if stressing the uncertainty regarding this outcome, does not seem to contribute to the development of patent intensity, or at least it decelerates its increase. Moving to the structural indexes, the variable linked to manufacturing activities resulted to be significant in three models out of four (models 1, 2 and 3), and the same is valid for the one linked to PST activities. The peculiarity is that while the variable linked to PST activities showed a positive coefficient and consequently a favourable correlation with the trend of patent intensity in all the three models, the one linked to manufacturing activities showed a negative correlation with the dependent variable once (model 2). Thus, it is not possible to assert that these two indexes are undoubtedly determinant for the dependent variable but while for manufacturing activities the result related to the correlation remains uncertain, at least for the variable linked to PST activities it is reliable that the correlation with patent intensity would be positive and favourable. This result partially confirms that both the business units operating in the manufacturing sector and the business units operating in the PST sectors are able to foster and positively influence the trend of patents and, as explained in Chapter 1. Patents appear to be an IPR whose utilization is widespread both among the secondary sector and also among the tertiary sector. Instead, the role of capital regions resulted to be relevant only in one model (model 2), that is an outcome that does not provide certainties regarding the linkage between this variable and patent intensity. For what concerns the dummy variables for countries only the one referred to Italy turned out to be relevant in describing the trend of the explained variable once (model 3). In that case the coefficient and consequently their impact on the dependent variable is negative, indicating that for all the regions belonging to Italy the results are in general significantly lower respect to the reference country that in that case was France. Anyway, the fact that this variable resulted to be significant only once, makes this outcome not reliable at all. Moving to the time dummies, none of them are significant when analysing the trend of patent intensity.

For what concerns trademarks the first peculiarity to point out is that the variable R&D expenditure plays a role deeply in contrast with the situation obtained for patents. In this instance, R&D expenditure resulted slightly or moderately significant in model 2, 3 and 4 while in the first one was not relevant. In addition, when this variable turned out to be significant the coefficient was negative and, therefore, the impact on the correlation with the dependent variable was unfavourable. This means that this variable is not relevant in contributing to foster the results of trademark intensity or, in some cases, it is even unfavourable. This outcome seems to confirm the fact that trademarks are deeply different from patents, and in particular they do not show a strong correlation with the R&D processes as it is for the other IPR. Instead, a variable that plays a relevant role is tertiary education that was found to be highly significant in all the models performed. The coefficients of this variable are always positive and consequently the impact on the development of the dependent variable is positive too. Hence, the situation regarding this variable is substantially different respect to the situation obtained for patents. The natural logarithm of GDP per-capita is an important variable also in this scenario; it resulted to be moderately or highly significant in all the models computed. In this case too, the coefficient for this variable is always positive and consequently the impact on trademark intensity is confirmed to be beneficial also with very high magnitudes. Employment rate turned out to be significant in two of the models performed (models 1 and 3). In both these cases, the coefficient and consequently the correlation with trademark intensity was negative. Hence, the outcomes regarding the relevance of this variable remain uncertain, even if it is possible to suppose that the correlation with the dependent variable would be adverse. Moving to the structural indexes, both the variable linked to manufacturing activities and the one linked to PST activities were found to be significant twice (models 1 and 2 for manufacturing and models 3 and 4 for PST). The level of significance for these two variables is not as high as the one obtained for patents. With that being said, there is no evidence that one of the two structural indexes is strictly determinant in influencing the trend of trademark intensity; nevertheless, when significant these variables resulted to be positively correlated with the dependent variable, that means that these variables could contribute to foster the final results for trademarks. The variable linked to capital regions was significant only once (model 3). In that case this variable was highly significant and with a positive correlation respect to the dependent variable. Anyway, as said before, this outcome does not allow to give assurances regarding the role of this variable.

For what concerns the dummy variables for countries, there are some of them that turned out to be significant in model 4. It is the case of Austria, Germany, Greece, Ireland, Italy, Luxembourg, Portugal and Spain. The peculiarity is that in all these cases the outcome suggests that the regions belonging to these countries registered higher results respect to the reference country that in that case was again France. Moving to the time dummies, only one of them resulted significant once (model 2); this is the case of the time dummy related to 2014 that, with a medium level of significance, showed that the results for trademark intensity in that year were particularly higher respect to the reference year, that was 2008.

For what concerns designs the first peculiarity to emphasize is that again the variable R&D expenditure plays a role deeply in contrast with the situation obtained for patents. In this instance, R&D expenditure is not significant in either the three models performed to study the variable. This means that this variable appears to be not relevant in contributing to foster the results of design intensity. Instead, a variable that plays a relevant role is tertiary education that resulted to be highly significant in two models performed (model 1 and 2). The coefficients of this variable are always positive and consequently the impact on the development of the dependent variable is positive too. Hence, the situation regarding this variable places somewhere between the one obtained for patents and the one for trademarks. It seems to be relevant in explaining the development of design intensity and the correlation appears to be positive. The natural logarithm of GDP per-capita is an important variable also in this scenario; it turned out to be moderately or highly significant in all the models computed. In this case too, the coefficient for this variable is always positive and consequently the impact on design intensity is confirmed to be beneficial. Employment rate was not significant in all the models performed in this case. The same is valid for the variable linked to manufacturing activities and the one linked to PST activities, that turned out to be not significant in all the models performed. Instead, the role of capital regions was found to be relevant in one case (model 2); with a medium level of significance, this variable reported a negative impact on the dependent variable meaning that results for design intensity are generally lower when focusing on capital regions respect to other regions. This outcome appears in contrast with the results obtained in Chapter 2 where all the averages intensities resulted higher in capital regions respect to the others, probably because the technological progress and the propensity to innovation registered by capital regions are more intense respect to other regions. Anyway, this variable is registered to be relevant only once so it is not enough to provide assurances regarding its role in analysing the dependent variable. For what concerns the dummy variables for countries, there are some of them that turned out to be relevant in describing the trend of the explained variable in model 2 and some other in model 3. In both the cases the reference country was France; Belgium, Ireland, Netherlands and Spain showed lower results respect to the reference country, while Luxembourg and Austria exhibited higher results respect to France. Also in this case the role of this variable does not appear to be determinant for the trend of design intensity. Time-dummies resulted to be not relevant in describing the trend of design intensity in all the models performed.

CONCLUDING REMARKS

The main purpose of this thesis was to analyse the trend of the main IPRs in Western European regions. In particular, the focus of this study was to detect and examine the main economic, social and structural factors that influence and determine the developing patterns of IPRs and that are consequently able to differentiate the innovation performances of regions.

Chapter 2 has provided an empirical analysis meant to determine the main innovation trends among EU regions. There were significant differences when switching from the absolute dimension to the relative one of IPRs and it resulted to exist an increasing concentration in the more advanced regions of the EU. However, a convergence pattern has been detected among the majority of EU-14 regions, due to similar trends registered for all the considered IPRs.

Moving to the econometric analysis, the first significant finding is that patents, trademarks and designs are deeply different, not only because of their peculiar characteristics, but also in the way they interact with different economic and innovation variables. The only variable that turns out to be positively and significantly correlated with all the three IPRs is the regional per-capita GDP, confirming that more economically advanced EU regions are characterized by a greater use and exploitation of IPRs.

For what concerns patent intensity, the variable that really characterizes the development of this IPR is the R&D expenditure, which resulted to be highly significant in three econometric models performed. This important result is in line with previous empirical analyses across EU regions and confirms what was stressed in Chapter 1: the technological nature of patented inventions implies substantial innovative efforts which are captured by R&D investments. Along with per-capita GDP and R&D, the characteristics that affect the regional intensity of patents are the employment rate and the structural index linked to professional, scientific and technological (PST) services, while the structural index for manufacturing activities exerts a positive effect only in some cases.

For what concerns trademark intensity, in addition to per-capita GDP, the other variable that resulted to be the most significant was the share of population with tertiary education. Accordingly, what matters for having better performances in terms of this peculiar IPRs, which is more linked with marketing activities and product differentiation, is the level of human capital of the workforce rather than the efforts for achieving technological innovations. Indeed, in this case R&D does not play a significant role and turns out to get even a negative and statistically significant coefficient. Contrary to the expectations, the intensity of trademarks does not seem affected by the presence of advanced services, and in fact the number of businesses operating in PST services appears to be not significant. The same is valid for the number of businesses operating in manufacturing.

Finally, for the regional intensity of registered designs the results are less satisfactory. Indeed, apart from the positive effect of per-capita GDP, the only variable that shows a certain relevance is again the one related to the level of tertiary education. However, in this case, the explanation given for trademarks about this correlation is not totally replicable. As explained in Chapter 1, industrial designs are more transversal than patents and trademarks, being concerned with both technological and non-technological (aesthetic) innovations. This is probably the main reason why it has been difficult to find specific explanatory variables for their use across EU-14 regions. The variables that were supposed to emerge from the econometric analysis, showing a significant role, are those related to the structural indexes for manufacturing and PST activities. Unfortunately, this initial assumption is not confirmed by the econometric outcomes obtained by the regressions performed in this study.

All the variables affecting the extent of the considered IPRs are the ones that policy makers should support and incentivize, with the aim of improving the economic and innovation performances of the EU regions.

For what concerns future possible developments of this thesis, it would be interesting to perform similar econometric analysis with more recent data (especially for patents) with the purpose of better emphasise and explain the variations occurred over the years for patents, trademarks, and designs among EU regions.

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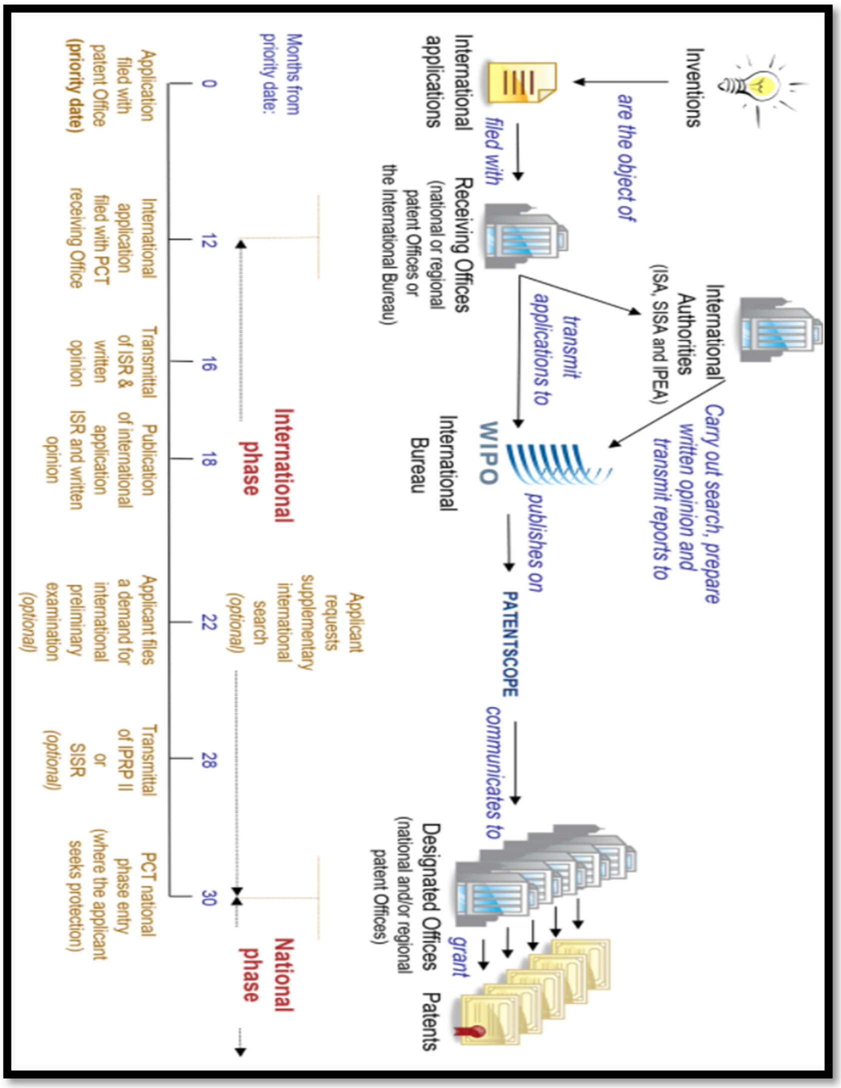
- Investopedia - Website - https://www.investopedia.com/
- Organisation for economic co-operation and development (OECD) – Website - https://www.oecd.org/
- World Intellectual Property Organization (WIPO) – Website - https://www.wipo.int/portal/en/index.html
- World Trade Organization (WTO) – Website - https://www.wto.org/

APPENDIX

Figure A: Overview of the PCT system



Source: World Intellectual Property Organization Website

Table B: Classification and codification of EU-14 regions

COUNTRY	REGION	CODE
AUSTRIA	Burgenland	***AT11***
	Niederösterreich	***AT12***
	Wien ***(CAPITAL REGION)***	***AT13***
	Kärnten	***AT21***
	Steiermark	***AT22***
	Oberösterreich	***AT31***
	Salzburg	***AT32***
	Tirol	***AT33***
	Vorarlberg	***AT34***
	Extra-Regio NUTS 2	**AT-EX**
	Not regionalised/Unknown NUTS 2	**AT-NR**
BELGIUM	Région de Bruxelles ***(CAPITAL REGION)***	***BE10***
	Prov. Antwerpen	***BE21***
	Prov. Limburg (BE)	***BE22***
	Prov. Oost-Vlaanderen	***BE23***
	Prov. Vlaams-Brabant	***BE24***
	Prov. West-Vlaanderen	***BE25***
	Prov. Brabant Wallon	***BE31***
	Prov. Hainaut	***BE32***
	Prov. Liège	***BE33***
	Prov. Luxembourg (BE)	***BE34***
	Prov. Namur	***BE35***
	Extra-Regio NUTS 2	**BE-EX**
	Not regionalised/Unknown NUTS 2	**BE-NR**
DENMARK	Hovedstaden	***DK01***
	Sjælland ***(CAPITAL REGION)***	***DK02***
	Syddanmark	***DK03***
	Midtjylland	***DK04***
	Nordjylland	***DK05***
	Extra-Regio NUTS 2	**DK-EX**
	Not regionalised/Unknown NUTS 2	**DK-NR**
FINLAND	Länsi-Suomi	***FI19***
	Helsinki-Uusimaa ***(CAPITAL REGION)***	***FI1B***
	Etelä-Suomi	***FI1C***

	Pohjois- ja Itä-Suomi	***FI1D***
	Åland	***FI20***
	Extra-Regio NUTS 2	**FI-EX**
	Not regionalised/Unknown NUTS 2	**FI-NR**
FRANCE	Alsace	***FR10***
	Aquitaine	***FRB0***
	Auvergne	***FRC1***
	Basse-Normandie	***FRC2***
	Bourgogne	***FRD1***
	Bretagne	***FRD2***
	Centre — Val de Loire	***FRE1***
	Champagne-Ardenne	***FRE2***
	Corse	***FRF1***
	Franche-Comté	***FRF2***
	Guadeloupe	***FRF3***
	Guyane	***FRG0***
	Haute-Normandie	***FRH0***
	Ile-de-France ***(CAPITAL REGION)***	***FRI1***
	La Réunion	***FRI2***
	Languedoc-Roussillon	***FRI3***
	Limousin	***FRJ1***
	Lorraine	***FRJ2***
	Martinique	***FRK1***
	Mayotte	***FRK2***
	Midi-Pyrénées	***FRL0***
	Nord-Pas de Calais	***FRM0***
	Pays de la Loire	***FRY1***
	Picardie	***FRY2***
	Poitou-Charentes	***FRY3***
	Provence-Alpes-Côte d'Azur	***FRY4***
	Rhône-Alpes	***FRY5***
	Extra-Regio NUTS 2	**FR-EX**
	Not regionalised/Unknown NUTS 2	**FR-NR**
GERMANY	Stuttgart	***DE11***
	Karlsruhe	***DE12***
	Freiburg	***DE13***
	Tübingen	***DE14***
	Oberbayern	***DE21***
	Niederbayern	***DE22***

	Oberpfalz	***DE23***
	Oberfranken	***DE24***
	Mittelfranken	***DE25***
	Unterfranken	***DE26***
	Schwaben	***DE27***
	Berlin ***(CAPITAL REGION)***	***DE30***
	Brandenburg	***DE40***
	Bremen	***DE50***
	Hamburg	***DE60***
	Darmstadt	***DE71***
	Gießen	***DE72***
	Kassel	***DE73***
	Mecklenburg-Vorpommern	***DE80***
	Braunschweig	***DE91***
	Hannover	***DE92***
	Lüneburg	***DE93***
	Weser-Ems	***DE94***
	Düsseldorf	***DEA1***
	Köln	***DEA2***
	Münster	***DEA3***
	Detmold	***DEA4***
	Arnsberg	***DEA5***
	Koblenz	***DEB1***
	Trier	***DEB2***
	Rheinhessen-Pfalz	***DEB3***
	Saarland	***DEC0***
	Dresden	***DED2***
	Chemnitz	***DED4***
	Leipzig	***DED5***
	Sachsen-Anhalt	***DEE0***
	Schleswig-Holstein	***DEF0***
	Thüringen	***DEG0***
	Extra-Regio NUTS 2	**DE-EX**
	Not regionalised/Unknown NUTS 2	**DE-NR**
GREECE	Anatoliki Makedonia	***EL30***
	Attiki ***(CAPITAL REGION)***	***EL41***
	Dytiki Ellada	***EL42***
	Dytiki Makedonia	***EL43***
	Ionia Nisia	***EL51***
	Ipeiros	***EL52***

	Kentriki Makedonia	***EL53***
	Kriti	***EL54***
	Notio Aigaio	***EL61***
	Peloponnisos	***EL62***
	Sterea Ellada	***EL63***
	Thessalia	***EL64***
	Voreio Aigaio	***EL65***
	Extra-Regio NUTS 2	**EL-EX**
	Not regionalised/Unknown NUTS 2	**EL-NR**
IRELAND	Northern and Western	***IE04***
	Southern	***IE05***
	Eastern and Midland ***(CAPITAL REGION)***	***IE06***
	Extra-Regio NUTS 2	**IE-EX**
	Not regionalised/Unknown NUTS 2	**IE-NR**
ITALY	Abruzzo	***ITC1***
	Basilicata	***ITC2***
	Calabria	***ITC3***
	Campania	***ITC4***
	Emilia-Romagna	***ITF1***
	Friuli-Venezia Giulia	***ITF2***
	Lazio ***(CAPITAL REGION)***	***ITF3***
	Liguria	***ITF4***
	Lombardia	***ITF5***
	Marche	***ITF6***
	Molise	***ITG1***
	Piemonte	***ITG2***
	Provincia Autonoma di Bolzano	***ITH1***
	Provincia Autonoma di Trento	***ITH2***
	Puglia	***ITH3***
	Sardegna	***ITH4***
	Sicilia	***ITH5***
	Toscana	***ITI1***
	Umbria	***ITI2***
	Valle d'Aosta	***ITI3***
	Veneto	***ITI4***
	Extra-Regio NUTS 2	**IT-EX**
	Not regionalised/Unknown NUTS 2	**IT-NR**
LUXEMBOURG	Luxembourg ***(CAPITAL REGION)***	***LU00***

	Extra-Regio NUTS 2	**LU-EX**
	Not regionalised/Unknown NUTS 2	**LU-NR**
NETHERLANDS	Groningen	***NL11***
	Friesland (NL)	***NL12***
	Drenthe	***NL13***
	Overijssel	***NL21***
	Gelderland	***NL22***
	Flevoland	***NL23***
	Utrecht	***NL31***
	Noord-Holland ***(CAPITAL REGION)***	***NL32***
	Zuid-Holland	***NL33***
	Zeeland	***NL34***
	Noord-Brabant	***NL41***
	Limburg (NL)	***NL42***
	Extra-Regio NUTS 2	**NL-EX**
	Not regionalised/Unknown NUTS 2	**NL-NR**
PORTUGAL	Norte	***PT11***
	Algarve	***PT15***
	Centro (PT)	***PT16***
	Área Metropolitana de Lisboa ***(CAPITAL REGION)***	***PT17***
	Alentejo	***PT18***
	Região Autónoma dos Açores	***PT20***
	Região Autónoma da Madeira	***PT30***
	Extra-Regio NUTS 2	**PT-EX**
	Not regionalised/Unknown NUTS 2	**PT-NR**
SPAIN	Galicia	***ES11***
	Principado de Asturias	***ES12***
	Cantabria	***ES13***
	País Vasco	***ES21***
	Comunidad Foral de Navarra	***ES22***
	La Rioja	***ES23***
	Aragón	***ES24***
	Comunidad de Madrid ***(CAPITAL REGION)***	***ES30***
	Castilla y León	***ES41***
	Castilla-La Mancha	***ES42***
	Extremadura	***ES43***
	Cataluña	***ES51***
	Comunitat Valenciana	***ES52***

	Illes Balears	***ES53***
	Andalucía	***ES61***
	Región de Murcia	***ES62***
	Ciudad de Ceuta	***ES63***
	Ciudad de Melilla	***ES64***
	Canarias	***ES70***
	Extra-Regio NUTS 2	**ES-EX**
	Not regionalised/Unknown NUTS 2	**ES-NR**
SWEDEN	Stockholm ***(CAPITAL REGION)***	***SE11***
	Östra Mellansverige	***SE12***
	Småland med öarna	***SE21***
	Sydsverige	***SE22***
	Västsverige	***SE23***
	Norra Mellansverige	***SE31***
	Mellersta Norrland	***SE32***
	Övre Norrland	***SE33***
	Extra-Regio NUTS 2	**SE-EX**
	Not regionalised/Unknown NUTS 2	**SE-NR**

Table C: The linkage between IPR, Innovation and Growth

The linkage between IPR, Innovation, and Growth.

Author(s)	Argument	Relationship between IPR and	
		Innovation	Growth
Arrow (1962)	IPR display an important role on R&D activities	Positive	Positive
Torun and Cicekci (2007)	IPR have a master role in the resolution of innovation and economic growth challenges.	Positive	Positive
Arora et al. (2008)	IPR reward innovators for their creations and directly enhance innovation through the investment in R&D activities, which in turn increases growth.	Positive	Positive
Yang et al. (2014)	The role of IPR protection in stimulating innovations across countries.	Positive	Positive
Bielig (2015)	IPR had a positive impact on the German economy, reflecting the strong economy structure and innovation system.	Positive	Positive
Grossman and Helpman (1991)	IPR protection may not be the key to long-run leverage of innovation and economic growth.	Negative	Negative
Boldrin and Levine (2009)	IPR protection should be reduced to increase growth and encourage creation and innovation.	Negative	Negative
Gould and Gruben (1996)	Results point to doubts about the importance of IPR on economic growth.	N/A	Inconclusive
Adams (2009)	IPR have a negative impact on economic growth in developing countries.	N/A	Negative
Kim et al. (2012)	Patent protection is a determinant of innovation and patentable innovations contribute to economic growth in developed countries, but not in developing countries.	Positive	Undefined
Ginarte and Park (1997)	IPR protection is insignificant for innovative activities and for economic growth.	Insignificant	Insignificant
Grossman and Lai (2004)	IPR protection is useful to increase innovation and economic growth, but only in developed countries.	Undefined	Undefined
Lerner (2009)	Patent protection-enhancing policies have a negative impact on innovation.	Negative	N/A
Kanwar and Evenson (2003)	IPR protection encourages innovation and may not have a direct effect on economic growth.	Positive	Indirect
Schneider (2005)	IPRs affect the innovation rate, but this impact is more significant for developed countries.	Positive	Indirect
Chen and Puttitanun (2005)	There is a positive impact of IPRs on innovations in developing countries and a U-shaped relationship between IPRs and economic development.	Positive	U-shaped
Falvey et al. (2006a)	The effect of IPR on growth is positive and significant for low- and high-income countries, but not for middle-income countries.	Positive	Positive
Hu and Png (2013)	IPR protection has a positive impact on industrial and economic growth even though it is stronger in developed countries than in developing ones.	N/A	Positive
Hudson and Minea (2013)	IPR exert a complex effect on innovation and the relationship is essentially a U-shaped curve.	U-shaped	N/A
Mrad (2017)	IPR protection positively affects economic growth in developing countries by attracting foreign technology embodied in capital goods.	N/A	Positive
Thompson and Rushing (1999)	Patent protection has a positive effect on total factor productivity and economic growth in richer countries.	N/A	Positive
Sweet and Maggio (2015)	Stronger IPR engender higher levels of economic complexity, but only in countries with an initial above-average level of development and complexity.	Positive	N/A
Zhang et al. (2015)	The weak IPR–growth evidence in previous studies may be due to a neglect of the role of finance markets and private IPR.	Positive	Indirect
Varsakelis (2001)	Countries with a strong patent protection framework tend to invest more in R&D	Positive	N/A
Sakakibara and Branstetter (2001)	Japanese firms did not increase significantly their R&D effort and innovative output in response to the country's 1988 patent reform.	Insignificant	N/A
Branstetter et al. (2011)	US-based MNE that make extensive use of IPR increased their use of inputs and expanded their scale of activities in response to IPR reforms.	N/A	Positive
Ang et al. (2014)	Local enforcement of IPR has an important role in encouraging financing and investing in R&D.	Positive	Positive
Bielig (2015)	Different types of IPR had different effects on German GDP.	N/A	Ambiguous

Source: Neves, Afonso, Silva and Sochirca (2021), "The link between intellectual property rights, innovation and growth: A meta-analysis" – p. 199

Table D: Analysis of the trend of the explanatory variables for the period 2008-2014

EXPLANATORY VARIABLES TOTALS AND AVERAGES FOR EU-14						
YEAR	**Average R&D Expenditure**	**Average Employment Rate**	**Average Tertiary Education**	**Average GDP per-Capita**	**Average Man.act. Index**	**Average PST act. Index**
2008	1,33%	65,27%	24,24	27.659	8,59%	19,10%
2009	1,82%	65,31%	24,89	28.201	7,96%	17,95%
2010	1,50%	65,08%	25,48	29.245	10,45%	17,73%
2011	1,75%	65,07%	26,14	30.032	10,13%	17,63%
2012	1,54%	64,49%	26,99	30.279	9,87%	18,00%
2013	1,80%	63,99%	27,79	30.518	9,96%	18,36%
2014	1,34%	64,37%	28,30	31.061	8,33%	16,53%
CAGR	**0,11%**	**-0,20%**	**2,24%**	**1,67%**	**-0,44%**	**-2,04%**

Source: Author's elaboration using the Eurostat Database

Table E: Patent intensity 3° Model - Between Model (with Country Dummies)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−1799.59	530.402	−3.393	0.0009	***
RDExpenditure	43.7742	8.65916	5.055	<0.0001	***
EmploymentRate	3.76451	2.42410	1.553	0.1230	
TertiaryEducation	−6.04494	2.54432	−2.376	0.0191	**
ln_Percapita_GDP	147.260	62.8993	2.341	0.0209	**
Manufacturing	10.6277	3.91380	2.715	0.0076	***
PST	8.56140	3.94299	2.171	0.0319	**
DCountry_Austria	−2.30224	51.3473	−0.04484	0.9643	
DCountry_Belgium	73.8317	54.5078	1.355	0.1781	
DCountry_Denmark	72.5763	65.5163	1.108	0.2702	
DCountry_Finland	75.6388	61.9594	1.221	0.2245	
DCountry_Germany	−31.1539	52.5787	−0.5925	0.5546	
DCountry_Greece	66.5801	59.0114	1.128	0.2614	
DCountry_Italy	−87.7979	52.3062	−1.679	0.0958	*
DCountry_Luxembourg	−41.1800	115.744	−0.3558	0.7226	
DCountry_Netherlands	−16.0702	43.4597	−0.3698	0.7122	
DCountry_Portugal	−5.03800	63.1074	−0.07983	0.9365	
DCountry_Spain	79.8047	62.0470	1.286	0.2008	

Mean dependent var	145.8649	S.D. dependent var	144.7160
Sum squared resid	965256.5	S.E. of regression	89.31588
R-squared	0.666012	Adjusted R-squared	0.619088
F (17, 121)	14.19346	P-value(F)	2.11e-21
Log-likelihood	−812.0069	Akaike criterion	1660.014
Schwarz criterion	1712.834	Hannan-Quinn	1681.479

Source: Author’s elaboration using the software GRETL

Table F: Patent intensity 4° Model - Fixed-effects Model

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−579.803	296.206	−1.957	0.0515	*
RDExpenditure	−2.60830	6.44998	−0.4044	0.6863	
EmploymentRate	−0.675797	1.63680	−0.4129	0.6801	
TertiaryEducation	−2.45971	1.32915	−1.851	0.0655	*
ln_Percapita_GDP	78.3628	33.1518	2.364	0.0189	**
Manufacturing	−0.546113	0.564733	−0.9670	0.3346	
PST	1.18536	0.763521	1.552	0.1219	

Mean dependent var	127.5069	S.D. dependent var	134.5160
Sum squared resid	87017.35	S.E. of regression	19.62225
LSDV R-squared	0.987003	Within R-squared	0.048214
LSDV F(144, 226)	119.1813	P-value(F)	3.4e-162
Log-likelihood	−1538.822	Akaike criterion	3367.645
Schwarz criterion	3935.494	Hannan-Quinn	3593.176
rho	−0.186310	Durbin-Watson	0.897462

Joint test on named regressors -
Test statistic: F(6, 226) = 1.90807
with p-value = P(F(6, 226) > 1.90807) = 0.080494

Test for differing group intercepts -
Null hypothesis: The groups have a common intercept
Test statistic: F(138, 226) = 44.0051
with p-value = P(F(138, 226) > 44.0051) = 2.80022e-114

Source: Author's elaboration using the software GRETL

Table G: Trademark intensity 3° Model – Random-effects Model (GLS)

	Coefficient	*Std. Error*	*z*	*p-value*	
const	−2112.97	258.220	−8.183	<0.0001	***
RDExpenditure	−10.6506	5.69766	−1.869	0.0616	*
EmploymentRate	−2.69090	0.959210	−2.805	0.0050	***
TertiaryEducation	4.35021	0.833593	5.219	<0.0001	***
ln_Percapita_GDP	226.423	29.6427	7.638	<0.0001	***
Manufacturing	1.06908	0.654694	1.633	0.1025	
PST	1.41066	0.851582	1.657	0.0976	*
CapitalRegion	132.026	45.6842	2.890	0.0039	***

Mean dependent var	164.6631	S.D. dependent var	209.0325
Sum squared resid	17749769	S.E. of regression	164.8693
Log-likelihood	−4302.382	Akaike criterion	8620.763
Schwarz criterion	8656.701	Hannan-Quinn	8634.693
rho	0.312149	Durbin-Watson	0.951353

'Between' variance = 20794.3
'Within' variance = 1049.42
mean theta = 0.883941

Joint test on named regressors -
Asymptotic test statistic: Chi-square(7) = 218.943
with p-value = 1.10577e-43

Breusch-Pagan test -
Null hypothesis: Variance of the unit-specific error = 0
Asymptotic test statistic: Chi-square(1) = 1587.69
with p-value = 0

Hausman test -
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(6) = 16.7448
with p-value = 0.0102684

Source: Author’s elaboration using the software GRETL

Table H: Trademark intensity 4° Model - Random-effects Model (GLS) (with Time dummies used for regression but not included – with Country Dummies)

	Coefficient	*Std. Error*	*z*	*p-value*	
const	−2379.29	201.419	−11.81	<0.0001	***
RDExpenditure	−6.73251	3.89763	−1.727	0.0841	*
EmploymentRate	−1.24354	0.793974	−1.566	0.1173	
TertiaryEducation	4.66632	0.754448	6.185	<0.0001	***
ln_Percapita_GDP	232.836	22.8712	10.18	<0.0001	***
Manufacturing	0.771932	0.637964	1.210	0.2263	
PST	2.34896	0.874404	2.686	0.0072	***
DCountry_Austria	192.953	29.0280	6.647	<0.0001	***
DCountry_Belgium	−0.972772	26.9208	−0.03613	0.9712	
DCountry_Denmark	17.9757	32.4600	0.5538	0.5797	
DCountry_Finland	−13.8937	32.1242	−0.4325	0.6654	
DCountry_Germany	82.1982	23.5768	3.486	0.0005	***
DCountry_Greece	105.368	31.2063	3.376	0.0007	***
DCountry_Ireland	124.653	50.0597	2.490	0.0128	**
DCountry_Italy	78.0111	28.1248	2.774	0.0055	***
DCountry_Luxembourg	1644.40	61.5876	26.70	<0.0001	***
DCountry_Netherlands	23.3943	25.9650	0.9010	0.3676	
DCountry_Portugal	176.281	32.3946	5.442	<0.0001	***
DCountry_Spain	95.0134	26.9583	3.524	0.0004	***

Mean dependent var	164.6631	S.D. dependent var	209.0325
Sum squared resid	2544433	S.E. of regression	62.95468
Log-likelihood	−3661.368	Akaike criterion	7360.737
Schwarz criterion	7446.089	Hannan-Quinn	7393.820
rho	0.312149	Durbin-Watson	0.951353

‘Between' variance = 2565.07
'Within' variance = 1049.42
mean theta = 0.687052

Joint test on named regressors -
Asymptotic test statistic: Chi-square(18) = 1744.87
with p-value = 0

Breusch-Pagan test -
Null hypothesis: Variance of the unit-specific error = 0
Asymptotic test statistic: Chi-square(1) = 514.837
with p-value = 5.62147e-114

Hausman test -
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(6) = 52.1095
with p-value = 1.77263e-09

Source: Author's elaboration using the software GRETL

Table I: Design intensity 3° Model - Random-effects Model (GLS) (with 1 year time-lags – with Country dummies – with Time dummies used for regression but not included because not significant)

	Coefficient	*Std. Error*	*z*	*p-value*	
const	−344.559	71.5325	−4.817	<0.0001	***
RDExpenditure_1	0.613531	1.20019	0.5112	0.6092	
EmploymentRate_1	0.390726	0.291581	1.340	0.1802	
TertiaryEducation_1	0.364496	0.295852	1.232	0.2179	
ln_Percapita_GDP_1	33.7272	8.17129	4.128	<0.0001	***
Manufacturing_1	−0.215549	0.180545	−1.194	0.2325	
PST_1	0.230949	0.249408	0.9260	0.3545	
CapitalRegion_1	−14.8792	6.50397	−2.288	0.0222	**
DCountry_Austria_1	15.4983	9.33986	1.659	0.0970	*
DCountry_Belgium_1	−11.0881	8.61753	−1.287	0.1982	
DCountry_Denmark_1	10.4539	10.1320	1.032	0.3022	
DCountry_Finland_1	−5.13922	10.1644	−0.5056	0.6131	
DCountry_Germany_1	−9.01810	7.35854	−1.226	0.2204	
DCountry_Greece_1	−5.19991	10.2383	−0.5079	0.6115	
DCountry_Ireland_1	−13.4707	15.2460	−0.8836	0.3769	
DCountry_Italy_1	1.58433	9.06722	0.1747	0.8613	
DCountry_Luxembourg_1	85.2390	20.0376	4.254	<0.0001	***
DCountry_Netherlands_1	−15.1645	8.06484	−1.880	0.0601	*
DCountry_Portugal_1	0.405206	11.3408	0.03573	0.9715	
DCountry_Spain_1	−9.99372	8.39934	−1.190	0.2341	

Mean dependent var	33.72464	S.D. dependent var	28.36899
Sum squared resid	187721.6	S.E. of regression	18.69692
Log-likelihood	−2426.569	Akaike criterion	4903.139
Schwarz criterion	5011.382	Hannan-Quinn	4945.402
rho	0.146285	Durbin-Watson	1.169690

'Between' variance = 260.926
'Within' variance = 64.2883
mean theta = 0.739786

Joint test on named regressors -
Asymptotic test statistic: Chi-square(24) = 236.367
with p-value = 8.17479e-37

Breusch-Pagan test -
Null hypothesis: Variance of the unit-specific error = 0
Asymptotic test statistic: Chi-square(1) = 436.202
with p-value = 7.26187e-97

Hausman test -
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(11) = 45.0091
with p-value = 4.83436e-06

Source: Author's elaboration using the software GRETL