The strategic use of patents and its implications for enterprise and competition policies

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Case study: Evidence on strategic patenting by using the PatVal -EU survey

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1. Executive Summary

This report was commissioned as a study into the strategic use of patents. In the course of its case investigations and legislative reviews the European Commission became aware of changes in the use of intellectual property, in particular the use of patents. It was noted that firms' uses of intellectual property are becoming increasingly strategic. This raised concerns about the implications of firms' patenting behaviour for enterprise and competition policy. The following report contains a comprehensive review of patenting behaviour, the extent to which patenting is becoming more strategic and the implications this has for competition and enterprise policies.

A surge in patent applications, "a patenting explosion", has been observed at the European Patent Office (E.P.O.) as well as at the patent office for the United States of America (U.S.P.T.O) and other patent offices world wide. Firms' patenting behaviour has changed in several industrial sectors. Most of these sectors draw on complex technologies. This means that final products embody a combination of a large number of patented technological advances. Most often a single firm does not possess all patents relevant to a final product. Strategic behaviour by rival firms supplying the same final product markets ensues: patent portfolios may need to be licensed, patents may be used to block rivals use of technology or to extract concessions. Strategic uses of patent portfolios are a new phenomenon flowing from the increased complexity of modern technology. Previously small patent portfolios could be used to protect an entire technology. Mobile telephony provides an example for the recent trend: the technical standards on which this technology is based contain hundreds of patents. These patents are owned by many different firms. Ongoing competition cases in this industry demonstrate the potential for strategic behaviour.

This study has two principal aims: first, to survey the existing economic literature on patenting so as to provide a grounded assessment of whether any kind of strategic use of patents is damaging to welfare and next, to provide an empirical survey of patenting trends in Europe which identifies patenting trends in different industrial sectors. Building on this analysis the report identifies which kinds of patenting and which sectors are most likely to require intervention using enterprise- or competition policy.

The report contains four principal sections. These are the description of the institutional setting (Section 2), a literature review (Section 3), an empirical investigation of patenting at the European Patent Office (E.P.O.) (Section 4) and a validation of the empirical findings based on two case studies (Section 5). Furthermore Section 6 contains policy conclusions derived on the basis of this work.

- Section 2 provides a discussion of international patent agreements such as the Patent Cooperation Treaty (PCT) as well as an overview over the patent systems of Europe, the United States and Japan. Furthermore this section contains a comparison of these patent systems.

- Section 3 contains a review of the theoretical literature on patent system design and of the literature on patent thickets and the patent explosion. Based on this review the section develops a theoretically grounded, analytical definition of the "strategic use of the patent system".

- Section 4 contains an in depth descriptive analysis of patenting trends at the E.P.O. based on data from the PATSTAT and EPASYS databases. These are described in the Appendix (Section 6).

- Section 5 contains additional analysis based on the PATVAL survey of patenting firms as well as a closer analysis of a specific industry.

- Finally Section 6 of the report contains policy conclusions. These are directed at Enterprise - and Competition Policy as well as the reform of the European Patent System as a whole.

The very extensive literature review in Section 3 has led to a definition of strategic use of the patent system focusing on patenting strategies that are leading to the "explosion" of patent applications which we observe in recent years. This patenting explosion has led to a fundamental revue of the functioning of the United States Patent system, which is documented in F.T.C. (2003). This development is also putting measurable strain on the way European patent systems, and the European Patent Office (EPO) in particular, operate. [1]

Drawing on the literature review in Section 3 this report sets out a definition of strategic use of the patent system as a form of patenting behaviour that may be anticompetitive. We define strategic use of patents narrowly:

Strategic use of the patent system arises whenever firms leverage complementarities between patents to attain a strategic advantage over technological rivals .This is anticompetitive if the main aim and effect of strategic use of the patent system is to decrease the efficiency of rival firms' production.

The definition is intended to help identify sectors and contexts in which enterprise or competition policy may be employed to counteract strategic patenting behaviour. The definition contains three requirements:

i) patents filed in a technology are *complements*;

ii) firms are building up *portfolios* of complementary patents;

iii) patent portfolios are *increasingly* employed to raise rival firms' costs of production.

If all three conditions are met then there is an increased likelihood of anticompetitive use of patent portfolios.

If a firm can demonstrate that the patents in its portfolio protect technology it is using, then the third condition is not met. If strategic patenting behaviour mainly affects rival firms' R&D incentives then the third condition is also not met. Such cases fall within the remit of innovation policy and patent law.

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[1] Compare the current discussion about the aims and means of operation of the E.P.O. of which E.P.O. (2007) provides a glimpse.

The definition of strategic use of the patent system identifies complex technologies in which patents are complements as a precondition for strategic use of the patent system. Patents are complements if the value of holding them jointly exceeds the sum of their individual values to different firms. In other words: patents are complements if they are more valuable when held in one patent portfolio. If a technology is complex the patents based on it are complements. Therefore, the definition excludes patenting activities in technologies that do not require a firm to own or license a portfolio of patents in order to use the technology, often referred to as discrete technologies.

The definition distinguishes between different aims of strategic use of the patent system in a complex technology: those that are anticompetitive and those that are not. The mere act of building a patent portfolio cannot be considered anticompetitive. This is also true of some discrete technologies in which firms have resorted to patenting very heavily. The use of a patent portfolio to exclude rival firms will usually just be the legitimate use of the exclusion right that defines a patent. However, firms can systematically employ patent portfolios and the procedures of the patent system to raise the production costs of their competitors. This is behaviour which we identify as damaging to welfare. Empirically we identify such behaviour by studying the way in which firms use the patent system itself. Typically, anticompetitive uses of a patent portfolio will be observable in the way which firms patent and seek to affect their rivals' patenting activities.

The definition of strategic use of the patent system does not cover all possible forms of anticompetitive activity which is connected to patents. In particular, anticompetitive use of the exclusion rights emanating from single patents is not covered. Such behaviour cannot be empirically identified by surveying patenting trends. Therefore, in this report we have sought to develop a coherent methodological approach for empirical work that focuses on strategic uses of entire patent portfolios. The methodology is focused on a clearly defined set of firm strategies. Implementing it we are able to deliver results on some very pressing issues.

Our review of the literature has shown that a *per se* test identifying anticompetitive behaviour in the patent system is not within reach at present. Neither the theoretical nor the empirical basis for such a test is currently given in economics. Furthermore there is no unified view on the basis for such a test amongst legal scholars either.

This leads us to a pragmatic approach to the problem of identifying possible antic ompetitive conduct within the patent system. This consists of a descriptive analysis of firms patenting behaviour which is informed by existing theoretical work on patenting.

Section 4 of the report provides a structured analysis of a set of indicators t hat jointly provide information regarding the amount of patenting, the quality of patents, strategic behaviour of patenting firms and the interactions between patenting firms in opposition. These indicators are constructed for a set of 30 technology areas and for the period between 1980 and 2002. Altogether these indicators provide a very comprehensive review of patenting trends at the E.P.O..

To support the empirical analysis of patent indicators Section 5 provides in depth analysis of patenting behaviou r in Europe based on the PATVAL survey of patenting firms. This survey contains information which allows us to infer how important different motivations for the use of patents are in different industries. The survey supports the main findings from the anal ysis of patenting behaviour at the EPO.

There are four general empirical findings from these two empirical sections:

i. The volume of patent applications and the length of patents ha ve increased substantially. This development is concentrated in specific t echnology areas. Strategic uses of patents are likely to be concentrated within these sectors.
ii. The complexity of firms' patent applications has increased noticeably in specific technology areas. Some of this may be due to attempts by firms to render the ex act coverage of patent applications opaque, which can confer strategic benefits.
iii. Various measures associated with the quality of patents show that patent quality is declining overall at the E. P.O.. This means that it is becoming less onerous to obtain

patents there. These findings are in accordance with much circumstantial evidence which we also cite below.

iv. There are three distinct patenting strategies which we can associate with the patenting behaviour of firms we investigate. Two of these strategies induce firms to build up large patent portfolios, but the uses of these portfolios differ by strategy.

These developments jointly imply that firms are obtaining more questionable patents than in the past. We argue that this development has social costs that affect both product market competition and innovation incentives.

We briefly describe the three patenting strategies we observe in the data using the indicators we analyze. Firms' patenting behavior is the result of several factors: R & D efforts, strategic considerations and the competitive environment. These factors are likely to differ across firms. It is therefore difficult to identify distinct patenting strategies clearly. Nonetheless, we describe very broadly three different strategies which we believe can be considered as candidates for such strategies (see Table A). While these are closely linked to the empirical analysis of patenting behavior on the level of technological areas and individual firms the strategies will not fit every firm subsumed under the strategies.

Based on the results from Section 4, we distinguish between strategies focusing on (i) "Portfolio Maximization", (i) "Portfolio Optimization" and (iii) "Protection of specific IP".

A strategy which describes larger firms active in technological areas like *Information Technology*, *Telecommunications* and *Electrical Engineering* is the attempt to maximize the coverage of the patent portfolio by increasing the number and breadth of patent applications. Often patents owned by different companies in these areas are relevant for the establishment of technological standards or interfaces. The strategy of "*Portfolio Maximization*" aims at improving a firm's situation in cross-licensing negotiations. It is well documented that in the technology areas mentioned above (which can be classified as complex technologies) cross-licensing agreements focus on granting access to a set of related technologies protected by a large number of different patents. Negotiations in these settings focus on a general comparison of the size of the relevant patent portfolios which protect the set of relevant technologies. Then licensing fees are determined relative to the size differences of the portfolios owned by the involved parties. Therefore, firms have a strong incentive to increase the number of patent applications while simultaneously putting less emphasis on the technological content and the legal validity of individual patents. This is reflected in a comparatively high fraction of marginal patents in patent portfolios. Moreover, as individual patents are rarely subject of licensing negotiations and firms are highly dependent on cooperation, firms pursuing a "*Portfolio Maximization*" strategy rarely use legal means of challenging individual patents as the benefit from invalidating single patents is low.

A second prototypical strategy could by termed "*Portfolio Optimization*". This patenting strategy is prevalent predominantly in areas like *Macromolecular Chemistry and Polymers*, *Organic Fine Chemistry*, *Pharmaceuticals and Cosmetics* or *Agriculture and Food*. This strategy also consists of increasing applications substantially. However here it is combined with frequent use of legal means like opposition proceedings to invalidate rivals' patents. In the technology areas mentioned above (which could broadly be classified as discrete technologies) independent technologies or technological solutions can be assumed to be more important than in complex technologies. Therefore, firms have a stronger incentive to achieve strong legal protection of those separate technologies. This is achieved by building strong protection provided by a number of closely related patents related to a single technical problem. This translates into a relatively high share of patents with shared priorities. The benefit from invalidating competitors' patents is higher in discrete areas. This leads to a comparably frequent usage of legal means like opposition proceedings. There is evidence that smaller firms face higher hurdles in these technology areas.

Table A

		Patenting Strategies		
		Portfolio Maximization	**Portfolio Optimization**	**Protection of specific IP**
Description		Firms try to increase the size of their patent portfolio by filing large numbers of patents. The share of marginal patents is comparably high while opposition/ litigious activities tend to be low.	Firms consequently build patent portfolios by constantly filing patents. IP protection is actively pursued by frequent opposition against competitors' patents.	Patenting behavior oriented on specific R&D output with less emphasis of strategic patent portfolio management. Share of marginal patents is comparably low.
Prevalent in		Telecommunications, Information Technology, Electrical Devices	Macromolecular Chemistry/ Polymers, Organic Fine Chemistry, Pharmaceuticals/ Cosmetics, Agriculture Food	Most remaining technology areas
Examples of firms		Broadcom, Infineon, Quallcom, NTT Docomo	L'Oreal, Beiersdorf, Schering, Henkel	n.a.
Indicator	**Section**			
Volume* of applications	4.2.1 & 4.2.3	very high	high	average
Use of opposition proceedings	4.2.4 & 4.5.2	below average	above average	average
Use of blocking patents	5.1	infrequent	frequent	average
Share of critical references per claim	4.3.2	average	high	average
Use of divisional patent applications	4.3.3	frequent filing of divisional applications	frequent filing of divisional applications	infrequent filing of divisional applications
Applications with shared priorities	4.3.3	average	above average	average

* Volume is applications multiplied by claims.

Portfolio Maximization and *Portfolio Optimization* differ chiefly in their occurrence in complex and discrete technology areas. This also explains the differing importance of opposition in these two strategies. In some technology areas such as *Biotechnology* the two strategies exist side by side as this technology builds on chemistry but increasingly shows signs of becoming a complex technology in which many different research tools covered by individual patents interact in the production of a single product.

A third prototypical patenting strategy that can be termed "Protection of specific IP" comprises the traditional use of patents. This patenting strategy is followed by firms that do not need to build up patent portfolios for strategic reasons. Therefore, many of the indicators with which we identify strategic use of patents will not provide any clear patterns. In such cases patent protection is sought in order to protect future income streams from the underlying invention. Similarly, competitors patents are challenged primarily if they pose a direct threat to the own R & D goals or to products sold by the firm.

The synthesis of the theoretical literature and our empirical research indicates that competition policy concerns are most likely to arise in those technology areas that fall under "Portfolio Maximization". Here the technology is complex, which implies that patents are complements and that licensing is very important. Firms will be in a position to hold up rivals and will interact strategically through the patent system to a greater extent than in other technology areas.

In Section 6 we discuss a number of policy measures that could be taken in response to the findings contained in the report. We recognize that the most suitable response to the trends we have identified relies on measures to change the way patenting is governed in Europe. As this report was specifically intended to cover also implications for policy areas connected to patenting, we investigate thoroughly the implications for enterprise and competition policy measures that derive from our work.

We find that there is scope for the following types of policy measures:

Enterprise policies that support small and medium sized enterprises (SME's) which are likely to be disadvantaged in the race for large patent portfolios. Such policies focus both on the development of own patent portfolios and more importantly on support for the costs of defending against patent litigation and hold-up. In particular we suggest the following policy measures should be further evaluated:

- Direct support to smaller companies which seek to patent but face high costs of doing so due to their small size. Such support should allow small companies to overcome the higher average costs of patenting which they face relative to larger firms.
- Indirect support to smaller companies which allows them to protect themselves against the threats of patent litigation by rivals holding disproportionately larger patent portfolios. The measures we propose here are intended to support firms which are harassed by litigation based on poor quality patents. This includes maintaining a centralised register of patent litigation, providing patent litigation insurance and strengthening incentives for patent review at an early stage, through patent opposition and third party review processes.

Competition policy measures

Competition policy must take account of the very different roles that patents play in the context of different technologies. In particular competition policy should recognize that patent protection does not have the same incentive effects for each kind of technology. In complex technologies firms often derive R&D incentives from lead time advantages or from customer relationships. In this context patenting is mainly a defensive activity, employed to prevent hold up or strengthen a bargaining position. This has several important implications for the practice of competition policy in the context of a complex technology:

- Competition policy should adopt a sectoral stance when evaluating questionable behaviour involving patents. In some sectors the invalidation of the exclusion right inherent in a patent may undermine R&D incentives while in others it may even strengthen them.
- Competition policy authorities should be able to reduce the scope of individual exclusion rights if this does not affect R&D incentives.
- Licensing practices will have important effects for firms' R&D incentives. This is particularly true in the context of complex technologies in which patent thickets arise. Patent thickets can only be unravelled with the help of licensing contracts. Economic

research highlights the complex effects for competition and R&D incentives that derive from different licensing practices. More research into and scrutiny of such practices is warranted in the context of complex technologies.

Patent system reform.

We outline a series of measures that would reduce the incentives for firms to build up large patent portfolios, where those contain largely spurious patents covering very marginal technological improvements. These measures would lower the costs that present patenting behaviour is imposing on society.

In particular we propose that:

- A series of measures which stem the tide of low quality patents be discussed and implemented at a European level. These include measures to realign the incentives of patent examiners and patent applicants.
- The governance of key institutions such as the EPO be reviewed in order to provide better institutional incentives for high quality in the patent system.
- Third party review mechanisms which reduce the likelihood of low quality patents being issued be introduced.

2. Description of the Institutional Setting

This section of the report is dedicated to a brief description of the institutional international and national settings in some of the world's most important patent systems. We start by outlining the history of harmonization of national patent systems through international treaties and agreements, giving particular attention to the Patent Cooperation Treaty and the TRIPS agreement. The subsequent sections then describe the institutional framework for patent application, examination, grant, opposition (where applicable) and litigation in the three largest patent systems and organizations: the European Patent Office, the US Patent Office and the Japanese Patent Office. We finally provide a short comparison, focusing on the most important differences between these patent offices.

2.1 International treaties and harmonization

A patent is the right to exclude others from making, selling, offering for sale, or importing the patent holder's invention; this right is granted in return for publication of the invention. Patents have been used as an institution to encourage inventive activity as early as in the 14th century in Venice. For the purposes of this study, we focus on attempts of international harmonization starting with the Paris Convention of 1883.[2]

2.1.1 The Paris Convention for the Protection of Intellectual Property

The oldest treaty related to patents is the Paris Convention for the Protection of Intellectual Property (1883). Before 1883, supranational arrangements in the field of intellectual property rights did not exist in Europe. Neither the premises nor the consequences of the different jurisdictions were recognized in other countries. It was due to growing international industrialization that a need for international validity of intellectual property rights was articulated

[2] For a short review of the historical development of patents as an institution, see Harhoff (2005).

at the end of the 19th century. As a consequence, in 1883 eleven countries[3] agreed to treat foreign patent holders like domestic patent owners; and that patent priorities could from that time onward be claimed internationally. The Treaty was revised at subsequent consultations and diplomatic conferences in Brussels on December 14, 1900, in Washington, D.C. on June 2, 1911, in The Hague, on November 6, 1925, in London, on June 2, 1934, in Lisbon, on October 31, 1958, and in Stockholm, on July 14, 1967 The Convention was amended on September 28, 1979. The Convention now has 170 contracting member countries .

The Paris Convention established - among other aspects - the patent priority system still in use in almost all national patent offices worldwide. If an applicant files a patent in a state that is a member to the Paris Convention, the applicant can within one year (the priority year) file patent applications based on this priority filing in other countries, claiming th e original filing date as the so-called priority date, i.e., as the effective filing date of the subsequent applications. Only inventions that were filed before the priority date will then be considered prior art to the filed application. The priority year gives applicant considerable option value – they may decide into which countries they want to carry their applications within the priority year. The relatively costly decision to file for patent protection into other national patent offices can be underta ken after relevant information has been taken into account. Under the Patent Cooperation Treaty (PCT, see section 2.1.2) this time period can be extended to 30 months. A second advantage of using the priority year fully is that the statutory term of patent protection is typically determined from the actual filing date (not from the priority date). The duration of protection in a foreign jurisdiction is therefore shifted by one year into the future.

Historically, the Paris Convention was a milestone in the g lobalization of commerce and trade. Besides establishing the priority system, it also establishes that foreign applicants are given the same rights as national applicants in any of the Paris Convention member countries.

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3 After a diplomatic conference in Paris in 1880, the Convention was signed in 1883 by 11 countries: Belgium, Brazil, France, Guatemala, Italy, the Netherlands, Portugal, Salvador, Serbia, Spain and Switzerland.

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2.1.2 The Patent Cooperation Treaty (PCT)

Negotiations on the PCT were concluded in 1970. The treaty was amended in 1970 and again modified in 1984. The PCT is open to states which are also party to the Paris Convention. Documents of ratification or of accession to the PCT must be deposited with the Director General of WIPO, the World Intellectual Property Organization.

The PCT allows patent applicants to see protection for an invention in a large number of countries by filing an “international application.” The filing can be made with the national patent office of the contracting State of which the applicant is a national or resident . Alternatively, it may be made with the International Bureau of WIPO in Geneva. If the applicant is a national or resident of a contracting State which is party to the European Patent Convention, the Harare Protocol on Patents and Industrial Designs (Harare Protocol) or the Eurasian Patent Convention, the international application may also be filed with the European Patent Office (EPO), the African Regional Industrial Property Organization (ARIPO) or the Eurasian Patent Office (EAPO), respectively.

Strictly speaking, a PCT filing is not a patent application, but grants the filing party the option to launch patent applications in up to 115 (as of April 1, 2002) PCT signatory countries within 30 months of the filing date (which becomes the priority date). Any patent application already filed can be turned into a PCT filing within the priority year. PCT filings are advantageous for applicants for several reasons. First, they allow the expansion of patent protection to a large number of countries without incurring the full costs and complexity of national application paths. Second, applicants will receive an international search report within a relatively short time period, informing them about prior art that may be relevant for the own application's likelihood of being granted. Third, the PCT filing, when compared to a national or regional application has a greater option value, since it allows applicants to delay decisions about the countries for which they want to designate the application for up to 30 months after the priority date. Costly decisions can thus be deferred for 30 months (and not just for the duration of the priority year, as with national and regional applications).

PCT filings can also receive a preliminary international examination which is authoritative, but not binding for the national or regional offices finally granting the patent. Applicants have to file the demand for the international examination within 4 months after the publication of the search report. The World Intellectual Property Organization (WIPO) also claims that "(...) any patents subsequently granted by the national or regional Offices on the international application can be relied on by the applicant to a greater extent than would have been the case without the benefit of the international search report and the international preliminary examination report' implying a greater legal certainty for PCT applications than for other applicati ons." Finally, PCT applications are not subject to particular cost rules, e.g., claims fees as they exist at the EPO and the USPTO.

Details on the PCT are available in the PCT Applicant's Guide and in the PCT Newsletter, both published by WIPO.[4] Due to flexibility and low costs, PCT filings have become extremely popular. In 1979, 2,625 international applications were filed with the International Bureau. In 2003, the number had risen to 110,065. Figure 2.1 summarizes the timeline for PCT filings.

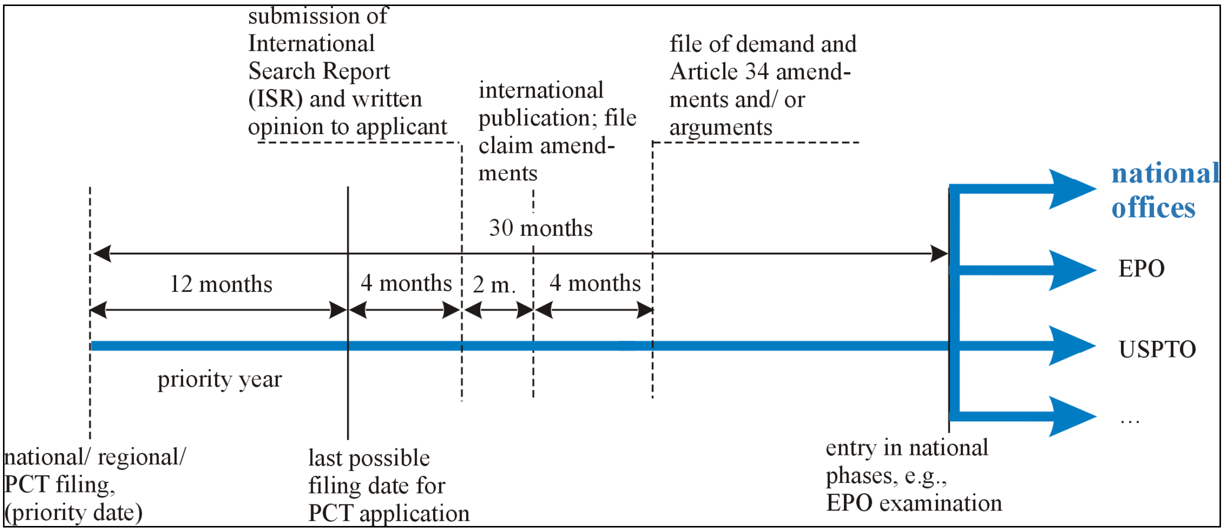

Figure 2.1: Timeline for PCT filings (Source: Harhoff and Wagner (2005))

[4] See http://www.wipo.int/pct/guide/en/index.html and http://www.wipo.int/pct/en/newslett/index.htm , respectively.

2.1.3 The European Patent Convention (EPC)

After the initial enactment of the Paris Convention and subsequent revisions, no further need for legal harmonization was felt until the end of the Second World War. The efforts of the European Economic Community (EEC) towards trade liberalisation and the establishment of a common market in Europe led to the *Patent Convention of Strasbourg* in 1963. The significance of this treaty lies in the alignment of terms of material patent law, such as novelty or inventive step.

It was followed by the rectification of the *Patent Convention of Strasbourg in 1963*, and the conclusion of the *European Patent Convention* in Munich in 1973. We focus here on the second convention, as the Strasbourg Convention led to the EPC and the establishment of a European patent organization. This alignment of material right terms in the different national legislation was a necessary step towards the conclusion of the *European Patent Convention (EPC)* in 1973. The EPC is nowadays the most important source of common European patent law. As a special agreement referring to the *Paris Convention for the Protection of Industrial Property in 1883* it regulates the filing and granting process of common European patents. It covers both, formal and material aspects of patent law. EPC member states acknowledge with their accession to the treaty that centrally examined and granted European patents are given the same validity as nationally granted patents. The EPC also stipulates that granted European patents can be centrally attacked via opposition, i.e., in a procedure comparable to a "first-instance challenge suit" in the United States. In opposition proceedings (see section 2.2.3 for details), any third party may challenge the granting decision of the EPO. As a consequence, the opposition may be rejected or the challenged (opposed) patent may be revoked or amended (i.e., narrowed).

While the PCT facilitates the organization of patent filing and prior art search from the applicant's perspective, it still leaves examination and grant to the national offices. The European Patent Convention goes considerably further by giving applicants access to a harmonized filing and examination process. An applicant files a single European Patent Application and indicates the designated countries in Europe in which he wants to achieve patent protection. The examination decision of the EPO is then accepted by all EPC member nations. We provide more details on the EPC below in our discussion of the EPO as the patent office executing the convention.

2.1.4 The TRIPS (Trade-Related Aspects of Intellectual Property Rights) Agreement

The TRIPS Agreement is Annex 1C of the Marrakech Agreement Establishing the World Trade Organization (WTO) and was signed by its signatory states in Marrakech, Morocco on 15 April 1994.[5] TRIPS defines minimum standards for most forms of intellectual property (IP) protection for all member countries of the WTO. It was negotiated at the end of the Uruguay Round of the GATT (General Agreement on Tariffs and Trade) treaty. Leaving aside the specific regulations for IPRs such as copyright, geographical indications, industrial designs, integrated circuit designs, patents, plant varieties, trademarks, trade dress, trade secrets and others, TRIPS also details minimum standards of enforcement procedures, remedies and dispute resolution procedures. While the obligations under TRIPS apply to all member states, developing countries have been given an extended time frame for compliance. The originally agreed upon transition period for developing countries expired in 2005. The transition period for the least developed countries was extended to 2016. Some observers expect that it might be extended even further.[6]

TRIPS has proven highly controversial in particular w.r.t. the implementation of IPR minimum standards in developing countries, some of which had not granted patent protection in important technical fields such as pharmaceuticals (see Reichmann 2000). For patents in developed countries, the significance of TRIPS lies in the fact that according to TRIPS, patents must be granted in all "fields of technology," although exceptions for certain public interests are allowed (Art. 27.2 and 27.3). This stipulation has played some role in the European debates on patent protection for "computer-implemented inventions".

2.2 The European Patent System[7]

This section reviews the institutional setup of patent application, search for prior art, examination, grant, oppositions and appeals at the European Patent Office (EPO).

[5] See http://www.wto.org/english/tratop_e/trips_e/t_agm0_e.htm .
[6] See Reichmann (2000) for a detailed assessment of TRIPS.
[7] This section uses passages from Harhoff and Wagner (2005), Harhoff (2005), Hall and Harhoff (2004) and from Webb, *et al.* (2005).

2.2.1 *Application*

Patent protection for European member states can be obtained by filing several national applications at the respective national patent offices or by filing one EPO patent application at the European Patent Office. The Convention on the Grant of European Patents, enacted in 1973 and typically referred to as the European Patent Convention (EPC), is the legal foundation for the establishment of the EPO. [8] The EPO provides a supra-national application and granting procedure to its applicants. Patents granted by the EPO attain the same legal status as patents granted by the various national offices in the EPC signatory countries. EPO patent grants are issued for inventions that are novel, mark an inventive step, are commercially applicable, and are not excluded from patentability for other reasons. [9]

The EPO application designates the EPC member states for which patent protection is requested. On average, the cost of a European patent amounts to about 29,800 EURO, roughly three times as much as a typical national application. [10] As a rule of thumb, if patent protection is sought for more than three designated states, the application for a European patent is less expensive than independent applications in several jurisdictions. This cost advantage has made the European filing path particularly attractive for applicants whose profits depend on selling goods and services in more than one European market. Figure 2.2 summarizes the development of applications and grants between 1978 (when the first European applications were accepted by the EPO) and 2004. The first patent was granted by the EPO in 1980. [11]

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[8] The full text of the convention is available at http://www3.european-patent-office.org/dwld/epc/epc_2000.pdf. While the EPC constitutes the legal foundation for the EPO and its patent examination activities, the actual process of examination in practice is detailed in the Guidelines for Patent Examination in the European Patent Office. See the EPO (2003). Guidelines for Examination in the European Patent Office. http://www.european-patent-office.org/legal/gui_lines/pdf_2003/index.html (Download on Nov. 1st, 2004). The Guidelines give a detailed account of the search for prior art (Part B), the substantive examination (Part C) and opposition (Part D).

[9] See Article 52 EPC.

[10] As in other patent systems, the official patent office fees are a relatively small part of the costs. For a patent that issues in eight EPC countries and lapses after 10 years, the office fees are 4,300 €. Professional representation before the EPO amounts to 5,500€ on average, while translation into the languages of eight contracting states requires 11,500€. National renewal fees (to be paid from year 5 to year 10) amount to roughly 8,500€. See "Cost of an average European patent as at 1.7.99", http://www.european-patent-office.org/epo/new/kosten_e.pdf (Jan. 14, 2004).

[11] Example: 48,074 applications with priority year 1987 were filed at the EPO. By April 2006, 30,676 applications from this cohort had been granted. Only PCT applications which actually entered the regional phase at the EPO are treated as applications here. Since designating the EPO as a target patent office under the PCT is virtually costless to applicants, treating all PCT applications as actual EPO applications introduces serious misconceptions. Note that parties filing PCT applications have up to 30 months after the priority date to enter the regional phase at the EPO.

2.2.2 *Examination*

The determination whether an invention for which patent protection is applied for is patentable subject matter consists of a search for prior art followed by an examination of the invention with regard to the criteria of patentability. A first starting point for a discussion of search procedures at the European Patent Office can be found in the examination guidelines published by the EPO [12]. The *Guidelines for Examination in the European Patent Office* became effective on 1 June 1978 and have been updated regularly since then. Following a general section, the guidelines are divided into five sections comprising among others, guidelines for formalities examination, guidelines for search, and guidelines for substantive examinat ion. Formalities examination involves checking formal requirements, e.g., the completeness of the application documents.

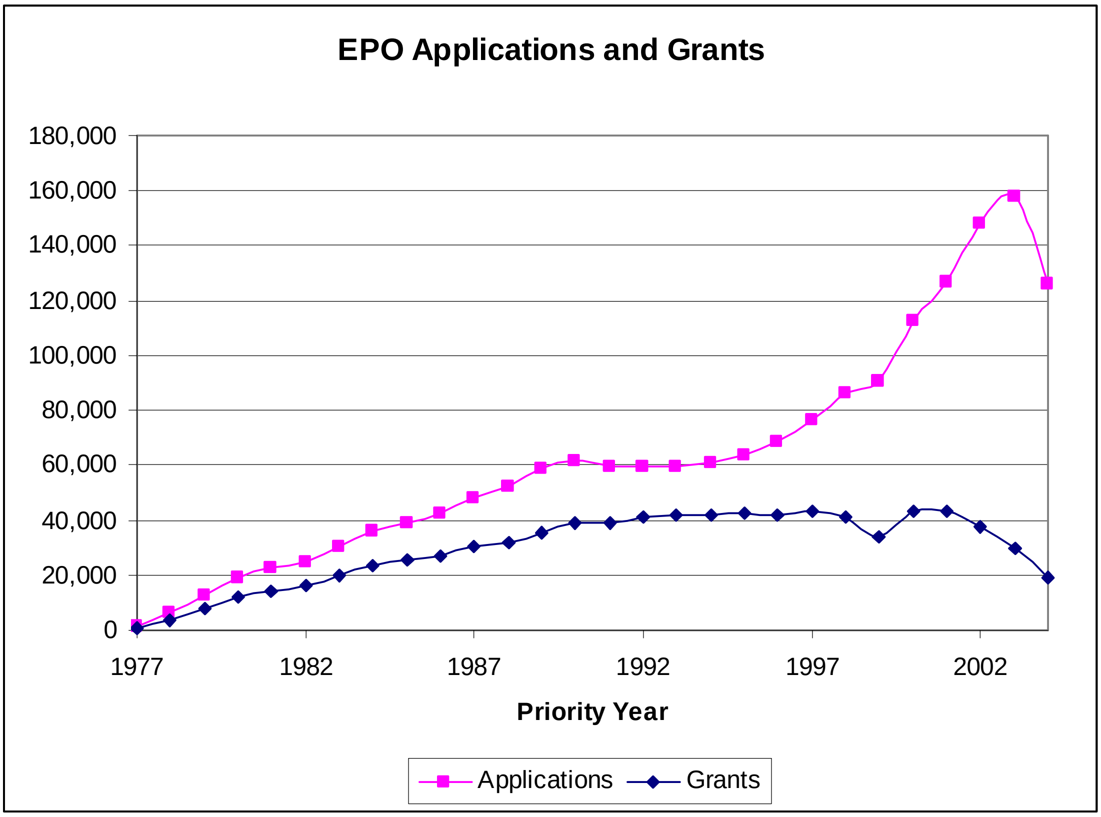

Figure 2.2: EPO patent applications and grants by priority year - 1977 to 2004

Therefore, there are considerable time lags – for the application cohort of 2004, the full statistics was available by the end of 2006. However, the EPASYS data we use only cover the time period to April 2006. The drop in grants in 1999 priority year applications is not an artifact but reflects the reduc ed granting activities in 2000/01.

[12] See http://www.european-patent-office.org/legal/gui_lines/pdf_2003/gui_03_full_e.pdf .

The search process seeks to identify patent and non -patent documents constituting the relevant prior art to be taken into account in determining whether the underlying invention is new and involves an inventive step. The objective of the substantive examination, finally, is to decide whether the invention meets the requirements for patentability: novelty, inventive step, and commercial applicability. Especially important for citation analysis is the search section of the *Guidelines* because European citation analysis use references to patent and non -patent literature derived from the EPO's search report. In order to enable appropriate use and interpretation of citation data, the European search and citation procedure underlying the EP search reports is described in the following paragraphs.[13] Figure 2.3 contains a simplified representation of the process of examination at the EPO.[14]

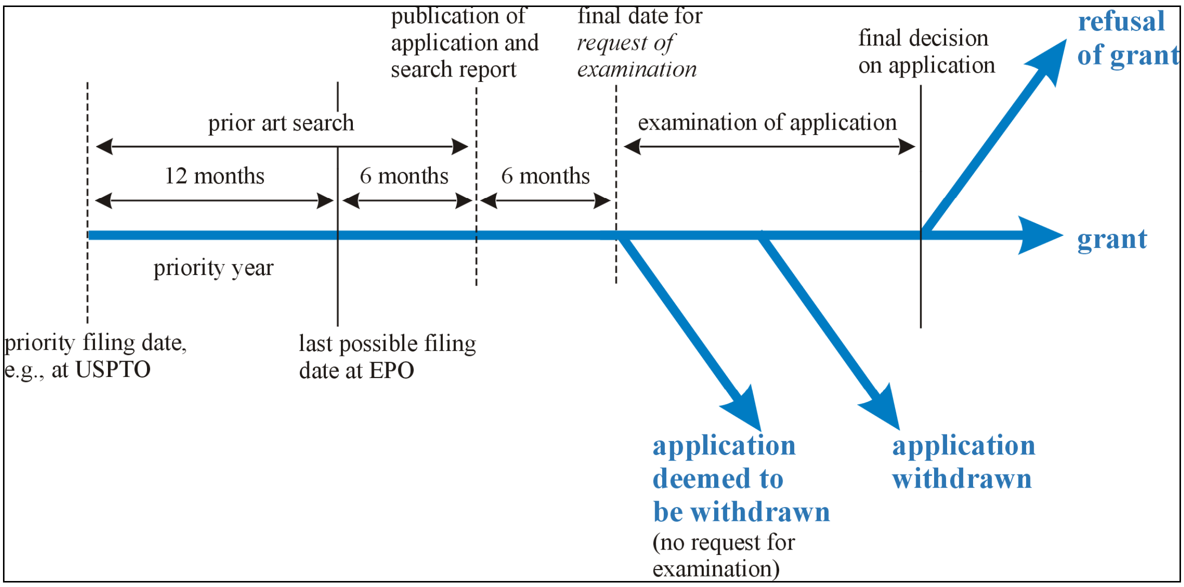

Figure 2.3: Simplified representation of the process of patent examination at the EPO (Source: Harhoff and Wagner (2005))

In this section, we describe the search process in great detai l for two reasons. First, this process lies at the heart of relating one patent to prior art. Deficiencies in the search process will limit the quality of subsequent steps and may ultimately lead to strong litigation activity. Second, since we

13 The following description of th e European Search Procedure is largely based on the *Guidelines for Examination in the European Patent Office* (EPO, 2003).

14 The timing of examination processes for the JPO and USPTO is explained in section 2.3 and 2.4.

will use citation data frequently in the course of this project on strategic patenting, it is tantamount to study how these indicators come about and from which data they are derived.

Overall responsibility for the search lies with the Directorate General for Search ing, located in The Hague. European searches are carried out by the Search Divisions of the EPO but may also take place in the national patent offices of certain contracting states [15]. The search should be directed to the most important characteristics of th e invention and is, therefore, conducted on the basis of the claims. The patent claims describe the scope of protection for which patent protection is designated. According to the guidelines, the examiner should carry out the search focusing primarily on novelty. At the same time he should pay attention to any document that may be important for the inventive step requirement as well as for other reasons, such as conflicting applications or documents facilitating the understanding of the underlying invention . The prior art search should be continued until the probability of discovering further relevant documents is very low in relation to the effort needed – a decision which is made by the examiner during the course of patent examination. The search may also be terminated when documents have been discovered which doubtlessly demonstrate a violation of novelty of the claimed invention. We note in passing that the prospective value (private or social) of an invention is not taken into account in determining the search effort.

After completion of the search, the examiner has to select the documents to be cited in the search report. The report should only include the most important documents. In case the search results in several documents of equal relevance, the search report should normally contain no more than one of them. The decision, on which one to use for citation, is made according to the expert knowledge of the examiner. In case of two documents, which are of equal relevance, one document published

[15] National patent offices are entrus ted, e.g., in case searches in documents in languages other than the official languages of the EPO are required. The *Protocol on Centralisation* as of 5 October 1973 (section IV(2)(a)) states "If the Administrative Council considers that it is compatible wi th the proper functioning of the European Patent Office … it may entrust searching in respect of European patent applications to the central industrial property offices of those States in which the official language is one of the official languages of the European Patent Office, provided that these offices possess the necessary qualifications for appointment as an International Searching Authority in accordance with the conditions laid down in the Patent Cooperation Treaty ", see: http://www.european-patent-office.org/legal/epc/e/ma3.html#CEN . The EPO also conducts searches for national offices. The share of national searches in 2003 amounted to 11% of the total searches (158,631), see: http://annual-report.european-patent-office.org/2003/_pdf/epo_anrep03.pdf . Information generated in these searches is not considered here, with the exception of the EPO acting as an *International Search Authority* (ISA) within the PCT/WIPO system.

before the date of priority and the other published between priority date and filing date, the search examiner should choose the earlier one. Michel and Bettels (2001) state that "(...) according to the EPO philosophy a good search report contains all the technical relevant information within a minimum number of citations." Frequently, the relevant information is obtained f rom one to two documents (Michel and Bettels (2001), 189). Citing no more than what is absolutely necessary can lead to an understatement of certain documents. Additionally, the examiner is obliged to favour early documents over later ones.

One major advantage of the EPO citation data over the USPTO citation data is the assignment of references to certain categories. All documents cited are identified by a particular letter in the first column of the search report representing the cited catego ry (combinations are possible) bearing the following meaning:

X	particularly relevant documents when taken alone (a claimed invention cannot be considered novel or cannot be considered to involve an inventive step)
Y	particularly relevant if combined wit h another document of the same category
A	documents defining the general state of the art
O	documents referring to non -written disclosure
P	intermediate documents (documents published between the date of filing and the priority date)
T	documents relating to theory or principle underlying the invention (documents which were published after the filing date and are not in conflict with the application, but were cited for a better understanding of the invention)
E	potentially conflicting patent documents, published on or after the filing date of the underlying invention
D	document already cited in the application
L	document cited for other reasons (e.g., a document which may throw doubt on a priority claim)

Table 2.1: Classification of references creat ed during the examination of an application at the EPO (EPO Guidelines for Examination in the European Patent Office, 2003, 176ff)

X-type references are the most important ones as to patentability of an invention. In case an application contains an X classified reference, this indicates that the claimed invention does not meet the requirements of novelty or of inventive step. In the search report, the search officer or examiner actually indicates to which claims of the application the prior art applies to in a critical way. Type A references merely provide technical background information. The frequency distribution of the most important reference types is summarized in Table 2.2.

Publication Year	**A**	**Y**	**X**	**Other (not coded)**	**D**
1978	38.5	0.0	16.7	44.8	6.0
1979	21.2	0.0	7.6	71.1	3.7
1980	13.4	0.0	6.1	80.5	1.8
1981	19.3	1.0	6.6	73.1	3.1
1982	36.3	8.2	9.3	46.2	4.7
1983	58.3	15.0	12.7	14.0	8.1
1984	52.9	13.4	12.0	21.6	7.3
1985	54.3	13.9	12.6	19.2	7.5
1986	53.0	13.8	12.8	20.5	7.4
1987	53.5	14.0	13.1	19.4	7.6
1988	55.3	13.7	13.6	17.4	8.3
1989	57.0	14.3	14.3	14.3	8.4
1990	59.5	14.6	15.2	10.7	8.6
1991	60.0	14.8	15.7	9.4	8.2
1992	63.4	16.1	17.7	2.8	8.0
1993	63.2	16.3	18.7	1.7	7.8
1994	62.8	16.0	20.0	1.2	8.9
1995	62.0	15.7	21.4	0.9	8.8
1996	61.0	15.7	22.5	0.9	8.7
1997	60.0	15.6	23.4	1.0	8.6
1998	58.7	14.9	25.3	1.1	8.2
1999	56.9	15.0	27.1	1.1	7.9
2000	53.9	15.3	29.6	1.1	7.5
2001	51.1	15.7	31.9	1.3	7.0
2002	49.8	15.3	33.6	1.4	6.8
2003	47.7	16.9	34.4	1.0	6.5
2004	46.1	16.9	36.2	0.9	6.7
2005	47.4	13.7	37.9	1.0	7.2
TOTAL	**54.0**	**14.8**	**23.4**	**7.8**	**7.5**

Note: The shares of X, Y, A and other (uncoded) references sum to 100%. D -type references can occur together with A, X, Y or other (uncoded) references.

Table 2.2: Classification of EP patent references 1978-2005 (Source: Webb, *et al.* (2005))

In case an invention is protected in more than one country and, therefore, several documents exist belonging to the same patent family, the examiner should preferably cite the patent document in the language of the application. Paying regard to language convenience on the part of the examiner may lead researchers to overestimate the influence of the applicant's home country. In this regard, Michel and Bettels (2001) show that 90% of the total number of patent citations made by the EPO refer to EP, DE (German), GB (British), WO (PCT), or US patent documents. At the USPTO and the JPO, 90% or more of the references in the search reports refer to national documents. The EPO Search Division cites only documents to which it has access. This procedure may also result in an understatement of the documents relevant to prior art. In particular, should relevant non-patent literature not be accessible in databases or arranged in the library of the EPO, it is likely to be missed in the search report.

The Search Division does not attempt to verify the claimed priority date, but takes the date of filing of the EP patent application as a reference date for the search. This approach is conservative, but it may lead to the inclusion of subject matter in the search report that has emerged after the relevant priority date. In some exceptional cases, documents published after the filing date may be cited. Examples are a later document containing the principle of a theory underlying the invention, which is instrumental in better understanding the invention, or a later document showing that matters of the invention are incorrect. These documents could also be chosen for citation in the search report. Cited documents that were published after the filing or priority date may lead to negative citation lags[16], depending on how lags are being computed. However, such documents are used to provide general information about the technical field. They are unlikely to contain "hostile" content that would threaten the novelty or inventive step of the application under inspection.

Documents cited by the applicant should be considered in the search report if they are decisive as to the state of the art, or when they are necessary for the understanding of the application. Citations which do not fulfil these requirements may be disregarded. Verbeek, Zimmermann and Andries (2002) describe the difference between examiner and applicant citations as follows: Whereas the examiner has to ensure the novelty of an invention, the inventor aims at identifying work "either

[16] „Citation lag" denotes the difference between the application dates of a patent referring to another patent. In general, patents referring to other patents are issued later and hence the difference is usually positive.

related to, but significantly different from, or else a useful step towards, the new invention or a use of the invention" (Collins and Wyatt (1988) cited according to Verbeek, Zimmermann and Andries (2002)). "Examiner citations, as a result, usually complement, rather than duplicate, the citations given by the inventor" (Verbeek, Zimmermann and Andries (2002)). Nevertheless, both examiner and inventor could refer to the same publications.

A survey of the uses of patent citations in econometric studies has been provided by Webb, *et al.* (2005). These authors also tabulate the classification of reference types by publication year which we replicate in Table 2.2. They also discuss special features of the EP citation data that should be taken into account before interpreting the data. In particular, a one-to-one transfer of the results stemming from studies which analyzed US citation data is not possible. The citations in a USPTO document are generated according to a different regulatory framework. The US system requires the patent applicants to cite *all documents relevant for the examination* of their patent application. A consequence of this regulation is that (1) USPTO patents contain a higher number of references to previous patents than EPO patents (since this regulations induces applicants to cite any loosely related patent and not only relevant documents) and that (2) a large fraction of the references in a USPTO patent are made by the applicant while this is not true for EPO patents.

Within six months after the announcement of the publication of the search report in the EP Bulletin, applicants can request the examination of their application. This request is a necessary prerequisite for the patent grant at the EPO. If examination is not requested, the patent application is deemed to be withdrawn. After receiving a possibly negative search report, many applicants either withdraw the application explicitly or simply fail to request examination. After examination has been performed, the EPO presents an examination report. At this point, the EPO either informs the applicant that the patent will be granted as specified in the original application or requires the applicant to agree to changes in the application that are necessary to grant the patent. In the latter case, a kind of negotiation process in which applicant and examiner exchange written statements and suggestions may ensue. Once the applicant and EPO have agreed on the specification of the patent, the patent is granted by the EPO. The applicant has then the right to validate the patent in each of the designated states where the patent is translated into the relevant national languages.[17] If the EPO declines to grant a patent, the applicant may file an appeal.[18] On average, the issue of a European patent takes about 4.2 years from the date of filing the application (Harhoff and Wagner (2005)). However, applicants can file a costly request for accelerated examination of their application which reduces examination times by 18% on average (Harhoff and Wagner (2005)).

2.2.3 Opposition and appeal[19]

The European Patent Convention (EPC) is also the regulatory framework governing post grant validity challenges which can be filed within the European Patent Office. Part V of the EPC (Articles 99 to 105) provides the foundations for the opposition procedure; Part VI of the EPC (Articles 106 to 112) describes the appeal process.[20] According to Art. 99, any third party may file an opposition against the patent grant within nine months after the grant of a patent by the EPO. The opposition may even be filed if the patent was never taken out in any of the designed EPC countries for which the EPO had granted it. The decision regarding the opposition has force in all designated EPC countries, and the opponent is involved in the proceedings as an *inter partes* participant – this provision makes the European opposition mechanism quite attractive for any potential challenger.[21] Art. 100 lists the admissible reasons for an opposition: i) that the subject matter is not patentable, i.e., that the three criteria of novelty, inventive step, and commercial applicability are not met, ii) that disclosure of the invention is not sufficient to enable somebody skilled in the art to perform the invention, iii) that the scope of the patent as granted exceeds the scope of the original patent application. Art. 101 describes the potential outcomes of the opposition proceedings – the patent may be revoked according to Art. 101 (1), the opposition may be rejected

[17] Validation is not automatic. Since naming an additional designated country in the EPO proceedings is relatively inexpensive, many applicants use the option to do so and decide about the regional scope of protection once the patent has been granted by the EPO. Validation of patents has not been studied analytically, Most deviations from the initially declared designation and the later validation occurs for smaller EPC countries.

[18] See Article 106 EPC. Any decisions made by the EPO receiving, examining, opposition sections and legal division can be appealed and the appeal has suspensive effect.

[19] Parts of this section of the paper are drawn from Graham, *et al.* (2003).

[20] For more detailed comments, see Harhoff (2005). Part VI of the EPC deals with appeals at the EPO in general, i.e., with appeals against the examiner's decision to refuse a patent grant and any other decision, such as the ruling of the opposition boards.

[21] However, note that the opposition mechanism at the German Patent Office (where rulings are valid for Germany only) has been utilized about as frequently as the EPO opposition mechanism in the past. We note this because the National Academy Report appears to suggest that a national US post-grant mechanism would be used less frequently than the EPO mechanism. We do not think there is enough evidence to support that presumption.

following Art. 101 (2), or the patent may be amended, i.e. narrowed, according to Art. 101 (3). In the latter case, a modified patent grant will be published by the EPO. The costs of opposition and appeal are born by each party following Art. 101 (4). However, Art. 101 (5) permits the opposition division to deviate from this cost allocation if it wishes to do so. Our interviews indicate that this is rarely the case so that typically, the costs of opposition are born by each of the parties themselves.

According to Art. 19 (2), the Opposition Division responsible for hearing the opposition case consists of three technical examiners, at least two of whom have not taken part in the examination. Moreover, the examiner may not be the chairman of the division. The opposition chamber may conduct oral proceedings, and it can be enlarged – if necessary – by a legally qualified examiner who has not taken part in the proceedings for grant of the patent. A number of additional procedural details are described in the *Implementing Regulations to the Convention on the Grant of European Patents* which accompanies the European Patent Convention.[22] It is important to note that the settlement options between the opponent and the patent-holder are seriously restricted once the opposition case has been filed. Rule 60 of the Implementing Regulation states that the EPO may pursue an opposition case of its own motion if either the patent has lapsed, if the opposition has been withdrawn by the opponent, or if the opponent has been legally incapacitated.

Opposition is a frequently used mechanism in Europe. In Table 2.3, we document the frequency of opposition for all patent grants occurring between 1980 and 2000. A total of 7.2% of all granted patents was opposed between 1980 and 2005, and roughly one third of these cases were then continued by an appeal. The median duration is about 1.9 years for opposition and 2.0 years for appeal cases. Getting to legal certainty for patents filed at the EPO is therefore a lengthy process – the median duration of examination is about 4 years, and for contested patents, another 4 years are needed to sort out the opposition and appeal cases.[23] Across technology areas, there is relatively little variation in opposition and appeal rates; moreover, the durations do not vary strongly, with the exception of cases involving chemistry patents for which the appeal stage takes 2.6 years at the median.

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[22] See http://www.european-patent-office.org/legal/epc/ for the text of the EPC and the implementation rules.

[23] It should be noted that a large part of the delay in the resolution of these cases is due to the applicants themselves exhausting existing time limits for written responses in the course of the proceedings.

Year of Patent Grant	Patent Grants	Oppositions	Opposion Rate
1980	1495	153	10.23%
1981	5569	567	10.18%
1982	8381	782	9.33%
1983	12718	1159	9.11%
1984	15666	1408	8.99%
1985	16573	1508	9.10%
1986	19300	1715	8.89%
1987	20054	1615	8.05%
1988	22184	1748	7.88%
1989	24649	1836	7.45%
1990	26614	1900	7.14%
1991	31454	2165	6.88%
1992	32661	2006	6.14%
1993	44181	2764	6.26%
1994	44122	2585	5.86%
1995	43948	2568	5.84%
1996	42273	2500	5.91%
1997	36098	2172	6.02%
1998	39480	2270	5.75%
1999	37078	1962	5.29%
2000	22080	1231	5.58%
2001	47396	2289	4.83%
2002	66009	3194	4.84%
2003	59610	2867	4.81%
2004	60073	2831	4.71%
2005	63933	775*	1.21%“
Total	**843599**	**48570**	**5.76%**

Table 2.3: Frequency of opposition for all patent grants between 1980 and 2005 (* truncated)

The opposition and appeal mechanism would not be remarkable if it did not lead to major changes to the preceding examination decision. Roughly one third of the patents (34.7%) are revoked, and in roughly another third (32.7%) the patent is maintained in amended form, i.e., its scope or breadth is narrowed in the opposition or appeals procedure. Only 27.4% of all cases lead to a clear rejection of the opposition. In 5.3% of all oppositions, the case is closed without yielding any of the three outcomes discussed so far. This result of the proceedings can be caused by a withdrawal of the opposition by the opponent, or it may be due to the patent -holder letting the patent lapse by not paying the renewal fees. Hence, this outcome may reflect some cases that were successful from the attacker’s point of view (the patent lapsed into the public domain) while others represent successes for the patent holder (the opposition was dropped). It may be also be the case that some informal agreements between opponent and patent-holder are captured by this classification. But note that this implicit settlement rate would be far from the settlement rate of about 90 percent in US patent litigation cases (Lanjouw and Schankerman (2001)).

Another major difference between EPO oppositions and US patent litig ation concerns the costs. While there are no official statistics that capture the cost information in a representative manner, interview data obtained in discussions with patent attorneys give a consistent picture. The cost per instance and per party is on the order of 15,000€ to 25,000€. This is considerably less than the amount of $4 million which has to be paid for getting to a Markman Ruling [24] in US patent litigation.

Another aspect of opposition that has been addressed in work by Harhoff (2005) , Harhoff and Reitzig (2004), Graham*, et al.* (2003), and Hall*, et al.* (2003) concerns the selection of cases for opposition. The results can simply be summarized as follows:

- particularly valuable patents are selected with higher likelihood than less valuable ones;
- patents in fields with technical and market uncertainty are attacked more frequently than patents in more established fields;
- patents with immediate market impact are more likely to be attacked;
- patents of independent inventors are attacked *less*, not more frequently than corporate patent applicants.

The first result confirms that opposition at the EPO has a screening property – particularly valuable patents are more likely to be opposed than relatively low -value ones. If we assume that the

[24] In 1996, the Supreme Court decided on the case of Markman v. Westview Inst ruments Inc. The effect of the Markman decision was to add (in many cases) a pretrial phase to litigation . In this phase the parties would discuss the meanings of key terms and phrases found in patent claims. The "Markman Ruling" is now considered a crucial step in patent infringement assessment, in which the judge determines the scope of the patent claims. Settlement decisions are often taken following the Markman Ruling. Hence the cost figures apply even to cases in which settlement solutions are pursued.

potential welfare losses (due to excessively broad patents) are particularly large in the case of privately valuable patents, this empirical result is very reassuring. The last result is particularly important given that the U.S. independent inventor lobby has voiced concerns that a post -grant mechanism may threaten financially weaker patent holders. For the EPO oppositio n mechanism, this is clearly not the case. So far, the results indicate that the EPO opposition mechanism can produce a large number of error corrections of earlier examination decisions. Given that an EPO examiner has considerably more time on average to examine a patent than his US counterpart, one would expect that a US post-grant challenge mechanism would yield similar or even more impressive results.

2.2.4 Litigation and infringement

While the EPO system provides a harmonized application and examinat ion procedure, the possible litigation and court proceedings applying to these patents have not been harmonized in Europe while such harmonization has occurred for trademarks. This has led to the peculiar situation that some patents (e.g., the famous Phili shave patent) have been granted by the EPO and were viewed very differently by the national courts which were asked to assess the validity of these patents. Currently, two proposals exist that would lead to harmonization (the EPLA proposal which allows for voluntary accession of EPC signatory states to a harmonized process, and the Luxembourg court proposal which was promoted by the Commission within its attempts to establish the Community Patent).

Ideally, the existence of an opposition system that leads to the revocation of a large number of patents should have considerable benefits if the revoked patents would lead to costly litigation in a patent system without a post-grant review. It is difficult to show this directly, since we do not have access to a suitable experiment. However, a comparison of the German and the U.S. system shows a remarkable difference (Harhoff (2004)). The filing rate of invalidity cases for EPO-granted patents with Germany as the designated country is only 0.3% of all patents. T he infringement filing rate has been estimated to be 0.9%. This compares quite favorably to the overall filing rate of 1.9% for the US which has been computed by Lanjouw and Schankerman (2004). This is a remarkable difference since there are a large number of factors that would bias the German estimate upwards.

For example, this calculation only concerns EPO-granted (relatively valuable) patents which are typically more valuable than German patents granted by the German Patent Office and are thus more likely to be attacked. Moreover, litigation in Germany is considerably less expensive than in the U.S., and the cases are resolved more quickly – hence, the low German filing rates are all the more surprising. Suppose for a moment that only 20 percent of the patents revoked in opposition and appeal would lead to patent infringement and litigation. In that case, the German litigation rate would increase by 0.52 percentage points (more than half of its current level).

Please note that we have relegated the review of competition law, which is relevant to the functioning of the European patent system, to section 3.4.2, to avoid duplicating any material within this report.

2.3 The U.S. Patent System[25]

2.3.1 Application

The U.S. patent system has three types of patents: utility, design, and plant. The majority of applications and issued patents are utility patents and the discussion below focuses on that type of patent. The statutory requirements for patentability specify that "any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof" may be patented. By itself, this definition does not create a subject matter restriction, although it has long been held that laws of nature, physical phenomena, and abstract ideas are not patentable subject matter. The patent statute (35 US Code 101-103 and 112) thus requires novelty, nonobviousness, and utility for patentability. In addition, it requires that the invention be disclosed in sufficient detail to enable a person skilled in the art to make and use it.

With certain rare exceptions (death or mental disability) only the inventor may apply for a patent on a given invention. The application for a patent is typically prepared by an attorney or patent agent who has registered with the USPTO and is composed of a series of claims and supporting

[25] Much of this material in this section comes from Appendix A of Merrill, Levin and Myers (2004) and the USPTO website http://www.uspto.gov.

documentation. A basic filing fee of $300 is payable on application; independent claims in excess of three are charged at $84 per claim and dependent claims in excess of 20 at $18 per claim. There is also a surcharge for application pages exceeding 100. These fees are designed to discourage some isolated cases of thousands of claims on a single patent. In addition to filing fees, search and examination fees totalling $700 are also payable in the course of patent prosecution. All these fees are cut by half for small entities (any small business concern as defined by the Small Business Administration and any independent inventor or non-profit organization including universities).

The application must be filed within 1 year of the invention's public use or publication. Applicants may file a non-provisional or a provisional application. A non-provisional (ordinary) application includes: (1) A written document which comprises a specification (description and claims), and an oath or declaration; (2) A drawing in those cases in which a drawing is necessary; and (3) Filing, search, and examination fees. The provisional application was designed to provide a lower cost first patent filing in the United States and to give U.S. applicants parity with foreign applicants who operate under the first-to-file system. Claims and oath or declaration are NOT required for a provisional application. Provisional application provides the means to establish an early effective filing date in a patent application and permits the term "Patent Pending" to be applied in connection with the invention. The applicant has one year to convert the provisional application into a non-provisional one.

Publication of patent applications is required by the American Inventors Protection Act of 1999 for most plant and utility patent applications filed on or after November 29, 2000. On filing of a plant or utility application on or after November 29, 2000, an applicant may request that the application not be published, but only if the invention has not been and will not be the subject of an application filed in a foreign country that requires publication 18 months after filing (or earlier claimed priority date) or under the Patent Cooperation Treaty. Publication occurs after the expiration of an 18-month period following the earliest effective filing date or priority date claimed by an application.

Allison and Lemley (2002) document a substantial increase in the average complexity of patent applications over time. They compared random samples of patent issued in 1976-78 and in 1996-98 and found that patent prosecution time had increased, especially in pharmaceutical and biotechnologies, with a greater use of continuation strategies (the addition of new material during the prosecution period). Patents issued in the late 1990s cited vastly more prior art (three times as many prior patents and ten times as many non-patent pieces of prior art) and there was a 50% increase in claims. They hypothesize that these changes have occurred because patents are increasingly valuable to businesses, who expect to use them in licensing negotiations or litigation and are therefore willing to spend more time and effort on obtaining them.

One administrative process that is unique to the U.S. patent system is the interference system. An interference is a consequence of the use of first-to-invent rather than first-to-file principle followed in the US patent system to establish priority for an invention. It is an adversarial administrative hearing held within the patent office in order to establish who has the right to the patent. Because of this, both parties in such a dispute are well aware of each other's invention and position prior to the award of the junior party's patent, which can lead to collusion. However, in actual fact, fewer than 0.1 to 0.25 per cent of applications result in interferences (Mossinghoff (2002); Lemley and Chien (2003)). Calvert and Sofocleous (1992) report that 80% of interferences in 1989-1991 were settled prior to a final hearing, and that fewer then 4% resulted in the junior party being granted priority. These figures suggest that the proceeding may be used in part by parties with closely related technologies to achieve some kind of non-competition agreement. One of the constants of recent patent reform efforts in the United States has been the elimination of first-to-invent, and hence the elimination of interference proceedings, but this has been firmly opposed by the independent inventor lobby. The opposition is puzzling since - according to Mossinghoff (2002)- independent inventors are slightly more likely than others to be disadvantaged by the first-to-invent system.

2.3.2 Examination

On submission, the patent application is classified by technology and assigned to an examiner in the relevant art unit (division) of the office. The examiner reviews the application for completeness, determines the scope of protection claimed, and carries out a search of prior issued patents and other published literature to determine the novelty of the invention, and also evaluates the application to see if it satisfies the other statutory requirements of a patent (nonobviousness, utility, and disclosure).

The patent examiner is the arbiter of the patentability, novelty, usefulness, and nonobviousness requirements cited above, judging these standards against the "prior art," i.e., prior inventions, in the field. Prosecution of the patent has been characterized as a "give-and-take affair," with negotiation and renegotiation between the patentee and the examiner that ordinarily continues for 2–3 years (Merges, *et al.* (1997)). The costs of prosecuting a patent through the USPTO range from $5,000 to $100,000 (including the USPTO issue fee), depending on the nature of the technology.

> The USPTO website has this to say about patentability:
>
> "In order for an invention to be patentable it must be new as defined in the patent law, which provides that an invention cannot be patented if: "(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent," or "(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country more than one year prior to the application for patent in the United States . . ."
>
> …… In this connection it is immaterial when the invention was made, or whether the printed publication or public use was by the inventor himself/herself or by someone else. If the inventor describes the invention in a printed publication or uses the invention publicly, or places it on sale, he/she must apply for a patent before one year has gone by, otherwise any right to a patent will be lost. The inventor must file on the date of public use or disclosure, however, in order to preserve patent rights in many foreign countries.
>
> Even if the subject matter sought to be patented is not exactly shown by the prior art, and involves one or more differences over the most nearly similar thing already

> known, a patent may still be refused if the differences would be obvious. The subject matter sought to be patented must be sufficiently different from what has been used or described before that it may be said to be nonobvious to a person having ordinary skill in the area of technology related to the invention. For example, the substitution of one colour for another, or changes in size, are ordinarily not patentable."

One of the more remarkable features of the U.S. patent system is that is essentially impossible for a patent examiner to reject a patent application because of the ability of the applicant to "continue" an application, that is, to file an amended application that has the benefit of the original priority date (Allison and Lemley (2002); Quillen and Webster (2001);Lemley and Moore (2004); Shapiro and Lemley (2005)). Although in some cases (largely in the biotechnology and pharmaceutical areas), continuations are a legitimate way to refine the claims in a patent in line with subsequent discoveries while still be able to ensure the original invention is patentable, this feature of the system is subject to a great deal of abuse. Commissioner Dudas (2005) reports that more than 100,000 of the 355,000 patent applications filed in 2004 were continuations of applications that had been previously reviewed by an examiner; that is, the examiner was forced to repeat work which had already been done. The work of Cecil Quillen and co-authors has established that over 85% of U.S. patent applications are granted, once continuations are taken in to account (Quillen and Webster (2001)).

Over the past ten years, the worst abuses of the U.S. continuation system have been eliminated, largely due to two statutory changes: first, the patent term is now 20 years from original filing date rather and 17 years from issue, which limits the ability of the patentee to shift the validity period of the patent via continuations. Second, the application is published 18 months after its submission unless the applicant chooses to forego patent protection outside the United States, so the practice of "submarining" (keeping a patent secret in the Patent Office for many years) is now limited. But many observers believe that continuation practice is still creating problems for the system via delay and uncertainty, the wearing down of examiners, the tailoring of claims to cover potentially infringing products already on the market, and the practice of "evergreening." "Evergreening" is an arcane practice in the pharmaceutical sector where multiple patents covering variations of the same invention are obtained using continuations. Although all such patents have the same priority date, they are then listed separately at the FDA at different times, which effectively extends the period of protection from generics for much longer than the patent term. This loophole was closed by special legislation in 2003 (Lemley and Moore (2004)) but it illustrates the potential of the system for strategic abuse.

2.3.3 Opposition and re-examination[26]

Once the patent has issued, there are only two ways for a third party to challenge its validity: the first is to request a re-examination by the USPTO, and the second is to counter sue for validity if sued or threatened with an infringement suit. Currently there is no adversarial opposition system in the United States like those in Europe or Japan, although there is wide agreement among policymakers, patent attorneys, and others familiar with the system that such a system is needed (Farrell and Merges (2004), Hall, *et al.* (2003), Hall and Harhoff (2004), Janis (1997), Levin and Levin (2002), Mossinghoff and Kuo (2002), Wegner (2001)).

Re-examination may occur any time during the life of a patent. There are two types of re-examinations possible: ex parte, where there is no third party participation, and inter partes, in which participation is allowed. Until November 2002, inter partes third party requestors were barred from appeal to the Board of Patent Appeals, and such third party requests were very infrequent.

Re-examination, originally envisioned as an alternative to expensive and time-consuming litigation, was created by the 1980 Bayh-Dole Act. The legislative history of this act suggests that the re-examination was intended to be a mechanism that would be less expensive and less time-consuming than litigation. During the legislative process, however, the act was purged of its intended adversarial characteristics, reducing the usefulness of the procedure for opponents of a given patent.

[26] Parts of this section of the paper are drawn from Hall, *et al.* (2003).

Procedurally, the re-examination proceeding permits the patent owner or any other party to notify the USPTO and request that the grounds on which the patent was originally issued be reconsidered by an examiner. Initiation of a re-examination requires that some previously undisclosed "new" and relevant piece of prior art be presented to the agency. Under the statute, a relevant disclosure must be printed in either a prior patent or prior publication —no other source can serve as grounds for the re-examination.

After being initiated by notification and the payment of a fee to the USPTO, the re-examination goes forward only if the USPTO finds a "substantial new question of patentability." Such a determination was intended by lawmakers to prevent the reopening of issues deemed settled in the original examination (Merges (1997)). The USPTO must make this determination within 3 months of the request and, having made the determination, must notify the patent owner.

When the owner is not the re-examination proponent (about half the cases)[27], the patentee is allowed to file a response to the newly discovered prior art within 2 months. If the owner chooses to respond, the requester is afforded an opportunity to reply within 2 months. By choosing not to respond, the owner can limit the requester's participation in the process. Thus the re-examination is an ex parte proceeding between the patent owner and the USPTO that provides limited opportunities for third-party involvement.

The party requesting a re-examination is entitled to notify the USPTO of the triggering "prior art," to receive a copy of the patentee's reply to the re-examination (if any), and to file a response to that reply. The owner's role in the process is much more involved: The re-examination statute contemplates a second examination, with the same type of "give-and-take" negotiation between owner and patent office that occurs during the initial issuance of a patent. The examiner remains the final arbiter of the process, and it is not uncommon for the original examiner to be assigned the follow-up re-examination, thus putting the question of whether prior art was overlooked in the

[27] The reason owners request re-exam is that often accused infringers turn up some piece of prior art that invalidates one or more claims. An easy way to fix this problem is to maki an ex parte request that the PTO re-exams the patent, submitting the prior art with the request. It will often result in a narrower patent, but leave it standing. The advantages are twofold: if the owner requests the re-exam, no third party can participate without filing their own request (and losing the right to use the prior art at trial) and also these things take up to ten years, which can delay the litigation if the judge grants a stay.

hands of the same government official who was responsible for ensuring that no prior art was overlooked in the previous search.

Once the re-examination goes forward, however, the statute requires that the Commissioner make a validity determination. The original patent is afforded no statutory presumption of validity in the proceeding, although the practice of assigning re-examinations to the original examiner may produce such a presumption. The re-examination cannot be abandoned or postponed to await the result of concurrent litigation proceedings, although it may be stayed during other USPTO proceedings, including reissue or interferenc es. A re-examination may result in the cancellation of all or some of the claims in a patent or the confirmation of all or some of the claims. Nothing in the re-examination procedure can expand the scope of the original patent's claims, but claims may be amended or new claims added during the renegotiation between the patent owner and the examiner.

In summary, for parties seeking to invalidate an issued patent, the re-examination procedure involves considerable costs and risks. The filing fee for the re-examination is substantial, and practitioners estimate the average costs of a re-examination at $10,000–$100,000 depending on the complexity of the matter. Although the costs of a re-examination are lower than those of litigation ($1–5 million), the third-party challenger in re-examination is denied a meaningful role in the process, and the patentholder maintains communications with the examining officer, offering amendments or adding new claims during the re-examination. Re-examination may make it more difficult for challengers to prevail in patent-validity litigation, because juries tend to give added weight to re-examined patents. Moreover, the Court of Appeals for the Federal Circuit has indicated that claims confirmed by the re-examining officer present added barriers to a successful contest. As a result, challengers face powerful incentives to forego re-examination in favour of litigation, a process that may well be more expensive, more time-consuming, and less expert in testing post-issue validity.

2.3.4 Litigation and infringement

Valuable patents are generally enforced via infringement suits. If a firm believes that a patent is being infringed, it can sue the infringer for damages and/or injunctive relief. Any firm that is alleged to have infringed, either via a specific letter of notification or by being a defendant in a suit, may sue the patent holder for declaratory relief, that is, for a judgment that the firm is not infringing a patent held by the defendant, or that the patent in question is not valid. Most patents are never litigated; the rate in recent years has been approximately 1 to 2 per cent of patents, and only 0.1 per cent ever go to trial (Lanjouw and Schankerman (2001)) Empirical studies confirm that those patents that are litigated tend to be particularly valuable (Allison, *et al.* (2004)).

Such suits are filed in the first instance at one of the Federal District Courts and appeals go to the Court of Appeals for the Federal Circuit, which was established via 1982 legislation as the appellate court for all patent-related Federal cases. In turn, the decisions of this court may be appealed to the U.S. Supreme Court. Prior to 2005, the Supreme Court seldom agreed to take such cases, but recently they have accepted several high profile appeals.

Many observers have pointed out that the creation of the specialized patent appeals court in 1982 (the CAFC) has led to stronger patents and a shift in case outcomes. Between 1953 and 1978, circuit courts affirmed 62% of district court decisions holding patents to be valid and infringed, and reversed 12% of the decisions holding patents invalid or not infringed, whereas in the years 1982 - 1990, the CAFC affirmed 90% of the validity decision and reversed 28% of the invalidity decisions (National Research Council (2004)).

Trends in patent litigation are difficult to measure, partly because cases may be filed in a number of jurisdictions in the United States, and such cases are not always reported to the USPTO or other data collection agencies in a consistent manner. Figure 2.4 shows the total count of patent suits filed each year in the United States between 1984 and 1999, it was drawn from the Derwent patent database by Lanjouw and Schankerman (2004)). The number of suits doubled during that period, roughly consistent with a doubling of patent grants during the same period. The flow of suits is approximately one per cent of the flow of patent grants. By the end of the period, this share has risen very slightly to 1.1 per cent. Thus the “rate” of patent litigation in the United States rose very little prior to the year 2000, although some evidence suggests that it has risen more during the past five years.

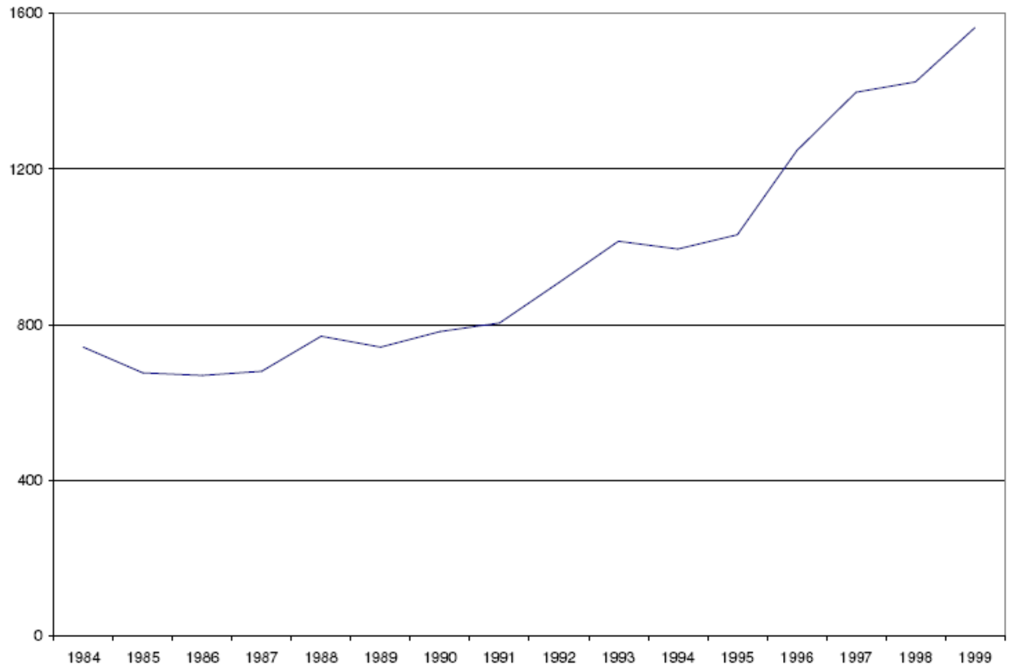

Figure 2.4: Patent suits filed in the United States (Source: Lanjouw and Schankerman (2004))

There is no doubt that industry views patent litigation as an increasingly costly activity that functions in some cases as a tax on innovation. In addition, firms in a number of sectors increasingly report threats from “patent trolls,” which are entities that own patents related to their technologies but are not working them. The problem here is that a patent that might cover a small part of the technology involved in manufacturing a product is capable of threatening an injunction that shuts down the entire product. Given this threat, many firms are willing to pay the troll to go away rather than fight it, even if the patent in question is of questionable validity (Reitzig, Henkel and Heath (2006); Farrell and Shapiro (2005)). Unlike the situation where they plaintiff is also a producing firm in the sector, in this case owning a large patent portfolio is no defence. An apparent increase in “hold-up” activity of this type has led to calls for reform of the standards for triple damages and for allowing courts to use discretion in issuing preliminary injunctions in patent cases. Much of the legislation discussed in the next section contains these features.

2.3.5 The U. S. patent reform bill and its current prospects

Weaknesses in the US patent system have received considerable attention over the last five ye ars. A report by the Federal Trade Commission (F.T.C. (2003)) came to the devastating conclusion that patents have become major obstacles to innovation in some sectors A major academic study on reform needs was produced by the National Academies of Science (National Academy of Sciences (2004)), recommending changes in examination and post -examination stages of the patenting process as well as in the patent litigation system. The U.S. Patent and Trademark Office (2003) developed a *Strategic Plan* to deal with the challenges, and American Intellectual Property Law Association (2004) came up with its own set of recommendations. Partly in response to the National Academy of Science and FTC reports as well as the position taken by the AIPLA, the US Congress has shown considerable interest in patent reform. Several hearings presided over by Senator Orrin Hatch have been held in the Senate and in June 2005, Representative Lamar Smith introduced a Patent Reform Bill (H.R. 2795) in the House and held a subcommi ttee hearing on June 9, 2005. Based on testimony and the input received from various stakeholders, Smith published a substitute bill and held hearings on it in September 2005. A summary list of hearings held is shown in Table 2.4 in order to document the t opics for which reform activity in the US is likely to continue.

Date	Committee	Topic
25 April 2005	Senate Judiciary, Subcommittee on IP	The Patent System Today and Tomorrow
7 June 2005	Senate Judiciary, Subcommittee on IP	Patent Law Reform: Injunctions and Damages
9 June 2005	House Judiciary, Subcommittee on Courts, the Internet, and IP	H.R. 2795, the “Patent Act of 2005”
14 July 2005	Senate Judiciary, Subcommittee on IP	Perspectives on Patents: Harmonization and Other Matters
15 Sept. 2005	Senate Judiciary, Subcommittee on IP	Amendment in the nature of a substitute to H.R. 2795, the “Patent Act of 2005”

Table 2.4: Summary of Hearings on Patent Reform, 109 th U. S. Congress

A number of interested groups have thrown their support behind the principle of patent reform, although they do not necessarily agree on all the individual items in the proposed bill. These groups are the Association of Attorneys Specializing in the Practice of Intellectual Property Law (AIPLA), the Intellectual Property Owners Association (IPO), the IP Law section of the American Bar Association, the Biotechnology Industry Organization (BIO), and the Business Software Alliance (BSA). A coalition formed by 37 large patent holding firms (9 chemical, 16 pharmaceutical and 12 in a number of other sectors), the AIPLA, and the IPO has presented a reform package that is similar to but not identical to the substitute H.R. 2795 bill published by Smith in September.

The original H. R. 2795 bill contained the following provisions:

1. Changes the current "first to invent" standard to "first inventor to file" (§3).[28] This is an important step in achieving international harmonization and was accompanied by a rewrite of the prior art rules that has caused some controversy in the legal profession but is a necessary part of harmonization. Accompanying this change was the preservation of a one year grace period after publication, intended to benefit small inventors and university researchers. Also accompanying it was an extension of prior user rights to all U.S. manufacturers of all inventions to protect those who use trade secrecy instead of the patent system. These changes are in the revised bills.
2. Eliminates the subjective "best mode" requirement from §112 of the Patent Act, delineating objective criteria that an inventor must set forth in an application (§4). This change also represents a move toward harmonization. It remains in the revised bill.
3. Imposes a duty of candour and good faith on parties to contested cases before the patent office, eliminating inequitable conduct as a defence of patent unenforceability (§5), unless at least one claim in the patent has already been found invalid.

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[28] In a "first inventor to file" system, the right to the grant of a patent for a given invention lies with the first person to file a patent application for protection of that invention, regardless of the date of actual invention. In a "first to invent" system, the right to the grant of a patent for a given invention lies with the first person to have discovered the invention. However, the first applicant to file has the prima facie right to the grant of a patent. Should a second patent application be filed for the same invention, the second applicant can institute interference proceedings to determine who was the first inventor (as discussed in the preceding paragraph) and thereby who is entitled to the grant of a patent.

4. Reduces the scope of wilful infringement by raising the standard of proof required, and limits the amount of damages a patent holder can collect from an infringer (§6). The substitute bill of Smith and the coalition reform package both change the wording but still try to limit the situations where treble damages can be assessed to cases where notice of infringement has clearly been given by the patent holder.
5. Limits patentees' ability to obtain injunctions (§7). This has proved very controversial and has been removed from the substitute bill and coalition reform package.
6. Authorizes the director of the patent office to regulate continuation applications (§8). Again, this is controversial and has been removed.
7. Establishes a new post-grant opposition system in the patent office (§9) with a 9 month window. A second window of 6 months at the time of litigation has since been removed, but of course re-examination could still be requested. The substitute bills contain changes intended to increase the take up of *inter partes* re-examination.
8. Allows members of the public to introduce new information to the patent office up to six months after the date of publication of the patent application to challenge the patent and to provide a final quality check (§10).

As indicated above, in committee a number of these provisions have been dropped or weakened, largely due to opposition from the pharmaceutical and biotechnology sector, but also from a number of large chemical firms, 3M, General Electric and large companies in traditional technologies who are more or less satisfied with the current system. The provision that allows the patent office to restrict continuations has been removed because of biotechnology industry opposition; this industry has been and continues to be a heavy user of continuations (Graham and Mowery (2004)).

In July of 2006, the Chair of the IP Subcommittee of the U. S. Senate Judiciary Committee introduced a new bill (S.B. 3818) that included some of these provisions, such as first-to-file, post-grant opposition (with a limited "second window" beyond an initial one-year challenge period), third party submissions of prior art, prior user rights and limitations on inequitable conduct and wilfulness defences. The bill does not include a repeal of the best mode requirement, however. It also includes a provision for apportionment of damages, repeals section 271(f) regarding shipment of components outside the U.S., and adds a requirement for attorney fee shifting when the claim or defence was not substantially justified. The latter is intended to discourage frivolous patent suits. This bill appears to be a placeholder bill, intended to be taken up after the next Congressional election.

An interesting recent development on the continuation issue has come from the USPTO itself in the form of a set of proposed rule changes and request for comment in the Federal Register of January 3, 2006. As was clear from the Dudas testimony (Dudas (2005)), continuations have become of major concern to the office because they take examiner time away from new applications, and often require reconsideration of material that has already been examined. Therefore they are proposing that all continuations (including continuations-in-part and divisionals) other than the first be accompanied by a "showing as to why the amendment, argument, or evidence presented could not have been previously submitted." The deadline for comments on this rule change was in May. It is not immediately clear that the change will have the desired effect, since it appears to call for even more documentation to be submitted with each continuation; presumably they are hoping that the requirement will reduce the actual number of continuations by sending a clear message to potential applicants.

The concerns of the computing sector lie in other areas. Apparently the BSA (representing Intel, Microsoft, and other big software producers) were strongly in favour of three "reforms" - a second window on opposition, no automatic injunctions where infringement is found, and that infringement damage calculations should be based on the contribution of the patented technology to the value of the product. They backed down on the first in the face of fierce pharmaceutical opposition. The second (and possibly the third) has been taken up by the Supreme Court when it granted certiorari in the eBay/Merc-Exchange case, although the outcome of that case is not yet known.

What effect that will have on legislation in this coming session is unclear, and the opposing sides appear not to have reached agreement on the question of either injunctions or damages when the patented technology is a small piece of the product. For reasons that are not entirely obvious, the pharmaceutical industry has been very opposed to changes in this area, whereas the computer hardware and software sectors are strongly in favour. Most observers (e.g., see Mark Lemley's testimony to the Senate subcommittee on June 7, 2005) would argue that the two sectors (pharmaceutical/biotechnology/medical devices on the one hand and information and communication technologies on the other) use the patent system in very different ways and face very different problems of enforcement and litigation, because of the nature of their products and the technologies they involve. Apparently the pharma sector is reluctant to change a system that they perceive is working to their benefit, especially in directions that might weaken it, even though some of the proposed changes would have little impact on those whose products are not based on complex technologies where a patent on a very small piece of the product can wield disproportionate power.

With respect to injunctions, the concern of upstream research entities such as the Wisconsin Alumni Research Foundation (WARF) is easy to understand. The wording in the bill appears to require injury to the patent holder from absence of an injunction, which sounds like a patent "working" requirement. This requirement is likely to be difficult for universities and public research institutions to meet and they are therefore opposed to any change in this area. On the other hand, such a provision is clearly targeted to the damage done by so-called "patent trolls." These are entities who are able to hold firms up for much larger sums than they would ordinarily receive in the form of licensing revenue because they have the capability to shut down an entire product line via injunction, even though their piece of the technology in the product might be very small.

2.3.6 Competition policy and patent policy

The interaction of competition (antitrust) policy and the use of patents is of considerable concern around the world and the US is no exception (O.E.C.D. (2005)). This topic was the subject of a set of hearings held by the Federal Trade Commission and Antitrust Division of the Department of Justice during 2003, which resulted in a report containing a series of recommendations for change (F.T.C. (2003)). The report also contained useful analysis of the relationship between the two that emphasized the importance that they work in tandem. A summary of the recommendations provided by the FTC follows. Note that most of them pertain to the operation of the patent system rather than to competition policy per se, which suggests that problems in that area were of the greatest concern to participants in the hearings.

The hearings found that questionable (low quality, invalid) patents caused harm both to competition and innovation because of a combination of the threat that they would be enforced via litigation together with the presumption of validity conferred on a granted patent. In industries with incremental innovation, such questionable patents were found to increase "defensive patenting" in many cases and to complicate licensing negotiations. A desire to improve the quality of patents led to a series of recommendations. The first was for the institution of post-grant review or opposition into the U. S. system. A second related recommendation was that legislation be enacted to specify that challenges to the validity of a patent be determined based on a "preponderance of the evidence," rather than by "clear and convincing evidence."

In addition, the FTC recommended tightening the rules determining "obviousness" when allowing patents and increasing the resources available to the Patent Office. They also recommended considering possible harm to competition, along with other possible benefits and costs, before extending the scope of patentable subject matter. Because of the strategic use of patent continuations to expand claims during the patent prosecution process (sometimes in secret), they proposed legislation be enacted to create intervening or prior user rights in the case of added or expanded claims.

A final set of recommendations was related to the interaction between agencies responsible for patent policy and competition policy. Rather than proposing a set of rules for competition policy based on patenting considerations, the FTC suggested that increased cooperation and communication between the two agencies would help to ensure that competition concerns were taken into account when policy within the patent agency was determined. That is, the FTC would pay more attention to filing Amicus briefs in the case of important patent litigation, and it would request re-examination of particularly contentious or questionable patents that raised competitive concerns.

2.4 The Japanese Patent System

2.4.1 Application

The origins of the Japanese patent system date back to the Meiji Era (1868 -1912) during which Japan started its modernization and rose to world power. In 1871, Japan proclaimed its first patent law, the "Provisional Regulations for Monopoly". The patent law was abolished in the following year because people in Japan did not understand how to use the law. Since it became apparent that a patent law was essential to increase economic power, a new law came into force in 1885, the "Patent Monopoly Act", which was designed after the French and the U.S. patent law.

The Patent Monopoly Act was replaced by the "Patent Act" in 1888, which was patterned after the German Code of Civil Procedure. The latter was replaced by the "Patent Act" of 1899 after the accedence of Japan to the Paris Convention for the protection of Industrial Property. [29] The Patent Act was finally completely revised in 1909, in 1921 and 1959. Today, in Japan, patent rights are still protected by the Patent Act of 1959, which has been frequently amended since then (J.P.O. (2006), Kotabe (1992)). In Article 1 Japanese Patent Law (JPPL), the major objective of the law is explicitly referred to as encouraging "inventions by promoting their protection and utilization and thereby to contribute to the development of industry".

The Japanese Patent Office (JPO) is a Japanese governmental agency under the Ministry of Economy, Trade and Industry (METI). The Patent Office is headed by a commissioner who is appointed by the METI and is generally replaced every two to three years (Kotler and Hamilton (1995)).

In 1993 and 1994, Japan signed a number of international and bilateral agreements, which had a major impact on the Japanese patent system. The agreements were designed to encourage a harmonization of the Japanese patent system with U.S. and European patent standards. The Framework Agreement[30] between the U.S. and Japan, e.g., led to the following changes: the

[29] See http://www.wipo.int/treaties/en/ip/paris/trtdocs_wo020.html (access on August 8, 2006).
[30] The "Mutual Understanding on Intellectual Property Rights between the Japanese Patent Office and the U.S. Patent and Trademark Office" was negotiated in 1993 and entered into force on January 20, 1994.

permission to file patent applications in Japan in English, the possibility to correct translation errors, a change of the opposition system, and an introduction of an accelerated patent examination procedure. In 1994, Japan signed the TRIPs (Trade Related Aspects concerning Intellectual Property Rights (IPR)) agreement, which aims at strengthening IPR in developing countries. To comply with the requirements of the TRIPs agreement, Japan had to make a number of additional changes in its patent law, including limited discovery procedures in patent infringement cases and the adoption of a patent protection term of 20 years from the filing date (Maskus and Mcdaniel (1998); Kotler and Hamilton (1995)).

The Japanese system is a first-to-file system (Article 39 Japanese Patent Law (JPPL)), which means that the first party to file the invention with the JPO is assigned the patent.

2.4.2 Examination

The Japanese examination procedure starts with a formality check. Before 1971, the formality check was automatically followed by an examination (Hayashi (2005)). After 1971, applications were examined only upon request of the applicant, which could be done within seven years from application (Goto and Motohashi (2006)). For applications filed after October 1, 2001, a three year period for requesting examination is applicable (Hayashi 2005). Otherwise the application is deemed to be withdrawn. During this time period of three years, no one else can claim a patent for the same invention and the applicant can file an opposition against another patent application based on the novelty requirement (Wineberg (1988)). Within 18 months from filing, Japan requires public disclosure of all patent applications in the Japanese Patent Gazette. After 18 months have expired from the filing date the application is published automatically (Article 64 (1) JPPL). In case, an earlier priority is claimed, the application is laid open 18 months after the earliest priority (Kotler and Hamilton (1995)). The European and the U.S. patent system also require public disclosure of patent applications. However, a special feature of the pre-1995 Japanese patent system was that as long as a patent had not been granted, competitors were allowed to use published inventions within their own research and development processes without any sanction or the payment of royalties. In case a competitor made a follow-up invention which built on the published technology, he was allowed to apply for a patent or a utility model claiming the improvement. Afterwards, he could force the applicant of the original invention into a cross -license agreement (Kotabe (1992)). This particularity was abolished during the revisions in the Japanese Patent law in 1995.

Following the bilateral U.S.-Japanese agreements in 1993 and 1994, by January 1, 1996, an accelerated examination procedure came into force, enabling applicants upon request to receive an assessment of the patentability of the invention within 36 months (at that time, a grant took more than six years; even more for pioneering technologies) (Kotler and Hamilton (1995)).

Prior to 1994, amendment of the application during examination was not allowed ("no new matter practice"). After 1994, amendment became possible under certain circumstances but was (and still is) limited to certain circumstances, e.g. incorrect translations, cancellation and restriction of claims, or clarification of an ambiguous description (Article 17bis JPPL). In case the applicant is allowed to amend the application, he may also divide the application in two or more applications, which are called "divisional applications". Divisional applications are dated back to the application of the priority date of the original application (Article 44 (1), (2) JPPL). As soon as the applicant receives a copy of the examiner's decision to grant the patent, amendments and divisional applications are no longer possible. Applications which have not been granted may be converted into a utility model within 5.5 years from application data. Utility models may be converted into patents within 7 years from application date (Schlagwein (2006)).

After a request for examination has been made the patent examiner checks whether the invention meets the requirements for patentability: (1) industrial applicability (Article 29 (1) JPPL), (2) novelty (Article 29 (1) JPPL), and (3) non-obviousness (Article 29 (2) JPPL). Inventions that meet the requirements for patentability are finally granted. [31]

A patent expires, at the latest, 20 years after application date. With approval of the TRIPs agreement in 1994, Japan (and the U.S.) has adopted the EU standard of a term of 20 years from

[31] In case inventions have been made available to the public before filing a patent application, the JPO grants a limited grace period of six months (Article 30 JPPL). The conditions under which the grace period is applicable are again extremely limited. For instance, disclosure is accepted only if the disclosure is made by the inventor or the applicant themselves. Third party disclosures, on the contrary, are an absolute bar to patentability (Kotler and Hamilton (1995)).

the first filing of the application. This 20 year protection can be increased by up to 5 more years for pharmaceutical patents. Figure 2.5 shows that foreign applicants abandon patents earlier than Japanese firms. Japanese government -related patents were maintained longest. This may arise due to the fact that government owned patents are subject to patent fee exemptions (Goto and Motohashi (2006)).

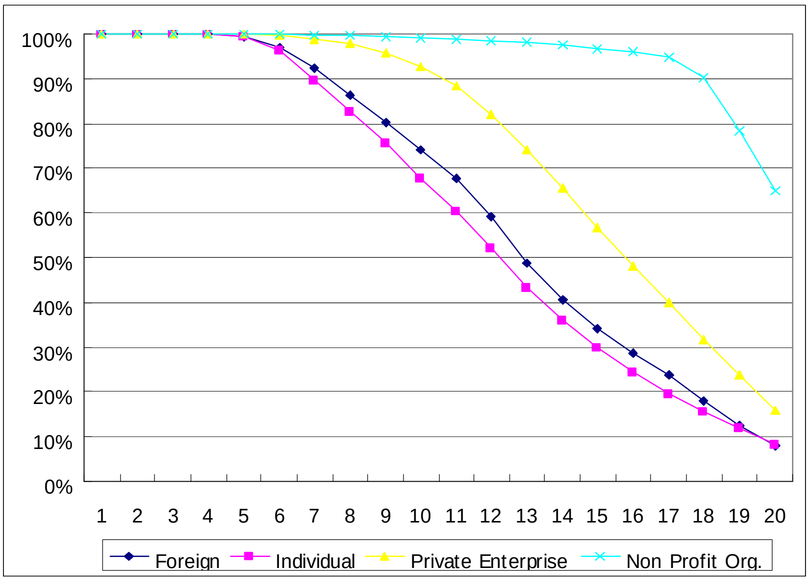


Figure 2.5: Patent life length by applicant type (Source: Goto and Motohashi (2006))

Figure 2.6 summarizes the patent application procedure at the Japanese Patent Office. Overall, the yearly number of patent applications filed with the JPO remained almost stable during the 1900s. Between 1997 and 2000, Figure 2.7 exhibits an increase in the number of patent applications. The slight decrease in the number of applica tions in 1994 may at least in part arose due to the possibility to file a single application with multiple claims for inventions that previously had to be filed as separate patent applications.

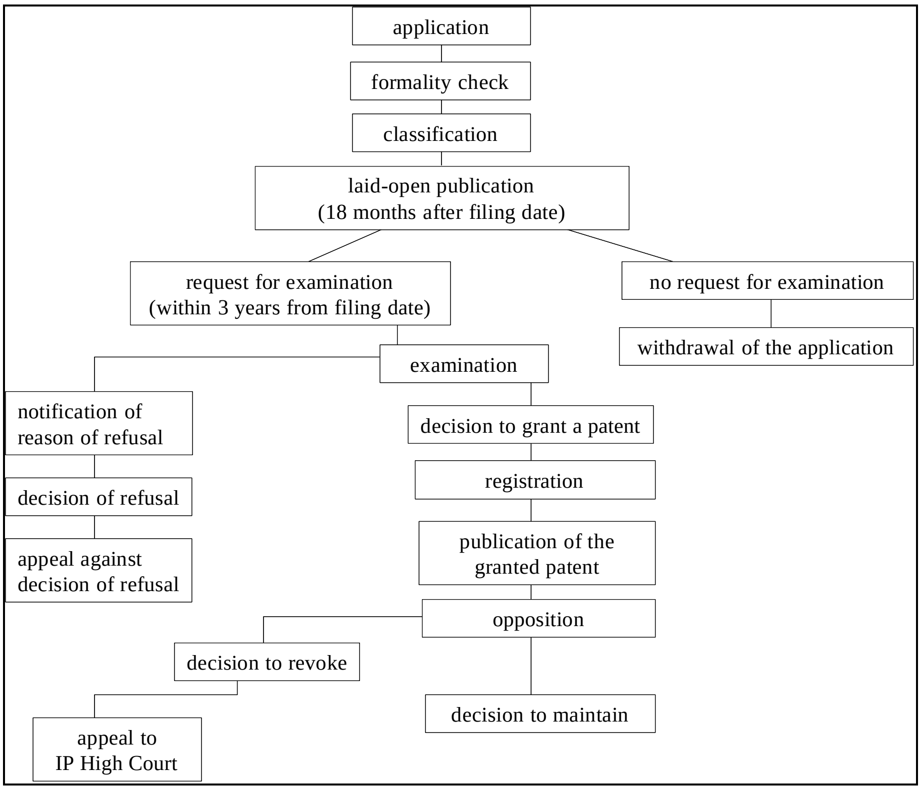


Figure 2.6: Patent grant procedur e in Japan as from 1996 (Source: Schneller and Pfau (2003))

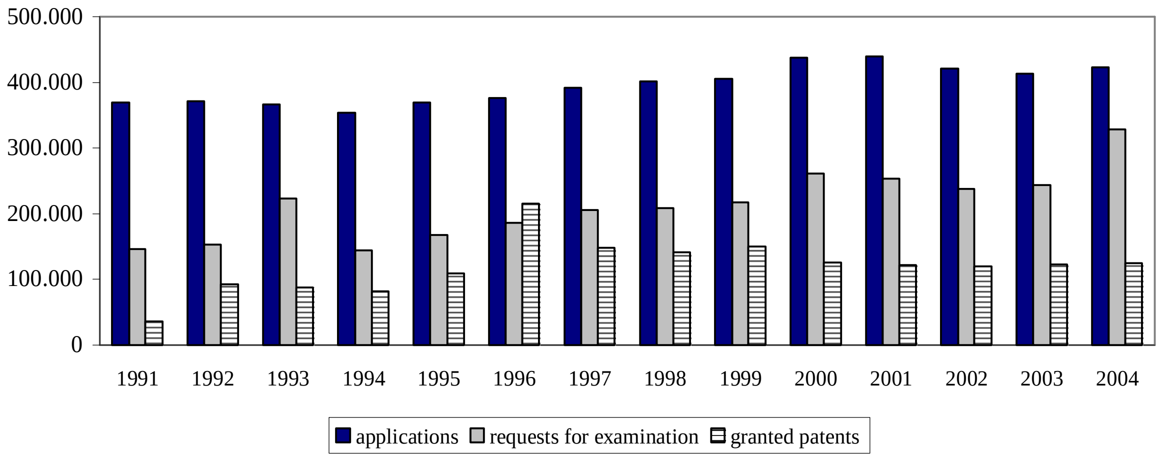


Figure 2.7: Patent applications, requests for examination and patent grants (Source: J.P.O. (2005), J.P.O. (2002))

At the JPO only 50 percent of the applications are examined and only about 30 percent of the applications are finally granted. From 2000, the number of requests for examination remained almost stable at 250,000. The sharp increase in 2004 (about 330,000 requests for exami nations) is due to the reduction of the period for requesting examination from seven to three years in 2001. In general, examination is requested intensively during the last year of the examination term. For patents filed in 2001 examination has to be requ ested in 2004 at the latest. These requests coincide with the examination requests for patents filed in 1997 (J.P.O. (2005)).

Japan is generally known for an inflation of narrowly scoped patent applications. This patenting behaviour originates from a special legal regulation, the single -claim requirement. Before 1988, the JPO required patent applications to be li mited to a single (independent) claim. Since 1988, the JPO has allowed multiple (dependent) claim applications (Art. 37 JPPL) to reduce the workload of the examiners. Nevertheless, the JPO still favours narrow patent applications containing only a small number of claims (Sakakibara and Brandstetter (2001); Rutchik (1995)).

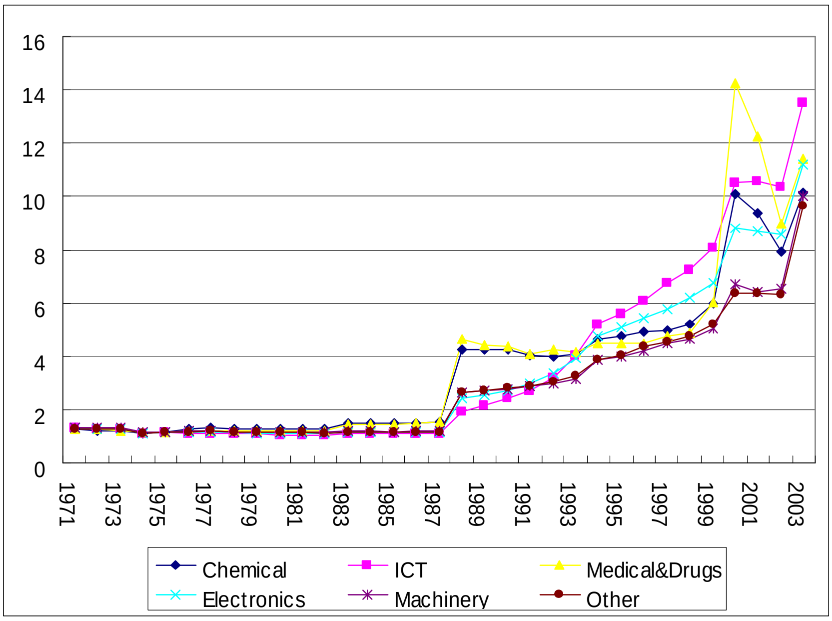


Figure 2.8: Number of claims by technology (Source: Goto and Motohashi (2006))

Figure 2.8 provides the number of claims per patent in different technical areas. In the mid 1990s, the average number of claims per patent amounted to less than five rising considerably afterwards. The IT and communications industry ex hibits the highest increase in the average number of claims.

2.4.3 Opposition

Before 1994 the Japanese Patent system allowed for pre -grant opposition. In particular, it allowed third parties, once a patent was examined and again published in the Patent G azette, to oppose to the pending patent application by submitting reasons why it should not be granted. The period to file an opposition was three months. The average annual opposition rate amounted to 7 percent. Following the bilateral U.S.-Japanese Agreements in 1994, the U.S. and Japan agreed to revise the Japanese opposition system. Starting on January 1, 1996, the pre -grant opposition system was replaced by a post-grant opposition system. Additionally, multiple oppositions were consolidated and addressed in a single proceeding to minimize the time spent on opposition (Kotler and Hamilton (1995)).

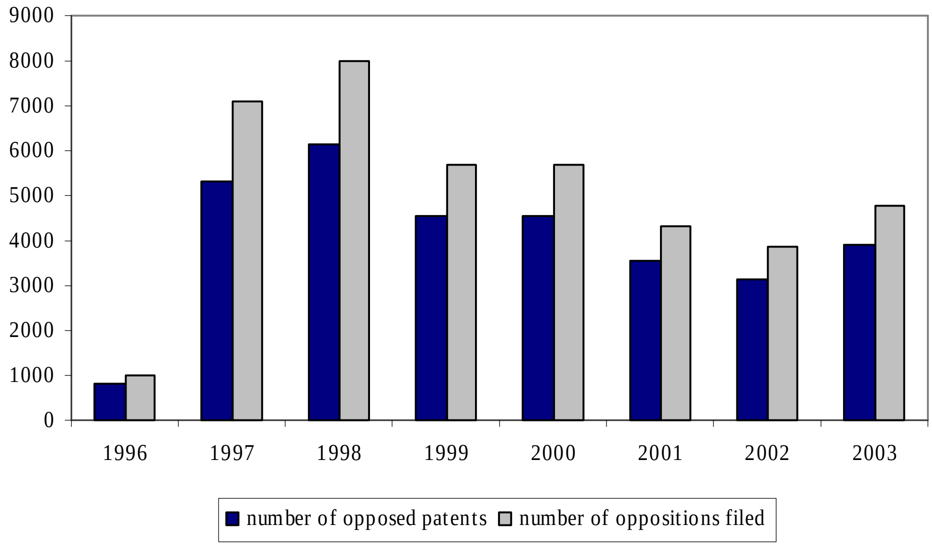


Figure 2.9: Number of opposed patents and number of oppositions filed (Source: J.P.O. (2005))

Figure 2.9 gives an overview of the development of oppositions since the beginning of the post - grant opposition system. Due to the requirement to publish patents in the Gazette and due to the opposition term of three months, the first oppositions were filed at the end of 1996 which explains the small number of oppositions in 1996. The backlog from 1996 in part explains the huge number of oppositions in 1997 and 1998. Additionally, the legal instrument may hav e enjoyed greater popularity during the first years.

2.4.4 *Litigation and infringement*

After expiration of the opposition term, the only possibility remaining for third parties to attack the patent is to file an invalidity suit. A challenge to the patent's validity is not brought before the courts, but instead directly to the Japanese Patent Office. Patent infringement cases without consideration of the validity of a patent are brought before the courts. According to Article 196 JPPL, patent infringement is a crime and is subject either to imprisonment up to five years or to a fine not exceeding 150,000,000 yen (approx. 1,500,000 EUR). In 2005, Japan has established a court dedicated to intellectual property disputes, the IP High Court [32], modelled upon the U.S. Federal Circuit Court of Appeals to speed up court proceedings and to reduce litigation costs. Currently, there is little empirical evidence how frequent these instruments are used.

2.4.5 *Relevant competition and enterprise policies*

Competition policy in Japan can only be understood against the background of some historical developments. Japan's industrial organization before World War II was characterized by the presence of "zaibatsu". Zaibatsu were family-controlled conglomerates organized around a holding company that came to significant power over a large number of financial and trading subsidiaries. Since antitrust regulations were absent in Japan before World War II, these conglomerates often dominated their respective markets. Additionally, cartels were legalized in 1925. In particular, the law allowed compulsory cartels under government supervision. In 1947 the Anti-Monopoly Act came into force, which was modelled on the basis of the U.S. antitrust statutes. One aim of this law was to facilitate free and fair competition. Especially, the Allies promoted the de-concentration and the de-monopolization of Japan, leading to dissolution of zaibatsu (Lin (2002)). The successors of zaibatsu were business groups called "keiretsu". Keiretsu firms were linked through equity cross-ownerships and the exchange of personnel. The core of a keiretsu consisted of a bank, which provided financial resources and a trading company that operated as an intermediary to enable transactions between member firms (Porter and Sakakibara (2004)).

[32] See http://www.ip.courts.go.jp/eng/aboutus/history.html (access on August 10, 2006).

In the absence of antitrust regulations, these conglomerates acted as a barrier to entry into the Japanese market (Lawrence (1991)). The weak antitrust enforcement, legalized cartels, trade barriers, and barriers to foreign direct investment were considered as beneficial to Japan's economic development since it served as a protection against external threats, i.e. market entry from foreign firms (Lawrence (1993), Porter and Sakakibara (2004)).

The deregulation of Japan's firms started in the 1980s. In the mid 1990s entry restrictions were further reduced in the telecom, financial service and electricity industries. The level of competition in the Japanese economy has further increased since then. Recently, a cooperation agreement between the European Community and Japan was signed including provisions on the cooperation on anti-competitive activities (the agreement entered into force on August 9, 2003).[33] Suzuki (2002) discusses the extent to which Japanese competition policy changed due to international pressure and reforms in the 1990s. He finds that "the scope of collective action has been reduced as a result of the economic internationalization" (p. 325). Nevertheless, the remaining business-government connection seems to have been strong enough to be an obstacle to competition in certain industries.

Empirical evidence indicates that industries in Japan today can be sorted into two groups: (1) industries like, for instance automobiles, consumer electronics, or robotic, which are highly competitive and (2) chemicals, transportation, and software that exhibit a lower level of competition. Comparison of the economic performance of these industries shows that industries with a high local rivalry perform much better, i.e. the latter industries are internationally more successful Porter and Sakakibara (2004).

Although the importance of the relationship between competition policy and patent policy has been widely recognized, little related research exists for Japanese firms. For instance Cohen, *et al.* (2002) show that intra-industry R&D spillovers occur more often in Japan than in the US. One of the reasons for greater spillovers in Japan may be that patents are used differently in Japan. In particular, the authors find that whereas the use of patents for negotiations with other firms is

[33] See Report on Competition Policy 2005 from the European Commission: http://ec.europa.eu/comm/competition/annual_reports/2005/en.pdf (access on September 15, 2006).

common in industries such as semiconductors in the US, this particular use of patents is common across the entire manufacturing sector in Japan. Additionally, Japanese firms diffuse information across Japanese rivals more willingly than US firms.

Ordover and Willig (1981) also finds that the Japanese patent system was designed to induce innovators to disclose information, i.e., patents are laid open 18 months after application. Additionally, institutional features encourage the diffusion of knowledge by creating incentives for (cross-) licensing of patents. Especially, the opposition system enhances licensing since granting a license could deter third parties from filing an opposition. In Japan, the Ministry of International Trade and Industry can force a patent holder to grant a license in case the patented technology is of national importance. Although the single claim requirement was abolished in 1988, the JPO still favours narrow patent applications containing only a small number of claims. A small number of claims have led to a large number of narrow and interdependent patents. Therefore, a patent holder could be forced into a licensing agreement to be able to use his patent.

The previously described competition policy of Japan is also reflected in the design and the execution of the Japanese patent system. Until 1993, Japanese patent law required applications to be filed in Japanese and the correction of translation errors was not allowed. This language requirement and the restriction of amendments led to increased costs for foreign applicants. For non-Japanese firms this regulation formed an entry barrier since applying for a patent in Japan was very expensive.

Overall, the Japanese patent system supports fair competition in the home country by facilitating the exchange of knowledge among Japanese firms and also by fostering cooperation, e.g., licensing agreements. However, the Japanese patent system can be used to increase entry barriers to the Japanese markets for foreign firms. Whether this is actually the case and how recent changes in the Japanese patent system can contribute to more international competition has to be investigated more closely in future research.

2.4.6 Incentives for innovative activity of Japanese firms

Until mid of 1990 the Japanese patent system impeded innovation rather than fostering the creation of pioneering technology. First of all, narrow claims and fewer claims per patent (single-claim requirement) lead to more patents per product. Assume that the different patentable elements of one product belonged to different parties, this resulted in mutual interdependences. Freedom to operate could only be guaranteed by cross-licensing agreements Cohen, *et al.* (2002). In order to increase bargaining power in cross-licensing negotiations firms started cluster patenting. Typically a large number of patent applications were filed on the same day, each representing an incremental variation or improvement when compared to the others. Patent scope is still much narrower in Japan compared to the U.S. or Europe. Therefore, in Japan patents are still rather used as an admission to cross-licensing than as a means to exclude others from using a certain technology Kotler and Hamilton (1995).

Second, before 1995, firms were allowed to use the inventions described in pending patents without permission or paying royalties. Therefore, Japanese firms were able to file patents or utility models for small improvement inventions while the application of the original patent was still pending. Assume that a competitor who built on an original invention made an improvement and filed a patent or a utility model claiming this improvement and forced the applicant of the original invention into a cross-licensing agreement. “In this way, the JPS Hayashi) rewarded firms that reverse engineered and modified inventions while penalized original inventors” (Maskus and Mcdaniel (1998) , 10).

Third, a seven year term to request examination of the application along with a pre-grant opposition system led to large grant lags. Thus, at the time a patent was granted, the remaining term for patent protection was relatively short.

Finally, until 1993, the Japanese patent law required applications to be filed in Japanese and the correction of translation errors was not allowed. This language requirement and the restriction of amendments led to increased costs for foreign applicants. Applicants often had to have the application translated into Japanese and afterwards re-translated into the original language by a second party in order to avoid translation errors. For non -Japanese firms this expensive procedure made applying for a patent in Japan rather unattractive. For Japan, this resulted in less knowledge transfer from other coun tries Maskus and Mcdaniel (1998).

After the change of the patent system in 1995 narrow patent scope and low novelty standards were replaced by raising novelty standards and acceptance of broader claims. These changes discouraged incremental and improvement inventions and encouraged more fundamental inventions. Additionally, the modifications of the patent law led to more freedom to operate since widening the scope of protection made cross -licensing agreements less important Maskus and Mcdaniel (1998). The Japanese government still pursues a pro -patent policy. In 200 3, for instance, the Japanese government published the "Strategic Framework for Intellectual Property Policy" which aims at promoting and strengthening IP protection Motohashi (2003). Results of scientific analysis for the U.S., however, revealed only marginal effects of strong patents on innovativ eness (Lerner (2002); Kortum and Lerner (1999)). Whether this pro-patent policy of Japan succeeds or not, remains to be seen.

2.5 A stylized comparison of the three major patent systems

Table 2.5 summarizes some important features of the patent systems in the three countries. We briefly discuss the most salient differences between the three major patent systems.

	United States	**Japan**	**Europe**
filing and examination	- *first to invent* - *One year grace period* (earliest public disclosure allowed before filing, otherwise novelty lost) - *filing options:* provisional application, standard application, continuation and continuation in part applications. - *examination:* automatic / alternative deferred examination path introduced in February 2003.	- *first to file* - *6 months grace period:* if the disclosure was made by the applicant or someone under his control. - *filing options:* standard patent application divisionals - *examination request*, not later than 3 years after filing.	- *first to file* - *6 months grace period*: only for public disclosure in certified international exhibitions and in unlawful breach of confidentiality or secrecy agreements. - *filing options:* standard patent application divisionals - *examination request*, not later than 6 months after publication of search.
challenges to validity	- *re-examination* at USPTO: no time limit, does not allow same level of participation of third parties as opposition. Third parties tend to rely on litigation to challenge validity.	- *post-grant opposition,* within 6 months from publication of grant	- *post-grant opposition,* within 9 months from grant, centralised process at EPO (litigation subject to national court decision in each designated country).

Table 2.5: Comparison of patent systems with respect to selected features (Source: Martinez and Guellec (2004))

The most outstanding difference between the systems in Japan and Europe on the one hand and the US on the other is the principle of first to file (JPO, EPO) versus first to invent (USPTO). The latter principle forces researchers and inventors to document research progress very accurately. However, empirically the difference has been found to be of rather minor importance. As we pointed out in section 2.3.1, fewer than 0.1 to 0.25 per cent of applications result in interference proceedings (Mossinghoff 2002; Lemley and Chien 2003).

Another interesting difference is the degree to which inventors can claim a grace period during which they are allowed to publish details about their inventions without endangering their later rights to be awarded a patent. Europe has the most stringent regulation under which only very select publications may be made. Both Japan and the US provide more leeway to inventors. These options are of particular interest to academic researchers who may have to postpone publication in order to safeguard their patenting options first. Many researchers in universities and publicly financed research institutions in Europe feel that the current European solution (sometimes coupled with bureaucratic tendencies in technology transfer offices pursuing the patenting process) renders them a competitive disadvantage vis a vis their Japanese and US competitors.

A much-discussed difference in the area of filing options concerns the US practice of allowing for patent continuations. The patent examiner at the USPTO has relatively limited power to reject an application for good. Instead, applicants may drop the original application and then forward a continuation or continuation in parts to the USPTO. Quillen et al. (2002) have criticized this practice and show that once the USPTO statistics are corrected for the effect of continuations, inventions are likely to receive patent protection in more than 90 per cent of all cases. Both the European and the Japanese Patent Office allow for divisional applications. In these cases, an invention that is deemed to be particularly broad by the examiner may be divided into two separate applications. Divisionals may be used for strategic purposes when the examiner restricts the patent narrowly. In this case, applicants may choose to accept the narrow-scope patent grant, but maintain an option on a broader patent right by filing a suitably defined divisional application. The extent and use of divisional applications will be studied empirically later on.

Finally, Japan allows applicants to delay examination by up to three years (until 2005, the delay could be last to seven years). Under new regulation, the USPTO has offered a new deferred examination path since beginning of 2003. Deferred examinations allow applicants to observe the development of markets and technologies prior to expending resources on examination. Similarly, since many of the deferred cases will simply be dropped, such a system offers advantages to resource-constrained patent systems. However, the option of delaying examination can be abused in order to modify the patent in such a way as to threaten competitors who have made investment decisions in a particular area. At the EPO, examination requires a request by the applicant, but cannot be delayed.

Finally, the US system relies mainly on courts to establish some form of quality control over granted patents. The re-examination proceedings available at the USPTO have not been very effective, as academic research has shown (cf. Graham, *et al.* (2003)). Conversely, opposition at the EPO has – despite the decline in utilization – been very effective in invalidating patent rights which would have been granted erroneously or in too broad a specification. The JPO offers a similar proceeding to third parties, but its efficacy has not been analyzed so far. Infringement and annulment proceedings in Europe are subject to national law. This fragmentation of the patent enforcement and annulment system has motivated several proposals to establish a harmonized European patent litigation system, either in conjunction with the Community Patent or in the context of the European Patent Litigation Agreement. The latter proposal has gained some support lately. The EPLA is a proposed optional agreement and foresees the establishment of a new international organisation, the European Patent Judiciary (EPJ). The EPJ would have as its organs the European Patent Court (with a Court of First Instance and a Court of Appeals) and the Administrative Committee. The Court of First Instance will be comprised of a Central Division at the seat of the EPJ and a number of Regional Divisions set up by the contracting states. Typically, there will be one Regional Division per country, in larger countries up to three Regional Divisions. The system will adopt the EPO's language regime, i.e. cases at Regional Divisions will typically be heard in the respective national language while cases at the Central Division will be heard in one of the three official languages of the EPO (English, French, German). Cases will be heard by panels of three or five judges, with at least one judge being technically qualified and at least two judges being legally qualified.

3. Strategic Use of Patents - A Definition and Implications for Enterprise and Competition policy

3.1 Introduction

Empirical research in the domain of patents has established that there was a significant shift in firms' propensity to patent – often referred to as the "patent explosion" - in the United States around 1984 and in Europe around 1995. This development is documented in part in Figures 3.1 and 3.2 below.[34] These shifts in firms' patenting propensities have occurred in industries that are not traditionally associated with patenting. There is now a large literature which deals with the driving forces and the consequences of the observed phenomenon.

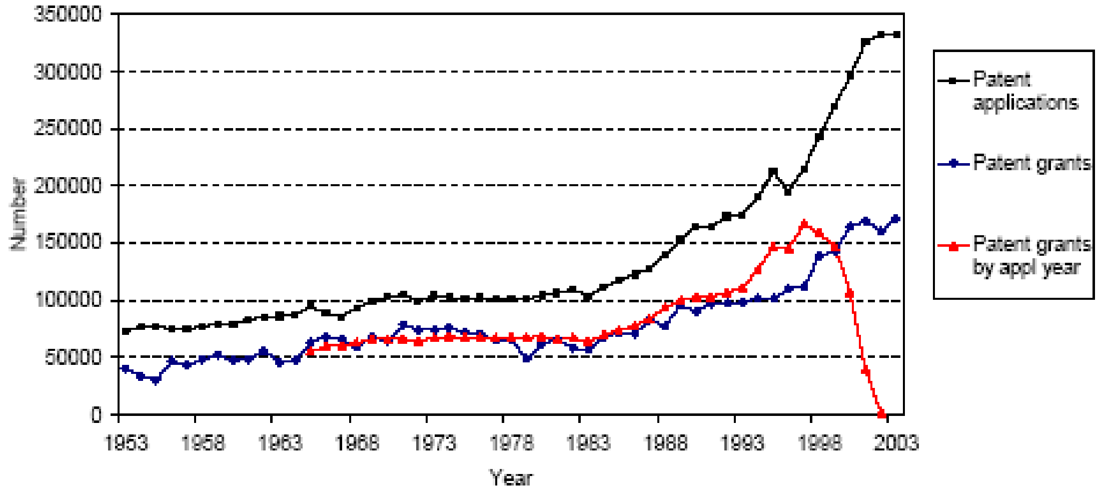


Figure 3.1: USPTO Utility Patents 1953 -2003 (Source: Hall (2005)).

In this paper we review the literature on the patent explosion, patent thickets and strategic patenting to derive a definition of "strategic use of patenting" (section 2.2). We discus s a series of phenomena that are associated with the patent explosion and show how the definition can help us to understand them (section 2.3). Finally we discuss the implications of the "strategic use of

[34] Please note that the number of patent applications at the EPO in the years between 1978 and 1990 rose steadily due to the increasing familiarity of patent applicants with the EPO which was founded only in 1978. The increase of patent applications after 1995 can be attributed to an increasing propensity to patent.

patenting" for competition policy (section 2.4). Th e conclusion contains a discussion of indicators and the methodology that can be used to study strategic use of patenting empirically (section 2.5).

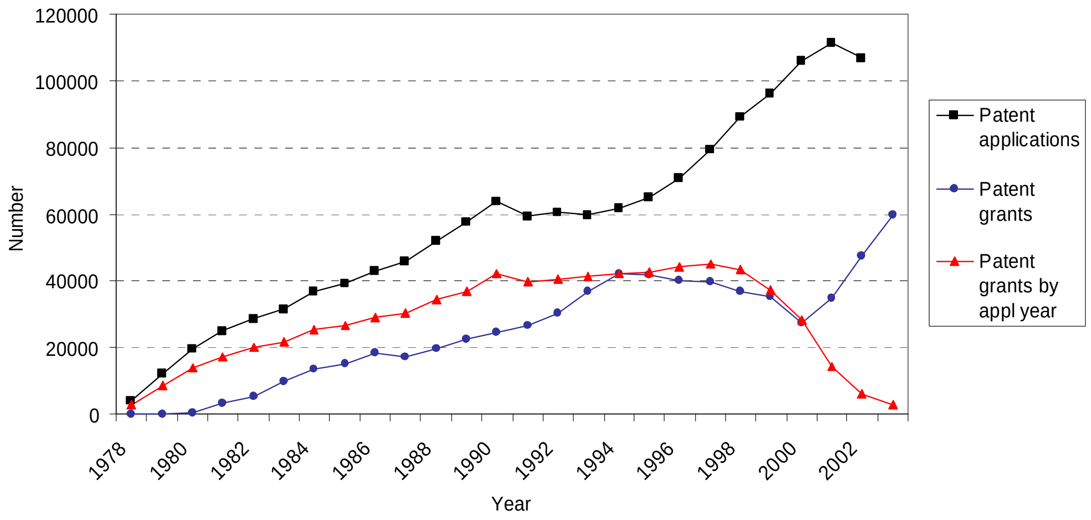


Figure 3.2: EPO Patents 1978 – 2003 (Source: EPO data)

In this introduction we discuss the traditional view of patents and the welfare arguments that support a patent system. Then we turn to a series of surveys through which economists have sought to discover why firms patent. Finally we touch on ways in which the literature has moved beyond the traditional view of patents in order to accommodate the results of these surveys and the more recent patent explosions in the United States and in Europe. [35] This discussion will prepare the ground for the following sections of the text by introducing several importan t concepts.

3.1.1 The traditional view of patents

Much of the economic literature on patents is founded on the convenient simplification that a patent protects a temporary monopoly over a market or at least a process or product innovation that provides significant market power in such a market. In this literature a granted patent right is assumed to be (i) valid, (ii) clearly defined in scope and (iii) clearly defined w.r.t. its statutory

[35] Note that developments in Japan are a good deal more complex due to the many legislative changes outlined in the previous chapter.

term. (iv) Furthermore, it is generally assumed that a single patent is sufficient to cover an entire product or process innovation (Nordhaus (1969)). (v) Finally much theoretical work has tended to ignore alternative methods of appropriating returns to innovative activity, suggesting that innovators always employ patents to protect innovations. In the absence of patents, perfect competition prevails.

This traditional definition of patents has proved a useful starting point for economic research into the optimal organization of patent systems and into the effects of patents on scientific endeavour and competition. In particular it has provided a basis for normative research on the patent system which studies the welfare effects of operating a patent system or the optimal length and breadth of patent rights. We summarize the welfare arguments that underpin the operation of a patent system here. These will be useful in our discussion of the welfare implications of the strategic use of patents below.

The justification for operating a patent system

In two seminal articles Nelson (1959) and Arrow (1962) provided the underpinning for the modern theoretical enquiry into innovation in economics. Nelson points out the problem of underinvestment specifically in basic research and Arrow shows that inventors' incentives to be inventive will suffer if they cannot appropriate the returns to their inventions, i.e. if others can freely copy these inventions. He argues that knowledge created by innovators has the characteristics of a public good. Most importantly this means that once an idea is passed on it may be used by those that have received it without the inventor having control over this use. This constitutes the appropriability problem and it will lead to an underprovision of innovation if left uncorrected.

Many incentive schemes to correct this underprovision of innovative activity exist and have been used in the past. The patent system which was first formally implemented in Venice (1474) is one of them. In a recent paper Gallini and Scotchmer (2002) compare the use of patents with other instruments such as prizes and procurement mechanisms. As they point out the patent system's main cost is the cost of the monopoly which a patent confers on the holder. Under the traditional view of patents, the patent holder will be able to monopolize a product market and charge a monopoly price. This leads to a deadweight loss. *Ex post* the existence of the patent is therefore inefficient. The social optimum would be achieved if the innovation covered by the patent were freely available.

However *ex ante* a patent system also has important benefits for society offsetting the negative *ex post* effects described above. In a context in which inventors have superior information about technology, which is due to their efforts to understand a technology, the patent system offers a reward for such efforts. This reward consists in the monopoly conferred by the patent and the protection against copying that it affords. Most importantly the value of such a monopoly need only be known to the inventor and not to the patent office. Thus in co ntrast to a system of prizes a patent system allows society to incentivize innovators, without the need to understand the value of their innovations and without the need to understand in which areas of technology the most promising innovations may reside. Accordingly, Scotchmer (1999) argues that the patent system is the best incentive system whenever society observes neither the cost nor the benefits of innovative activity. Gallini and Scotchmer (2002) note that a patent system requires the public to sustain experts who are able to judge the value of patent applications to some extent. Thus society must observe at least some components of the value of innovations ex post.

The precise value of the monopoly offered by the patent office depends on many factors. The most important are the duration of the patent and its breadth. The longer a patent right lasts, the greater is the expected value of that right, ceteris paribus. The same is true of greater patent breadth. Broader patents allow a firm to exclude a larger range of substitute technologies from use by competitors. Following Nordhaus (1969) an extensive literature has emerged that studies the trade-off between the deadweight loss due to patents and the incentive effect necessary for innovation to take place. This literature has shown that a proper understanding of the welfare effects of the patent system will depend not only o n length and breadth of patents but also on the cost of imitating patents and on firms' incentives and ability to license patents to rivals. In particular if firms can license technologies to one another efficiently, then patents should be narrow and long lived because this is likely to allow several firms to enter a given market with rival technologies and because longer lived patents are more likely to give rise to licensing which leads to lower prices.

If we take as given the length and breadth of a patent, the economic literature has also investigated the question of the welfare effects of races for individual patents (Reinganum (1989)). The welfare analysis of patent races is ambiguous as it shows that symmetric firms increase their R&D efforts whenever firms compete for the only patent covering a product market. Firms may invest more in the acquisition of such contested patents than these are worth to society; this is referred to as overinvestment. Models of patent races were thought to be particularly pertinent to industries which conform to the traditional view of patents. An industry which is often cited as embodying the traditional view of patents is the pharmaceuticals industry (excluding biotechnology). Here a single drug is usually based on a single patent. Empirical research by Cockburn and Henderson (1994) in this industry has not provided evidence that patent races, such as those described in the theoretical literature, arise when firms compete for patents on new drugs. Therefore, it is usually assumed that firms generally underinvest in R&D even in the presence of the patent system. The empirical literature focusing on spillover effects typically detects positive externalities emanating from rivals' R&D. Therefore, the assumption is largely coherent with the empirical studies.

To sum up the theoretical literature on patents has found that under the traditional view of patents the welfare effects of the patent system depend on the breadth and duration of patent rights as well as the costs of imitation and the likelihood that firms will license patented technologies to one another. If the traditional view of patents and Arrow's analysis of the public goods character of innovation are an accurate model of reality, then a patent system will provide innovators with increased R&D incentives which counteract the tendency to underinvest in R&D. This is the traditional justification for the operation of a patent system.

It should be noted that theoretical research in this area has demonstrated that the optimal design of the patent system depends on industry characteristics that are not reflected in patent law. Nordhaus (1969) shows that the elasticity of demand and the technological opportunities in an industry can have a strong influence on the optimal duration of patent protection. Therefore it is unlikely that a homogeneous patent system ("one size fits all") provides a complete remedy to the appropriability problem analyzed by Arrow across all industries and technologies.

This discussion has shown that under the traditional view of patents it is incumbent upon patent law to stimulate firms' innovative activities through the design of clearly delineated property rights. However theoretical work in this area has also demonstrated that patent law is not independent of competition law. Rather the design of competition law rules that affect firms' licensing and cooperative research activities (which are substitutes for licensing) directly affects the optimal design of patent rights. In the following sections we will return to this nexus of competition policy and patent law.

Going beyond the traditional view of patents

While the traditional view of patents has proved a fruitful simplification of reality, its defects have been widely recognized for some time. Economists have therefore studied innovation in settings in which innovation is cumulative and more recently settings in which patents are complementary. Furthermore firms' choice between patenting and secrecy has been studied. Here we briefly review work on cumulative innovation and on the choice between patenting and secrecy. The effects of complementarities between patents are discussed in the following section.

A first step beyond the traditional view of patents is taken when we consider that patents often build on previous patents, i.e., that innovation is often a cumulative process. Where this is the case the patent system should be designed to compensate earlier innovators for benefits that follow-on innovators draw from preceding research. Once more the alternatives the literature considers are broad patents that are short-lived and narrow patents that are long-lived. Here the concept of breadth or "leading breadth" refers to the inventive step which is necessary in order for a follow-on patent not to infringe an earlier one. This notion of breadth must be contrasted with the notion of breadth in the literature based on the traditional view of patents. There the breadth of a patent refers to its ability to block contemporaneous (substitute) innovations.

As before the question whether licensing is possible affects the conclusions of this line of research. Gallini and Scotchmer (2002) argue that broad, short lived patents are beneficial because they prevent duplication of innovative activities and provide incentives for follow on research while still providing rewards for early innovators. Under such a system the breadth of early patents forces follow on innovators to take out a license in order for them to bring their newer product/process to market. Thereby the earlier innovator is compensated for the benefits which the follow on innovator derives from the earlier patent. The reasoning which supports broad and short lived patents fails if licensing is not possible. In this case the breadth of the initial patent would reduce any incentives for follow on innovation by rival firms.

To sum up, this literature also finds that the ability of patenting firms to license their innovations has an effect on the optimal design of the patent system. Furthermore the literature shows that the inventive step (breadth) which is necessary for follow on patents to be granted is an important consideration in the welfare analysis of the patent system. The incidence of licensing, affected by the regulation of licensing, is an important determinant of conclusions regarding the optimal design of the patent system also when technology is cumulative. However, the design conclusions for patent law that emerge from this literature seem to be the exact opposite of those which we drew from the literature based on the traditional view of patents.

The work surveyed so far has focused on the design of the patent system itself and has therefore adhered to assumption (v)[36] of the traditional view of patents. We turn now to empirical research which has shown that patents have traditionally not been important in the appropriation of rents from innovation in many industries. Thus the central premise of Arrow's work that the public goods nature of knowledge implies that innovators cannot appropriate any returns from innovation is misplaced in such industries. Instead firms in many industries mainly rely on a combination of secrecy and lead time to appropriate substantial returns to innovation.

Empirical research conducted by Levin, *et al.* (1987) and Cohen, Nelson and Walsh (2000) has tried to establish how important patents are to firms which protect innovations and what purpose patents serve. This work has shown that firms in the United States value patents as highly as secrecy and lead time only in the drugs, medical equipments and special purpose machinery industries. In all of these industries the prevention of imitation and the intention to block rivals' applications (which would protect *substitutes* of the firm's products) was considered the most important motive for patenting.

[36] This assumption is that patents are always used as a means to protect innovation.

Cohen, Nelson and Walsh (2000) find that U.S. firms in several industries value patents at least as much for the prevention of copying and for blocking as for their use in negotiations with rival firms and to prevent suits. Industries in which this aspect of patents was important include steel, electrical equipment, electronic components and communications equipment. It is important to note that in most of these industries patents are viewed as less effective than secrecy or lead time in protecting benefits from innovation.

European evidence from similar surveys suggests that patents are even less important for firms than in the United States. In a series of papers Arundel and Kabla (1998), Arundel (2001) and Arundel (2003) use the Community Innovation Survey (CIS) and the KNOW survey to study appropriation of innovation rents in Europe. They find that patenting is consistently less important than secrecy and lead time for European firms in the appropriation of return s to innovation. This remains true if small firms and large firms are considered separately, and if sectors are disaggregated. Unfortunately, they provide no evidence on the strategic use of patents in Europe. However, their results about the relative impo rtance of patents amongst sectors are broadly consistent with findings in US surveys.

Summing up this evidence, we find that industries have differed substantially in their use of patents. In particular there are a few industries, such as pharmaceuticals that have used patents in ways that correspond closely to the traditional view of patents. In other industries patents have been valued for use in negotiations and to prevent suits. This suggests that strategic use of patents going beyond the traditionally envisaged use of patents as an exclusion mechanism have weighed more heavily on the decision to use patents in these industries.

3.1.2 Patent uses in complex technologies

In this section we review recent work on the patent explosion and strategic patenting. This literature is largely empirical with some notable exceptions. In contrast to the literature reviewed above it attempts to relax almost all of the assumptions underlying the traditional model of patents. The implication is not that the traditional vie w is never correct, rather that alternative views apply to an possibly increasing number of industries.

Industries in which strategic patenting, as defined below, has led to a patent explosion are usually complex technologies. In such a technology a product or process depends on many separate components, all of which may be subject to innovative change. Two facets of complex technologies are relevant to the analysis which follows: firstly complex technologies are often modular; and secondly patents on a complex product or process are generally held by several, often rival, firms. A modular technology is one which can be separated into components each of which is related to others through a given set of design rules or interfaces. This allows independent efforts in the improvement of individual components to take place, without the need for coordination of these efforts. Modularity can lead to specialization of firms on different stages of the product innovation process as we outline later. This often contributes to the fragmentation of control over property rights on a single technology. We analyze the effects thereof here.

The literature on the patent explosion begins with the observation that the patenting strategies of firms in the semiconductor industry in the United States changed in the mid 1980's. Grindley and Teece (1997) argue that semiconductor firms traditionally did not make much use of patent protection because innovation rents were appropriated through lead time and first mover advantages. They note that the strengthening of intellectual property that occurred in the United States in 1982 (Jaffe (2000)) led Texas Instruments and other firms to assert their semiconductor patents more aggressively. As Hall and Ziedonis (2001) show, this led to an industry wide explosion in patenting activity as all leading semiconductor producers scrambled to build up large patent portfolios. Hall (2005) shows that this shift in patenting behaviour has spilled over into other patent areas as semiconductor and electronics firms pursue their strategy of patenting aggressively. The trend has been supported by the low examination requirements of the US Patent Office documented in Quillen, Webster and Eichmann (2003).

The most extensive evidence on the patenting explosion is available for the semiconductor industry. Following the work by Grindley and Teece (1997) and Ziedonis and Hall (2001) there has been further empirical research on semiconductor firms' patenting strategies and their determinants by Ziedonis (2004a), on litigation by Somaya (2003) and Ziedonis (2003) as well as on licensing by Siebert and Von Graevenitz (2005). However there is also work on the effects of increased patenting in other industries. The effects of firms' patenting strategies in the software industry have been studied by Hall and Macgarvie (2006), Schankerman and Noel (2006) and Bessen and Hunt (2004). In the field of biomedical research an early paper by Heller and Eisenberg (1998) raised serious questions regarding the effects of patenting on research productivity in this field, especially at the level of basic scientific research. they argue that patent thickets in biomedical research would make it difficult or impossible for researchers to access basic research tools. By implication research progress in these industries would be stifled. More recent work by Walsh, Arora and Cohen (2002) and Walsh, Cho and Cohen (2005) does not show that these concerns are generally valid. In the field of nanotechnology Lemley (2005) has documented that firms and universities are patenting at an unprecedented pace for such a new technology. He points out that this is the first new technology to emerge in which basic scientific building blocks are being patented. Finally there is the work by Hall (2005) who studies the development of the patenting explosion on aggregate as well as looking more closely at firms in the software industry. Close inspection of this literature demonstrates the following two points. First, empirical work on the patenting explosion is very new, much of it as yet not published in peer reviewed journals. Secondly it shows that there is still some uncertainty about the effects of the surge in patenting on firms' and universities' research incentives. This is particularly apparent in economic research on the effects of patenting in the fields of biomedicine, software and nanotechnology.

What unifies all of this work is its focus on patenting in technologies in which a product is based on a large number of patents, i.e., industries in which products are complex. These patents are valuable only as a set of complementary patent rights. Thus, assumption (iv) [37] of the traditional view of patents is violated. Shapiro (2001) argues that firms in industries based on such complex technologies face a growing "patent thicket": a dense web of overlapping patents in which a firm is often faced by rivals that hold patents which may block the use of its own patents.

Shapiro (2001) shows that complementarities between patents belonging to rival firms will reduce firms' innovation incentives because firms must share access to these patents. He surveys cross licensing, patent pools and standard setting as possible mechanisms through which firms may overcome the challenge posed by complementarities. It should be noted that all of these mechanisms are forms of coordination and collaboration between firms that are traditionally

[37] Assumption (iv) states that one patent covers the inventions leading to one new product.

regulated by competition policy authorities. Therefore it is likely that the connection between competition policy and patent law becomes more important in the context of complementary patents.

Shapiro (2001) also points out that there is the threat of hold-up of technologies that are already implemented – here hold-up refers to the ability of a second party to extract part of a firm's profit by leveraging a property right over a part of that firm's production process. Hold-up is usually based on patents that are complements to an implemented technology. It is now widely documented for the United States that firms threatened with infringement suits often avoid costly litigation and settle. The threat of an infringement suit that may be coupled with an injunction to cease using a litigated technology constitutes a very powerful form of hold-up as the interview partners of Hall and Ziedonis (2001) consistently argue. The problem of hold-up is exacerbated when the number of patents issued grows, when these patents become increasingly complex and as the duration of patent examination (and thus uncertainty about the outcome) increases.

In response to the combined effects of complementarities and the threat of hold-up, large firms often resort to building large portfolios of intellectual property rights. These serve the primary purpose of enhancing the firm's bargaining power in negotiations over complementary patents. Ziedonis (2004a) and Schankerman and Noel (2006) document that firms are more likely to resort to patenting intensively if they face a large number of rivals with complementary patents than if they face a smaller number of such rivals. The intuition is that it is easier to collectively refrain from hold-up if the number of interacting firms is small. Therefore it is not so important to protect against hold-up by building up a patent portfolio when a firm faces fewer rivals. Ziedonis (2004a) refers to the dispersion of patents amongst rival firms as the degree of fragmentation of patents connected to a given technology.

Large patent portfolios and the corresponding bargaining power may be used either to prevent or contain infringement actions brought by rivals (defensive use) and to raise firms' incomes from active licensing programs[38] (offensive use). Neither of these forms of using patent portfolios is *per*

[38] It is often noted that IBM, Texas Instruments instituted quite successful programs to manage the licensing of their intellectual property rights. Texas Instruments caught the industry's attention by reaping more income in the early 90s from licensing than from manufacturing operations.

se illegal under either patent or competition law. However in individual cases firms' strategies of using their patent portfolios have been and are being scrutinized by competition policy agencies and the courts. Examples include: Intel/Intergraph, documented in OFT/CRA (2002), Shapiro (2003b); Yamaha/Bombardier documented by Rubinfeld and Maness (2005) and Qualcomm Inc., documented in Parchomovsky and Wagner (2004). Offensive use of large patent portfolios is most likely to be successfully implemented by first movers in any given technology, e.g., Texas Instruments.

The strategy of building up a large patent portfolio to enhance bargaining power is sometimes referred to as "strategic patenting" Schankerman and Noel (2006). As we have noted this notion loosely covers at least two distinct uses of a large patent portfolio, the defensive use which may arise in response to fragmented property rights and the offensive use which may arise where firms are first movers in adopting strategic patenting. The offensive form of strategic patenting seems sometimes to emerge in response to reductions in demand for an industries, as in the Yamaha/Bombardier case discussed by Rubinfeld and Maness (2005) or a firms products as in the case of Texas Instruments which is discussed by Grindley and Teece (1997). Thus it is a reflection of a change of strategy which encompasses intellectual property rights. Once a firm in an industry adopts the strategy of building up a large patent portfolio, rival firms are faced with the choice of following suit, as occurred in the semiconductor industry, or of trying to contain the flood of patents by challenging their validity. Such strategies of containment are in evidence in the franking devices industry as discussed by Wagner (2005), in cosmetics as discussed by Harhoff and Hall (2003), and in the personal watercrafts industry as discussed by Rubinfeld and Maness (2005). The extent to which one or the other strategy is a better response will depend on the degree to which a patent system is able to stem the flow of patents that contribute only very marginally to technological progress.

To summarize, this section has shown that in certain industries a new model of patents is emerging. By analogy to the traditional view of patents, this new paradigm can be summarized as follows:

- The validity, scope and duration of individual patent rights depends on the resources which society invests in their examination and the opportunities society affords third parties to challenge applications (Lemley and Shapiro (2005) Meurer and Bessen (2005)).
- Furthermore, where technology is complex the inventive step required to obtain a patent is an important determinant of the complexity of the web of intellectual property rights covering the technology. Cohen, *et al.* (2002) (v) In addition to the traditional motives for patenting, firms may engage in strategic use of the patent system if technologies a re complex and the patent system (including the institutions for patent litigation) provides incentives which support strategic behaviour.

This view of patents which emerges from patenting strategies in complex product industries differs from the traditional view of patents in emphasizing the institutional context in which patent applications are made and patents are granted. Furthermore, it differs by focusing on patenting strategies which are based on the exploitation of complementarities between patent s. As noted above this literature is very recent. There is thus far no accepted theoretical model of the interaction of firms R&D incentives and the design of the patent system. Therefore it is too early to draw wide ranging policy conclusions about the op timal design of the patent system in the face of the patent explosion. Furthermore, it is difficult to tell whether the patenting explosion has been accompanied by fundamental changes in the process of technological change. In order to support the exploration of these issues, it is all the more important to be able to identify technologies and sectors in which potential problems might occur due to the developments just described.

It is sometimes suggested that firms caught up in a patent thicket engage in patent portfolio races (Hall and Ziedonis (2001)). Such races might be expected to lead to wasteful increases in R&D investments. Thus far there is no direct evidence of effects of the patenting explosion on firms' R&D efforts. What is clearer is that transaction s costs have increased and this may have negative welfare implications. Welfare would decrease where firms devote increased efforts to defence of their "freedom to operate" (Grindley and Teece (1997)) by building up patent portfolios that do not serve other purposes and that mainly co nsist of questionable technological innovations. Then the escalation of spending on "freedom to operate" would consist socially wasteful spending tha t raises barriers to entry. If expenditure on patenting is sufficiently high these effects could lead to reductions in the number of competing firms through an *escalation mechanism*.

Escalation mechanisms have been identified by Sutton (1991, (1998, (2002) as resulting from competition between firms through escalation of spending on R&D, advertising or any other strategic variable. The escalation of spending by all firms in a market on such a variable has the effect of raising the level of expenditure necessary for any one firm to be able to compete in that market. In other words, an escalation mechanism leads to rising barriers to entry into a specific industry. These barriers are endogenous in the sense that they result from the competitive interaction of firms within that market. Nonetheless, it must be noted that in the context of free entry, firms cannot escape the operation of such an escalation mechanism either individually or collectively. Current developments within the patent systems of the United States and Europe can be analysed using this theoretical framework. Existing analysis of these developments is based on the concept of patent portfolio races (Hall and Ziedonis (2001)). Viewed through the prism of an escalation mechanism, patent portfolio races represent the process of escalating expenditures on patent applications. The analogy between these models is helpful in the analysis of welfare effects that patent portfolio races may have. It should be emphasized that we do not yet have sufficient empirical evidence to conclude whether escalation mechanisms are at work in patent intensive technologies. Research into the welfare effects of patenting competition is currently very active.

In spite of all of the uncertainty that affects this new literature, it is very clear that the regulation of licensing will be an important determinant of how firms are able to deal with the challenges posed by complementarities between patents. Just as under the alternative models of patenting, which we have surveyed above, an important nexus between competition policy and patent law lies in the regulation of licensing of patents. We will return to this issue in section 3.4 below.

3.2 A definition of strategic use of patents

In this section we provide an analytical definition of the strategic use of patents and discuss it. The definition we provide here will be used as a working definition for the further course of the project. It will be subject to review and possibly to modifications. Our proposed definition is:

Strategic use of the patent system arises whenever firms leverage complementarities between patents in order to attain a strategic advantage over technological rivals. This behaviour is anticompetitive if the main aim and effect of strategic use of the patent system is to decrease the efficiency of rival firms' production efforts .

Note that this definition has two parts: the first is intended to help us to identify a broad set of strategic uses of patents while the second identifies which forms of strategic use of the patent system are anticompetitive.

As noted in the previous section the economic literature on patenting in complex product industries and on patenting in general provides no widely accepted definition of either "strategic patenting" or "strategic use of the patent system". The definition of the latter concept which we propose in this section seeks to pull together the most important factors that are associated with patenting strategies that have emerged in complex product industries in the last two decades. The definition has two aims:

1. To provide a foundation for the identification of "strategic use of the patent system" based on patent indicators.
2. To provide a theoretical basis for the evaluation of a firm's strategic use of patents from a competition policy perspective.

We stress that this definition is not taken from any source in the economic literature and that no attempt has been made in this literature so far to provide a concise definition of patenting strategies that is related to competition policy concerns.

The definition we propose also has two important and intentional limitations:

1. The definition cannot and does not seek to provide a *per se* rule for the identification of anticompetitive behaviour based solely on a firm's patenting strategy. The reasons for this limitation are discussed in section 3.4 below.

2. Furthermore the definition expressly limits itself to patenting strategies that are based on the use of large numbers of patents. The reasons for this limitation are discussed here.

There are three reasons for this second limitation. Most importantly competition law already has mechanisms in place to deal with the abuse of a firm's market power if it is based on individual patents. What our review of recent patenting trends in the following section will show is that such mechanisms do not yet exist in competition or patent law when we turn to patenting strategies based on the exploitation of large patent portfolios. A second practical reason to restrict ourselves to patenting strategies based on patent portfolios is the identifiability of such strategies in patent statistics. As we argue in section 3.5 it is likely that some strategies may be identified using patent statistics, but the indicators we propose are unlikely to work for individual patents such as the ones implicated in the Astra Zeneca case [39] or in the Spundfass case [40]. Lastly it is unlikely that all possible forms of abusing either patents or the patent system for anticompetitive aims are amenable to a single analytical definition. We believe, however, that it is possible to provide an analytical definition of such behaviour related to the exploitation of patent portfolios.

We now turn to an in-depth discussion of the proposed definition at hand. Once we have discussed the definition we turn in the following section to the application of its first part to various patenting phenomena. This discussion will provide additional means of classifying different forms of strategic use of patents. After this step we will provide a discussion of the competition policy aspects of the patenting strategies we identify. To clarify the definition we provide a discussion of the terms "complementarity", "strategic advantage" and "decrease of efficiency" next. Thereafter we return to the implications of this definition as a whole.

3.2.1 Complementarities between patent rights

Our definition identifies complementarity between patents as a source of strategic behaviour within the patent system. Where complementarities between patents arise the threat of hold-ups arises as noted by Shapiro (2001). This threat increases as the fragmentation of patent ownership in a

[39] See press release IP/05/737, available at www.europa.eu.net .
[40] See case BGH KZR 40/02.

particular technology increases. As noted in section 3.1.2, firms that move first to build up large patent portfolios will have a strong strategic advantage. Parchomovsky and Wagner (2004) argue that an additional advantage of a patent portfolio is its ability to cover different avenues of possible technological change. Therefore they argue it is increasingly likely that firms in *all* technological fields will adopt patenting strategies based on the construction of patent portfolios. While this conclusion is quite far-reaching, their analysis underscores the need for policy makers to address the challenges of patenting strategies based on the patent portfolio as opposed to individual patent rights.

Patents are complements if the value of holding them jointly is greater than the sum of their individual values to different firms (Scotchmer (2005)). By assumption (iv) of the traditional view of patents, complementarity of patents is ruled out, because it is explicitly assumed that each product is protected by a single patent and it is implicitly assumed that demand for individual products is independent of demand for other products. Empirically this assumption is violated whenever individual patents are embodied in technology protected by more than one patent. In such cases the various patents embodied in the product become "technological complements". Technological complementarity is one cause for overlapping patents and for the existence of blocking patents. Thus it is one precondition for the emergence of patent thickets and for the amassing of patent portfolios.

Next to technological complementarity, assumption (iv) of the traditional view of patents may be violated if we allow for complementary products. Then even patents that protect individual products may become complementary in terms of their effect. This happens if the protected products are complements in the product market. Products are complements whenever the value of owning them jointly is greater than the sum of their values to consumers, if held individually. We refer to this form of complementarity as "demand-induced complementarity" between patents. Such complementarity is entirely compatible with the explicit assumptions that jointly make up the traditional view of patents. However it has not been considered in the literature that builds on this view of patents.

The traditional view of patents often rules out any interactions between patents at all. Thus it also rules out the possibility of patents that are technological substitutes. Technological substitutability in the simplest form arises if there is more than one technology which achieves a certain aim and if each technology is covered by a separate patent. As long as substitute patents are held by competing firms they guarantee that the underlying product market is at least oligopolistic. However, frequently a firm will seek to patent as many substitute technologies as possible itself, even if only one is finally implemented. The aim of building such "patent fences" (Reitzig (2004)) is to raise rivals' costs of imitating a technological improvement. In this case a number of substitute patents held by a single firm will become "legal complements" because each of the patents in the fence reduces the threat of competition and raises the value of the patent which is actually used, to its owner.

Note that a group of patents that are "technological complements" may also become "legal complements" if they are all held by a single firm. In this case the firm will be able to improve the technology of its product using the whole set of patents.

We argue that a patent portfolio owned by one firm must contain patents that are technological- or demand induced complements to rivals' patents or technological substitutes if it is argued that the use of this portfolio constitutes a strategic use of the patent system. The existence of such a portfolio of patents cannot by itself imply that the use of the portfolio is anticompetitive however.

Where firms use individual patents or patent applications in questionable ways the examination systems at patent offices and the courts provide avenues for affected rivals to counter this behaviour at the level of individual patents. In contrast Parchomovsky and Wagner (2004) argue that the use of patent portfolios creates challenges to which the patent system and competition policy are not well adapted at present because it is very costly to challenge all the patents constituting a patent portfolio individually. That this is the case is not surprising as patent system design continues to be guided by the view that individual patents are the appropriate unit of analysis.

This begins at the examination phase in which the patent examiner deals with each patent application separately. This means that an examiner may seek to control the breadth of an individual patent, but they have little or no control over the breadth of a portfolio of patents which a firm may be creating through a series of contemporaneous patent applications. Similarly at a stage at which third parties are able to make observations on the validity of patent applications or to challenge these, it is presently not possible or customary for rivals to challenge connected patent rights. In the face of an applicant who has the capability to produce large numbers of closely related contemporaneous patents, opposing or litigating firms that must challenge each individual patent may be at a disadvantage. One of our policy recommendations will focus on this divergence.

We defer the problems which patent portfolio strategies pose for competition policy to section 3.2.3 below where we discuss the term “decreased efficiency” in our definition of strategic use of the patent system.

3.2.2 Strategic advantage as derived from patent rights

The definition introduced above suggests that firms may leverage complementary patents in order to derive a strategic advantage over their rivals. This part of the definition clarifies that firms must have in place a strategy of patenting which exploits complementarities between patents for competitive advantage. Here a strategy is understood as a plan of action which takes into account the reaction of rival firms and is implemented over a longer period.

This part of the definition is included in order to clarify that the definition applies to strategic behaviour following a longer term plan. Thus it rules out any short term or one off actions by firms. This aspect of the definition focuses our attention on activities that require some planning and resources in order to be sustained for a longer period. Thus a patenting strategy that seeks to exploit complementarities between patents may require that a firm strengthen or build up a division dealing with the management of its intellectual property rights. Such a division will exist in all large companies that hold patents, but its ability to implement a certain strategy will depend on the type of people working within the division. As an example consider the hiring by Microsoft in 2003 of Marshall Phelps, an IBM executive who set up a patent-based revenue program at IBM in

1985.[41] This hiring is having the intended effect of allowing Microsoft to change the way it uses intellectual property rights.[42]

3.2.3 Reducing rivals' efficiency by using patents or the patent system

The third element of our definition focuses on whether strategic use of the patent system is anticompetitive or not. We propose that strategic use of the patent system as identified through the first two elements of our definition is anticompetitive if such behaviour has the primary aim and effect of making rivals' production less efficient.

This criterion is based on the wide definition of predation set out by Ordover and Willig (1981).[43] The criterion of the efficiency of rival firms focuses our attention on strategies which raise rivals' costs. However, our definition also makes clear that it must be the main aim and effect of strategic use of the patent system to raise rivals' costs. If a firm can provide a justification for its patenting strategy which is related to the efficiency of its own production, then strategic use of the patent system will not be anticompetitive. A similar standard is suggested by Carrier (2003).

While theoretically appealing, this standard will not be easy to apply. On the one hand it is clear that antitrust authorities cannot be put in a position in which they protect firms which have failed to protect themselves, by not applying for patents, by not licensing patents on vital components of the technologies they employ or by not using alternative measures which prevent the patenting of such technologies by rivals. On the other hand antitrust authorities must be able to intervene where firms make systematic use of implicit or explicit threats based on large patent portfolios. Such threats are not unlikely to constitute a justified defence of their own intellectual property if infringement of these patent portfolios is not found or the patents in the portfolio are of low quality and are found to be invalid. Cases in which firms use courts in an anticompetitive manner making use of intellectual property rights are documented by Meurer (2003) and references therein. There is some

[41] For more information on this hiring refer to The Register at
http://www.theregister.co.uk/2003/12/08/microsoft_aiming_ibmscale_patent_program/

[42] Further comment on this process can be found on the web at:
http://www.msnbc.msn.com/id/5578247/site/newsweek/

[43] Predatory behaviour in the sense of Ordover and Willig (1981) arises if an action is profitable solely because it allows the firm to exclude its rivals. This definition of predation expressly includes non price predation strategies.

anecdotal evidence of similar actions being brought in Europe but little systematic evidence to date.

Meurer (2003) argues that such practices are partly the consequence of weak and poorly delineated patents. Thus improvements in the quality of patent examination will have the effect of reducing the scope for such actions. Similarly, measures which affect the frequency of patenting by raising the costs of patent applications and renewals will force firms to focus on the most important patent rights. This will reduce the number of patent applications and reduce the likelihood of the use of very large patent portfolios to threaten infringement.

This observation points to an important division of labour between patent law and competition policy which we will explore further in our study. The provisions made in patent law should seek to reflect the tradeoffs between the provision of incentives to innovate and the deadweight loss of the associated monopolies. Therefore our definition of the anticompetitive effects of strategic use of the patent system restricts itself to the effects of a firm's use of its patent portfolio on production by a rival firm. The definition is not concerned with the effects of patent portfolios on rival firms' patenting activities. In our view the effects of a firms' patenting strategy on others' innovation incentives should be primarily addressed through the design of patent law.

The role that remains for competition policy is to scrutinize firms' use of patents and patent portfolios. As argued in Régibeau and Rocket (2004) competition policy should not seek to rebalance of firms' R&D incentives as they are set in patent law. Our definition limits the role of antitrust agencies to the immediate consumers' surplus and producers' surplus effects of the use of patent portfolios. Thus the correct role for competition policy is to prevent the misuse of intellectual property directed at product markets. This task, as we argue next, is very challenging. The literature in this field is in its infancy, and therefore our definition of anticompetitive behaviour is not as detailed as one might wish it to be.

As an example of the difficulty in judging whether the use of a patent portfolio in licensing negotiations and infringement actions is anticompetitive we turn now to a case documented by Rubinfeld and Maness (2005). They discuss a case brought by Yamaha against Bombardier at the

U.S. International Trade Commission in 2001. There Yamaha argued that Bombardier infringed a number of patents owned by Yamaha. After a four week trail the case was settled. In the process of the trial several of the patents which Yamaha were referring to were found to be not infringed or lacking domestic industry in the United States [44]. Rubinfeld and Maness (2005) provide evidence which is strongly suggestive of the fact that Yamaha were trying to raise the costs of all of their rivals in the affected industry (personal watercraft) by forcing each one into a package licensing deal. Yamaha used their disproportionately large patent portfolio (90% of industry patents) to back their demands for a licensing deal with their competitors. In some cases this demand was met and in one case a rival left the industry soon after signing such a deal. The difficulty in this case was to prove that Yamaha were misusing their patent portfolio with the intention of raising industry prices. Clearly such an allegation requires the use of data on product markets and their development as set out in Rubinfeld and Maness (2005). This case makes clear that an investigation of firms' patenting behaviour by itself cannot in general be expected to provide proof of anticompetitive actions. However, it can provide an indication where such behaviour might be expected, a form of early warning indicator. In this case, the strong concentration of IP rights in the hands of one producer could be such an indicator.

This concludes our discussion of the definition of the strategic use of patent systems. In the following section we discuss phenomena which the definition may be applied to.

3.3 Empirical Observations

As noted in the introduction there has been a significant increase in the number of patent applications both at the USPTO as documented in Hall (2005) and at the EPO as documented by Harhoff and Hall (2002) and Hoisl (2005). In this section we survey a number of phenomena that are associated with this increase in patenting. In each case we will comment briefly on how the phenomenon fits into the definition offered above. Additionally, we will discuss possible competition policy implications of the phenomenon and ways of identifying the underlying patenting strategy.

[44] Some additional information on this case may be found on the internet such as on this website: http://www.morganfinnegan.com/our_services/service_areas/litigation/itc.html .

To structure this section we will consider each step of the process through which a patent application becomes a granted patent. This process has four main phases:

1. Application;
2. Examination;
3. Opposition;
4. Litigation;

If firms adopt patenting strategies that fall under the definition of strategic use of patents their patenting strategies will take particular form at each of these steps,

3.3.1 Application

The patent application step is the one at which we observe the largest number of phenomena that we would classify as falling under the strategic use of the patent system. We will discuss the following phenomena in turn: increased applications; increased entry of specialized firms ; increased complexity of applications. Most of the evidence discussed here pertains to the semiconductor industry because this industry is the most extensively studied complex product industry to date. We have noted those studies that exist on the effects of the patenting explosion in other industries in section 3.1.2. above.

Increased applications

Hall (2005) shows that the increase in patenting at the USPTO arises across all patent classes apart from those covering chemicals and pharmaceuticals. Thus it has occurred in those industries which traditionally do not value patent protection very highly. Surprisingly, she also finds that this increase in patenting is due mainly to firms that have traditionally patented in the electrical, computing and instruments industries. These firms have begun to patent more widely in other patent classes, than those which they are traditionally associated with.

Additionally she shows that the recent increase in patenting at the USPTO is driven almost entirely by applicants from within the United States. This finding fits in well with the results of a study by Wagner (2005) who studies patenting at the EPO in the franking devices industry. He finds that the firms that patent most aggressively in this very concentrated industry originate in the United States. These findings raise the important question what is driving the increase in patent applications that is observable at the EPO? Harhoff (2006b) provides evidence that the increase in patent applications at the EPO is not due solely to firms from the United States. We have yet to establish which firms are mainly responsible for this development.

As noted above the semiconductor industry is one of those in which the patenting explosion first arose. Direct studies of patenting strategies adopted by semiconductor firms suggest that the shift in patenting strategies that occurred in that industry in 1984 is mainly defensive (Hall and Ziedonis (2001, Somaya (2003), Ziedonis (2003, Ziedonis (2004a)). In this industry firms adopted a strategy which was outlined in the introduction as strategic patenting. The strategy consists of amassing of large patent portfolios. The aim of the strategy is twofold: First it provides firms with bargaining chips that can be used in cross-licensing negotiations with other firms. Such negotiations are frequently little else than mutual pacts of non aggression (Siebert and Von Graevenitz (2005)). The second purpose is to insulate the firm against opportunistic patent infringement suits brought by smaller rivals. We discuss such opportunistic patent suits in more detail below.

Both of these aims are directly traceable to the underlying complementarities between patents. A large patent portfolio is valuable in bargaining only because of the uncertainty that is created by a large number of patents that are located in the same patent classes as those of rival firms. These patents pose a threat because they may become the basis of a patent infringement suit. Such suits currently represent very powerful threats as they often result in preliminary injunctions against the alleged infringing company's business (Meurer (2003)). Large patent portfolios generally neutralize each other if they are of similar size and simultaneously help to hold at bay any rivals that have weaker patent portfolios as long as these have an active business to protect.

(Somaya (2003)) begins his paper on patent litigation in the semiconductor industry with a quotation from a CEO who makes clear that he sees little value in the defensive patenting game which is played out in the semiconductor industry. However now that the strategy of aggressively asserting patent rights has been adopted by virtually all major firms in this industry it seems unlikely that any one semiconductor firm can afford to deviate from this strategy.

Defensive patenting as described does not raise any immediate concerns for competition policy. The principal aim of firms adopting the strategy is to protect their business not to interfere or hold up the business of rival firms. Where firms such as Texas Instruments (Grindley and Teece (1997)) have also begun to assert their patent rights more forcefully they have generally not done this to disadvantage specific rivals but to generate income (Hall and Ziedonis (2001)). This activity has contributed significantly to the rise of defensive patenting. Thus within industries in which defensive patenting arises there should always be at least one firm that also seeks to extract licensing revenues from its patent stocks. This is the first mover who introduces the strategy of building patent portfolios for strategic advantage.

Clearly the adoption of this strategy has imposed large increases in transactions costs on firms. This is documented by Meurer (2003) and in F.T.C. (2003) for instance. Thus the rise of defensive patenting strategies may be interpreted as a process in which the endogenous sunk costs of entry into an industry increase. This would suggest that fewer firms operate in the industry in the long run. This pattern is so far not borne out in any industry studies we are aware of.

Increased entry of specialized firms

The patent explosion has coincided with a process of increased entry into such complex product industries as the semiconductor industry (Hall and Ziedonis (2001)). As documented by Arora, Fosfuri and Gambardella (2001) there has been an increase in the number of firms specializing in the design of chips or components in the semiconductor industry. Similar patterns are documented for other complex product industries such as software and biotechnology. This literature provides no evidence for a causal effect from increases in patenting to increased entry however.

Hall (2005) shows that the valuation of entrants in complex product industries increases strongly if these hold patents whereas the valuation of incumbents is not affected much by their patent portfolios. This reflects what Hall and Ziedonis (2001) call the financing hypothesis: patents allow start-up companies to secure financing.

In the semiconductor industry entry of specialized firms such as “fabless” semiconductor firms which specialize in the design of components has taken pl ace over the same period as the patenting explosion. These specialized firms emerged once semiconductor technology became standardized enough for designers and producers of semiconductors to produce at arms length (Macher and Mowery (2004)).

It is difficult to draw any general conclusions from the experience of the s emiconductor industry regarding the effects of the patenting explosion on competition in general. This is due to the simultaneity of different influences affecting this industry. On the one hand the patenting explosion might be expected to impose substanti al costs on firms operating in the industry and to lead to a process of concentration, on the other semiconductor technology is developing in such a way as to lower barriers to entry.

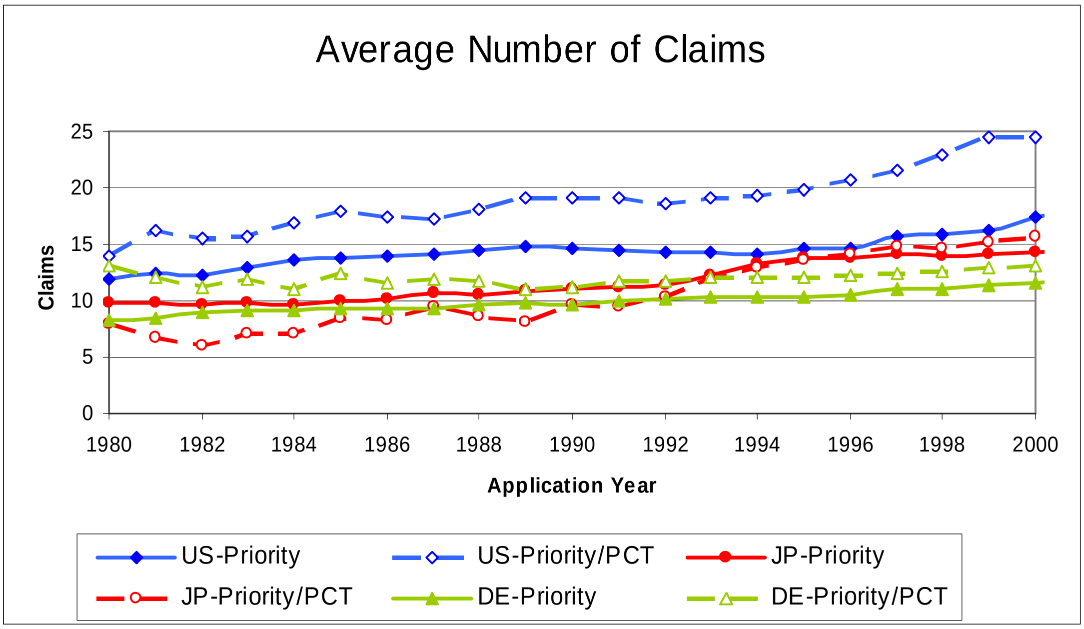
As argued above it is the standardization of the product development p rocess that creates opportunities for entry into complex product industries. We have also argued previously that complementarity of patents is present in complex product industries by definition. Therefore complementarity of patents and periods of increas ed entry activity may be observed jointly quite frequently without any causal effects from one to the other.

Patenting by semiconductor firms that are new entrants into a market does not create any direct concerns for competition policy, on the contrary both entry and patenting at this level are beneficial. However increased entry may also give rise to greater numbers of failing firms and this provides a crucial input for the business of patent trolls. These we discuss below in the litigation section.

Increased complexity of applications

Simultaneously with an increase in patent applications at the USPTO there has been an increase in the complexity of patent applications (Allison and Lemley (2002)).[45] In particular they compare two random samples of patent applications form 1976 -78 and 1996-98 and find that the number of independent claims has increased by about 30% on average while the number of dependent claims per independent claim has increased by 18%. The complexity of applications has also been rising at the EPO. Between 1980 and 2000 the average number of claims per patent grew from 10.1 to 16.9 claims per patent. In particular applications coming from the United States have exhibited strong increases in the number of claims Harhoff (2006a). This is documented in Figure 3.3 below.

The increase in complexity of applications is cause for concern because it is increasing the workload at patent offices and the time which it takes for patents to be issued. (Allison and Lemley (2002)) show that all types of patent applications spent significantly longer in the examination process in the 1996-98 sample than in the 1976-78 sample. The length of examination affects the period during which firms have patent protection because the length of patent protection which is laid down by the law is measured form the filing date of a patent. Thus the increased complexity of firms' patent applications is imposing a negative externality on all patent applicants, which does not seem to be internalized properly through existing claims fee schedules.



[45] Recent developments in patent grants and a brief discussion of patent complexity may be found at http://www.ificlaims.com/press_release012006a.html .

Figure 3.3: Average number of claims per year. (Source: Harhoff (2006a)).

It is likely that some firms are using the complexity of their applications in order to mask the content of their applications from competitors or to create uncertainty about that content. Harhoff (2006a) cites the extreme case of a WO patent application with so many claims (10,247) that the EPO are refusing to examine the application. This a pplication will nonetheless maintain the priority date which it attained with the initial patent application at the WO. Such a patent application will create uncertainty for applicants in the affected patent classes and rivals of the applicant. While this particular application may be an extreme example, it seems likely that some firms are using increases in the number of claims to achieve strategic aims.

The data we have at present do not allow us to determine whether the complementarity of patents is related to the increased complexity of patent applications. Measures that would allow us to connect the number of claims in patent documents and the connectedness of patents have not been evaluated together in the empirical literature on patents to date. Lanjouw and Schankerman (2001) provide evidence for the United States that significant differences between technology fields exist in the number of patent claims filed. They find that " drugs and health, chemical, and electronic inventions have more claims per patent" than "mechanical and other types of inventions". We will need to investigate for Europe to what extent patent strategies based on extremely complex patents or patents that are kept within the examination process for a long time are more likely to arise in complex or discrete product industri es and are related to complementarities between patents.

We comment on the competition policy aspects of strategies which exploit the application and examination process at the end of the following section.

3.3.2 Examination

The examination step is a crucial step for the quality of the average granted patent. The quality of the average patent is important because a lower quality leads to more probabilistic patents, i.e. uncertainty about the validity of patent rights grows. Such uncertainty creates costs beca use it leads to more litigation and more attempts by firms to introduce even weaker patents into the patent system – a feedback process ensues.

In this section we discuss the implications of changes in examination standards at patent offices which directly affects patent quality. Thereafter we deal with firms' incentives to exploit the rules of the examination process in order to gain strategic advantages. Here we provide evidence that firms may adopt anticompetitive patenting strategies if the patent sy stem provides perverse incentives.

Patent quality

There is much anecdotal and some hard evidence to suggest that the quality of patent examinations at the USPTO (Quillen, Webster and Eichmann (2003)) and at the EPO has been decreasing. This has implications for firms' incentives to apply for patents. Thus low examination standards may be fuelling the increase in patent applications we have commented on above as discussed in Harhoff (2006a).

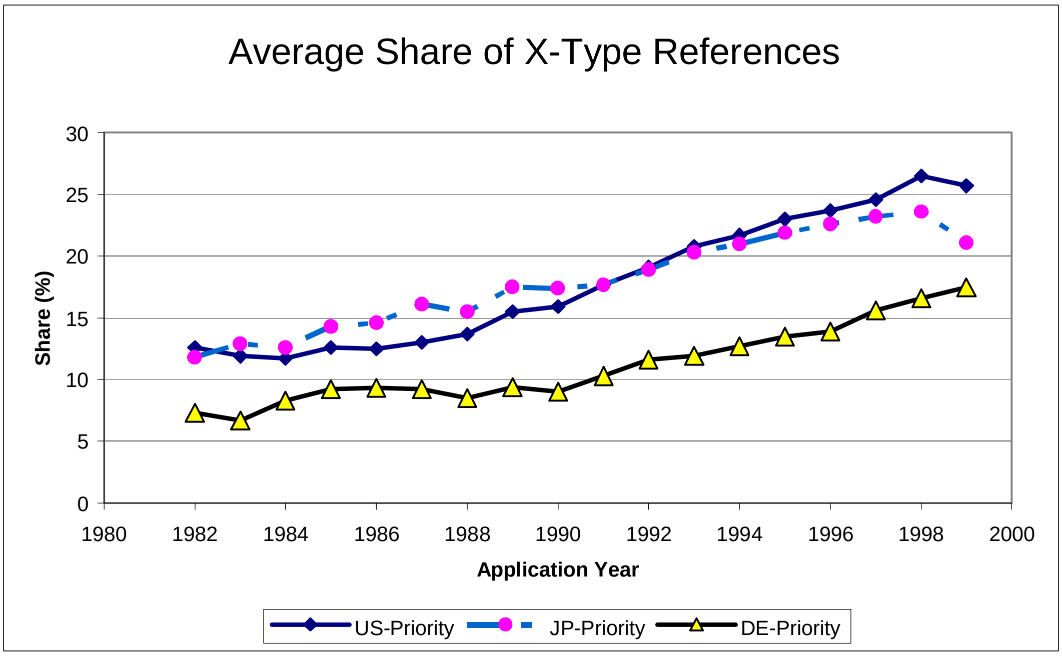


Figure 3.4: Average share of X-type references per year. (Source: Harhoff (2006a))

Figure 3.4 above provides evidence on the number of X -type references received by each patent at the EPO between 1980 and 2000. An X -type reference is a reference which is potentially damaging to a claim in a patent and may cause the claim to be deleted. Figure 3.4 suggests that the quality of patent applications at the EPO has been decreasing. Harhoff (2006a) also shows that there is a marked increase in the number of X-type references per claim, thus Figure 3.4 above does not simply reflect the increase in claims per patent we have commented on previously. Harhoff (2006a) argues that the observed decrease in quality of patents at the EPO may partly be the result of decisions made by patent offices and those that fund them. Specifically there may be pressure on the patent office to maintain the level of patent applications in order to generate income for the patent office. At the EPO this pressure arises because the national patent offices derive income from the activity of the EPO.

The finding that patent quality has decreased is worrying as the quality of patents also affects firms' interactions in the product market. Shapiro and Lemley (2005) argue that firms' incentives to challenge weak patents are too low relative to the social optimum. Thus a patent office that generates many "bad" patents is creating monopolies that raise prices without adequate compensation to society. In "good" patents such compensation would come from a reduction of production costs or improvements in the quality of products as discussed above.

From the perspective of competition policy such a development must be worrying. If it is easy to obtain a legal monopoly at the patent office without too much investment in R&D, then this undermines much of the work that antitrust agencies will undertake. Antitrust agencies are held by the law to observe intellectual property rights as property rights that cannot simply be withdrawn from their holders (Motta (2004)). In the context of diminishing quality of patent examination however the equality of patents and other property rights in the law becomes questionable.

Continuations

From the perspective of firms' patenting strategies the examination stage is important for a further reason. The complexity of the rules that apply at this stage is an important determinant of firms' ability to exploit the system in order to attain strategic advantages. Here we survey evidence from the United States that provides an important example of how firms make strategic use of rules in the patent system. This discussion is based on Graham and Mowery (2004).

In the United States it is possible to file continuations on patents whereas this is not possible in the patent systems of Japan, the EPO or the national European patent offices. This means that an already existing patent application is abandoned and a new one filed in its place. The new application maintains the "priority date" of the original application however. Before March 2001 patent applications in the United States remained secret until the issue of a patent. This meant that continuations were a means for applicants to hide their applications within the patent system for prolonged periods of time, sometimes several decades. In the case of so called submarine patents the aim of the applicant was to entrap subsequent applicants or those commercializing a technology without patent protection in order to extract significant rents. This usually involved repeated filing of continuations to keep the patent application secret for a long time.

In 1995 the term of patent protection was changed from 17 years from the date of issuance to 20 years from the date of application. This changed the incentives of those seeking to hide their applications, but it did not stop the use of continuations. A further change was introduced in 2001 when the patent office were required by further legislation to make all patent applications public after 18 months. Therefore submarine patents are now much less likely to arise. The requirement to publicise a patent application can only be avoided if the applicant specifically requests it. They must declare that they do not intend to file the patent in a jurisdiction (such as those belonging to the EPO) which requires patent applications to be made public after 18 months. This means that it is possible to this day to file continuations on patents in the United States, although the uncertainty created by this practice has been reduced somewhat.

A particularly successful adoption of the continuation strategy is exhibited in the Rambus case (Oft/Cra (2002)). Here the firm kept a patent hidden which codified a communications standard and it seems that this violated the rules of the standard setting organization at which this standard was agreed. The standard was adopted by the producers of DRAMs (dynamic random access memory) in the context of an industry standard setting process. Rambus were able to extract large royalty payments from the majority of DRAM producers once their submarine patent issued. The

FTC recently found that Rambus[46] "(…) unlawfully monopolized the markets for four computer memory technologies that have been incorporated into industry standards for DRAM chips." It may be interesting to note that the EPO recently revoked a patent issued to Rambus on a technology connected to this case. This patent spent 9 years in the examination process at the EPO.[47] This underscores the need for an examination of firms' delaying tactics within the EPO system.

Graham and Mowery show that by 1997, 25% of all patents issued by the USPTO were affected by a continuation at least once. Thereafter they detect a decrease reflecting the changes in legislation outlined above. They also show that some large firms adopt a strategy of using continuations extensively. Finally they find that applicants make use of continuations for patents that are cited more frequently and that are subsequently more likely to be involved in litigation. This suggests that applicants used continuations to keep particularly valuable patent applications from becoming publicly available for some time. Much of the current use of continuations is now in bio technology where firms view it as important because it allows them to modify claims as they learn more about their discovery. This behaviour is not strategic, but principally due to the relatively slow pace of research in this technology area.

This may reflect a combination of the strategies of secrecy and patent protection in which applicants choose the publication date of their patent so as to maintain lead time, while knowing that they have a patent in hand if necessary to protect their business.

Mowery and Graham examine software patents in detail. This is an area of technology that is considered to be complex due to the sequential nature of innovation. Unfortunately the aggregate statistics they provide which compare software to other technologies do not allow us to establish whether continuations were more likely to be filed in complex product industries than in discrete product industries.

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[46] The FTC's decision in this case can be found on the following webpage: http://www.ftc.gov/opa/2006/08/rambus.htm . Further information is given at: http://www.managingip.com/default.asp?page=9&PubID=198&SID=645308&ISS=22326&LS=EMS102738` .

[47] A note on this revocation may be found here: http://www.heise.de/newsticker/meldung/44600 .

Where continuation strategies are chosen to create submarine patents the applicant is clearly embarking on a course to extort rivals and as in the Rambus case this is likely to be considered anticompetitive behaviour. In the case in which firms use continuations as a form of mixing secrecy with patent protection the strategy is not obviously anticompetitive. It does however add significantly to the workload at the examining patent office (Quillen, Webster and Eichmann (2003)) and this has negative consequences of its own.

The attempt by firms to create additional uncertainty surrounding their patent appli cations is presently not something that many European legal scholars are troubled by, although we have indications that such strategies are available at the EPO too. Rather the work of European legal scholars currently focuses on abuses in the enforcement of intellectual property such as refusals to deal (Dolmans and O'Donoghue (2006)). Nonetheless uncertainty surrounding patent applications deserves more attention as it may damage to competition in two ways :

1. Firms may seek to hold up rivals who are implementing a technology with the use of previously filed patents. For this strategy to work patents must be kept hidden (as in the United States) or made sufficiently obscure, as in cases in which excessive numbers of claims are filed. The Rambus case illustrates that the use of continuations, thoug h restricted to the USPTO may nonetheless have significant effects in Europe. This is because of the importance of the United States markets for European firms and because global technology standards are often set there.
2. Firms may seek to prevent rivals fr om inventing around or at least significantly raise their costs of doing so by creating uncertainty around their patents. This strategy may be directly applicable to patents filed at the EPO as suggested by cases of applications with large numbers of claim s.

This implies that we should analyze the patent strategies of firms in order to detect whether some regularly seek to generate uncertainty within the patent system and exploit this. If such patenting strategies exist, then these should be a matter of concern for competition authorities as well as patent offices affected by them.

3.3.3 Opposition

Currently the EPO and several other national patent systems in Europe and Japan allow third parties to challenge patent grants in a low -cost proceeding. Opposition represents a second process of screening in which third parties may challenge the delineation of patent rights in order to defend their own or to provide information about prior art which undermines the patent entirely. Typically firms challenge more valu able and more damaging patents and therefore this process provides an important correction element to the examination process to which third parties typically do not provide much input. About one third of all opposed patents are revoked and one third are a mended.

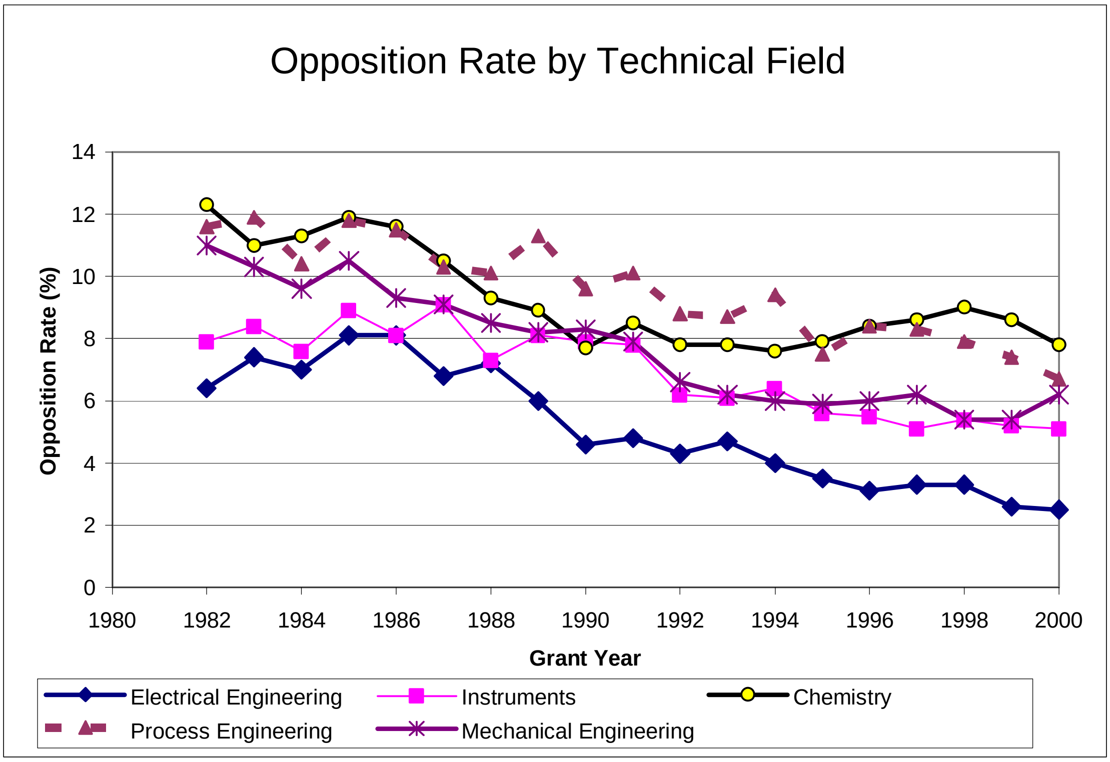

Figure 3.5: Opposition rate by technical field (Source: Harhoff (2006a))

As Figure 3.5 documents the rate of opposition at the EPO has steadily declined since th e late 1980's. Thus far we have no understanding of the reasons for this development. The following possibilities have been suggested by Harhoff (2006a):

1. More marginal patents have been granted and th ese marginal patents are not so damaging for competitors, therefore the rate of opposition decreased;

2. The group of firms affected by a single patent may have increased – this is consistent with increases in the number of claims, reviewed previously. If the number of affected parties is greater, then each affected firm may refrain from opposing in the hope that some of the other affected parties oppose. Opposition then becomes a public good that is underprovided because no opponent reaps the full social bene fits of opposition. This is essentially the same public goods effect invoked by Shapiro and Lemley (2005) in their argument regarding the damaging effects of weak patents. Their argument relates to the likelihood of litigation. If complementarities between patents have increased, due to changes in technology, then greater fragmentation o f property rights and the observed increase in the public goods problem might result.
3. A greater number of patents granted falls into patent classes in which complementarities matter. If firms owning complementary patents frequently interact they may have strong incentives to settle patent disputes away from the patent office. Such incentives arise whenever firms must resolve disputes repeatedly. Game theoretic research has shown that such repeated interaction of competitors can give rise to collusive outc omes (Tirole (1988, Phlips (1998)). The incentives to collude are particularly strong where firms are in a position to hold each other up, which is more likely where patents are complements. Additionally settlements of patent opposition could be based on patents that are known to be weak but which are used to bolster collusive licensing agreemen ts. Antitrust concerns created by such licensing agreements are discussed by Shapiro (2003a).

It is quite likely that each of these exp lanations has some relevance to the phenomenon we observe in Figure 3.5. For instance the first and third of these explanations are entirely compatible with one another.

The second and particularly the third of these explanations are troubling from the po int of view of competition policy. Collusive behaviour at the EPO is presently also not on the agenda of competition authorities. Nonetheless this form of behaviour, if identified could have significant effects on welfare, if it supports monopolies that wo uld not exist if the patent office were aware of all the facts related to weak patents.

Calderini and Scellato (2004) provide evidence on patent oppositions at the EPO in the telecommunications sector. They show that opposition activity in telecommunications increased in line with patent grants at the EPO until 1996. Thereafter oppositions in this sector decreased sharply while granted patents remained constant or grew. They provide evidence that suggests the larger firms in their sample are acting collusively, due to a remarkable dearth of opposition cases between them. They find that the vast majority of opposition cases involve quite a symmetrical players, with either a small firm being opposed by a large firm or vice versa. Unfortunately their paper does not allow us to establish whether larger firms were systematically more successful in the opposition process than smaller firms.

While the average opposition rate at the EPO has decreased there is evidence of extensive opposition activity in some areas of the patent system as documented in Harhoff and Hall (2002). They find that the opposition rate for patent grants in the area of Cosmetics is twice the average rate. Furthermore they find that in this sector opposition takes place repeatedly amongst larger players and that one firm is particularly active in opposing others' patents.

The industry they investigate is similar to the pharmaceuticals industry in that technological complementarities between patents have traditionally been thought of as of little relevance. This may be one reason why the incumbents in the industry so vigorously oppose each other's patents. Where patents cover individual products or product attributes that are independent of one another, it is less likely that firms need access to each other's patent portfolios to market products. In such a setting engaging in repeated conflict with rivals is not damaging to one's own products. If a firm is manifestly better at patent opposition than its rivals, then a strategy of seeking conflict helps that firm to establish a reputation which may be valuable by itself. Indeed Harhoff and Hall (2002) observe in their study of the cosmetics industry that those firms that engage in frequent oppositions are not themselves attacked as frequently as others.

These findings raise an important question however – is it possible and do firms in this industry systematically pick on smaller rivals to raise their costs? If such strategies exist, have firms been able to keep entrants out of particularly attractive product segments? These questions remain to be answered but would be interesting from the point of view of competition policy.

We comment on the competition policy aspects of strategic behaviour in opposition at the end of the following section as they overlap substantially with those in that section.

3.3.4 Litigation

The litigation step is the one which poses most problems for empirical research. As there are few systematic databases of litigation cases filed, authors are frequently forced to compile databases by hand. Nonetheless there is a sizeable literature which provides indications about patent litigation trends in the United States. The main concern here is whether litigation is increasing and to what extent such litigation arises between parties that are not of the same size. There are two main patterns to discuss:

1. Litigation initiated by large firms against smaller firms that own production facilities.
2. Litigation initiated by small firms without production facilities; here the defendants are usually larger firms.

Economists have long studied the phenomenon of litiga tion, because it presents an interesting puzzle: if two parties to a dispute have (a) the same information about the value which they are in dispute over and (b) the same information about the law, then they should settle their dispute and avoid going to court. The fact that we observe litigation suggests that these two conditions are not always met. The economics literature on litigation (Priest and Klein (1984)), (Bebchuk (1984)), (Schweizer (1989)), (Waldfogel (1998)), (Lanjouw and Lerner (1998)) has emphasized three different mechanisms that may lead parties to fight a dispute through in court. These are:

- Divergent expectations, which arise when uncertainty leads parties to different expectations about facts of the case or the law;
- Asymmetric information, which arises when one party tries to exploit superior information in order to extract rents;
- Asymmetric stakes, which arise when the defendant in a suit is unable to ade quately compensate the patentee. This will arise if the patent in dispute has a value to the owner which goes beyond the market in dispute. Somaya (2003) provides a good discussion of such cases.

Empirical analysis of litigation has focused mainly on the third of these explanations, due to the expectation that court proceedings themselves usually mitigate the fa ctors underlying the first two. Asymmetric stakes have been found to play an important role in intellectual property litigation in several empirical studies: Waldfogel (1995, (1998, Siegelman and Waldfogel (1999) and Somaya (2003). These studies all focus on the experience of the United States. There are presently no studies on the effects of asymmetric stakes in patent litigation in Europe.

It is more likely that such asymmetric stakes arise if patents are complements to one another. Then the validity or the licenses on one patent will affect the value of one or several others. Thus we would expect patent litigation to arise increasingly in complex product industries. This is borne out in the dataset constructed by Somaya (2003) who investigates litigation in computers (semiconductors, data storage, computer systems, I/O devices, computer applications and networking technologies) and research medicines (biotechnology, drug delivery systems, assays and dental innovations). Consistently with this hypothesis he also finds that computer suits typically involve more than one patent.

Evidence provided by Meurer and Bessen (2005) shows that the likelihood of litigating and of becoming a defendant in a patent suit is particularly high (relative to expenditure on R&D) in t he electronics (SIC 36) and instruments (SIC 38) industries, both of which are classified as complex product industries above. We reproduce this evidence, part of which is not included in their paper, in Table 3.1 below.

The main finding of recent empiric al studies is that on aggregate litigation has increased in line with patenting (Somaya (2003)), (Ziedonis (2003)), (Lanjouw and Schankerman (2001, Lanjouw and Schankerman (2004)), (Meurer and Bessen (2005)). Another important finding is that small firms are more likely to be involved in either the defence of their own patents (relative to patents) or as alleged infringers of others' patents (relative to R&D expenditure) than large firms (Lanjouw and Schankerman (2004)), (Meurer and Bessen (2005)).

Litigation Hazards					
		As Patentee Litigant		As Alleged Infringer	
	Suits per $billion R&D	Expected Suits per year	Suits per 1000 patents	Expected Suits per year	Suits per $billion R&D
All Firms	3.0	0.223	11.8	0.185	2.5
1987	2.9	0.198	10.5	0.116	1.7
1999	3.1	0.271	11.7	0.256	2.9
Small firms (emp.<500)	15.2	0.079	42.5	0.064	12.3
Large firms (emp.>=500)	2.7	0.304	10.7	0.254	2.2
New firms	7.1	0.114	30.3	0.095	5.9
BY INDUSTRY					
chem/pharma	3.1	0.334	14.4	0.229	2.1
mach/computer	2.9	0.217	13.0	0.170	2.3
electronic	3.7	0.202	8.8	0.194	3.6
SIC 3674	3.1	0.216	7.8	0.225	3.2
instrument	7.2	0.216	17.6	0.191	6.4
other manu	2.2	0.230	10.3	0.188	1.8
bus svcs inc sw	1.3	0.108	8.4	0.103	1.3
retail/wholesl	2.0	0.021	5.9	0.111	10.9
oth non manu	1.9	0.141	8.0	0.152	2.1

Table 3.1: Reproduced from Meurer and Bessen (2005) with additional information kindly provided by Jim Bessen.

Finally there is evidence that repeated interaction reduces the likelihood of litigation (Lanjouw and Schankerman (2004)). This econometric evidence underscores the descriptive results we cited above for opposition at the EPO that repeated interaction is likely to reduce the probability of opposition/litigation. Lanjouw and Schankerman (2004) also find that large asymmetries between the patent portfolios of rival firms within a technology area have the effect of reducing the number of court cases the larger firm gets involved in. This confirms the value of building up large patent portfolios, if these outstrip the patent portfolios of rivals.

Patent infringement suits brought by large firms directed at small firms

There is now a whole host of studies which show that patent litigation presents a serious and elevated cost to firms with small patent portfolios relative to firms with large patent portfolios. Lerner (1995) found that small biotechnology firms avoided patenting in certain patent classes if patent litigation affected many patents in these classes previously. Lanjouw and Schankerman (2004) and Meurer and Bessen (2005) find that small firms face substantially higher marginal costs of protecting their patents than larger firms and that these costs have been increasing recently.

These findings imply that we must investigate to what extent opposition activity at the EPO and litigation activity which we have data on involves cases between asymmetric parties. We will seek to establish whether oppositions and litigation have similar effects on small firms' costs of patenting in Europe as in the United States.

Patent infringement suits brought by small firms directed at large firms

In this section we discuss the phenomenon of patent trolls. A patent troll is a company that acquires patents of failed companies or independent innovators and uses these to threaten suit against infringing parties, without having the intention of actively using the patent they assert [48]. This definition is quite slippery as patents are created in order to allow inventors to recoup fixed outlays on R&D. Typically a suit will be classified as being brought by a patent troll if the patent being asserted is of dubious quality; this often means that the patent is also very broad. Patent trolls can earn a lot of money because many of those they seek to hold up are unwilling or unable to fight a patent infringement case through to a judgement in order to have the patent invalidated.

The problem of patent trolls is more likely to arise as the quality of patent examination decreases. More weak patents mean that there is more ammunition to fuel to process of hold up and that the ideal patent for this purpose which is typically vague but covers an extremely lucrative process [49].

[48] Brenda Sandburg traces the origin of the term "patent troll" back to Peter Detkin, the assistant general counsel at Intel. Her account of the activities of such firms can be found at: http://www.phonetel.com/pdfs/LWTrolls.pdf . A good article on patent trolls can be found on Wikipedia.

[49] One example cited by Brenda Sandburg are the patents on machine vision and bar code technologies owned and enforced by Jerome Lemelson. Wikipedia provides interesting information on Lemelson's methods and his successes and failures in court. He has been occupying courts in the United States until very recently.

Reitzig, Henkel and Heath (2006) argue that the troll's business model works best in industries in which patents are complements. This is due to the fact that in such industries products are often based on very large numbers of patents and no firm can ever be absolutely certain that it has ruled out the risk of infringement entirely. In such settings it is profitable for firms to acquire obscure patents and wait for these to be infringed. They point out the strategy of being infringed is profitable because of the threat of injunctions and because the damage awards that are attainable are usually very large. They argue that courts generally refuse to consider the costs of inventing around a patent, that the infringer would have had, had they been aware of the patent, as a basis for damages. They provide examples in which these costs are almost zero and yet the damages awarded are very large[50]. If the costs of inventing around were taken into account, then the marginal value added to a product by the patent under dispute would become the main issue in court. This would doubtless be so low that many cases would no longer come to court.

While this argument is an interesting one, it disregards the large costs faced by a defendant in the process of coming to a court decision on a litigated patent. These may include the effects of injunctions (Hall and Ziedonis (2001)). At present there is very little evidence of the activities of patent trolls in Europe, but even their activities in the United States may be costing European firms large amounts of money as the following quote found by (Reitzig, Henkel and Heath (2006)) reveals:

"From an IP management perspective, patent sharks (the same as patent trolls) currently pose one of the great challenges to our firm" (Peter Halkjaer, Senior IP Manager, Mobile Phones at Nokia).

3.4 Competition policy, patent law and strategic use of patent systems

This section summarizes what we know at present about the competition policy implications of strategic use of the patent system. In particular the section summarizes which role competition policy can play in industries affected by strategic patenting. To do this we consider: i) the main

[50] Interestingly this is another case involving Mr Lemelson. The patent covered a coupling technology which Mattel Inc. used in a toy truck. Mattel were forced to pay Mr Lemelson almost $25 million.

welfare effects of strategic patenting as far as they have been identified, ii) the main antitrust legislation that is related to behaviour we have identified and iii) the way in which we propose that our study must proceed to provide an assessment of the empirical importance of the welfare effects identified in Europe.

In the introduction to this chapter (3.1) we undertook a review of the welfare justification for the operation of a patent system. We also showed that this form of analysis provides guidance regarding the extent of protection provided by patent rights. We turned then to the subject of this study: strategic use of the patent system, primarily by firms in complex product industries (3.1.2). Here we noted the fact that the economic theory and empirical research are still in a state of flux. Although some implications from this research are emerging, it is too early to draw strong welfare implications from this literature regarding the extent of protection provided by patent rights in complex product industries. This does not mean that we are unable to draw any conclusions from the current literature on the patent explosion. Rather it implies that this study is in many respects advancing into new territory and that we must take this into account. The methodology we propose in the following section is a reflection of this fact.

The literature we reviewed in section (3.1.2) and in section (3.3) shows that a proper understanding of the impact of firms' patenting strategies calls for an in depth analysis of the institutional details of the patent system to an extent not attempted by earlier theoretical work on patents. This raises a central question: how should competition policy and patent law interact?

In our discussion of the definition of strategic use of the patent system (3.2) we note that it has been the domain of patent law to provide the correct incentives for innovating firms. The domain of competition policy has been to regulate firms' interactions in product markets and in particular the effects of these interactions on consumers. This division of labour is clearly set out and analyzed in Régibeau and Rocket (2004). Our review of the literature on the patent explosion and strategic uses of the patent system indicates that where patents are complements, competition policy and patent law must draw closer together. The literature review does not indicate that the fundamental division of labour delineated here must be abandoned.

Our review has found that complementarity of patent rights calls for a closer integration of patent law and competition policy because firms must resort to instruments of coordination such as licensing contracts, patent pools, standard setting in order to insure themselves against hold -up. Thus the regulation of licensing will have even stronger effects on the way in which patent systems affect firms' incentives to innovate. To make this point starkly: in a world of complementary patents the prohibition or restriction of licensing would reduce firms' incentives to innovate. There would be no mechanisms to resolve hold -up situations and innovating firms would be threatened with expropriation of their innovations. Therefore the *ex ante* effects of licensing rules on incentives to innovate and patent must be taken into account both by those designing these rules and by those who design patent law.

Competition policy also has ex post effects on firms' behaviour. These arise where competition policy authorities act on the rules they have set to determine in practice how firms should act. Here the literature we have reviewed has not achieved a consensus on what should be the basis of ex post action by competition authorities. In particular it is argued by Carrier (2003) that competition authorities should take into account mainly the dynamic effects of firms' patenting strategies on rival firms' innovation incentives. Similarly the doctrine of innovation markets suggested by Gilbert and Sunshine (1995) implies that competition authorities should take into consideration how firms' agreements and transactions affect resources devoted to research and development directed at competition in some future market. Both of these proposals imply that competition authorities involve themselves in detailed deliberations regarding the development of technology and its relation to product markets. In practice the literature on the concept of innovation markets has shown this to be a difficult concept to implement and so it has been used with restraint (Davis (2003)).

The definition we have set out above is more restrained in its definition of the remit of competition authorities in the field of the strategic use of patent systems. We argue above (3.2.3) that patent law has a large role to play in reducing firms' incentives to patent extensively where patents are often just variants on a theme and to affect firms' incentives where these are misusing the process within the patent system to create uncertainty. In our view much could be done to reduce the problem of strategic patenting by strengthening firms' incentives to focus on really important patents.

Therefore our definition of anticompetitive effects of the strategic use of the patent system restricts itself to direct effects of firms' patenting strategies on product markets. This is a more conservative position than that discussed in the previous paragraph. Given the present state of the art we feel that this is appropriate. The following discussion will show that this does not leave antitrust agencies without a role in regulating firms' behaviour ex post. The main effect is to preclude antitrust agencies from focusing on the provision of innovation incentives.

3.4.1 Summary of welfare effects identified

In this section we summarize the findings of section 3.3 and highlight the most likely problems to be addressed by competition policy. Table 3.2 below summarizes the results of the previous section.

Our review of the empirical literature in section 3.3 has shown that the strategic use of patent systems raises concerns about collusion and about unilateral behaviour. In general the complementarity of patents in complex technologies gives rise to greater frequency of interaction between firms. This happens when firms disentangle the patent thicket and insure themselves against hold-up through licensing or similar forms of cooperation and coordination.

	Complementarities involved ?	Direct competition policy aspects ?	Indirect competition policy aspects ?
Application			
Increased applications	Yes	None	Collusion opportunities
Increased entry	No	None	None
Increasing complexity of applications	**Possibly**	None	Uncertainty, possibly aim to raise entry barriers, induce exit
Examination			
Poor quality	No	None	Monopolies, Collusion opportunities
Uncertainty	Yes	Raise costs, Raise entry barriers	
Opposition			
Collusion	Yes	Monopolize markets	
Predation	Yes	Predation / Raising rivals' costs	
Litigation			
Collusion	Yes	Monopolize markets	
Predation	Yes	Predation / Raising rivals' costs	
Trolls	Yes	None	Create large inefficiencies
Licensing	Yes	Collusion, Foreclosure	

Table 3.2: Summary of the results

We have identified both the role of first movers who make use of patent portfolio strategies first to gain competitive advantage and industries in which all firms have adapted to a new business model in which patent portfolios assume an important role. Where this business model has been established we have shown that the ability of small firms to compete with larger firms may be threatened.

Table 3.2 summarises the phenomena we have discussed in section 3.3. It provides information on the question whether complementarities between patents are relevant to the behaviour and whether there are direct or indirect competition policy aspects. The remainder of this section discusses how each form of behaviour identified is connected to concepts that underpin competition policy.

Collusive behaviour

Section 3.3 has shown that collusion connected to strategic use of patents may arise in three different ways: collusion of firms in adversarial proceedings (1) at the opposition stage, (2) at the litigation stage and (3) collusion of firms in general. We comment on each of these briefly:

Collusion during adversarial proceedings

The term collusive behaviour is usually reserved for firms that act jointly to raise prices and restrict output in specific markets. Above we have argued that there can be collusive behaviour in adversarial proceedings that regard patents. The parallel to price fixing arises, because firms that cooperate to avoid re-examination of patents may have agreed to withhold information from the patent office that would invalidate a patent.

In such cases the patent constitutes an exclusion right which should not exist or should be restricted in its reach. In either case a patent right that is vacuous but remains in force constitutes a basis for market power which ultimately is borne by consumers. In this sense cooperation of firms to avoid re-examinations of patents constitutes a form of price fixing or collusion, albeit indirectly.

In order to prevent this form of cooperation the antitrust authorities must impose rules on the types of licensing contracts which firms are permitted to write and enforce these rules. Shapiro (2003a) and Maurer and Scotchmer (2004) discuss principles on which such regulation might be founded. The enforcement of such principles remains challenging as it is hard if not impossible for competition authorities to collect information on licensing contracts between firms. Information on the incidence of opposition and litigation in different industries may provide clues to the likelihood of collusive licensing between firms. Furthermore patent data allow us to classify firms as rivals in technology space. This together with an analysis of the type of technology, the concentration of competitors' shares of the technology space and the stability of these shares can provide clues to the likelihood of collusion. For instance if a technology is complex, there are few large firms, that have large shares of the patents covering such a technology and the identity of these firms is stable over a long period of time, then existing theories of collusion suggest that collusive behaviour is sustainable (Phlips (1998), Tirole (1988)).

If a suspicion is entertained that firms in a specific sector are colluding at the opposition and litigation stages of the patent system it remains to establish what aim such activity has.

It may be that the firms involved are attempting to reduce transactions costs that arise within a patent thicket. In this case it is incumbent on patent offices to note that firms are avoiding opposition and to evaluate critically whether this is reducing the quality of patents which are granted.

On the other hand it may be that collusion within the opposition and litigation stages of the patent system is a signal for collusive activity that affects product markets. Such effects might be the traditional price fixing effects. Research on multimarket contact by Bernheim and Whinston (1990) has shown that firms will be able to sustain collusion more easily if they interact on several markets simultaneously. The punishment which a cartel can implement is much greater if firms collude in one market but are able to sanction one another on multiple markets in case of deviation from a cartel agreement. The patent system adds an additional level of strategic interaction for firms which is akin to strategic interaction on a separate market. Therefore in the context of the patent system one might surmise that the threat of more intense opposition by a rival at a patent office and in the courts could be used to provide additional stability to a cartel agreement."

Finally, a cartel might also consist in an attempt to erect entry barriers against smaller entrants as discussed below.

The important empirical question in this context is to what extent firms that have the ability to hold each other up or punish one another in the patent sphere are also competitors in product markets. There are suggestions in the recent empirical literature (Bloom, Schankerman and Van Reenen (2005)) that product market rivals also hold patent portfolios that interact, but this question has not been studied very extensively yet. Furthermore we do not know whether such constellations are more likely to arise in industries in which patents are complements.

Unilateral conduct

Here we consider two forms of unilateral conduct, predation and foreclosure. Possibilities for each of these types of behaviour arise within the patent system. Our main purpose here is to clarify where this may occur.

Predation

Predatory behaviour in the sense of Ordover and Willig (1981) arises if an action is profitable solely because it allows the firm to exclude its rivals. This definition of predation expressly includes non price predation strategies and it is this form of predation we are dealing with here. The problem, as always with predation, is to demonstrate that a firm or group of firms is using its patent portfolio to affect market competition in this way. We should repeat our observation from section 3.2.3 here: it cannot be the role of a competition authority to insure firms against situations in which a rival has patented a series of blocking patents that prevent the adoption of a new technology. However Rubinfeld and Maness (2005) demonstrate that firms may have a case to answer if they employ a portfolio of patents of dubious quality to affect the ongoing business of rival firms. To assess such a case a competition authority will need data on the development of competition in underlying product markets. Furthermore the competition authority will need strong evidence that the patent portfolio in question is of poor quality or does not support the allegation of infringement which is brought by the patent owner.

Therefore acts of predation will leave traces in patent data if they are connected to opposition or litigation activity. In such cases firms are likely to focus their oppositions or infringement suits on rivals, whose costs they seek to raise. Meurer (2003) provides examples and further literature regarding such activities in the United States.

We have described this type of behaviour as predation in Table 3.2. . This alludes to the literature on litigation which has found that in particular small firms are susceptible to being forced out of markets if confronted with systematic threats of litigation. Where such litigation is frivolous in the sense of Meurer (2003), e.g. based on infringement claims that are found to be without substance, the litigating firm may be attempting to raise its smaller rivals' costs.

Foreclosure

As Table 3.2. shows we are concerned with horizontal foreclosure in the sense of D.G.Competition (2005)[51]. This form of foreclosure arises when a dominant firm in an upstream market seeks to foreclose access to downstream customers. Foreclosure often involves exclusive licenses that create barriers to entry for an efficient upstream rival as discussed by Motta (2004), Rey and Tirole (2005) and Whinston (2006). Such exclusive licensing contracts are considered in the recent discussions surrounding Article 82 and intellectual property (Dolmans and O'Donoghue (2006)).

Modern theories of foreclosure emphasize that externalities between firms on one side of the market are an important ingredient in allowing the other side of the market to attempt foreclosure (Whinston (2006)). Thus foreclosure opportunities are more likely to arise in markets in which complementarities between patents are important as such complementarities give rise to externalities between firms. Our attempt to identify patent classes in which patents are complements is an important first step in a systematic assessment of the opportunities for foreclosure which may be arising in the context of the European patent system. Beyond this we do not see any role for our research into firms' patenting strategies to provide direct information about the likelihood that firms are foreclosing markets. This has to do with the kind of information that is contained in patent data. In particular, we do not have information on licensing contracts and it will be impossible to infer that foreclosure is taking place from the data on patent applications, on references to and from patent documents or on opposition and litigation of individual patents.

This concludes our review of patenting strategies that are likely to give rise to competition policy concerns. We turn now to a brief review of the relevant competition legislation connected to the practices we have discussed here.

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[51] The discussion paper on Article 82 provides a very wide ranging definition of foreclosure. In particular this subsumes predatory pricing. We distinguish between non price predation, which is not included in the definition of foreclosure in the discussion paper, and horizontal foreclosure as defined t here.

3.4.2 Review of relevant competition law

As we have noted in the introduction to this section as well as in previous sections the most important competition legislation for the operation of the patent system are the rules regarding licensing. Additionally our discussion above has identified that firms may use patent portfolios to support collusion or to raise rivals' costs which is a form of non price predation. Furthermore, there is the question how weak patents affect competition law cases regarding licensing. Tom and Gilman (2003) discuss the effect of uncertainty about the validity of patents on the question whether firms are to be considered competitors or not; we briefly deal with this issue below. Finally, we also briefly review competition law relevant to such activities. We restrict ourselves to a review of competition law in Europe here.

In general European competition law rests on the provisions of Articles 81 and 82 of the Treaty of the European Communities as well as on the Merger Regulation. Article 81 prohibits agreements between firms which may distort trade between member states and competition within the common market. Article 82 prohibits the abuse of a dominant position by one or several firms.

The competition legislation relevant to licensing

In May 2004 Regulation 1/2003 (the "modernisation" regulation) came into force which provides for a much greater role for the competition authorities and national courts in the enforcement of the provisions of Articles 81 and 82. Together with this regulation the previous system of notifications of licensing agreements came to an end. Under this system licensing contracts that did not fall under the provisions of the Technology Transfer Block Exemption (TTBE) applying to technology transfer agreements (Regulation 240/96) or the block exemption for research and development (Regulation 418/85) had to be notified to the commission with a request for an exemption from the provisions of Article 81(1).

Licensing is now regulated under Regulation 772/2004, the block exemption regulation for technology transfer. This regulation contains market share ceilings below which firms are exempt from the provisions of Article 81. Under the regulation the following practices are black listed (prohibited) and have the implication of preventing the application of the block exemption to the licensing contract in general: price fixing, limitation of output, the allocation of markets, restrictions on the ability of the licensee to use technology provided by third parties if the parties are competitors in the market. Under this regulation firms are considered to be competitors if they would have been able to compete in the absence of a license. If firms are considered non-competitors, then the regulation is less restrictive than in cases in which firms are competitors. Tom and Gilman (2003) argue that uncertainty about the validity of patent rights is crucial here. In a competition case the validity of a patent may determine whether firms would have been competitors or not. Specifically, if a patent is invalid, then there is no requirement for a license and firms would have been able to compete. Similarly, if a patent is narrower than claimed by the holder firms would have been able to compete. However this is only the case if the actual breadth of the patent is clearly established. These distinctions are not mere formalities, Tom and Gilman (2003) cite a number of cases fought in the United States over precisely this question. They point to the fact that also in the United States the court have not yet developed a unified approach to the problems posed by patent uncertainty.

If it can be established that firms are not competitors the list of black listed practices in Regulation 772/2004 is less restrictive than if the firms are competitors. In this case it precludes only price restrictions and passive sales. Furthermore the regulation does not apply to grant back provisions if these are exclusive or require the transfer of property rights to a technology. Non exclusive grant back clauses are permitted in order to encourage licensing. This is particularly relevant to technical fields in which innovation is cumulative. For further detail regarding this regulation refer to Korah (2004).

Regulation 2659/2000 – the group exemption for cooperative R&D – exempts some form of research joint ventures. Such agreements may be substitutes for ex ante cross licensing agreements. Just as in the technology transfer regulation a market share ceiling applies.

In general these regulations are viewed to be quite tough as they impose strong market share restrictions that may exclude licensing in markets in which costly research and development activities naturally lead to high levels of concentration. However, if agreements do not fall under these exemptions, they are not prohibited per se, but have to be analysed on a case -by-case basis, the outcome of which can still be that they are not considered to be anti-competitive.

Finally it should be noted that even if licensing agreements are not caught by the provisions of Article 81, they may nonetheless be affected by the provisions of Article 82. The application of Article 82 to exclusionary practices is currently being reviewed. Most relevant to licensing contracts are the provisions regarding the refusal to license intellectual property rights. These proposals outline when a dominant firm or group of firms may be required to license a technology. The introduction of such rules is likely to strengthen weaker firms relative to dominant firms if patents are complementary and should enhance these smaller firms' innovation incentives. Incentives will be improved where smaller firms would otherwise not have access to the technology of the dominant firms.

The competition legislation relevant to collusion

Collusion with the object to fix prices or production quotas is prohibited under Article 81. This article also prohibits agreements to limit or control technical development. We have discussed above that collusion, whether explicit or tacit, within the opposition process at the EPO is not the same as price fixing. However we have also argued that it may have effects on product markets where it allows a group of firms to erect barriers to entry into a specific technology. If this can be demonstrated collusion within the patent system together with its effects on product markets may fall under the provisions of Article 81(1) and therefore may be illegal. Of course collusive agreements that are enforced through threats of patent litigation would fall under this article as well.

The competition legislation relevant to non price predation

Non price predation as outlined in the previous section (3.4 .1) arises where firms use their patent portfolios to raise the costs of their rivals in order to induce exit or less aggressive competition within the market. This type of behaviour is presently outside the scope of the review of Article 82 outlined above. Nonetheless this form of behaviour should fall under Article 82. It is hard to find good precedents for this in case law however. The reason is that here, contrary to most cases of raising rivals' costs, the dominant firm is not supplying an input to the affected firm. Rather they are directly affecting the firms' costs by involving them in litigation. In the case discussed by Rubinfeld and Maness (2005) the dominant firm is trying to provide an input to the firms it threatened with litigation. The fact that this type of case is hard to pigeon hole underscores the difficulties that arise in this area.

3.4.3 Applying competition policy analysis to patent data

Here, we address a very general methodo logical problem to do with the interaction of patents and product markets. This could be called the problem of identifying a market. Under the traditional view of patents a patent was tied to a single product. If one suspected that the firm owning a patent was violating antitrust rules, then the market in which that firm was seeking to maintain or establish a monopoly with that patent was clearly identified through the patent.

Under the new view of patents there is a problem in identifying the market which the firm owning a patent is monopolizing. For instance there are technologies for which there are many markets and often these are not final goods markets but markets for intermediate inputs. Whether these markets for the technology are monopolistic or no t is irrelevant, although we would expect some element of market power to be present. Furthermore, it is often necessary to assort a whole array of patents in order to be able to use such a technology. In this setting it may be very profitable to monopoliz e just a bottleneck component of a technology in order to extract large surpluses from the application of the technology in diverse markets. A bottleneck component would be a patent which is necessary for the technology to operate and for which no viable s ubstitute exists.

This form of monopoly is very different from the monopoly typically analyzed in competition cases. There is no longer a clearly definable market which is being monopolized as the bottleneck patent by itself will have no value or little value at all. Only the combination of the bottleneck patent with complementary patents, which then constitutes a technology, is valuable. The owner of the bottleneck does not hold a monopoly over this technology, although they may be able to extract a major part of the surplus which it generates through bargaining with the owners of the remaining complementary patents. The outcome of such a multiparty bargaining process depends on factors that are very specific to the group of bargaining firms and the barga ining setting (Binmore (1992)), (Muthoo (1999)) and is not amenable to analysis using the standard monopoly model.[52] In particular, the monopoly model assumes that the monopolist sets a price for their good, whereas a bargaining model allows for negotiations between both parties. In such a case outcomes very different from the monopoly result may emerge.

This discussion shows that in a setting in which patents are complements, identifying a market which is the relevant antitrust market may be very hard or well nigh impossible. This problem is compounded when we are faced with the analysis of firms' patenting strategies and where each individual firm holds large patent portfolios. A complementary practical problem also emerges: patents are classified into IPC classes using the International Patent Classification whereas firms are often assigned to industry classifications according to their principal line of business. Any attempt to link between patents and product markets must assign patents in IPC classes to industry classes. Attempts to do this exist (OECD (1994)), but these disregard the problems in linking product markets and patent classes which we noted above[53].

Due to these problems we have chosen an alternative approach to the study of the competition policy implications of strategic patenting. In the previous section we have delineated carefully what is known about firms' patenting strategies. In this section we have extended this discussion by drawing out how some of these strategies could give rise to competition policy concerns.

This approach follows the "first principles" approach to competition policy advocated by Salop (2000) and OFT/CRA (2002). Salop argues that competition policy analysis should focus on the competitive effect of firms' actions. This is contrasted with the usual approach to competition policy in which the definition of a relevant market and the question of market power must be addressed before competitive effects are considered (Geroski and Griffith (2003)), (Motta (2004)). The first principles approach is an effects based approach to competition policy. It is based on the direct evaluation of competitive harm to consumers of an allegedly anticompetitive action. Thus

[52] The complexity of undertaking competition policy analysis in the context of bargaining is currently affecting regulation in other areas, such as that of telecommunications. In a useful paper (Binmore and Harbord (2005)] show how bargaining affects settings that were traditionally analyzed using monopoly models.
[53] Note that we will make use of the definitions of the 30 technology areas set out in the appendix to this report, but we do not make use of the link between these fields and product markets which is also suggested by the report for reasons discussed in the text.

our aim is to provide as much information as possible from patent data about the effects of a firm's actions on competitors. Given this information an antitrust authority will be able to collect information on impacts this may have had on consumers buying from these competitors or the original firm. The benefit of patent data in this case is that they provide information about the firms affected by allegedly anticompetitive behaviour. There is therefore no need to identify the relevant market in order to determine which firms and which firms' customers might be affected by the conduct in question.

4. Empirical Assessment: Importance and Identification of Affected Sectors

4.1 Introduction and Methodology

In the first interim report to the Commission we proposed a n empirical **two-step procedure** for the identification of technical a reas which might be considered prone to anti -competitive behavior of firms. The chosen approach is of a descriptive nature and will employ a series of indicators which will be computed from patent data. In a first step, relevant technical areas which are p rone to be influenced by strategic use of the patent system will be identified. In a second step, individual patenting strategies within selected technical areas at the firm level are analyzed based on the findings from the first step of our analysis. Our procedure relies on the analysis of comprehensive large-scale patent databases provided by the EPO. These databases cover approximately 1.76 million patent applications filed at the EPO between 1978 and 2006. [54]

Step 1) Identification of technical fields w arranting further investigation

The aim of step 1 is the identification of technical areas in which strategic use of patents is most likely to occur. As we have noted in our tender document, the patent literature does not contain a recognized or reliable method to map patents to product markets. In some technical fields, IPC classifications can be related fairly precisely to some markets (e.g. in cosmetics), in other fields it is almost impossible to do so (e.g., biotechnology). Therefore, in this study we will rely on the original **International Patent Classification Scheme** (IPC) used by the patent offices world -wide. The IPC is a hierarchical system in which the whole area of technology is divided into a range of sections, classes, subclasses and groups. [55] All patent applications are assigned to at least one IPC group during their examination by the patent office based on the technological nature of the underlying invention. The OST-INPI/FhG-ISI Technology Classification is used to classify the

[54] We use the PATSTAT database as of September 2006 and the EPASYS database as of May 2006. These datasets provide comprehensive coverage of all patent applications at the EPO.

[55] See http://www.wipo.int/classifications/ipc/ipc8/?lang=en for more information.

patents into one of 30 technology areas which can be aggregated to six broader main areas. [56] Based on this classification of different technical areas we will compute different indicators for each of the areas in order to characterize different patenting regimes.

Moreover, we will compute many of these indicators on an annual basis in order to analyze and to compare their development over time. For most of the indicators we will use the **priority year** of a patent application as the reference year for the indicators. The priority year is the year in which a patent application was filed for the first time at a patent office. Within the priority system established by the Paris Convention the application can be subsequently filed within one year after the exact priority date (the priority year) at another patent office in nations that have ratified the Paris Convention. Therefore, in many cases the priority year can be different from the year in which the application has been filed at the EPO (**application year**).[57] Nevertheless, we use the priority year as the reference year for the annual computation of our indicators, since the priority year is more directly linked to a firm's initial decision to apply for patent protection for a given invention. In cases where our indicators r elate to opposition against granted patents we will use the **grant year** as reference year for these indicators. Opposition only arises once a patent is granted. Since the time lag between the filing of a patent application at the EPO and its final grant is on average more then four years (Harhoff and Wagner (2005)) and varies greatly over different applications, using the grant year for indicators relating to disputed patents is more appropriate than its priority year.

We will compute different indicators based on patent counts and patent references for each of the 30 technical areas over time. Table 4.1.1 gives a brief description of the indicators we compute as well as a short interpretation of their meaning.

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[56] The OST-INPI/FhG-ISI Technology Classification is an aggregation scheme which classifies the IPC subgroups into 30 technology areas (see Oecd (1994)

[57] For example, an application could have been filed at the USPTO in March 1995 and then – within its priority year – filed at the EPO in February 1996. In this case priority year and application year at the EPO will differ.

Table 4.2.1

Indicator	**Description**
Number of patent applications	The most basic indicator we use is the **count of patent applications**. Computing the numbers of patent applications per technical field yields interesting insights into patent filing trends. In particular, increasing **growth rates in patent application counts** in a technical area might be a consequence of a shift in the patenting strategies of firms active in the respective technological area. Patent applications at the EPO are set out by the yea r in which the application for the patent was first made at a patent office world wide; this is called the priority year.
Concentration of patent holdings	The **concentration of patent holdings** among firms in a technical field is computed based on establis hed concentration measures like the **Herfindahl index**[58], the concentration ratios of the largest 4 (**C4**) and the largest 8 (**C8**) firms[59].[60] Below we have concentrated on the C4 ratio as this is based on consolidated names of firms. We have found that the Herfind ahl index is unreliable as long as all names are not consolidated. Consolidating the names of all patent applicants would be a herculean task however, given that there are over 250,000 different firm names in the patent database.

[58] The Herfindahl-Index is the sum of the squared shares of the patents held by a firm relative to all patents in an IP C subsection.

[59] C4 (C8) concentration measures are the share of pat ent applications filed by the 4 (8) most largest applicants in given IPC subsection.

[60] Please note that the computation of concentration measures relies on applicant names provided withi n the PATSTAT database. We will consolidate these names (consolidation of conglomerates and correction of typos) using a proprietary scheme which will be made public after this study.

Indicator	Description
Entry and exit of patentees	The analysis of the concentration of patent holdings among firms can be complemented by studying **entry and exit**. There is no generally accepted definition of entry and exit into technological areas. We define an entrant into a technology area in a given year t as a firm that has not applied for a patent in the three years prior to t in that technology area, that is applying for at least one patent in year t and that goes on to apply for at least one further patent in one of the three years after year t. Conversely we define a firm exit as a firm that has applied for at least one patent in the technology area in one of the three years preceding year t, is applying for a patent in year t and then fails to apply for further patents in the three years after year t.
Rate of oppositions	The count of **oppositions relative to the number of patents granted** in a given technological area will be computed and analyzed in combination with other indicators. For example, a growing concentration of patent holdings among firms combined with a decreasing number of oppositions might be a first indicator of collusive behaviour of firms active in a technological field.
Number of claims	The **number of claims** contained in a patent application can be seen as a measure of the complexity of patent applications. It has also been suggested that some applicants file an excessive number of claims in order to create uncertainty about the true scope of the patent. Here uncertainty derives from the volume of claim s filed which has increased substantially over the period studied.

Indicator	Description
Number of divisional patent applications	A divisional patent application is a type of patent application which contains matter from a previously -filed application (the "parent" application). Divisional applications exist to cover cases in which the parent application describes more than one invention and the applicant is required to split the parent into one or more divisonal applications each claiming only a single invention. However, we suspect that divisional patent applications are also used more strategically by applicants in order to increase flexibility during the examination process.
Number of shared priorities	We compute the average number of patents whic h share one or more priority filings. It might well be the case that this indicator is higher in areas where patentees try to create patent thickets.
Number of X references	We compute the average **number and share of X references** contained in a patent a pplication. X references point to previous patents and other documents which are conflicting with the application under consideration. Increasing shares of X references in a patent application can be considered an indication for decreasing quality.

Step 2) Analysis of individual patenting behaviour in relevant technical fields

In the second step of our analysis we examine patenting in a selected set of technology areas. Based on the results from the first stage we select **nine** areas for closer inspection.[61] For the selected areas an in-depth analysis is provided focussing on the patenting behaviour of individual firms. Since the number of firms in a given technology area is relatively high, we restrict our analysis to the most important firms in the selected technology areas. The indicators we compute characterize (1) the **patenting activities** of the analyzed firms and (2) the **interaction** of these firms with other firms patenting in the same area.

[61] We select these areas on the basis of several indicators. The selecti on is undertaken in section 4.4 below.

We undertake three types of analysis:

- we compute an indicator to infer the areas most likely affected by patent thickets;
- we analyze firms' opposition behaviour in order to see whether opposition affects smaller firms or larger firms more;
- we analyze the patenting behaviour of the 30 largest firms in **six**[62] selected technology areas using a range of indicators. These are: the number of applications, the number of claims per patent, the average share of critical references on a firm's patents, the number of citations indicating blocking power related to a firm's patents and the concentration of a firm's patenting activity across technology areas.

We identify whether there has been a substantial change (relative to levels before 1995) in the rate of patenting and the range of patenting of specific firms in Europe. Hall (2005) has found that the patenting explosion in the United States can be traced to firms in the electronics and semiconductor industries. It is important to establish which firms and sectors are driving the patenting explosion we observe in the data from the European Patent Office, too.

Table 4.1.2 gives a brief description of the indicators we compute and a short interpretation of their meaning.

Table 4.2.2

Indicator	**Description**
Concentration of references made by a cohort of applications in a given technology area.	This indicator shows how concentrated the references on a group of patents are. If the concentration is high then all patents in the group cited the same patents; this indicates that the patents were closely related. In contrast, if concentration is low then patents in the group cited very different patents; this indicates that patents were not so closely related. This measure provides us with an indication of the technology areas in which patent thickets are likely to have arisen.

62 These six classes are a subset of the nine classes selected at stage one of our analysis. They are selected on the basis of the preceding analyses within the second step analysis.

Indicator	Description
Occurrence and frequency of opposition proceedings between firms	We try to identify firms' opposition strategies by analyzing the **opposition activity within the selected technical fields at the firm level**. Our data allow us to identify opposing and opposed parties and therefore to trace patterns of repeated oppositions between firms.
Number of patent applications	We compare firms' **patenting rates** over time. The aim here is to establish which firms are affected by the logic of defensive patenting set out above.
Concentration of firms' patenting activities across technology areas	We compare the concentration of firms' patenting activities across all technology areas in two periods. To do this we calculate Herfindahl indices measuring the concentration of patenting across the 30 technology areas for each firm. This measure also tells us something about whether firms are pursuing a strategy of patenting defensively or not.
Number of claims per patent	We compare the number of claims a firm made on its patent applications for two periods in order to establish whether the firm has shifted towards drafting more complex patents.
Number of patents per area with claims above the 75 percentile of the number of claims in the area of the patent.	We compare how many patents a firm submits to the patent office bearing a high number of claims relative to the average patent in a technology area. With this measure we seek to identify firms that submit more complex patents than firms patenting in the same technology areas. These firms are likely to be pursuing strategic aims with such patents.
The average share of critical references noted on a firm's patents[63]	Critical references indicate that parts of a patent are closely related to prior art. This suggests that the patents do not embody a high inventive step. We compare the average quality of a firm's patents in two periods in order to understand whether firms shifted towards the acquisition of larger patent portfolios of lower quality or not.

[63] This indicator is related to but not the same as the X-references indicator on page 7 above.

Indicator	Description
Number of citations	We also analyse **patent citations**[64] and compute the share of citations received indicating that firms possess blocking power. We compare this indicator for two periods for all firms.

Please refer to section 4.6 for a description of the datasets used in the following analysis.

4.2 Review of European patenting trends

In this section we illustrate the main trends in patenting at the EPO for the period between 1980 and 2003. The main trends we uncover in the data are:

1. sharply increasing numbers of patent applications after 1992
2. a corresponding increase in patent grants aft er 1992
3. no change in the proportion of applied patents that were granted
4. an increasing number of claims per patent indicating greater complexity of patent applications
5. a decrease in granted patents that are opposed
6. large differences in opposition rates a cross technology areas
7. strong increases in the share of divisional patents filed which indicates strategic behaviour by firms

Table 4.2.1 ranks all technological areas by growth of patent applications between 1990 and 2000.[65] The technology areas that we select in Section 4.4 are highlighted in this table for ease of reference. The Table shows that there was an increase in the number of patent applications of more than 100% in seven technological areas. Two of these (*Telecommunications* and *Information Technology*) come from the main technology area Electronics. Additionally *Electrical Devices* grew by 91%. A further two come from the main technology area Chemicals and Pharmaceuticals (*Pharmaceuticals, Cosmetics* and *Biotechnology*). In the main technology area Mechanical

[64] Patents can be cited by subsequent patents in the search report of the latter. Previous studies show that the number of citations a patent receives is a noisy correlate to the patent's monet ary value and to its technical relevance.

[65] The base year for these growth rates is 1990.

Engineering *Engines, Pumps and Turbines* and *Transport* also grew strongly. Finally the technology areas *Medical Engineering* and *Analysis, Measurement, Control* from the main area Instruments also grew strongly. We concentrate on all of these tech nology areas in the following section to establish whether this growth is connected to strategic patenting behaviour or not. Table 4.2.1 also shows that patent applications also became more complex. On average the number of claims contained in a patent gr ew by 35% and in eight technology areas the growth of claims on a patent application was over 50%.

In addition to the technology areas already noted we will also focus on *Audiovisual Technology* (Electronics) and *Macromolecular Chemistry* (Chemicals and Pharmaceuticals). These are selected because the growth in claims was also very high.

In the following sections we illustrate patenting trends for four main technology areas in greater detail using graphs that display time series data. These provide a riche r impression of the trends than a table. Only the most salient graphs are discussed. The Appendix to this report contains graphs for the remaining areas.

<u>Methodology:</u>
We insert a brief methodological remark here which applies to all indicators we have ca lculated. All patents are classified into patent classes (IPC classes). These classes are aggregated into the 30 technology areas we use as the basis of our analysis. It is possible and occurs frequently that the patent classes on a patent fall into more t han one technology area. In order to avoid a somewhat arbitrary ascription of patents to technology areas we have counted how many patent classes a patent falls into. From this information we calculate which fraction of a patent falls into which technology area. We use the fractional patents as the basis of our analysis. This choice allows us to be more precise in many indicators which we generate. Sometimes it has a cost too as becomes clear in our analysis of firm opposition matrices (Section 4.5.2).

Table 4.2.1 Annual applications and claims per patent across 30 Technology areas

Rank	Technical Area	Main area	Annual Applications			Claims per Patent			Total no. of claims
			1990	2000	Total Growth	1990	2000	Total Growth	2000
1	Telecommunications	*Electronics*	3273	11554	253%	11.6	18.6	60%	466%
2	Pharmaceuticals, Cosmetics	*Chemicals, Pharmaceuticals*	1896	6080	221%	17.1	25.8	51%	328%
3	Information Technology	*Electronics*	2754	7540	174%	13.5	21.1	57%	384%
4	Biotechnology	*Chemicals, Pharmaceuticals*	1193	3176	166%	11.6	15.3	32%	149%
5	Medical Engineering	*Instruments*	2298	5708	148%	13.5	20.4	51%	275%
6	Engines, Pumps, Turbines	*Mechanical Engineering*	1369	3245	137%	12.1	14.6	21%	154%
7	Transport	*Mechanical Engineering*	2269	5037	122%	12.5	18.7	50%	232%
8	Electrical Devices, - Engineering	*Electronics*	3818	7296	91%	11	14.6	33%	63%
9	Consumer Goods and Equipment	*Consumer goods*	2370	4414	86%	11.4	14.6	28%	89%
10	Analysis, Measurement Control	*Instruments*	4412	7712	75%	12.7	18.1	42%	89%
11	Semiconductors	*Electronics*	1523	2524	66%	12.5	17.4	39%	89%
12	Mechanical Elements	*Mechanical Engineering*	2123	3509	65%	10.5	12.8	23%	139%
13	Thermal Processes and Apparatus	*Process Engineering*	809	1334	65%	11.9	14.9	25%	133%
14	Civil Engineering, Building, Mining	*Consumer Goods*	1918	3111	62%	11.3	14.2	25%	54%
15	Surfaces, Coating	*Process Engineering*	1089	1759	61%	13.1	17.7	35%	251%
16	Environment, Pollution	*Process Engineering*	492	791	61%	10.8	12.2	14%	186%
17	Machine Tools	*Mechanical Engineering*	1642	2533	54%	10.6	12.4	17%	101%
18	Handling, Printing	*Mechanical Engineering*	3205	4942	54%	12.7	15.6	23%	104%
19	Audiovisual Technology	*Electronics*	2413	3666	52%	11.2	17.2	54%	131%
20	Agriculture, Food	*Chemicals, Pharmaceuticals*	639	963	51%	13.3	17.5	32%	79%
21	Agricultural - and Food Machinery	*Mechanical Engineering*	711	1055	48%	11.2	13.6	22%	74%
22	General Technological Engneering	*Process Engineering*	2172	3142	45%	11	13.6	24%	75%
23	Optics	*Instruments*	2742	3863	41%	13.4	18	34%	80%
24	Chemical -, Petrol-, Basic Mat. Chem.	*Process Engineering*	1757	2301	31%	12.7	16.9	33%	118%
25	Materials, Metallurgy	*Chemicals, Pharmaceuticals*	1580	2040	29%	11.8	16	36%	106%
26	Macromolecular Chemistry, Polymers	*Chemicals, Pharmaceuticals*	2927	3544	21%	14	21.8	56%	98%
27	Material Processing	*Process Engineering*	2913	3518	21%	12.8	16.3	28%	80%
28	Organic Fine Chemistry	*Chemicals, Pharmaceuticals*	4158	5005	20%	12.1	16.4	36%	82%
29	Space Technology, Weapons	*Mechanical Engineering*	330	393	19%	11.5	14.4	25%	47%
30	Nuclear Engineering	*Mechanical Engineering*	302	293	-3%	13.9	21.1	52%	49%
Total			61100	112049	78%	12	17	35%	145%

4.2.1 Patent applications by priority year

This section illustrates the following points:

- Patent applications grew substantially after 1992. Growth is concentrated in a few technology areas.

- After 2000 the number of patent applications per annum is substantially above 5,000 in *Telecommunications*; *Electrical devices*; *Information technology*; *Analysis, Measurement, Control*; *Pharmaceuticals, Cosmetics* and *Medical engineering*.

Each of the following graphs contains a series illustrating the development of patent applications in a fictitious average technology area. This just represents the total number of patent applications per annum at the EPO divided by 30. This series is included to pr ovide a reference point for the reader.

Figure 4.2.1 confirms that patent applications in the Technology area *Telecommunications* grew very substantially between the late 1980's and the period after 2000. Additionally, the number of patent applications in *Electrical devices* and in *Information technology* was also high after 2000, relative to the late 1980's. A comparison with Figures 4.2.2, 4.2.3 and 4.2.4 also illustrates that the annual number of applications in each of these technology areas is higher t han in any other technology areas. These observations suggest that much of the growth in patenting observed at the EPO is due to information technology and its applications. This finding is in line with the results of Hall (2005) who shows that the growth in patenting at the USPTO is driven mainly by semiconductor firms. She shows that these firms patent in a very diverse set of technology areas. In order to confirm this hypothesis we investigate whether the set of technology areas in which the firms that led patenting in the main area Electronics patented in 1990 increased by the year 2000. This investigation is set out in section 4.5.3 below.

Figure 4.2.1.1

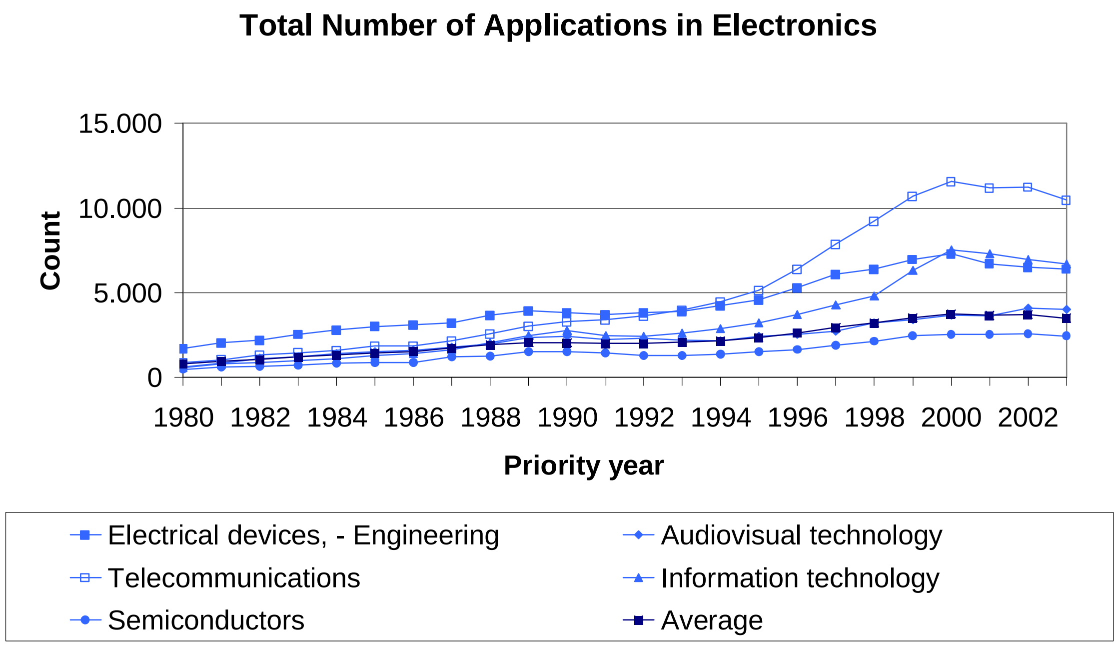


Figure 4.2.1.2

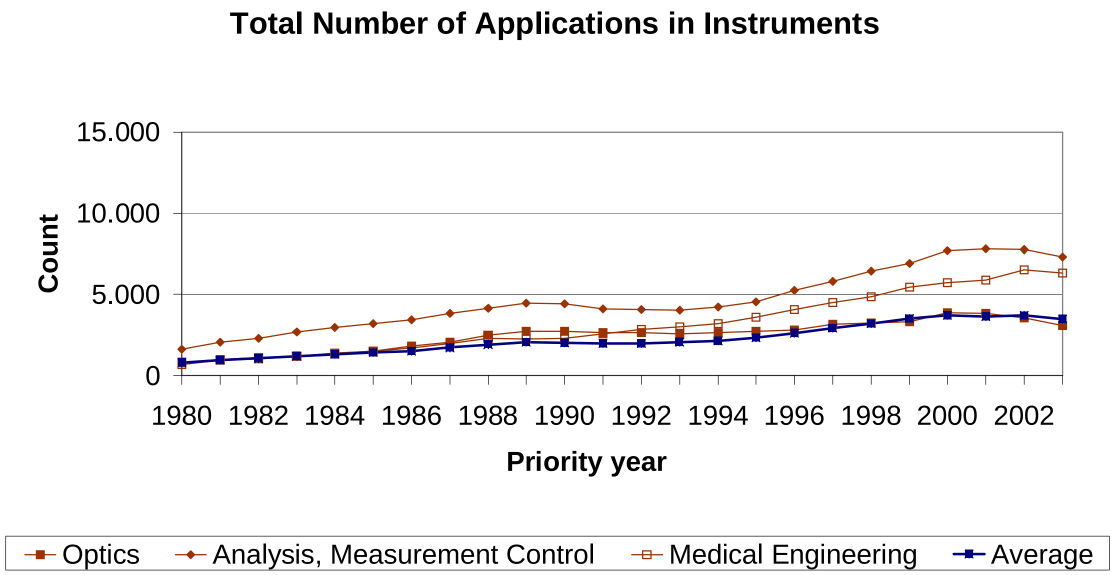


Figure 4.2.1.3

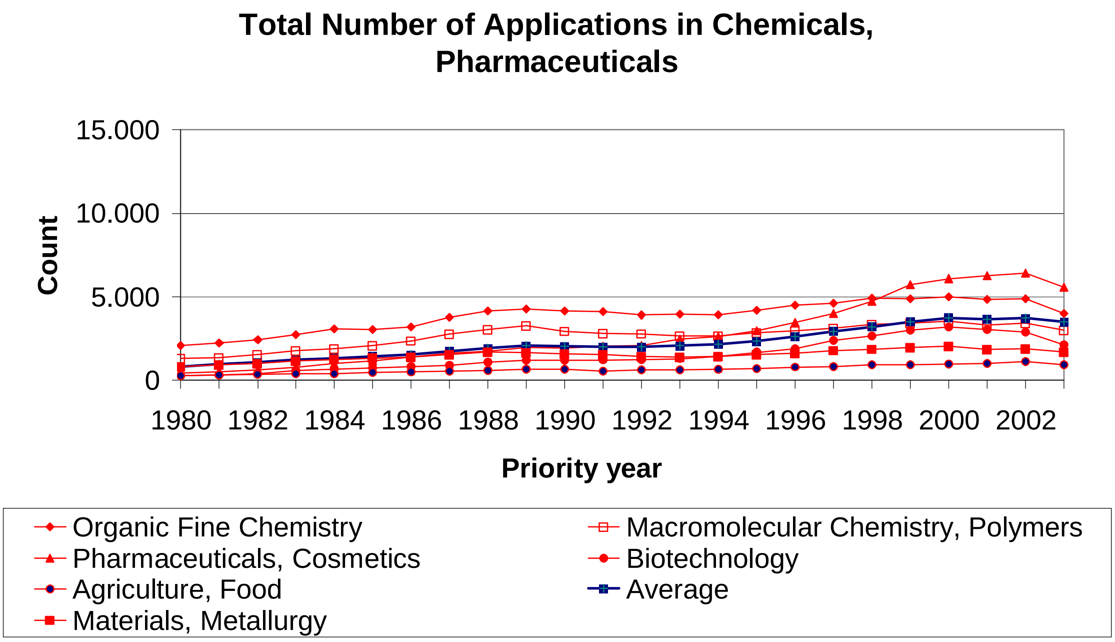
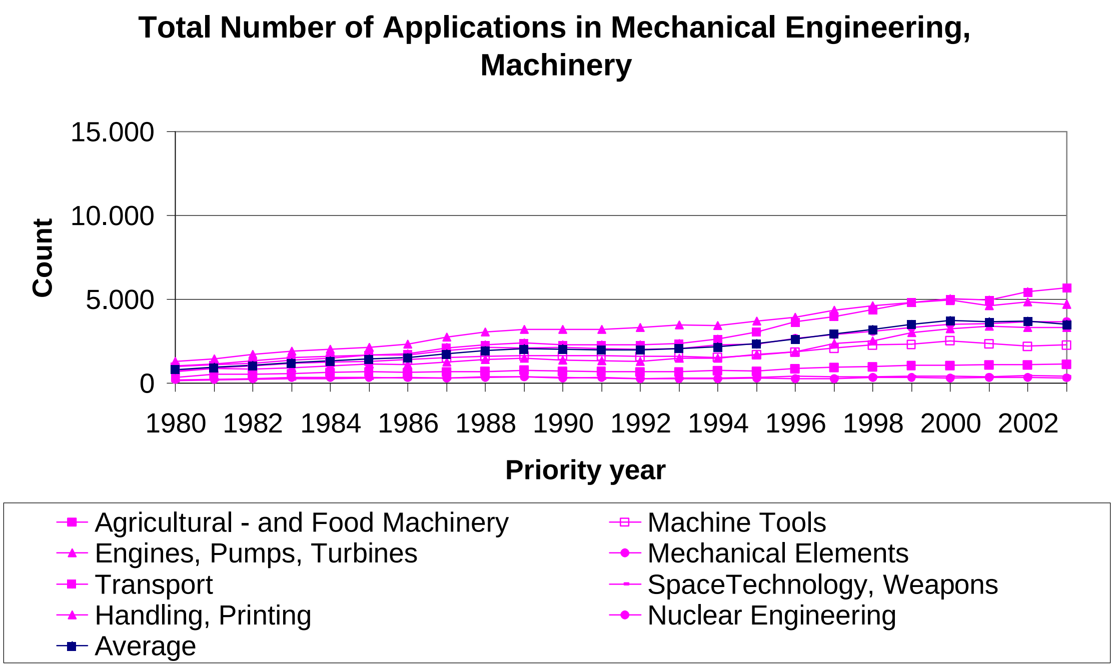


Figure 4.2.1.4



4.2.2 Outcomes of patent examination

This section illustrates that:

- The likelihood of obtaining a patent grant at the EPO is almost constant over the entire sample period.
- On average two thirds of all patent applications are granted.

Therefore the observed increase in patent applications has also led to a marked increase in the number of granted patents. The following Figures illustrate how the grant rate developed in the main areas Electronics (Figure 4.2.5), Instruments (Figure 4.2.6), Chemicals and Pharmaceuticals (Figure 4.2.7) and Mechanical Engineering (Figure 4.2.8). These Figures are based on data obtained September 2006.

Figure 4.2.2.1

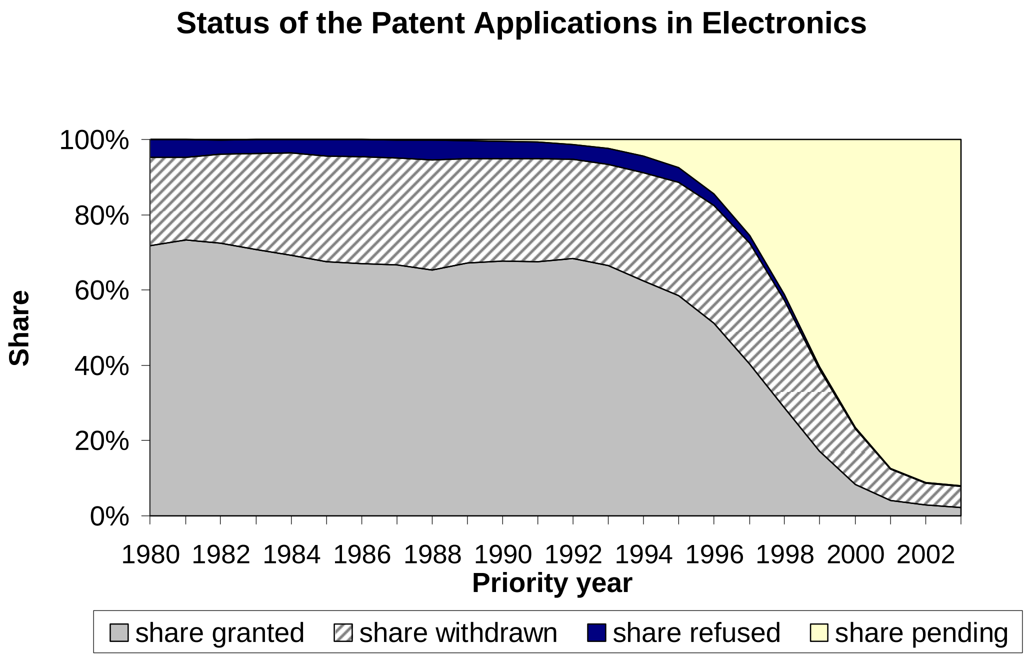


Figure 4.2.5 shows that the grant rate in Electronics, t he main area most affected by the dramatic growth in patent applications in the 1990’s was stable if not slightly increasing between 1988 and 1995. The strong decrease in the grant rate after 1995 is a consequence of the large share of patent applications that are still pending. The long delay between the grant of a patent and its first submission at a patent office – the grant lag - is partly due to the application process chosen

by many firms and partly an expression of the complexity of the patents invo lved given the office's examination capacity.

Figure 4.2.2.2

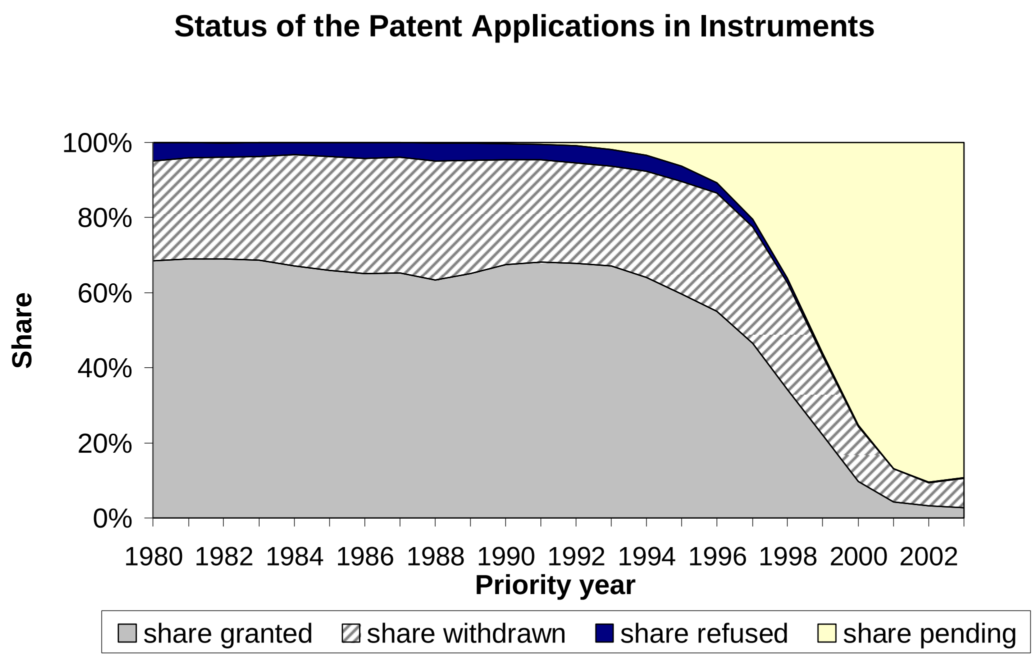
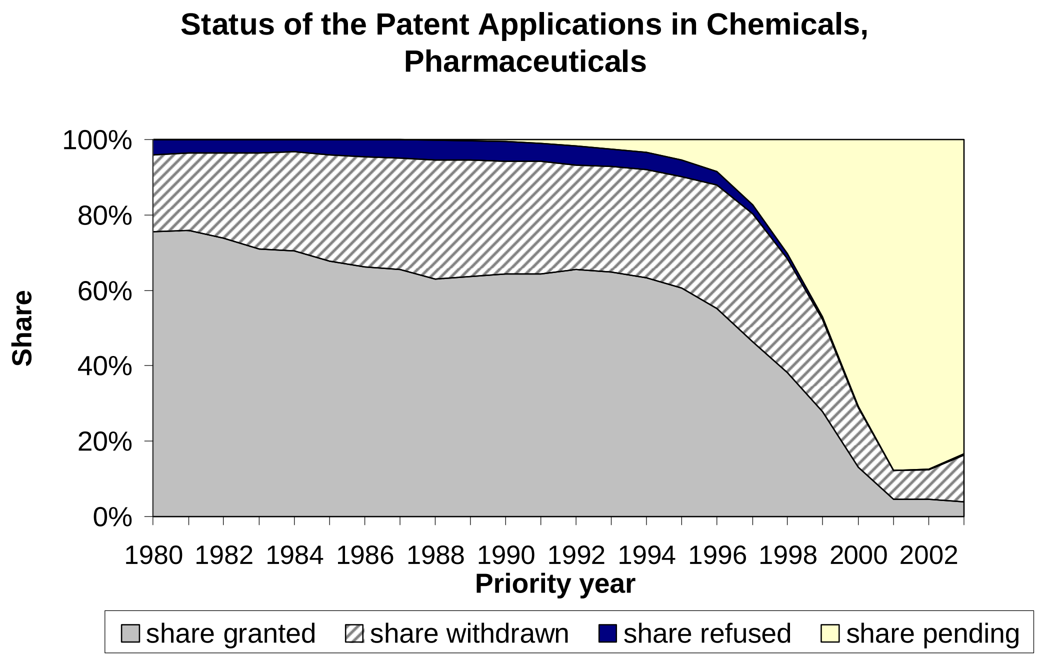
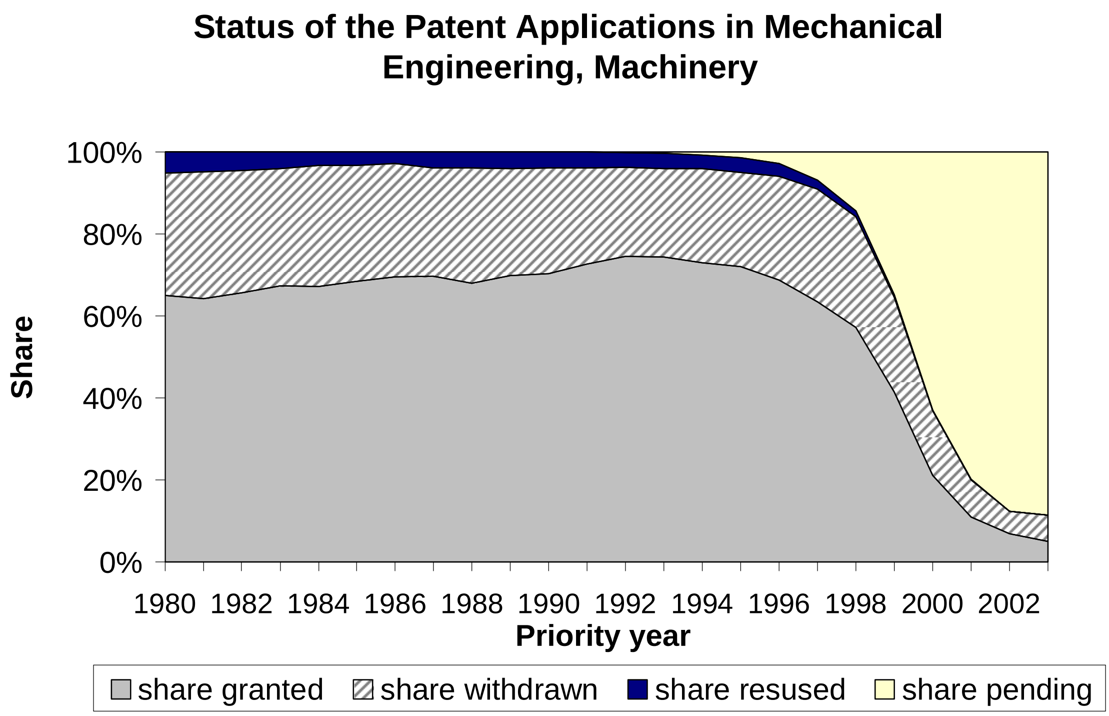


Figure 4.2.2.3



Firms generally do not submit their first version of a patent to the EPO but rather to a national patent office. They than have one year to submit their patent to the EPO. At the EPO the average patent is granted in approximately four years after its EPO filing date (Harhoff and Wagner (2005)).A comparison of the Figures in this section shows that patents in Mechanical Engineering have shorter grant lags than those in the other three main areas which we illustrate here.

Figure 4.2.2.4



It is interesting to note that the grant rate in Mechanical Engineering has been increasing since the EPO started to operate. This implies that an increasing fraction of applications were granted.

4.2.3 Claims per patent

This section documents that: [66]

- Not just the number, but also the complexity of patents measured as the number of claims increased after 1992.

[66] It should be noted that the EPO instituted a reform of its fee structure in 2003. This led to changes in the cost of claims and may be the cause of the observed decline in claims per patent at the very end of the time series reported below.

- While the growth in claims was strong in Electronics or Instruments it was especially pronounced in Chemicals and Pharmaceuticals.
- The highest average number of claims per patent occurs in *Biotechnology*.

Each patent document consists of a number of claims. A claim contributes to the delineation of the patent's scope. A higher number of claims per patent indicate a higher complexity of the patent. More complex patents are more costly to examine and raise costs for rivals who are seeking to understand, oppose or avoid the patent. How many claims a firm puts on a patent is partly a matter of choice. Therefore strategic behaviour of patent applicants may be reflected in the number of claims per patent they file.[67] This indicator is not conclusive, however. It only suggests in which technology areas we should investigate firms' patenting behaviour more carefully. The average included in all the figures reflects the average number of claims for all patent applications at EPO. The Figures below show that this average masks considerable variation across technology areas.

[67] Patent documents contain independent and dependent claims. The latter clarify the former. Our data do not distinguish between these kinds of claims. A detailed analysis of the relationship between these types of claims would be very interesting but is presently not possible due to data limitations. More detail on the development of the number of claims on patent applications can be found in Archontopoulos et al. (2006).

Figure 4.2.3.1

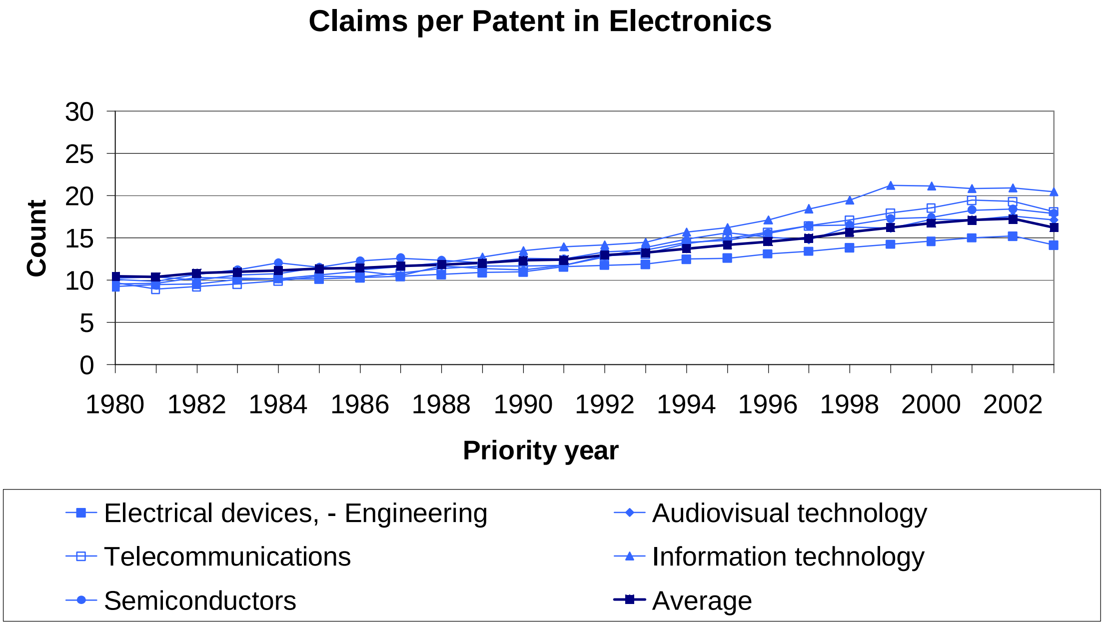


Figure 4.2.9 shows that the number of claims per patent grew in all technology areas in Electronics apart from *Electrical devices*. Figures 4.2.10, 4.2.11 and 4.2.12 illustrate that patents in all technology areas included in Instruments and in most technology areas included in Chemicals and Pharmaceuticals became considerably more complex after 1992.

Figure 4.2.3.2

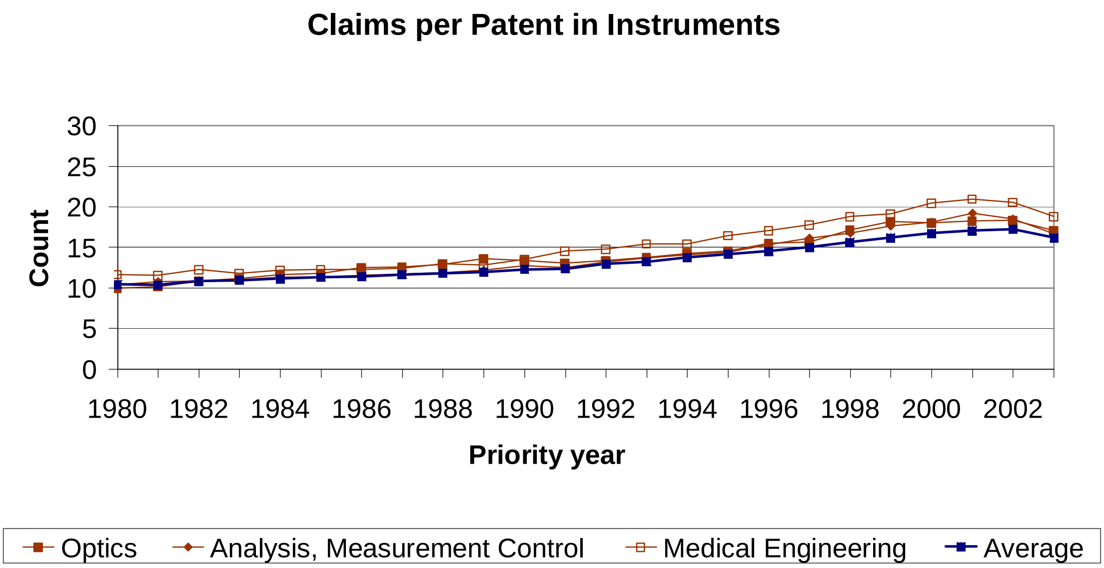


Figure 4.2.3.3

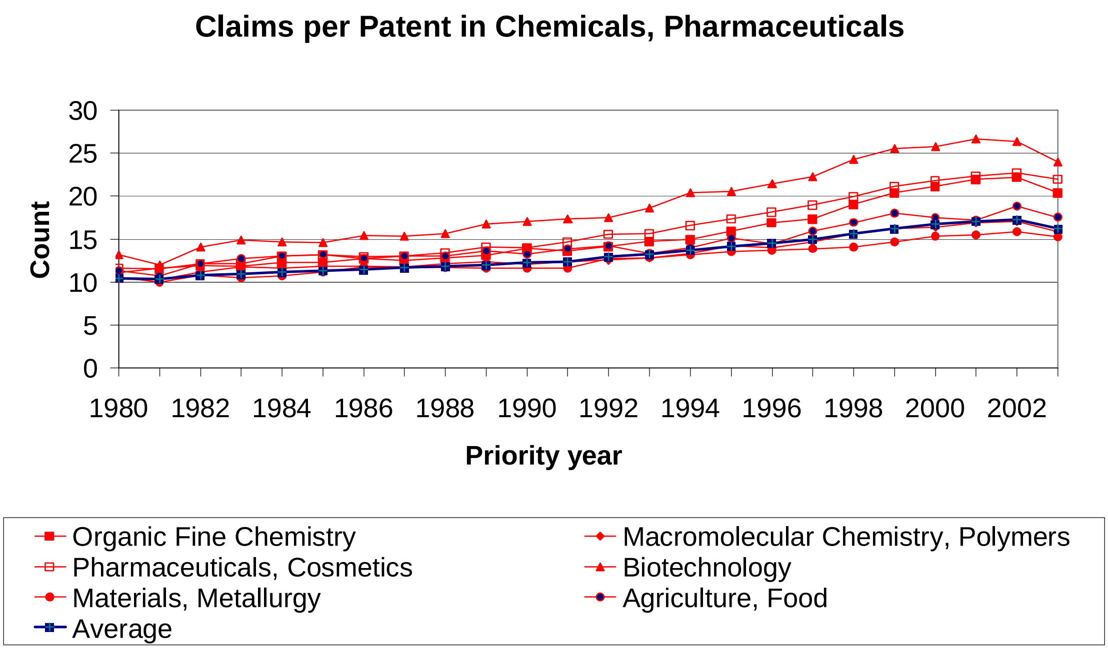
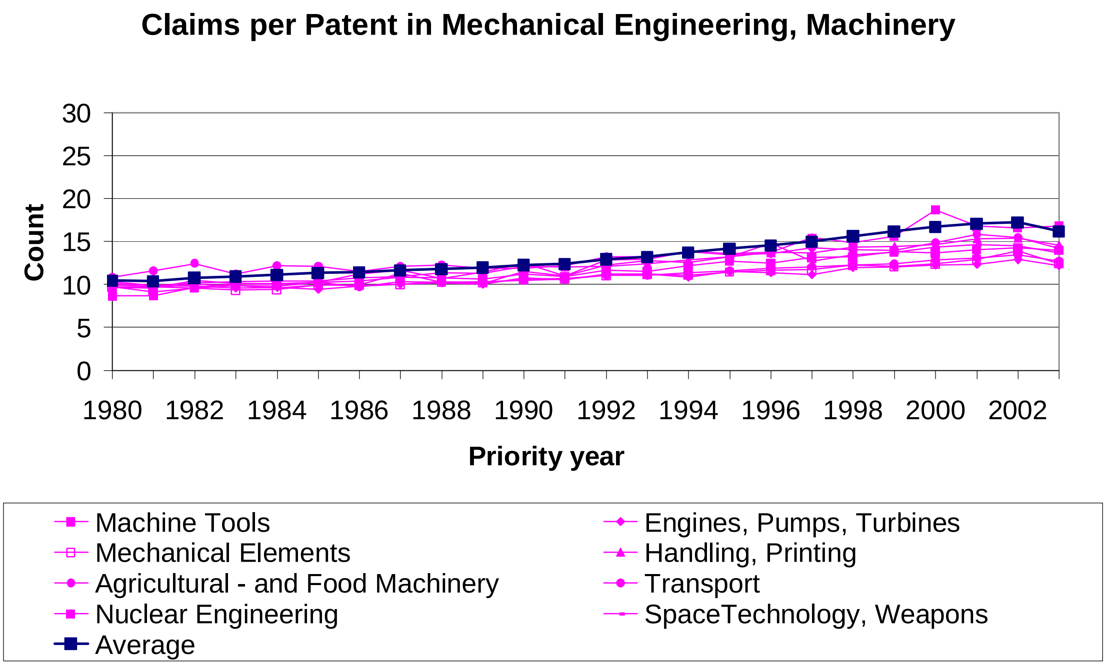


Figure 4.2.3.4



The number of claims on patents in all areas of Mechanical engineering grew only slightly, indicating much slighter increases in complexity of patents than in the other main areas surveyed above. Additional information about the workload faced by the EPO as a result of the increasing complexity of patents is provided by Archontopulos, *et al.* (2006) .

To summarize the differences between the main technology areas we analyze the growth of claims per patents in the four main areas we focus on (Electronics; Chemicals, Pharmaceuticals; Instruments; Mechanical Engineering) relative to the remaining two (Process Engineering and Consumer Goods) in Figure 4.2.13 below. This Figure shows clearly that claims per patent grew substantially faster in Chemicals, Pharmaceuticals than in any other main technology area. The Figure also makes clear that claims per patent in Electronics grew much less quickly.

Figure 4.2.3.5

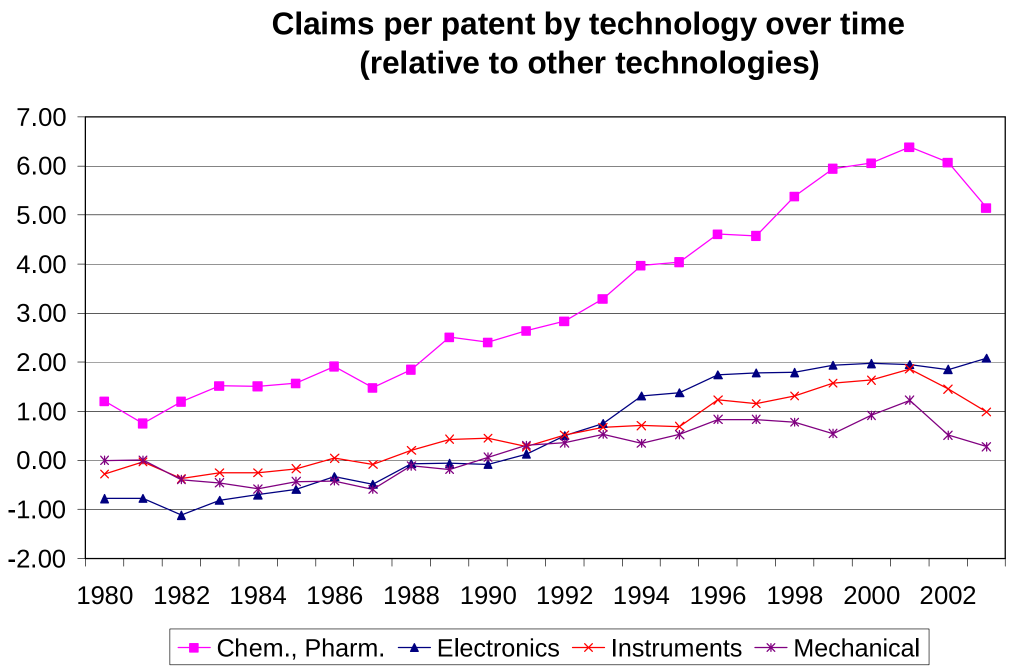


Figure 4.2.13 shows time dummy estimates from a weighted regre ssion of claims per patent on a full set of time dummies and individual time dummies for each of the four technology sectors. The number of observations was 30 tech classes by 24 years.

4.2.4 Rate of patent opposition cases

In this section we show that:

- On average the rate of opposition to patents fell at the EPO after 1985.
- The rate of opposition was very low in: *Information Technology*, *Audiovisual Technology* and *Organic Fine Chemistry*.
- The rate of opposition to patents was high in: *Medical Engineering*; *Agriculture, Food*; *Pharmaceuticals, Cosmetics* and *Transport*.

At the EPO a granted patent may be opposed by other patent holders and other interested parties. An analysis of patent oppositions can provide information about the intensity of R&D rivalry amongst firms in a technology area. Furthermore, opposition contributes to the quality of the patent stock by introducing additional checks and additional sources of information into the process of patent examination.

The findings we report here show that technology areas fall into two groups: those in which opposition activity has remained very strong and those in which it has steadily declined since the EPO started operating in the late 1970s. We will show that in combination with information regarding the concentration of patent applications and exit and entry into technology areas these findings provide indications of differences in the development of technological areas which we study.

In Electronics the rate of opposition is consistently below the weighted average for technology areas. The opposition rate is particularly low in *Telecommunications*, *Information Technology* and *Semiconductors*. There is not much variation in the rate of opposition over time after 1990 and all of the technology areas display the same downward trend.

Figure 4.2.4.1

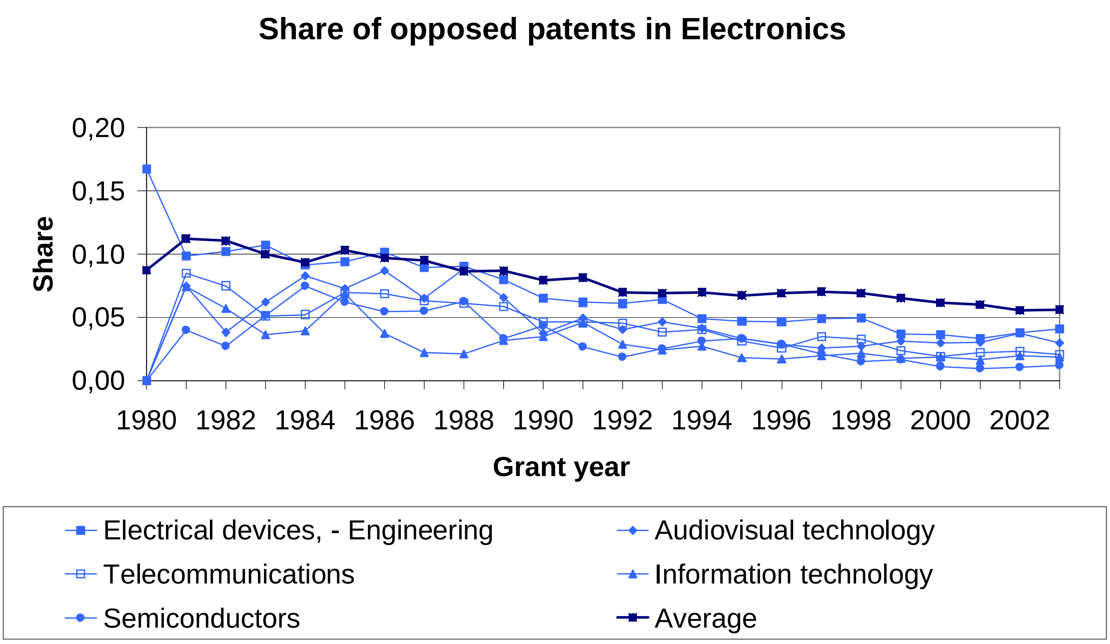


Figure 4.2.4.2

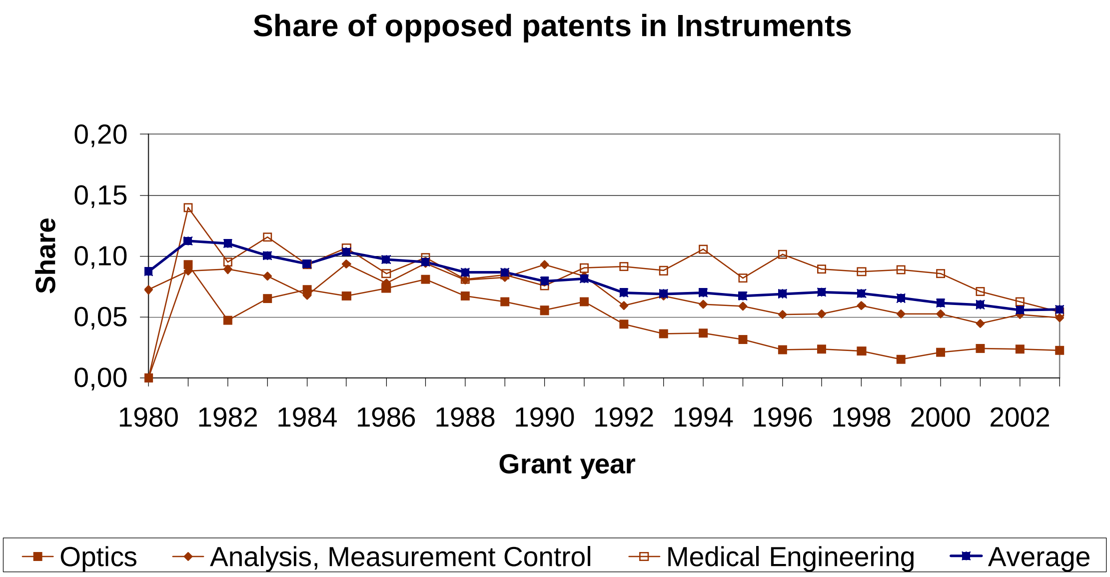
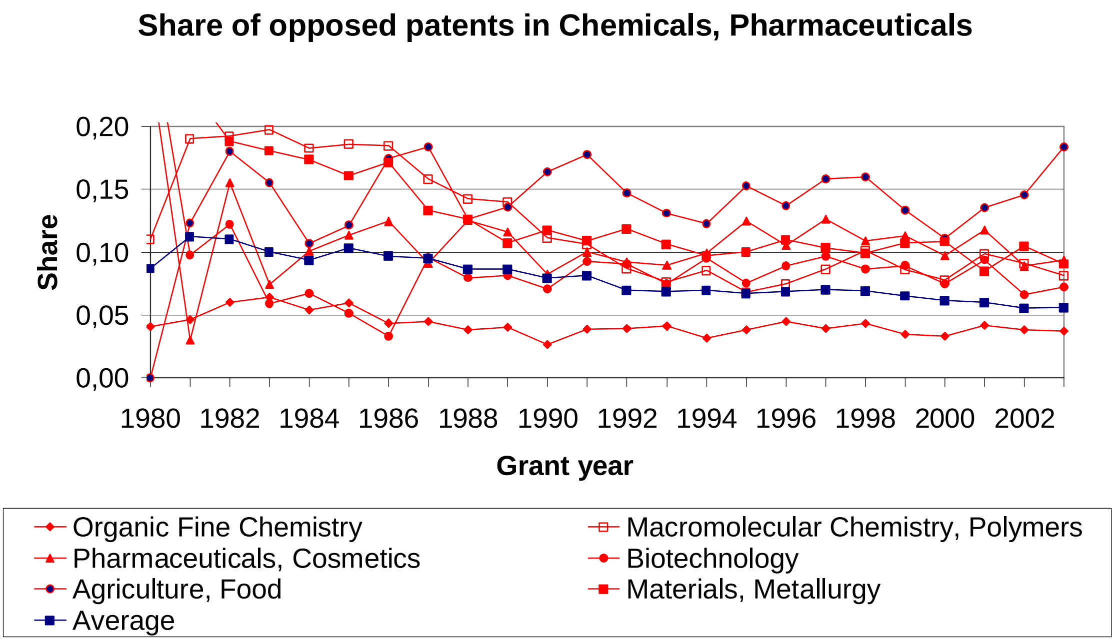


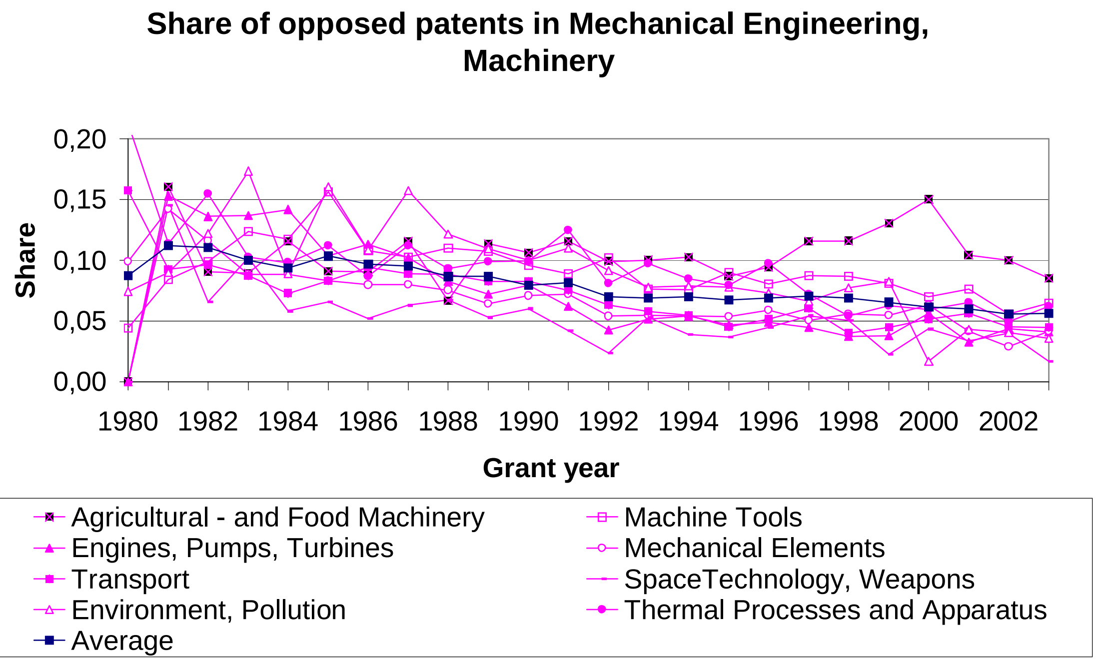
Figure 4.2.4.3



The opposition rate in Instruments differs significantly by technology area. It is higher in *Medical Engineering* than in *Analysis, Measurement, Control* or *Optics*. Furthermore, the opposition rate in *Medical Engineering* does not fall until 2000. This is especially remarkable as Table 4.2.1 shows that patent applications grew faster in this technology area than in *Optics* or *Analysis, Measurement, Control.*

In light of the general downward trend in the average rate of op position Figure 4.2.15 above, summarizing opposition rates in Chemicals and Pharmaceuticals, is especially interesting. The Figure demonstrates that opposition rates have been high and variable in *Agriculture and Food*, in *Pharmaceuticals and Cosmetics* and in *Materials and Metallurgy*. It is also noteworthy that opposition rates are very low over the whole sample period in *Organic Fine Chemistry* which we showed to be a technical area receiving a particularly high rate of patent applications (viz. Figure 4.2.3).

Figure 4.2.4.4



The rate of opposition in technology areas that receive high numbers of patent applications is interesting if it is either very high or very low. The former indicates a high degree of technological rivalry amongst firms while the latter indicates that firms are generally not interested in preventing each other from patenting.

To round clarify the evidence provided above we undertook an analysis in which we compare the aggregate opposition rates in the four main areas we have singled out relative to the remaining two, i.e. relative to Process Engineering and Consumer Goods. Figure 4.2.18 below shows that opposition rates in Chemicals, Pharmaceuticals have increased over time and are significantly higher than in all other main technology areas. Meanwhile opposition rates in Electronics are much lower than those in all other main technology areas.

Figure 4.2.4.5

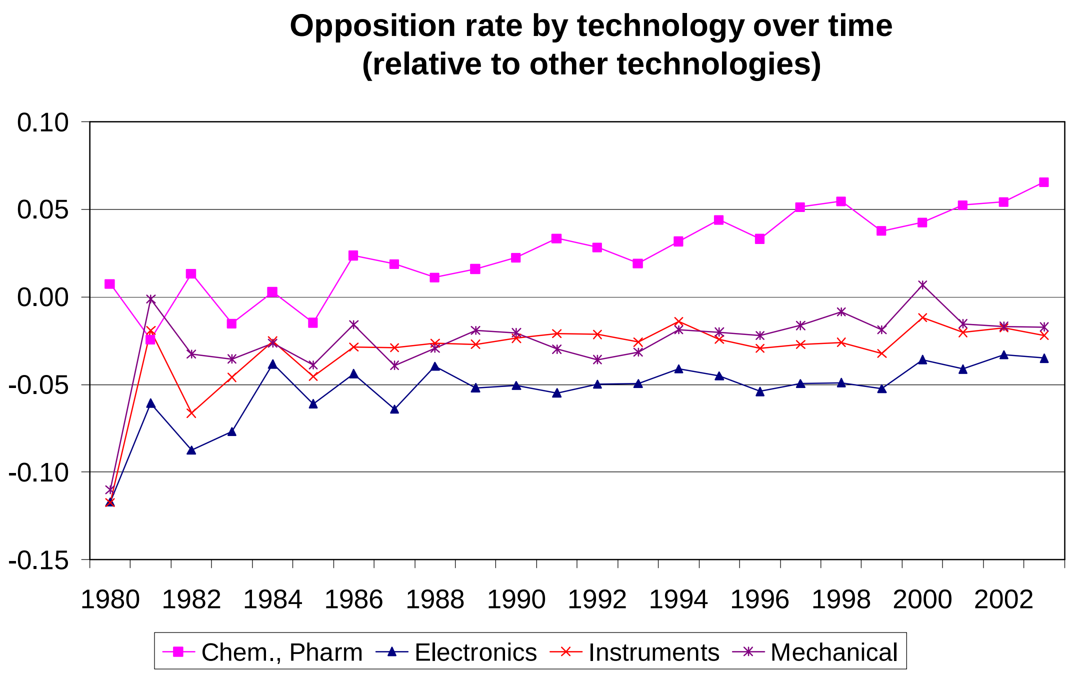


Figure 4.2.18 shows time dummy estimates from a weighted regression of the opposition rate on a full set of time dummies and individual time dummies for each of the four technology sectors. The number of observations was 30 tech classes by 24 years.

In section 4.5.2 below we investigate which kinds of firms oppose each other. To do this we focus on the following technology areas: *Medical Engineering*; *Pharmaceuticals, Cosmetics*; *Agriculture, Food; Agriculture-, and Food Machinery* (high opposition rates) and *Telecommunications*; *Information Technology; Audiovisual Technology* (low opposition rates) as well as *Analysis, Measurement, Control* .

4.3 Identification of technology areas warranting further investigation

The previous section provided a general review of broad patenting trends affecting the EPO in the last two decades. We showed that the number and complexity of patent applications increased dramatically in some technology areas. At the same time the grant rate remained the same, while the rate of opposition to patent applications frequently decreased substantially.

Taken together these findings raise questions about the quality of patents granted in several technology areas. They also provide a first suggestion that firms might be acting strategically in their applications for patents.

In this section we try to identify which technology areas could be affected by strategic behaviour in the patenting process. To do this we make use of indicators that provide better information about the quality of patent applications and about the application strategies of firms in different technology areas. This section has three parts: the first deals with evidence regarding the concentration of patent applications, the second with evidence regarding the quality of patent applications and the third with evidence regarding strategic behaviour by applicants.

4.3.1 Size of patent portfolios and their effects

In this section we set out evidence regarding the concentration of patent applications and entry and exit into technology areas. This information will prove useful in assessing whether the trends we observe elsewhere are the result of strategic behaviour between a few firms or result from the actions of many different firms.

Originally, it was our intention to study the Herfindahl index as well as the C4 and C8 concentration ratios. As the Herfindahl index would have been unreliable for reasons noted above and as we are already presenting a very large amount of empirical evidence, we have found it useful to concentrate on the C4 ratio alone. We have calculated the C8 ratio as well. This confirms the results we present here.

Concentration measures

In this section we show that:

- The concentration of patent applications varies strongly by technology area.
- The share of patent applications accounted for by the four most frequent applicants is high in *Audiovisual Technology*; *Telecommunications*; *Engines, Pumps and Turbines* and *Optics*.[68]
- The share of patent applications accounted for by the four most frequent applicants is remarkably low in *Medical Engineering* and *Biotechnology*.

The figures presented in this section are based on the PATSTAT dataset. The applicant names from this dataset were consolidated on the basis of the DERWENT Appendix.[69] Additionally we consolidated the names of the 15 largest applicants in each of the 30 technology areas on the basis of information about firm ownership patterns which we researched ourselves. The averages reported in the Figures below represent the average share of the top four applicants across the 30 technology areas.

Figure 4.3.1 shows that a large share of patent applications in all of the technology areas included in Electronics is concentrated in the hands of a few applicants. These applicants are also very similar across all of these technology areas. In contrast, patent applications are much less concentrated in Instruments. Additionally, the concentration of patent applications in Chemicals, Pharmaceuticals has dropped in the last ten years.

[68] The data also show that Nuclear Engineering is highly concentrated. Due to the overall insignificance of the number of patents in this technology area (viz. Table 4.2.1) we do not analyze it at all. Concentration in Information Technology was high until the early 1990's but has since declined.

[69] This is the appendix to a document that may be found on the internet at http://www.thomsonscientific.com/media/scpdf/patenteecodes.pdf .

Figure 4.3.1.1

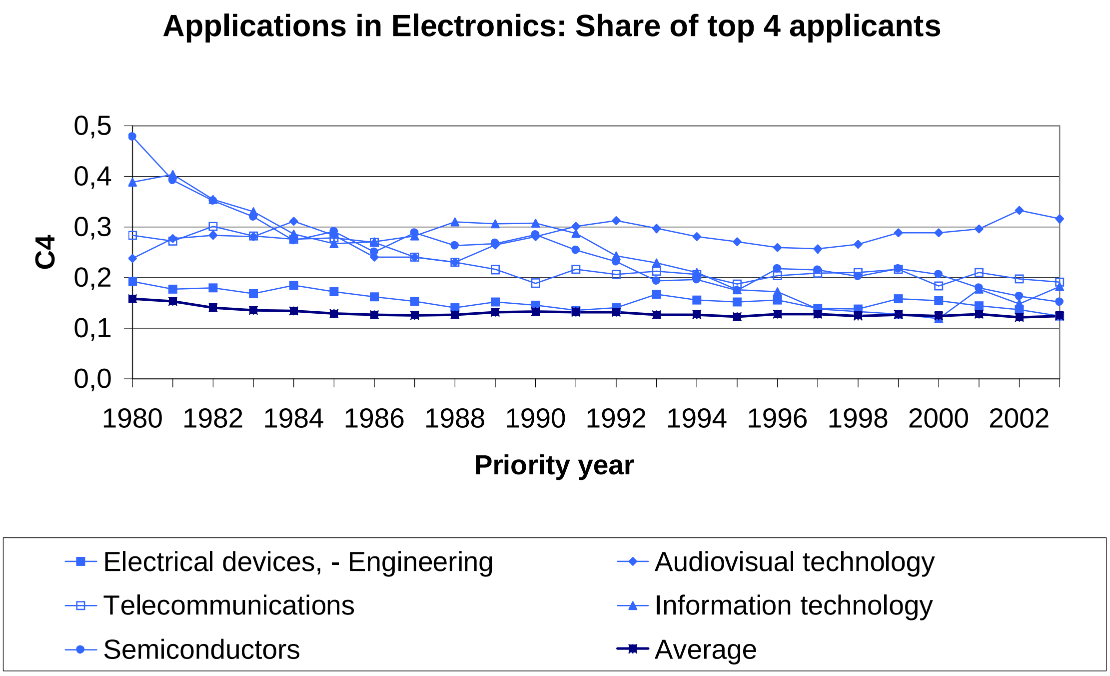


Figure 4.3.1.2

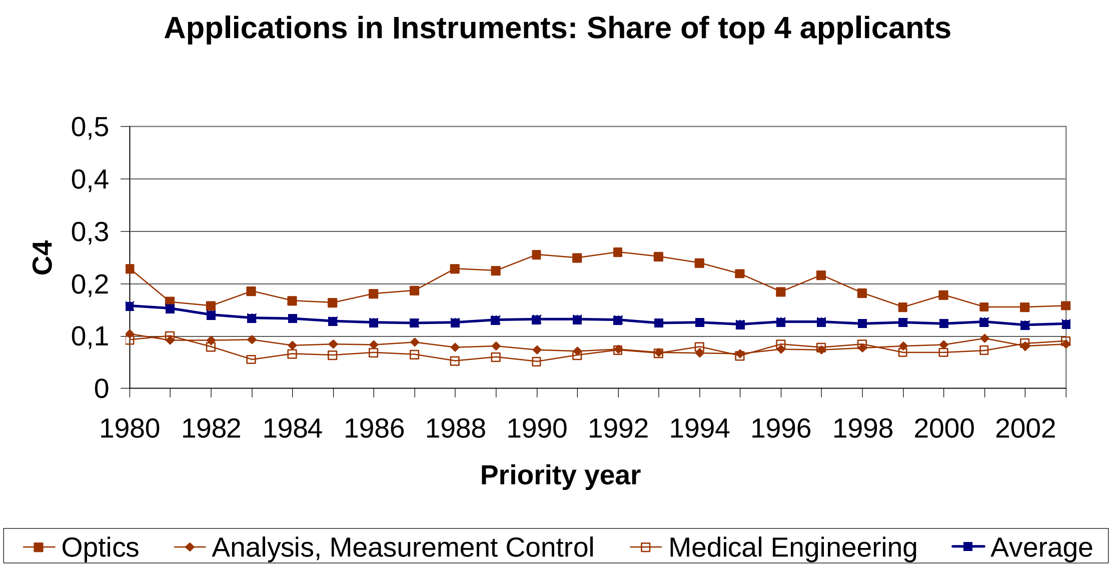


Figure 4.3.1.3

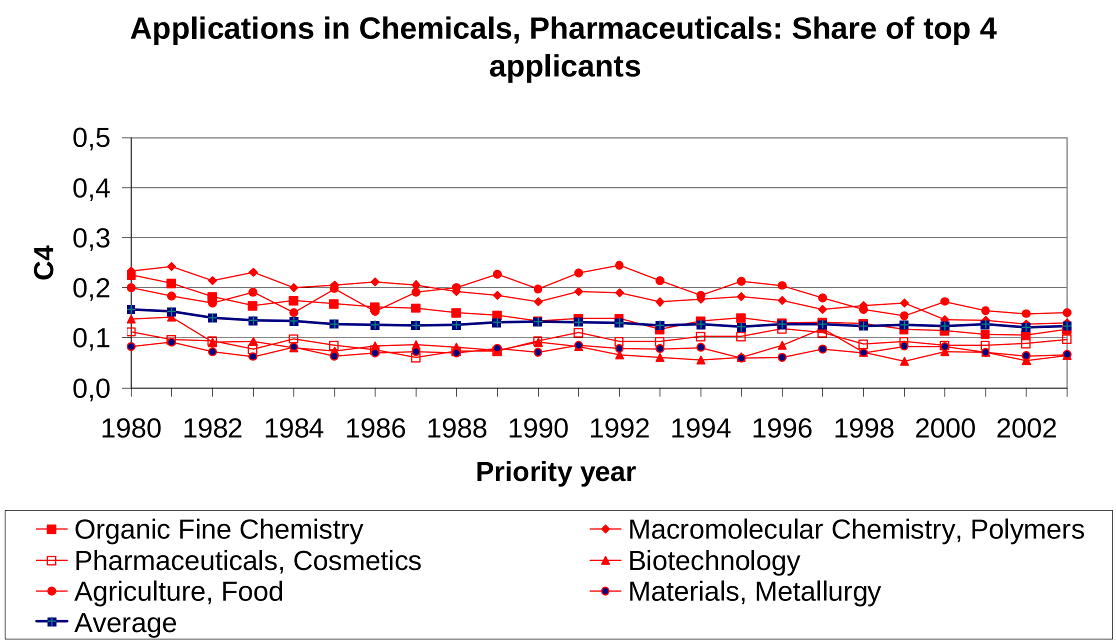
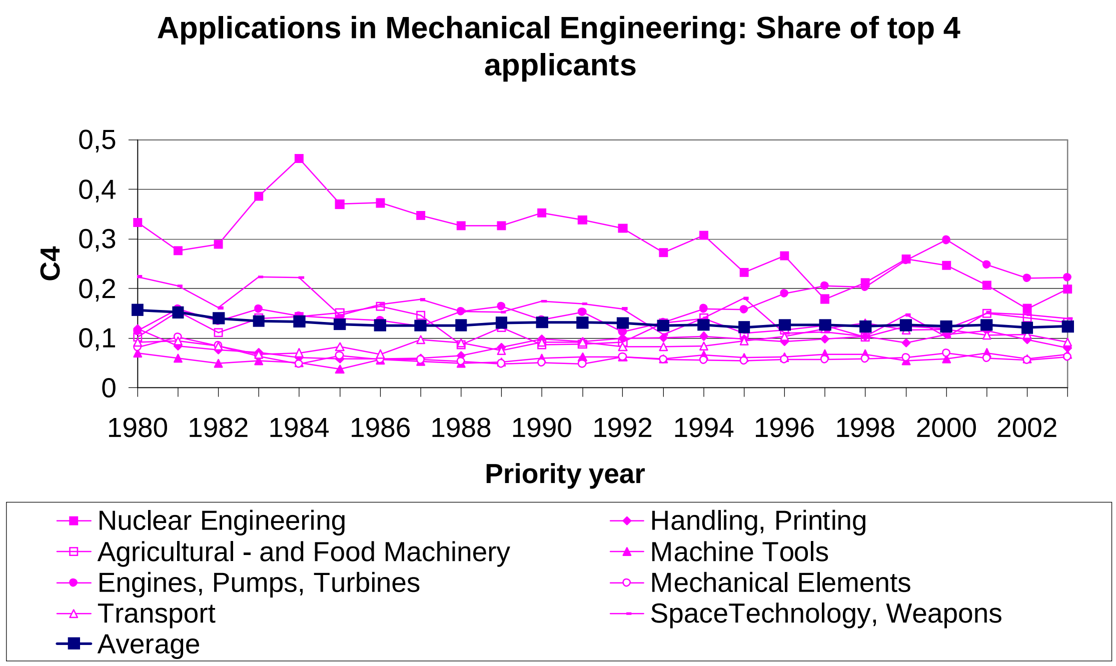


Figure 4.3.1.4



In Mechanical Engineering the concentration of patent applicati ons has always been high in *Transport*. This is still the case but much less so as Figure 4.3.4 reveals. Interestingly the concentration of applications has risen very steadily in *Engines, Pumps and Turbines* since 1992.

Entry and exit of patentees

In this section we show that:

- On average entry into all technology areas fell before 1990 and increased thereafter. [70]
- On average exit from technology areas was highest between 1990 and 1995.
- There is considerable variation across technology areas in entry and ex it rates.

Measures of entry into- and exit from technology areas may be interesting if they reveal substantial changes over time. Lerner (1995) argues that in the United States the incidence of high litigation against patents in certain patent classes had the effect of deterring further patent applications to these classes by small firms. On the other had Hall and Ziedonis (2001) show that the patent explosion in semiconductors was accompanied by increased entry of small and specialized niche players.

[70] The definition of entry and exit used in this section (compare page 6) implies that entry rates are likely to decrease in the last four years of the time series shown. Similarly it implies that exit rates are likely to increase in this period. This is due to the three year lags which are contained in the definitions of entry and exit. Therefore we discount these last years when interpreting the time series set out in this section.

Figure 4.3.1.5

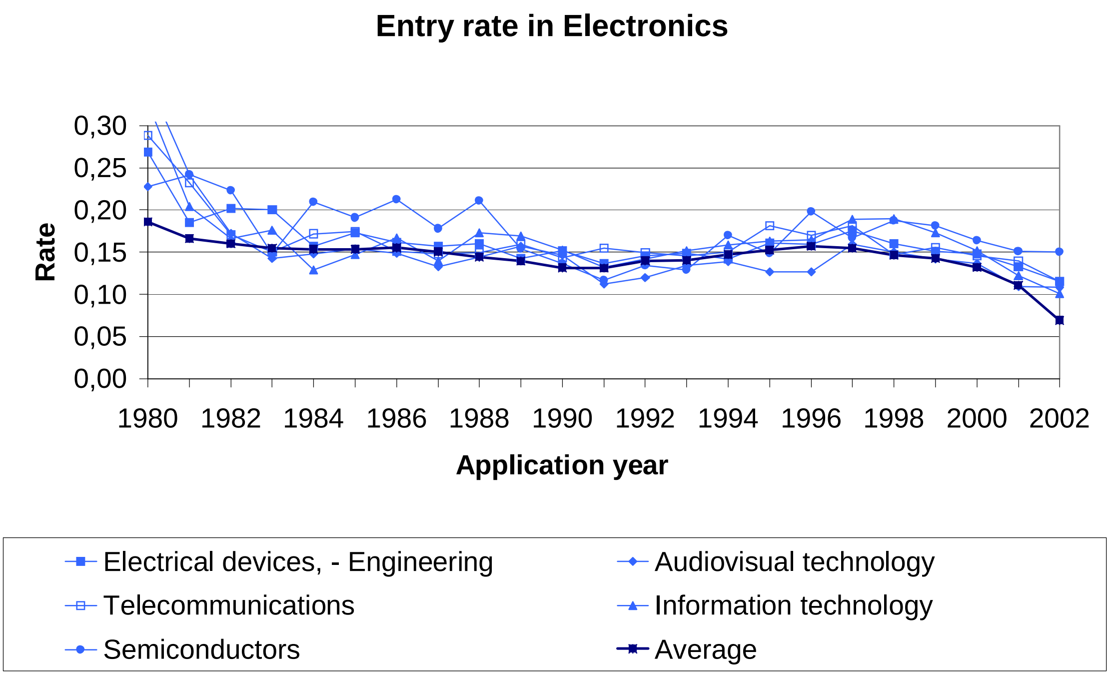


Figure 4.3.1.6

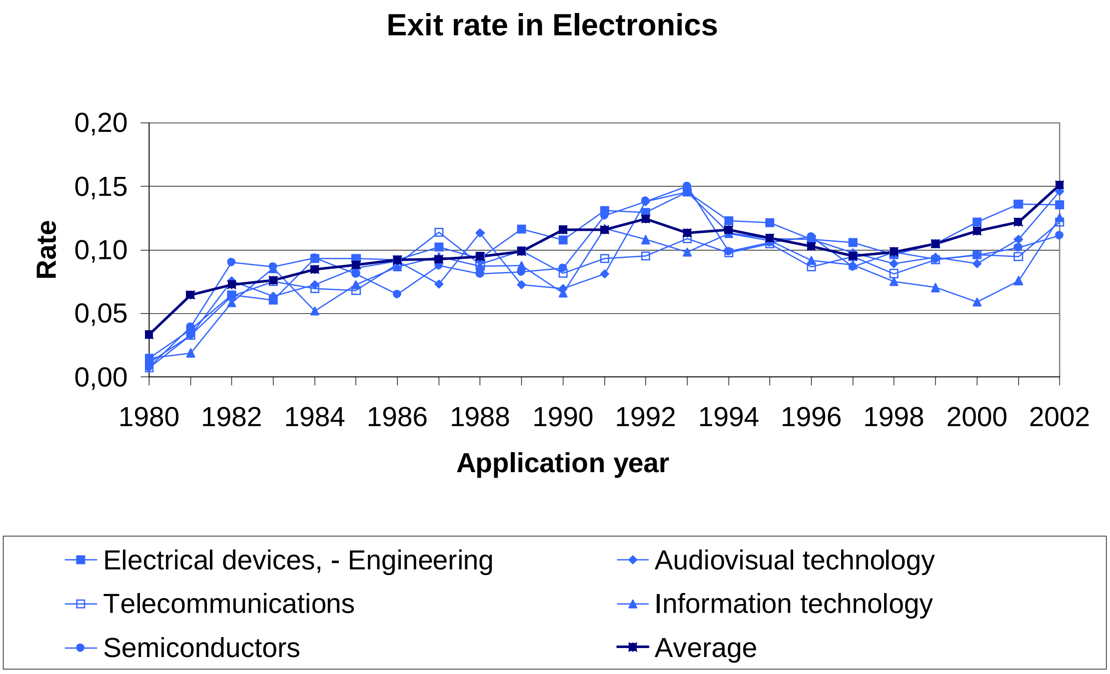


Figure 4.3.1.7

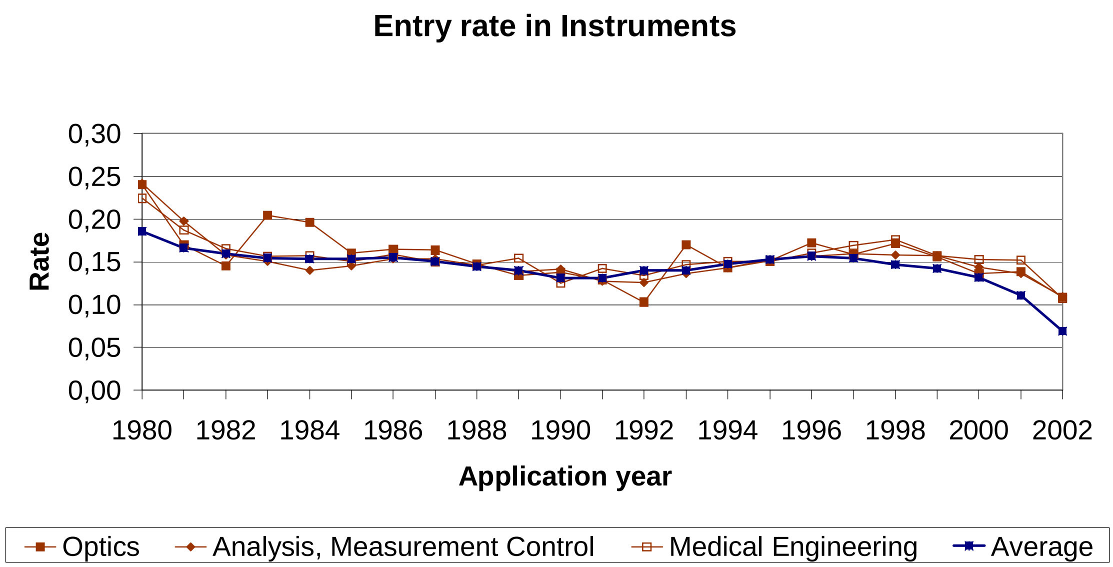


Figure 4.3.1.8

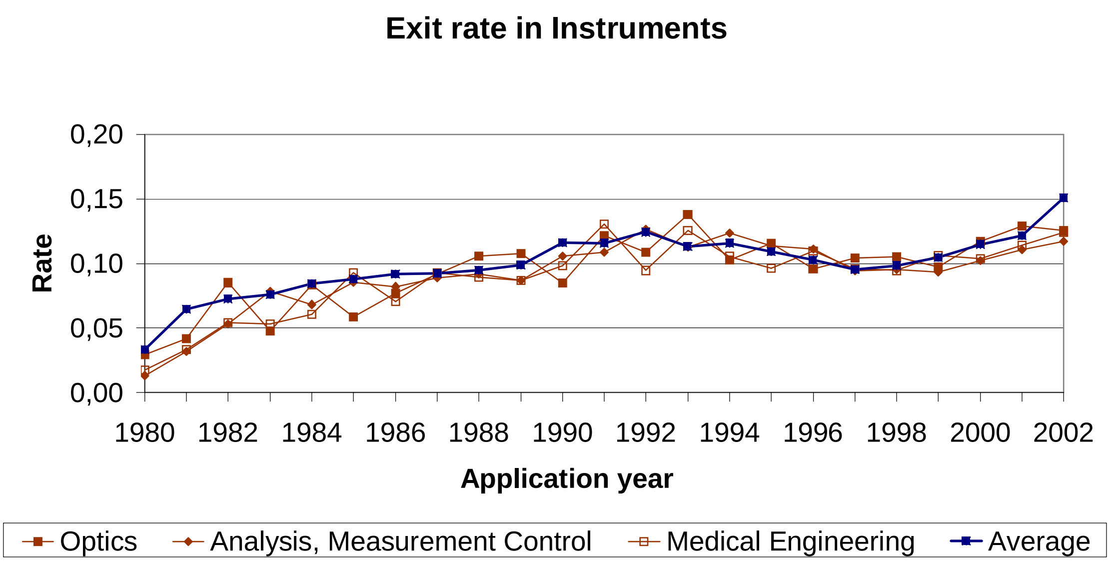


Figure 4.3.1.9

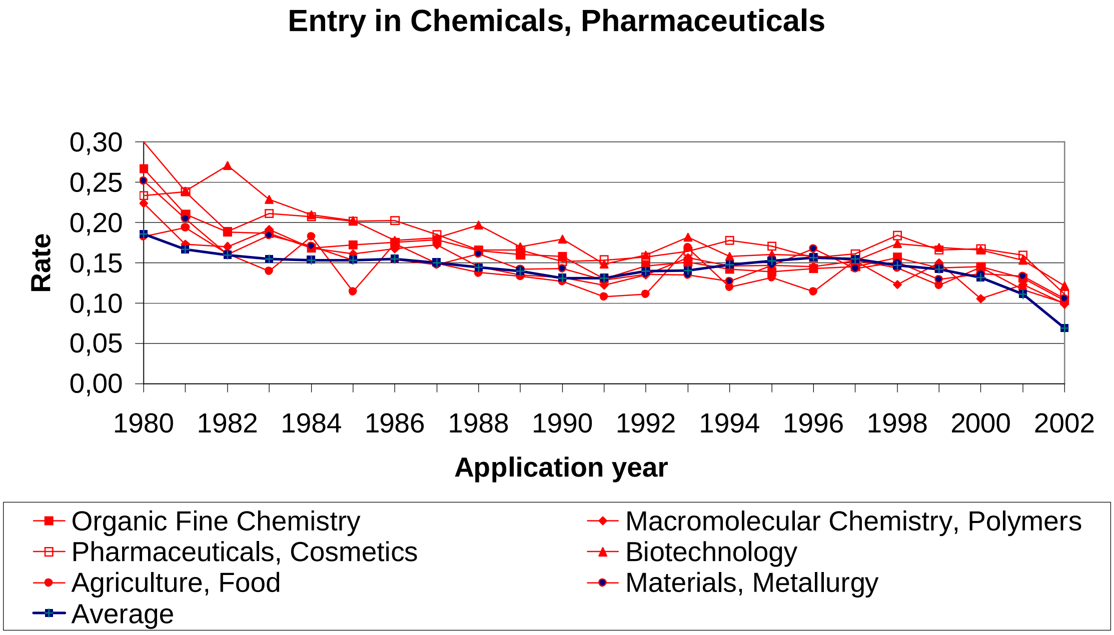


Figure 4.3.1.10

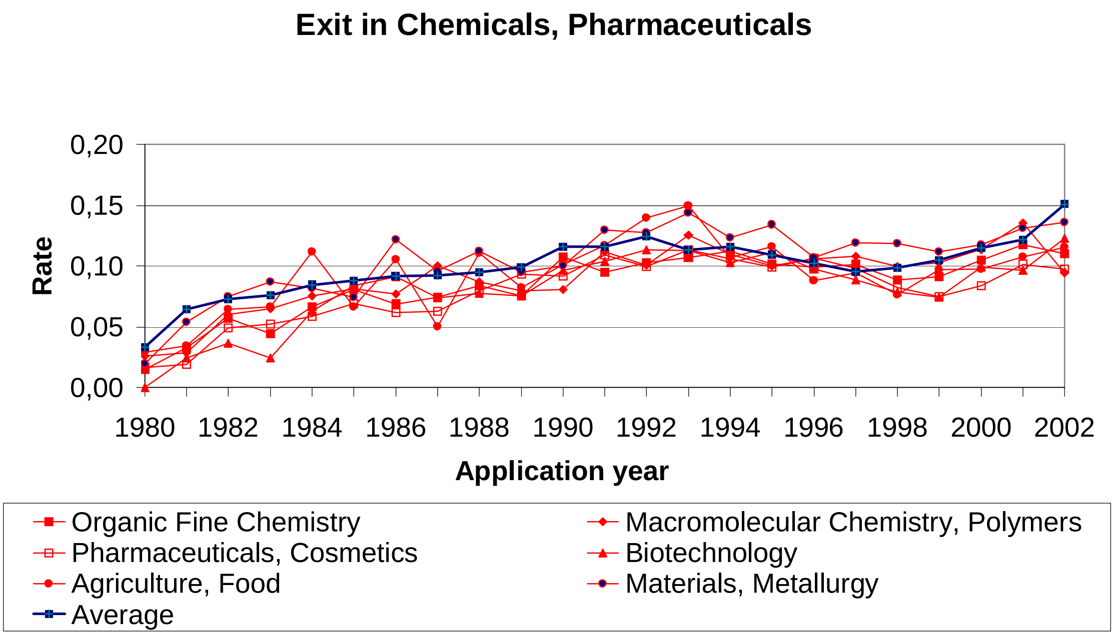


Figure 4.3.1.11

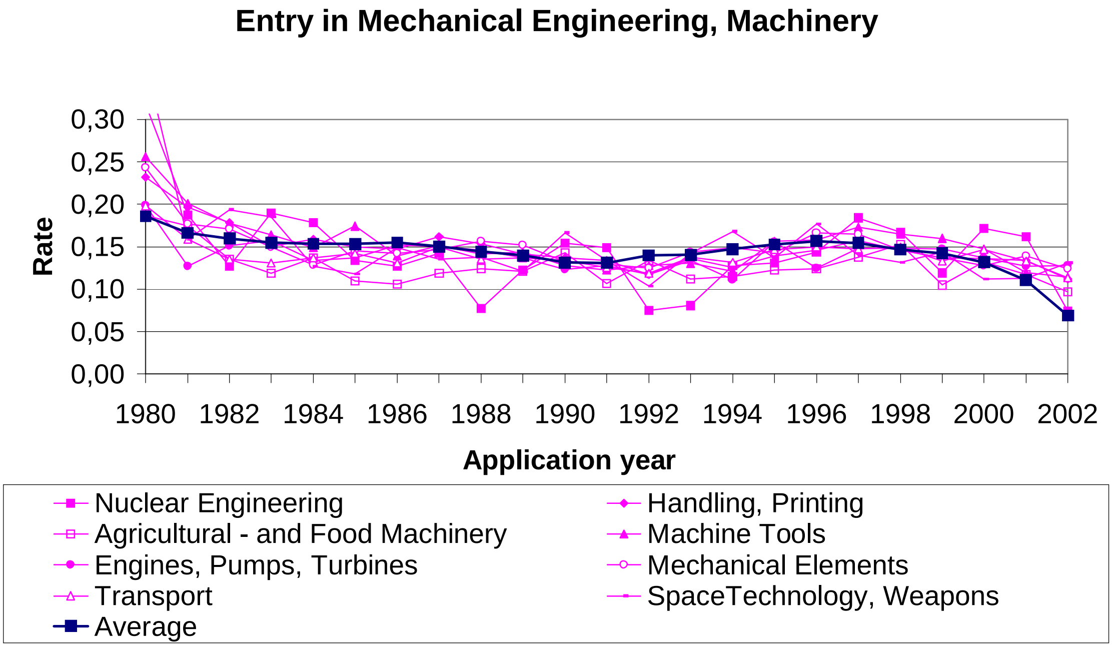
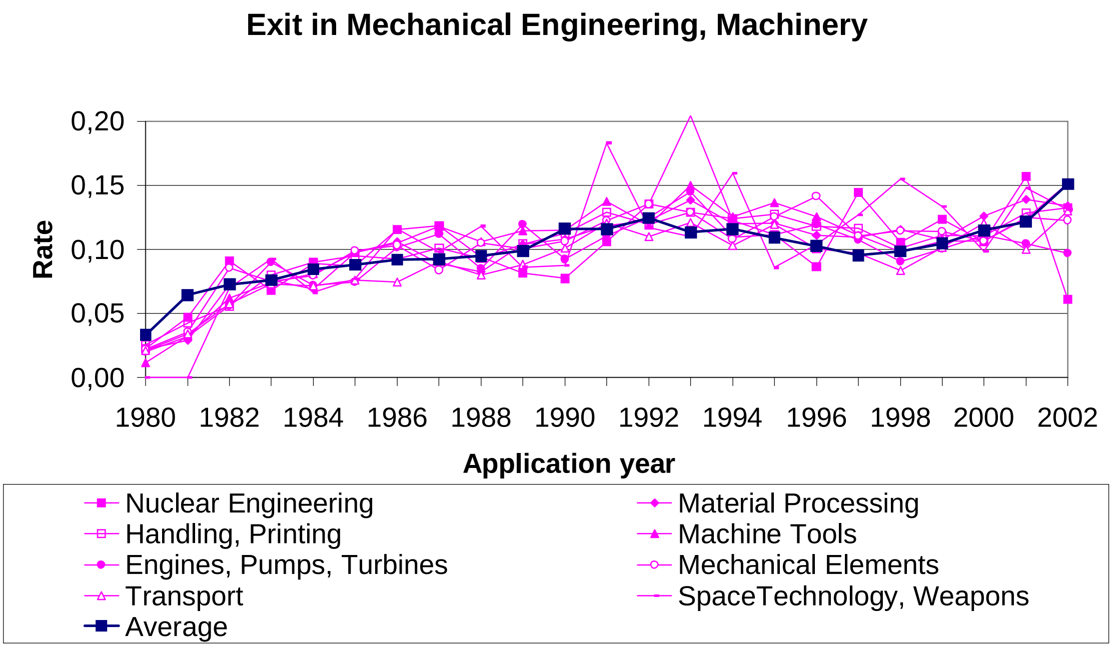


Figure 4.3.1.12



There is no widely accepted definition of entry and exit in the literature. In this section we define an entrant into a technology area in a given year t as a firm that has not applied for a patent in the three years prior to t in that technology area, that is applying for at least one patent in year t and that goes on to apply for at least one further patent in one of the three years after year t. Conversely we define a firm exit as a firm that has applied for at least one patent in the technology area in one of the three years preceding year t, is applying for a patent in year t and then fails to apply for further patents in the three years after year t.

Figures 4.3.5-4.3.12 show that a substantial proportion of patenting firms enters and exit each technology area in a given year. These Figures reveal a general downward trend for entry rates and an upward trend for exit rates over the whole sample period. The average series depicted are weighted averages which reflect the importance of each technology area in the entire sample for each year.

Figures 4.3.5 and 4.3.6 reveal that in Electronics the period in which patenting activity started to explode (1989-1995) is a period in which entry decreases to its lowest level and exits rise to a comparatively high level. A similar pattern is observable for Instruments in Figures 4.3.7 and 4.3.8. This pattern suggests that patent applications in these technology areas were made by fewer firms. At the same time these firms were responsible for a considerable increase in patent applications as documented in Figures 4.2.1 and 4.2.2.

Figures 4.3.9- 4.3.12 show that entry and exit in Chemicals, Pharmaceuticals and Mechanical engineering are less affected by the overall trend towards concentration. In the following section we summarize our findings regarding applications, opposition, concentration, entry and exit in Table 4.3.1.

Summary of findings regarding opposition, concentration, entry and exit for the period before 2000

Table 4.3.1

Technology Area	*Applications*	*Oppositions*	*Concentration*	*Entry*	*Exit*
Telecommunications	+++	--	++	+	-
Audiovisual technology	o	--	+++	o	-
Information technology	++	---	o	++	---
Electrical devices	++	-	o	+	o
Pharmaceuticals, Cosmetics	++	++	-	+	--
Biotechnology	o	+	--	+	--
Agriculture, Food	---	+++	+	o	o
Engines, Pumps and Turbines	+	--	+++	o	o
Transport	++	+++	-	o	o
Medical engineering	++	++	--	+	-
Analysis,Measurement, Control	+++	-	--	+	-

Table 4.3.1 shows no immediately obvious patterns. It is clear that high opposition activity can be the result of high levels of applications as in *Pharmaceuticals, Cosmetics*; *Transport* and *Medical engineering*. This is what we would expect if opposition is used by firms to stop questionable patents and if the increases in patent applications have reduced the quality of the average patent application.

However, opposition activity in all of Electronics does not follow this pattern. Table 4.3.1 shows that this failure of opposition activity can only be part ly explained on the basis of high concentration levels for the top four applicants. Further below (Section 4.5.2) we investigate the determinants of opposition in greater detail. This will provide us with a clearer picture of firms' opposition behaviour.

Finally we note that the level of entry into technology areas that have high concentration levels for the top four firms and that are characterized by high rates of patent applications has risen towards the end of the sample period. This suggests that the patenting explosion is not generally stopping firms from entering new technology areas. Below (Section 4.5.3) we investigate whether entry is due to established firms from other technology areas or to firms that have not patented previously at all.

4.3.2 Quality of patent applications

In section 4.2 we showed that the number of patent applications at the EPO increased substantially after 1992 while the grant rate remained constant or increased slightly. Therefore the number of patents granted by the EPO has i ncreased proportionately to the number of applications. This raises the question how the quality of patent applications has been affected by their increase. Quality of a patent can be measured in several dimensions such as the novelty the non-obviousness or the clarity of the disclosure made by the patent. For further discussion refer to Graham, *et al.* (2003).

The literature on strategic patenting indicates that firms in the United States have been turning more marginal innovations into patents than previously. Their aim in this activity is to increase the size of their patent portfolios. The patents themselves are frequently used as bargaining chips in licensing negotiations between firms over access to patents. Another use for the patent portfolio may be as an insurance against hold -up by rivals seeking to enforce their own patents. This is discussed at length in the literature review in this report (Section 3).

In this section we investigate whether the quality of patents at the EPO decreased in the period in which we observe the patenting explosion. We show that:

- The number of references in EPO and International Search Reports has been very stable.
- The proportion of references indicating that the novelty of patent applications is at least partly questionable is increasing per patent and more importantly per claim.
- The quality of patent applications has fallen particularly in *Semiconductors; Agriculture and Food*; *Pharmaceuticals and Cosmetics*; *Macromolecular Chemistry*, *Polymers; Materials*, *Metallurgy* and *Engines, Pumps and Turbines*.

The strong increase in patent applications and patent grants at the EPO raises the question whether at the same time the quality of patents remained constant or decreased. In this section we use the number of X-References on a granted patent and the number of citations to patents to discuss the quality of patents granted at the EPO over the sample period. In doing this we assume that a lower quality of patent applications will be reflected at least partly in lower quality patents given that the patent grant rate has remained constant.

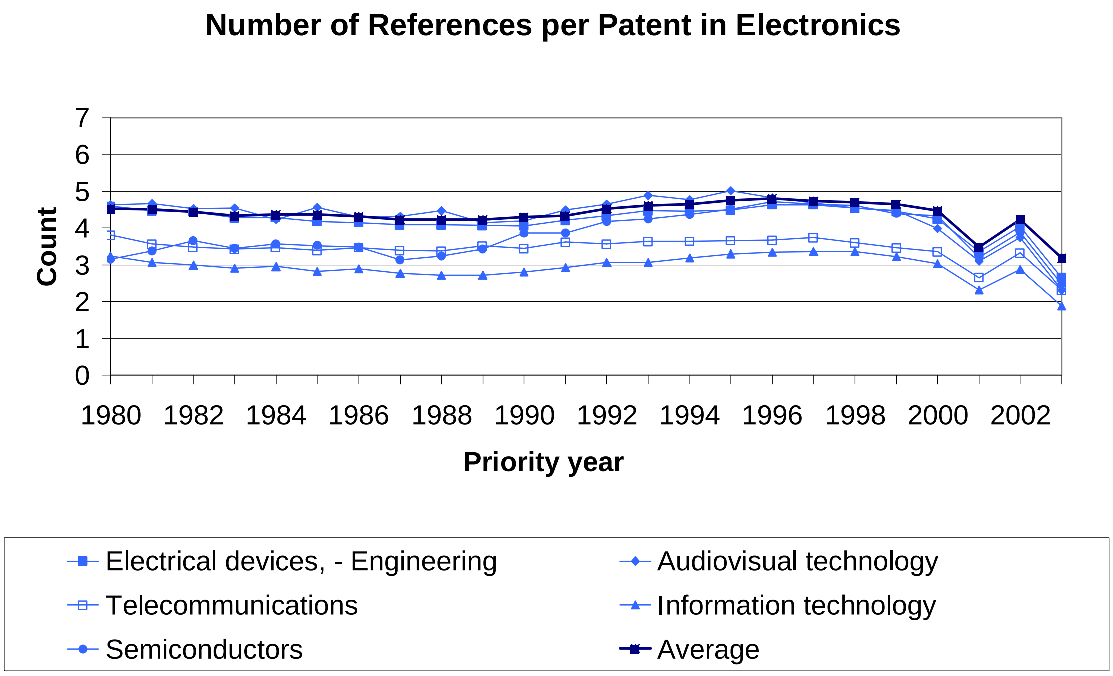
<u>X-References</u>

We begin by studying those references on a patent document that indicate that it may be partly or wholly inadmissible. All references on a European patent application are added to the patent by the examiners at the EPO. The total number of references on a patent document is regulated by the rules for patent examination in force at the EPO. Indeed we find that the number of references is stable at 4.5 references per patent on average over the entire sample period (viz . Figure 4.3.13).[71]

Please note that the stability of the number of references per patent illustrated in Figure 4.3.13 is representative of all technology areas. Therefore, we omit Figures for the remaining main areas from this report.

[71] Figure 4.3.13 displays a dip for the year 2001 that we attribute to errors in the data. The same is true for all Figures relating to X-Type references (4.3.14 - 4.3.17). These errors do not affect our interpretation of the data.

Figure 4.3.2.1



Therefore, the share of references indicating that a patent application is questionable is a useful indicator of patent application quality as it shows that patent examiners are replacing references to prior art with references indicating poor quality.

We find that on average the share of X -References has increased since 1989. At the same time we showed above that the grant rate of patents remains constant while the number of patent applications increases over the same period. The increase in the number of X -References suggests that the grant rate of patents should decrease unless all problems that critical references point to can be resolved. This seems unlikely. As the grant rate does not decline this sugge sts the possibility that on average more questionable patents are being granted by the EPO. Another interpretation of the data suggests that the examiners at the EPO have been able to find more critical references due to improvements in search technology. If the problems giving rise to critical references are removed from these patents, they may be of high quality. Then our data would simply reflect improvements in the quality of search undertaken at the EPO.

Figure 4.3.2.2

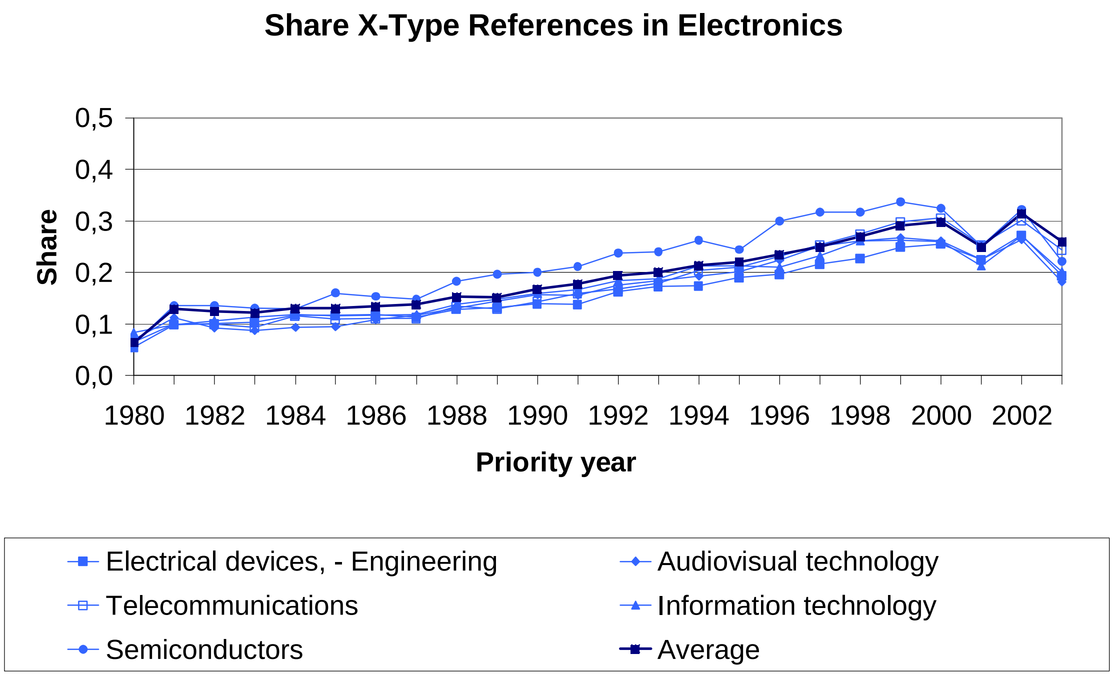


Figure 4.3.2.3

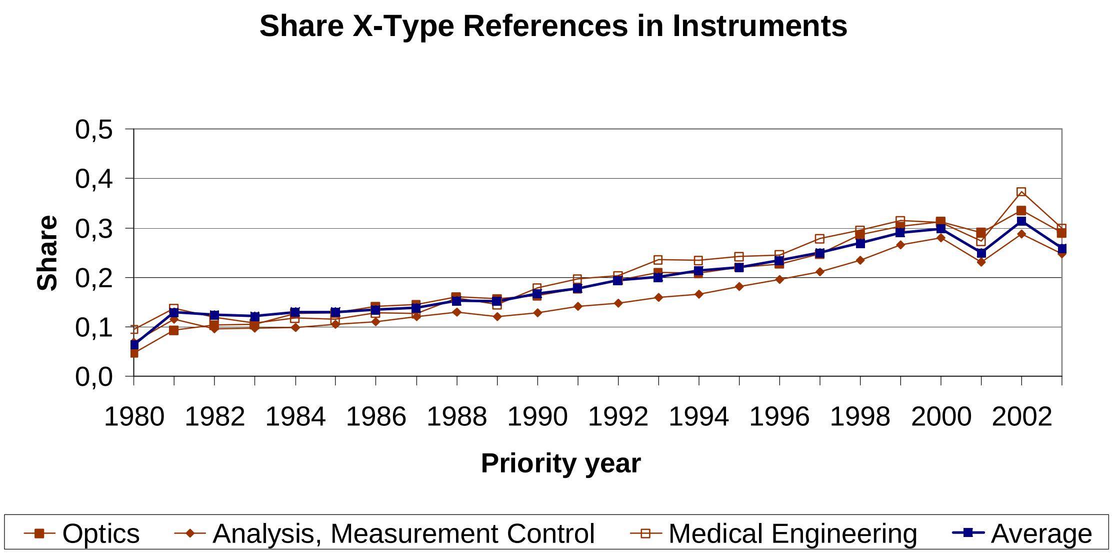


Figure 4.3.2.4

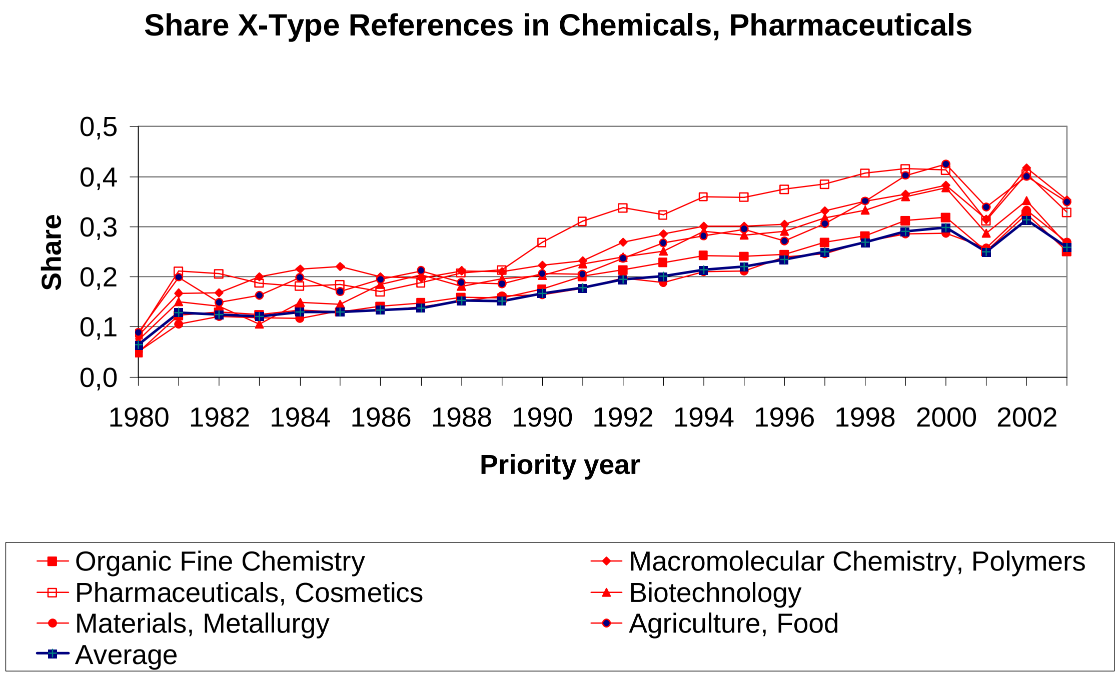
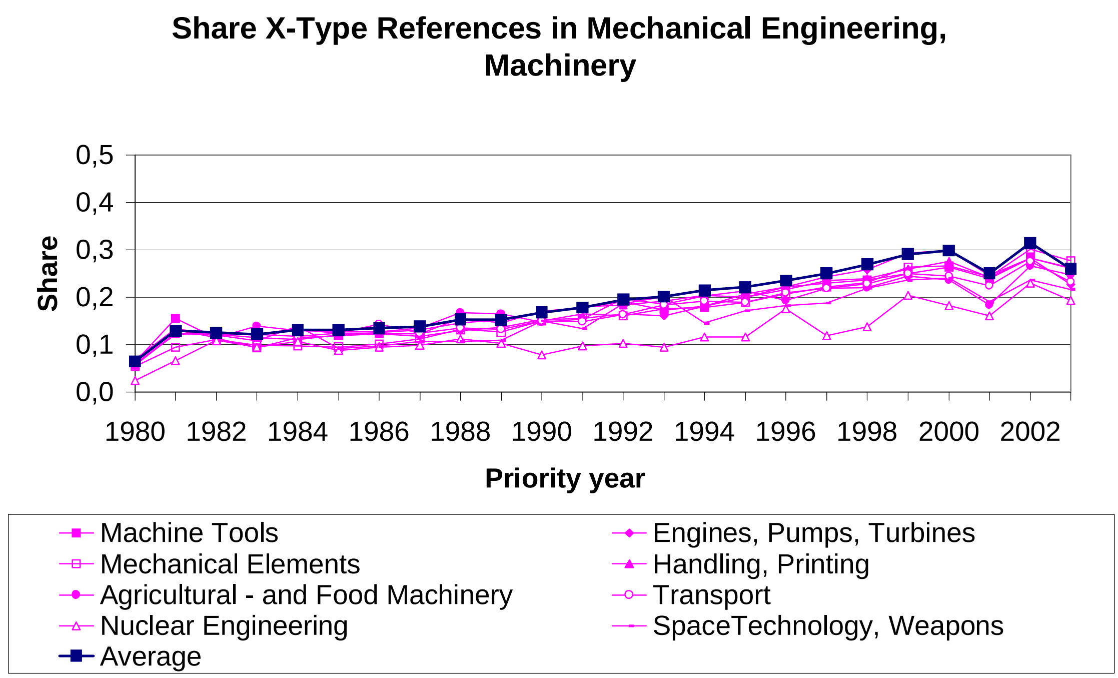


Figure 4.3.2.5



The analysis of opposition at the EPO (Harhoff and Reitzig 2004, and Section 4.5.5.2 below) shows that the probability of success in opposition cases depends on the number of critical references which these patents received in the search report. Thus, granted and opposed patents which are of lower quality also received more critical citations. This indicates that the examination process at the EPO does not remove all problematic claims from a granted patent. [72] Supporting this interpretation Guellec and van Pottelsberghe (2006) indicate that it is likely that the EPO has found it increasingly difficult to uphold the quality of patents granted in face of the growing workload faced by the EPO. Clearly then, our measures are not perfect indicators of patent quality but they provide indications of a trend that should not be ignored.

Figures 4.3.14-4.3.17 illustrate that X-References are particularly high in *Semiconductors*, *Medical engineering* and extremely high in *Pharmaceuticals and Cosmetics* and *Agriculture and Food*. Apart from *Semiconductors*, all of these technology areas are also characterized by high rates of patent opposition. This suggests that the quality of patent applications in all of these technology areas fell dramatically.

However, we also noted above that the number of claims per patent has increased since 1990. Therefore, we now investigate how the number of X-References per claim has developed. If the number of X-References per claim increases, patent applications are becoming more complex and questionable. If the number of X-References per claim remains constant patent applications are just becoming more complex.

[72] It might argued that only opposed patents are affected by problematic quality as indicated in critical references and that opposition cases deal with this problem adequately. This remains an open question however. It has not been investigated whether the quality of granted patents not opposed is unrelated to the quality of the original patent application. This is a question which will be pursued in future research.

Figure 4.3.2.6

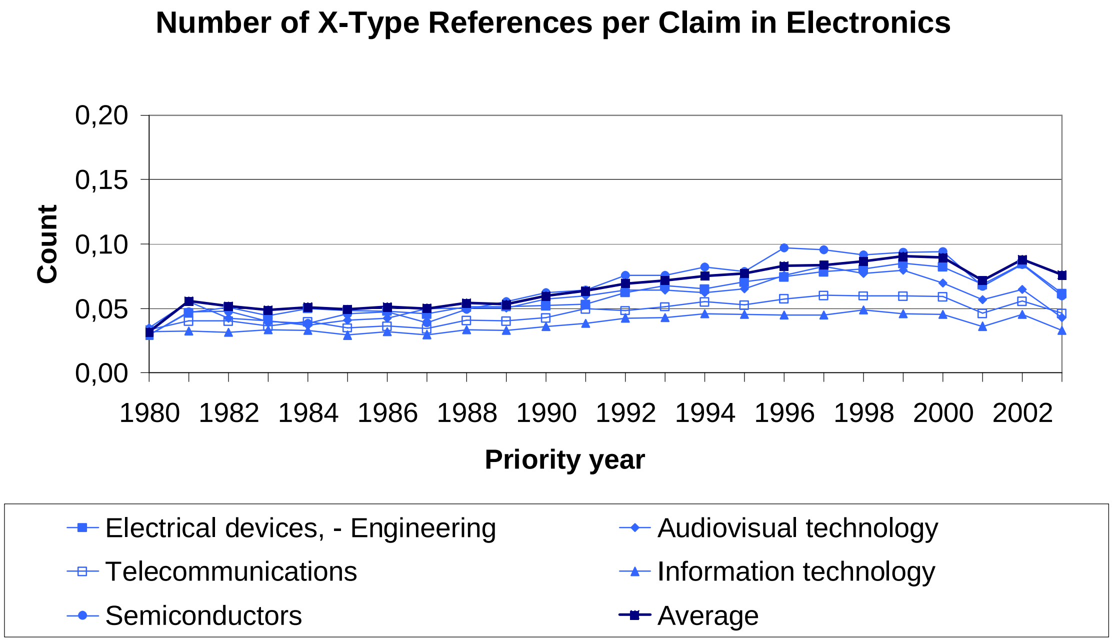


Figure 4.3.2.7

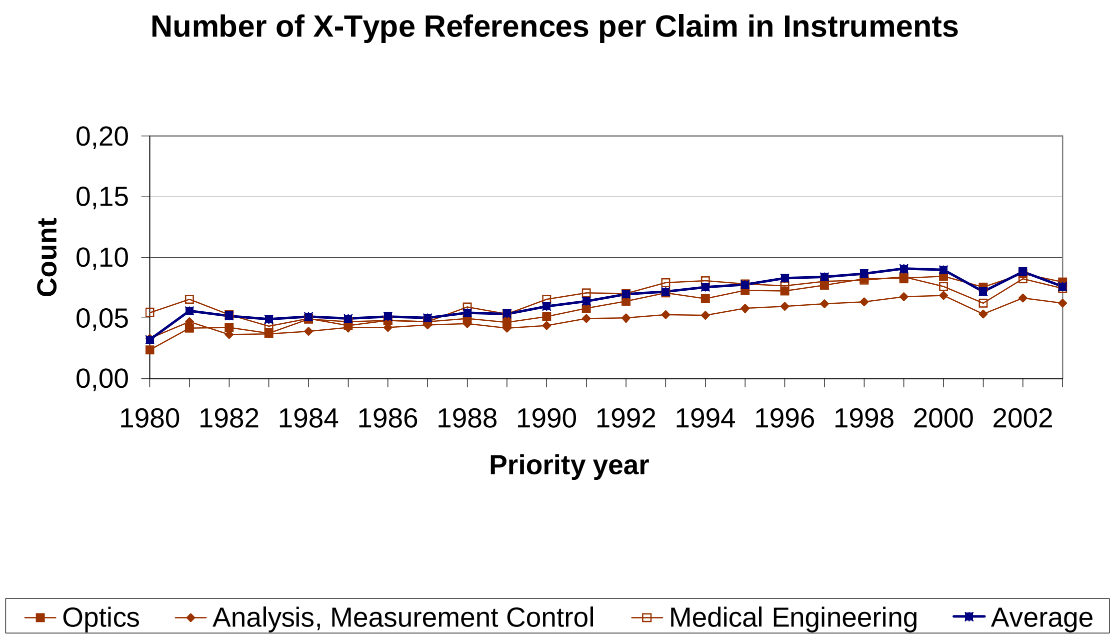


Figure 4.3.2.8

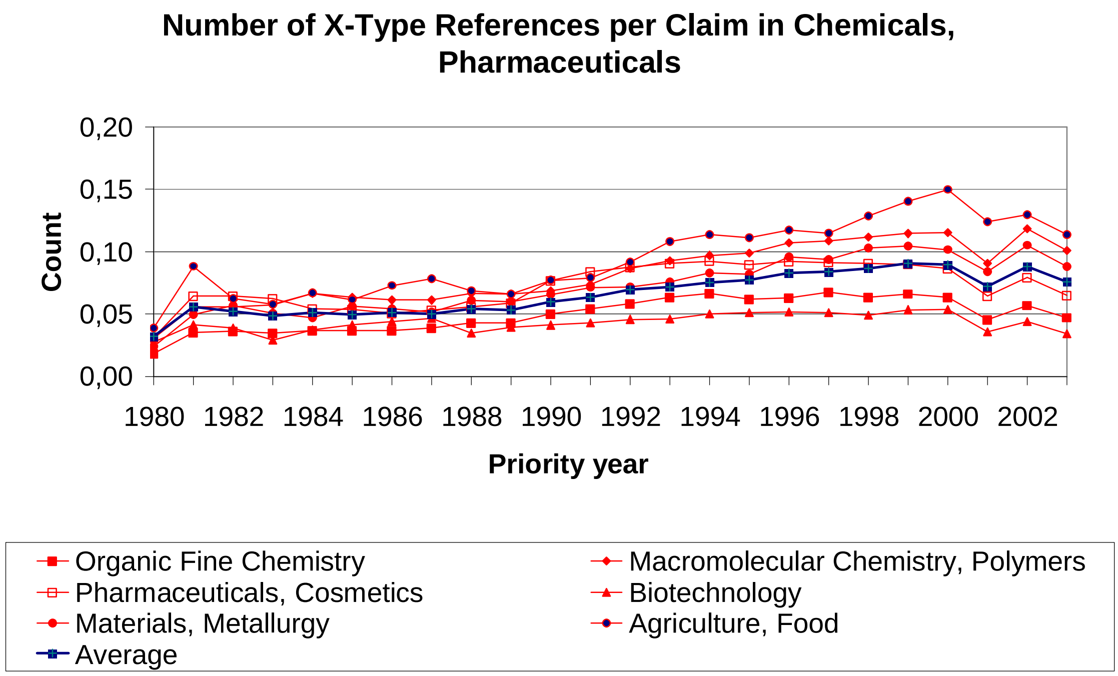
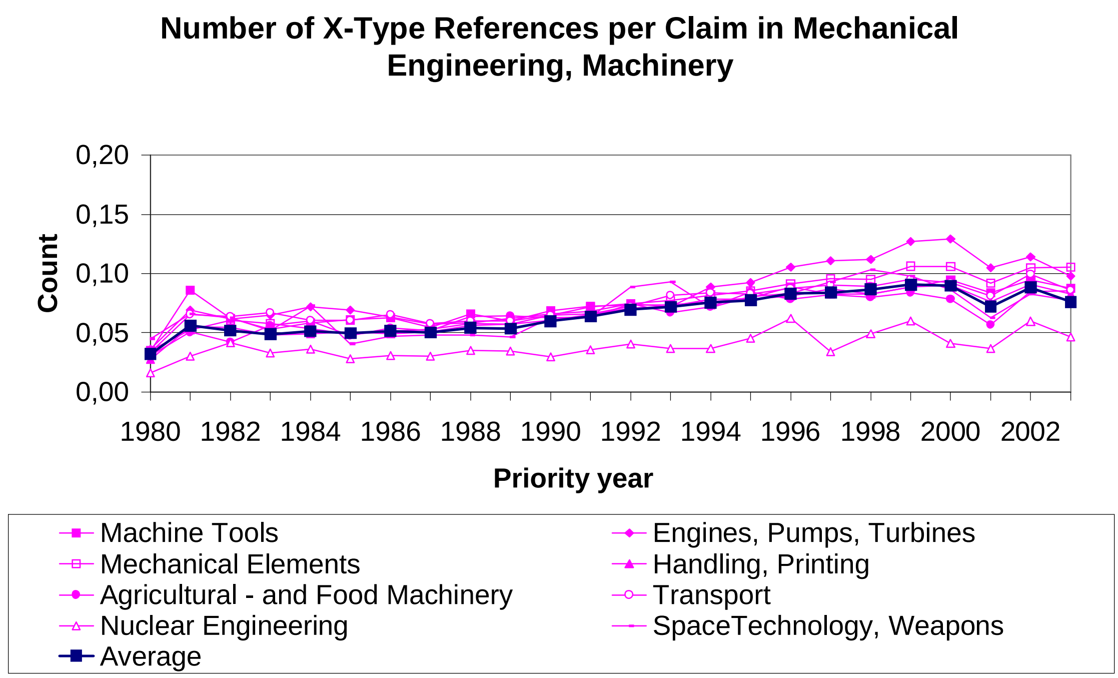


Figure 4.3.2.9



Figures 4.3.18- 4.3.21 show that there are technology areas in which more patents with more claims are being granted and these claims receive more X -References during examination. This is true on average which supports the view that patent quality is declining on average at the EPO. The average increase of X-References per claim is from 0.05 to 0.09; this is a large increase.

The following technology areas are particularly affected by increases in X -References per claim: *Semiconductors; Agriculture and Food*; *Pharmaceuticals and Cosmetics*; *Macromolecular Chemistry*, *Polymers; Materials*, *Metallurgy* and *Engines, Pumps and Turbines*. In these technology areas the quality of patent applications has dropped significantly.

In contrast, there are technology areas in which the number of X -References per claim has remained more or less constant. These are: *Information Technology*; *Biotechnology* and *Nuclear Engineering*. Here patent applications have become more complex but the quality of the claims has remained constant. The remainder of the technology areas show some evidence of declining claim quality.

Patent Citations

The empirical literature on patents shows that the citations a patent receives can be an indicator for the importance of a patent. The evidence also shows that this indicator is noisy, i.e., not very reliable for an individual patent but helpful in characterizing large numbers of patents. We have already shown that the number of new patent applications at the EPO grew strongly between 1990 and the present. Additionally we showed that the number of references per patent was constant over this time. This alone suffices to indicate that the number of references to previous patents should increase over time. These increases should be particularly pronounced in technology areas that are characterizes by larger increases in patent applications. As a result time series of patent citations are not presented here as comparisons between technology areas or within a technology area are unlikely to be very informative.

4.3.3 Complexity of patent applications and strategic behaviour by patent applicants

In this section we focus on indicators that tell us something about the way in which firms apply for patents. These indicators provide direct information about the aggregate results of strategic behaviour by patent applicants. In this section we find that there is strong evidence for strategic behaviour in several technology areas.

Number of claims

Section 4.2.3 provides evidence that the number of claims made on patent applications at the EPO has increased substantially in many technology areas. In part this may be the result of attempts to confuse rivals or to create uncertainty about patent applications for rivals. In order to distinguish this explanation from alternative ones we provide an analysis of the number of patents with a comparatively high number of claims in section 4.5.3 below.

Number of divisional patent applications

In this section we analyze the share of patents which are split off from previous patent applications. Provision for such "divisional" patents is originally made by the EPO to allow for patent applications that contain subject matter which can form the basis of more than one patent. The recent increase in patenting activity seems to be leading to an abuse of this provision. Reasons for this might be that firms are seeking to create uncertainty about the final extent of their patents or that they are seeking to keep open options about exactly what subject matter they will protect. Divisional patents can only be narrower than the original patent application. Nonetheless, the attempt to keep options open together with the long grant lags at the EPO will create uncertainty for rival firms. Knowing what might be patented is not the same as knowing what will be and therefore the use of divisionals may force rival firms to use less efficient technologies because they wish to rule out that they could be affected by a pending patent application.

In this section we demonstrate that:

- Divisional applications are particularly prominent in *Audiovisual Technology*; *Information Technology; Telecommunications*; *Medical Engineering*; *Biotechnology*; *Pharmaceuticals*, *Cosmetics* and to some extent in *Transport*.
- Simultaneously there is a general trend towards increased use of divisional applications across all technology areas.

In the time series we set out in this section there can be quite long lag effects as the EPO allows second generation divisionals. These are divisionals derived from a first generation divisional. This may explain the hump shape of all time series in the figures that follow. If so, then the data show clearly that divisional patent applications are generally on the rise. This is the clearest evidence at the macro level that we have of strategic patenting behaviour, because divisional patent applications constitute the attempt to create uncertainty about the extent of a patent.

As Figure 4.3.22 shows divisional patent applications are very prominent in Electronics, a technology area that is often categorized as containing complex technologies. This is also true of *Biotechnology* which is the technology area in which divisionals have the longes t tradition at the EPO as Figure 4.3.24 below demonstrates.

Figures 4.3.24 and 4.3.25 show that divisional patent applications are less important in technology areas which are not likely to harbour complex technologies, such as *Macromolecular Chemistry* or *Engines, Pumps and Turbines*. Even here there is evidence of increases in the number of divisional patent applications. However this may be the natural consequence of the increased size of the patent stock which is the source of divisional applications.

Figure 4.3.3.1

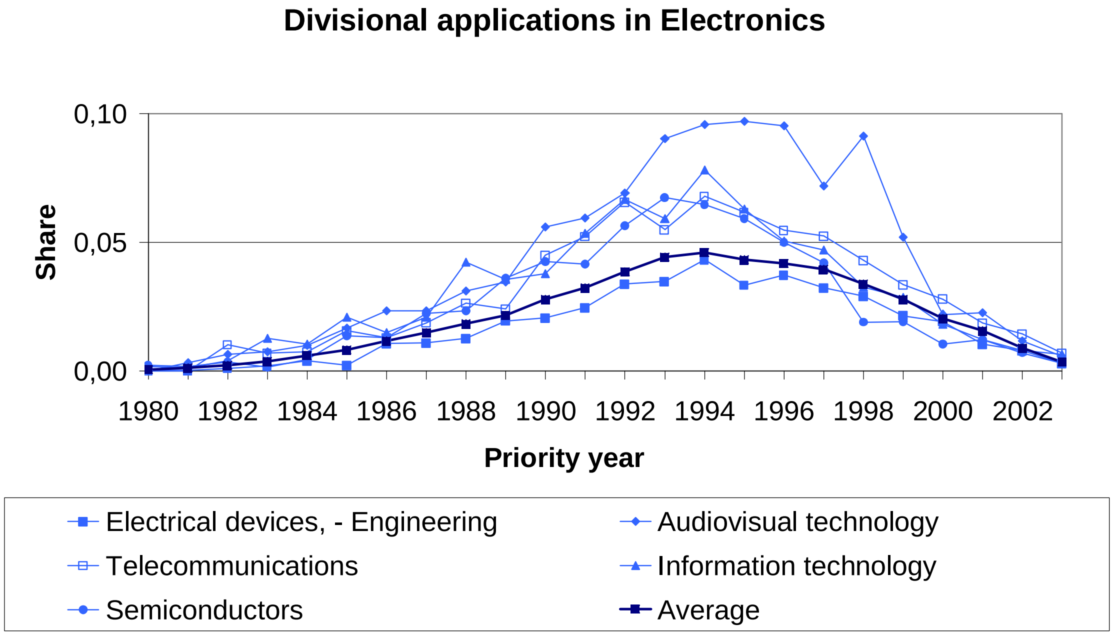


Figure 4.3.3.2

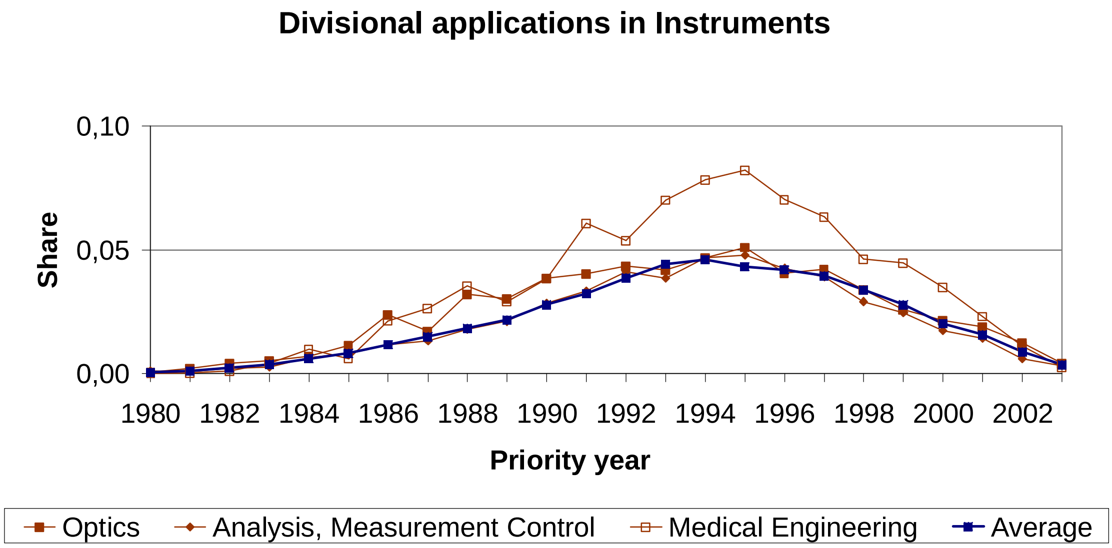


Figure 4.3.3.3

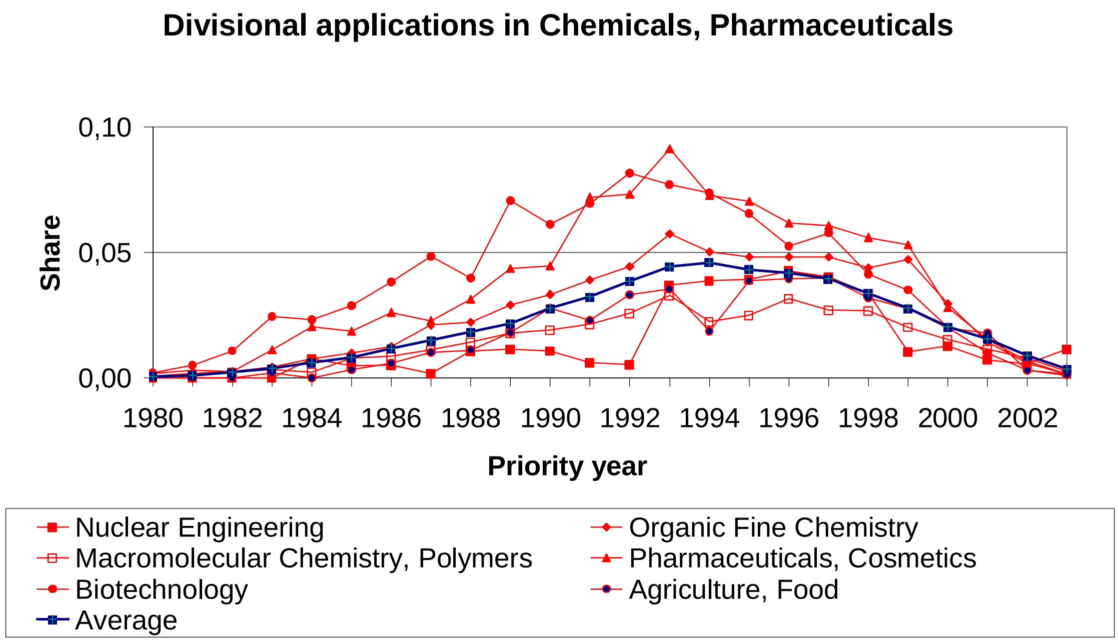
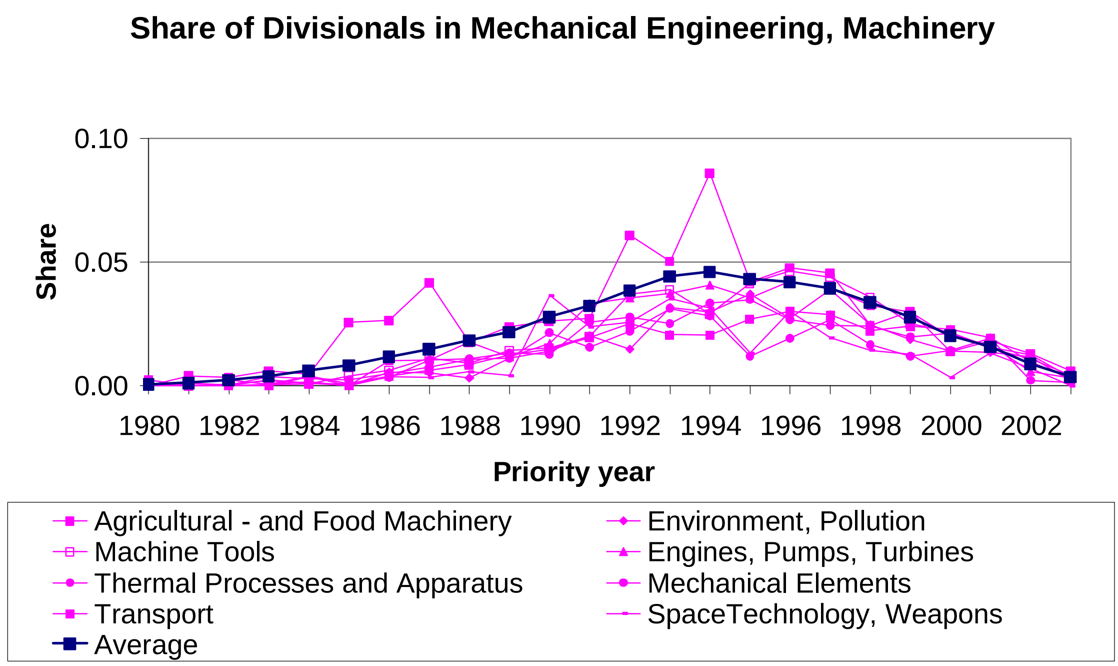


Figure 4.3.3.4



Finally it should be noted that the technology area *Transport* deserves special attention since the propensity to make particular use of divisional applications seems to come and go in this technology area. We will investigate this more closely at the firm level in order to determine whether this is due to specific firms' actions.

Number of shared priorities

In this section we analyze how many patents in a given technology area share priorities with at least one other patent. This means that two or more patents applications at the EPO are derived from one and the same original patent application at another patent office (the priority patent application). Increased occurrence of such shared priorities may be due to greater uncertainty about technologies or to differences in the way different patent offices examine patents. It may also indicate that firms are seeking to confuse their rivals about the exact extent of the patent protection they are seeking at the EPO.

The following Figures indicate that:

- Shared priorities increasingly arise across all technology areas.
- Shared priorities are particularly frequent in most of the technology areas that also exhibit increased use of divisional patent applications. These are: *Telecommunication*; *Information Technology*; *Biotechnology*; *Pharmaceuticals*, *Cosmetics* and to some extent in *Medical Engineering*.
- Shared priorities also arise in *Agriculture, Food*.

The most interesting result of the analysis here is the almost complete similarity of the analysis of divisional patent applications and of the incidence of shared priorities. [73] Both of these indicators which are most likely to indicate in which technology areas we might observe strategic behaviour in patent applications point to the same technology areas. An other interesting observation is the fact that shared priorities became more important at the same time as firms started to increase the number of patent applications filed. The figures in this section demonstrate that at the same time the share of applications which derive from a common root has increased.

[73] In order to avoid double counting the following Figures represent the share of applications with shared priorities that are not also divisional patent applications. Therefore this indicator is truly independent of the preceding indicator presented in section 4.3.3.2 .

Figure 4.3.3.5

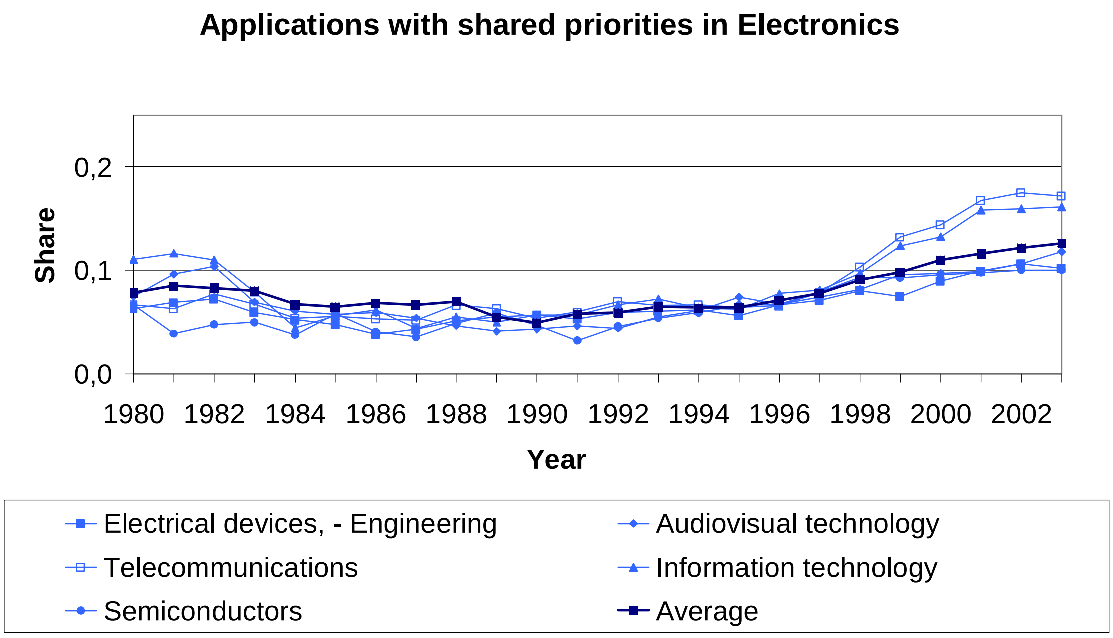


Figure 4.3.3.6

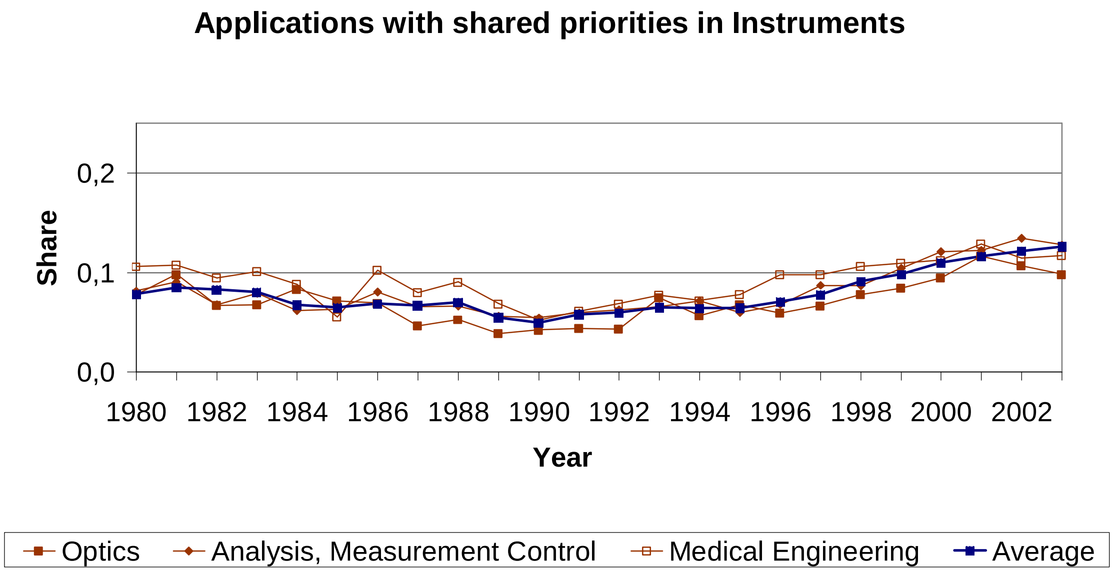


Figure 4.3.3.7

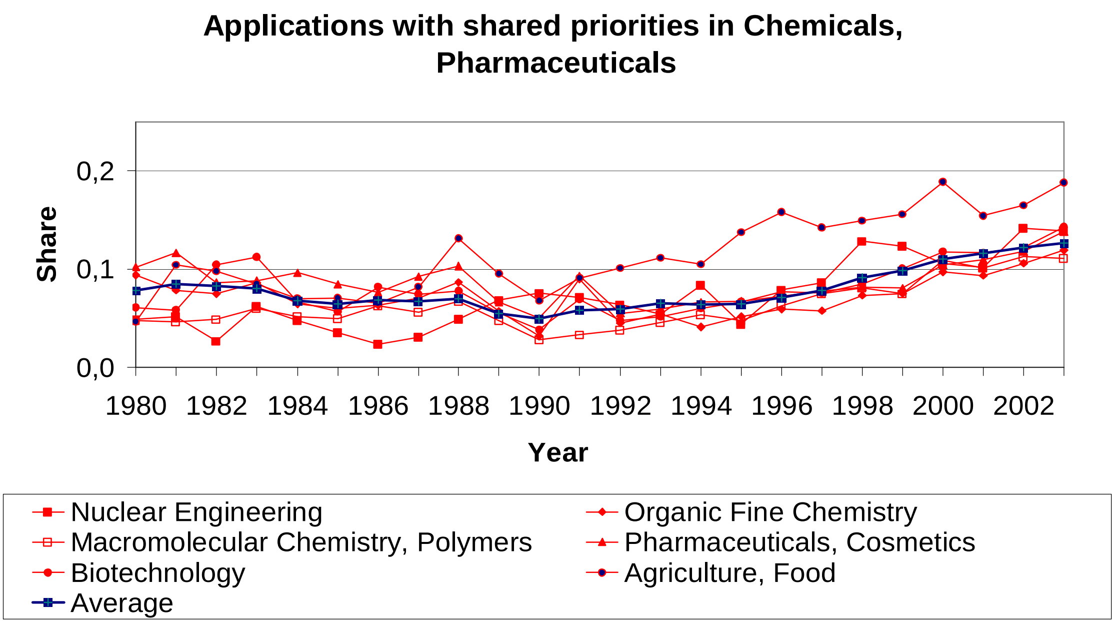
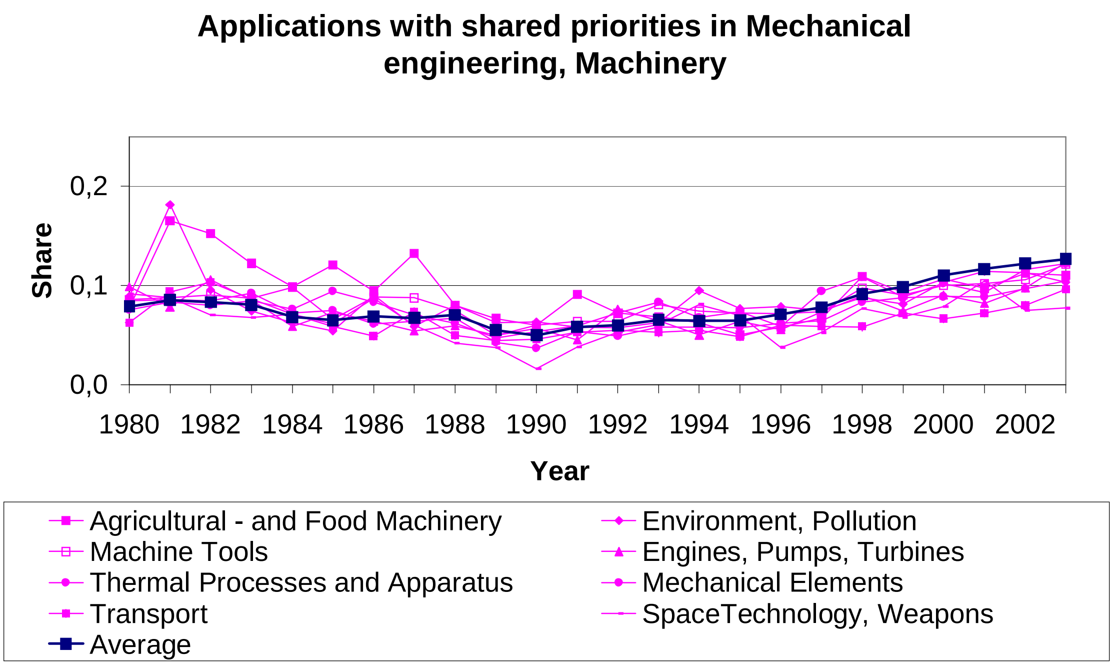


Figure 4.3.3.8



4.4 *Summary: technology areas in which there is evidence of strategic use of the patent system*

In sections 4.2 and 4.3 a variety of different indicators related to patenting behavior of firms are discussed for 30 different technology areas over the period from 1980 to 2003. The results of this exercise reveal important trends characterizing the European patent system in general:

- strong growth in application figures over time;
- increased complexity at the level of individual patents;
- a slightly decreasing opposition activity relative to the number of issued patents;
- indications of deteriorating patent quality;
- signs of increased strategic patenting behavior.

In addition to the identification of these general trends, our analysis also revealed large differences in the development of the indicators across different technological areas. In particular, areas belonging to Electronics; Instruments; Chemicals, Pharmaceuticals and to some extent Mechanical Engineering proved to be major driving forces behind these developments. Table 4.4.1 provides a concise summary of the development of our indicators in the technological areas belonging to the broader main areas.

By and large, all of these main areas are characterized by a strong increase in patent applications and an increase in the complexity of patent applications which seems to be most pronounced in Chemicals, Pharmaceuticals. Moreover, three main areas exhibit clear signs of increasingly strategic patenting behavior of applicants which again is most pronounced within Chemicals, Pharmaceuticals but also visible in Electronics and in Instruments. With regard to opposition activity we observe clear differences across the main areas. While opposition rates are strongly decreasing in Electronics, the converse is true for most areas within Chemicals/Pharmaceuticals. We interpret this finding as an indication of different patenting strategies within complex industries dominating Electronics compared to more discrete technologies related to Chemicals/ Pharmaceuticals. The finding of different developments of the rate of opposed patents is especially interesting when compared to the concentration of patent holdings in the according areas. In Electronics, decreasing opposition rates go along with strongly increasing concentrations of patent holdings. The inverse is true in areas belonging to Chemicals, Pharmaceuticals, where increasing rates of oppositions are accompanied by decreasing concentration rates. One notable exception is the area of Agriculture, Food where we observe a strong increase in opposition rates and also in the concentration of patent holdings among applicants.

In the following, we comment on the development of the different technology a reas within the four selected main areas in more detailed below and select individual technology areas for further investigation at the firm level based on the different patterns of patenting behavior in these areas.

Table 4.4.1: Summary of important patent indicators. +++, ++, + denote developments of indicators above the average of all 30 areas, while ---,--,- denote developments of indicators below the sample average.

Main Area	Area	Applications filed	Claims per Patent	Opposition Rate	Concentration Ratios	Share of X-References per Patent	Share of Divisional Applications	Share of Patents with shared Priorities
Electronics	***Telecommunications***	**+++**	**+**	**--**	**++**	***o***	**++**	***o***
	Electrical Devices	++	-	-	o	o	o	o
	Information Technology	**++**	**++**	**---**	**+**	***o***	**++**	***o***
	Semiconductors	-	o	--	+	+	+	o
	Audiovisual Technology	***o***	***o***	**--**	**+++**	***o***	**+++**	***o***
Instruments	Analysis, Measurement Control	+++	o	o	-	-	o	o
	Medical Engineering	**++**	**+**	**+**	**-**	**+**	**+++**	***o***
	Optics	o	o	---	++	o	o	-
Chemicals, Pharmaceuticals	***Pharmaceuticals, Cosmetics***	**++**	**++**	**++**	**-**	**++**	**+++**	**++**
	Organic Fine Chemistry	++	++	--	o	o	o	+++
	Agriculture, Food	**--**	**-**	**+++**	**++**	**++**	**--**	**+**
	Biotechnology	**++**	**+++**	**+**	**--**	**+**	**+++**	**+**
	Materials, Metallurgy	---	o	++	--	o	-	-
	Macromolecular Chemistry, Polymers	o	o	+	o	+	o	o
Process Engineering	Chemical, Petrol- and Basic Materials	--	o	++	++	o	-	+
	Material Processing	o	o	++	-	o	--	-
	Surfaces, Coating	-	o	o	o	-	-	o
	General technological Engineering	-	o	o	--	o	o	o
	Handling Printing	+	-	-	o	o	++	o
	Environment, Pollution	--	o	-	o	o	o	-

Table 4.4.1 continued: **Summary of important patent indicators. +++, ++, + denote developments of indicators above the average of all 30 areas, while ---,--,- denote developments of indicators below the sample average.**

Main Area	Area	Applications filed	Claims per Patent	Opposition Rate	Concentration Ratios	Share of X-References per Patent	Share of Divisional Applications	Share of Patents with shared Priorities
Mechanical Engineering, Machinery	***Agricultural- and Food Machinery***	**++**	**-**	**+++**	***o***	***o***	**++**	**+**
	Machine Tools	-	o	o	-	--	o	o
	Thermal Processes	--	-	-	-	--	--	-
	Transport	**++**	**-**	***o***	**+++**	**-**	**--**	**-**
	Engines, Pumps, Turbines	o	--	-	++	o	-	o
	Mechanical Elements	--	-	o	-	o	--	-
	Space Technology, Weapons	--	-	--		-	-	--
	Nuclear Engineering		-			--	-	o
Consumer Goods, Civil Engineering	Consumer Goods and Equipment	o	o	o	--	o	-	o
	Civil Engineering, Building, Mining	o	o	o	--	o	-	o

(i) Electronics

We observe a **strong increase in the number of patent applications** filed in Electronics which is largely driven by the technology areas *Telecommunications*, *Electrical Devices* and *Information Technology*. Interestingly, this increase in the number of applications in Electronics is going along with an **increase in the concentration** of patent holdings across patentees – the increase in concentration is most pronounced in Audiovisual Technology. This increase in application figures is accompanied by a **moderate increase in the complexity** of the corresponding applications in *Telecommunications* and *Information Technology*. In contrast, the complexity of applications in the remaining areas evolves within the overall average across all 30 areas. Applying the share of X-References contained in a patent, we find **little evidence of deteriorating patent quality** in Electronics.

It is a striking feature that the **opposition rate (relative to granted patents) decreased over time** in Electronics – the decrease is most pronounced for Telecommunications and Information Technologies – and has reached levels well below the overall average of all European patents. In addition, we find **indications for more refined application strategies** applied by the applicants in almost all areas of Electronics. Again, *Telecommunications* and *Information Technology* clearly exhibit an above average development in the indicator of strategic patenting behavior, the share of divisional applications. In addition, applicants in *Audiovisual Technology* make use of divisional applications most frequently.

Based on these findings, we select the technology areas of (1) Telecommunications, (2) Information Technology and (3) Audiovisual Technology for further investigations at the firm level in the following part of the study.

(ii) Instruments

The **increase in application figures** within the main area Instruments is well above the overall average and is similar to the development in Electronics. This increase is largely driven by strong application activities in the areas *Analysis, Measurement, Control* and *Medical Engineering*. However, with regard to the opposition rates in *Instruments*, we observe a strong decrease in *Optics*, while opposition rates in *Analysis, Measurement, Control* and *Medical Engineering* remain within average levels. Similar to Electronics (but to a lesser extent) this increase in opposition rates is accompanied by a decrease in the concentration of patent holdings.

The development of the **complexity of patent applications in Instruments is comparable to the overall average, again with the exception of Medical Engineering** . Medical Engineering is also the only area within Instruments where we observe a strong increase in the reliance on divisional patent applications which points to systematic differences in the patentin g activity in this area.

Based on these findings, we select the area of (4) Medical Engineering for further investigations on the firm level in the following part of the study .

(iii) Chemicals/ Pharmaceuticals

Within Chemicals/ Pharmaceuticals applications figures rose strongly within the areas *Pharmaceuticals*, *Cosmetics*; *Organic Fine Chemistry* and *Biotechnology* but were stable in the technology area *Macromolecular Chemistry, Polymers*. Contrarily, we observe a below average growth of applications in *Agriculture, Food* and *Materials, Metallurgy*. It is striking that the development of application rates is intensified by an increase in the complexity of the individual applications: We observe **strong increases in the number of claims per patent** within *Pharmaceuticals, Cosmetics*; *Organic Fine Chemistry* and *Biotechnology*, which are not present in the remaining areas within *Chemicals, Pharmaceuticals*.

Moreover, **opposition activity has been above average** in almost all areas within *Chemicals, Pharmaceuticals* with the exception of *Organic Fine Chemistry* where we observe a decrease in opposition rates over time. Compared to Electronics, increasing opposition rates are associated with decreasing concentration of patent holdings in the different areas with one exception : In *Agriculture, Food* opposition and the concentration of patenting activities both increased.

In general, the use of more refined application strategies increased across all areas of *Chemicals, Pharmaceuticals* with most pronounced peaks in *Pharmaceuticals, Cosmetics* and *Biotechnology*.

Based on these findings, we select the areas of (5) Pharmaceuticals, Cosmetics, (6) Agriculture, Food and (7) Biotechnology for further investigation at the firm level in the following part of the study .

(iv) Process Engineering

Compared to the other main areas application figures in most fields associated with process engineering rose below the overall average and the complexity of the individual application evolved according to the average. Moreover, we do not see intere sting patterns of opposition activity or concentration of patent applications. Since the measures of strategic patenting behavior also are in line with the overall trend, we think that **no area within Process Engineering warrants further research** .

(v) Mechanical Engineering

While application figures within Mechanical Engineering developed below the overall average, we observe a **strong increase in patent applicat ions** in the areas *Agricultural-, Food Machinery* and *Transport*. These two areas are distinct from the other fields in Mechanical Engineering with respect to the different indicators presented. In particular, *Agricultural-, Food Machinery* is characterized by above-average opposition activity and an increased use of divisional applications filings. While being not of particular interest with regard to these indicators, *Transport* is characterized by a sharp increase in the concentration of patenting activities across firms.

Based on these findings, we select the areas of (8) Agricultural-, Food Machinery and (9) Transport for further investigations at the firm level in the following part of the study .

(vi) Consumer Goods/ Civil Engineering

The development of the computed indicators within the areas of Consumer Goods, Civil Engineering is by and large with in the overall average across all 30 areas. Moreover, concentration rates are going down and there are no indications of strategic patenting behavior within this are. Therefore, we select no area from Consumer Goods, Civil Engineering for further analysis.

4.5 Analysis of firms' patenting behaviour in relevant technical fields

The analysis in the previous sections has revealed that there are nine technology areas in which patenting trends suggest that strategic behaviour by patent applicants may exist. The pu rpose of this section is to analyze these technology areas in greater detail. In particular we will now begin to analyze patenting behaviour at the firm level.

This section contains three parts:

- In the first we look for signs of patent thickets in the t echnology areas we have selected above.
- In the second we analyze individual firms' opposition activity in the selected technology areas
- In the third we analyze a broad range of patent based indicators for individual firms in the selected technology areas.

These sections will progressively take us towards the goal of identifying indicators for strategic use of patents by individual firms.

4.5.1 The relatedness of firms' patents by technology area

The purpose of this section is to provide information about the li kelihood that a technology area harbours one or more patent thickets. In the literature a patent thicket is defined as a field of technology in which many patents are connected to individual products, e.g. a mobile phone which embodies 3G technology.[74] Direct measures of patent thickets would require information about the link between patents and products. This information is not available in patent data.

In order to learn something about the likelihood that patent thickets exist we have investigated how concentrated the references of a given cohort of patents are in a given technology area. To do this we have identified which patents are cited in a given technology area by a given patent. We also know what type of citation is made, i.e. whether the referenc e is critical of the citing patent indicating that it is not very original. Using this information we calculate two indices: i) the Herfindahl index over the set of cited patents and ii) the Herfindahl index over the set of critical citations to patents. Here we use both X- and Y-References. These indicators are higher and indicate higher concentration, if the same set of patents is frequently cited by all the patents of a cohort.

[74] Bekkers and West (2006) identify 23 patenting entities and 140 essential patents for 3G technology between 1988 and 1991. For the subsequent UMTS standard they identify 73 patentors and 1227 patents.

Using these indicators we find that:

- The concentration of references decreases over time in almost all technology areas, which reflects the increasing pool of patents that may be cited.
- There is much variability in the concentration of references across technology areas, which reflects technology specific differences.
- Several technology areas are characterized by constant or slightly increasing concentration of references. These areas are most likely to harbour patent thickets. They are: *Telecommunications*; *Electrical Devices*; *Analysis, Measurement and Control*; *Medical Engineering*; *Pharmaceuticals and Cosmetics*.

In using these measures we assume that patents which are used as complements within the same products will also reference the same prior art more often than patents which are independent. The measures are informative if complementary patents within a patent thicket are used jointly in the product market and derive from similar prior technology. Our measure is not informative if complementary technologies entering a set of products such as a telephone are also based on independent inventions. The measure is also misleading if different patents are related in a technological sense but used independently in the product market. Any other measure derived from patent data will have the same weaknesses.

The two measures we use provide different information. The first measure uses all references on the patent documents. It captures the similarity of technologies best because it is based on all patent references contained in the patent documents, a very comprehensive set of data. The second measure focuses on patents that are cited as X-References. X-References indicate that a new patent or claims on a patent do not represent an inventive step in light of the cited document. As such the cited patent may block the new patent. Thus the measure based on the concentration of X-References is an indicator of the extent that a subset of patents blocked later patents. The results of the two measures are broadly similar. Nonetheless, the second measure is sometimes useful in sharpening the picture. For instance it shows more clearly that references to blocking patents in *Pharmaceuticals and Cosmetics* behave quite differently from the overall trend.

Please note that Figures 4.5.1 – 4.5.8 all display an increase in 2001 which we attribute to an error in the underlying dataset. This is the same problem which is also manifested in the time series on references per patent (Compare pages 39 and 40).

Figures 4.5.1- 4.5.4 show that references are more concentrated in Electronics and Instruments than in the other main areas. *Telecommunications* is clearly the technology area with the highest concentration of patent references as well as with the largest increase in patent applications.

Electronics

Figure 4.5.1.1

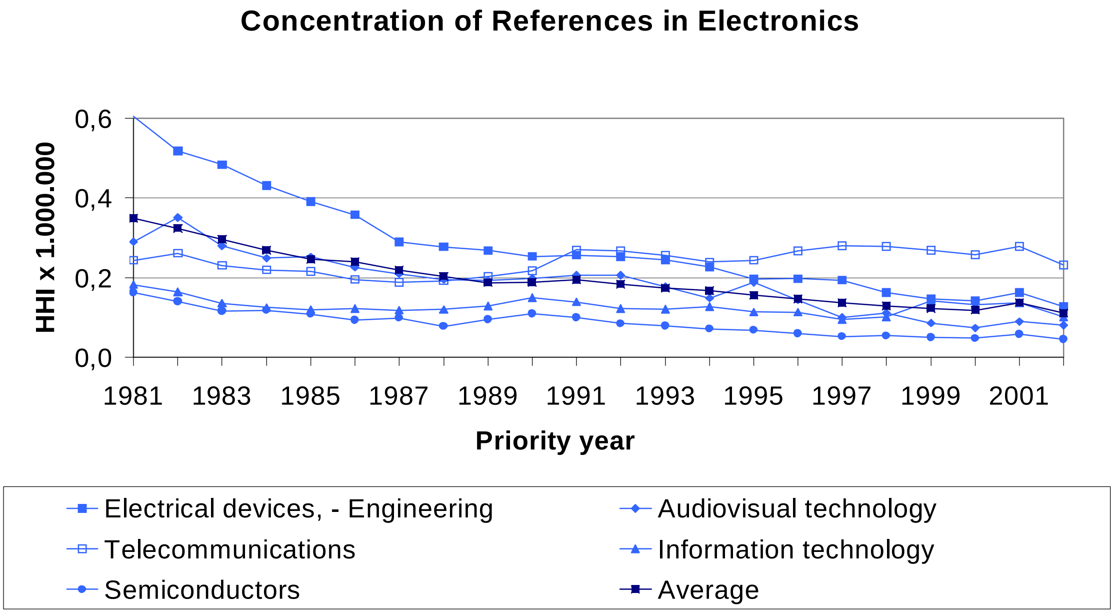
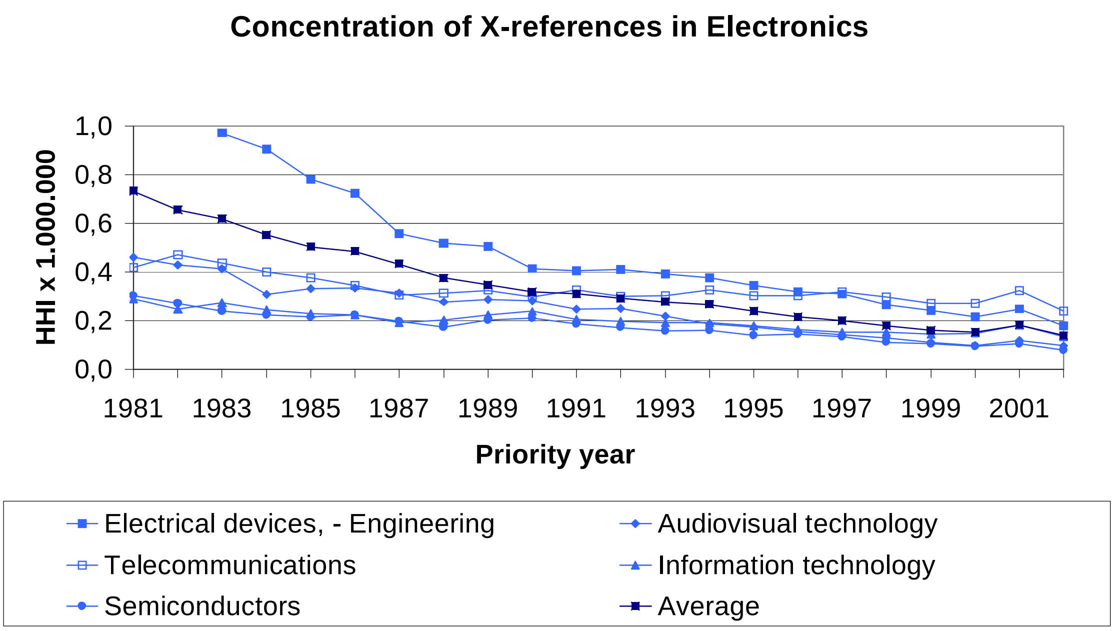


Figure 4.5.1.2



<u>Instruments</u>

Figure 4.5.1.3

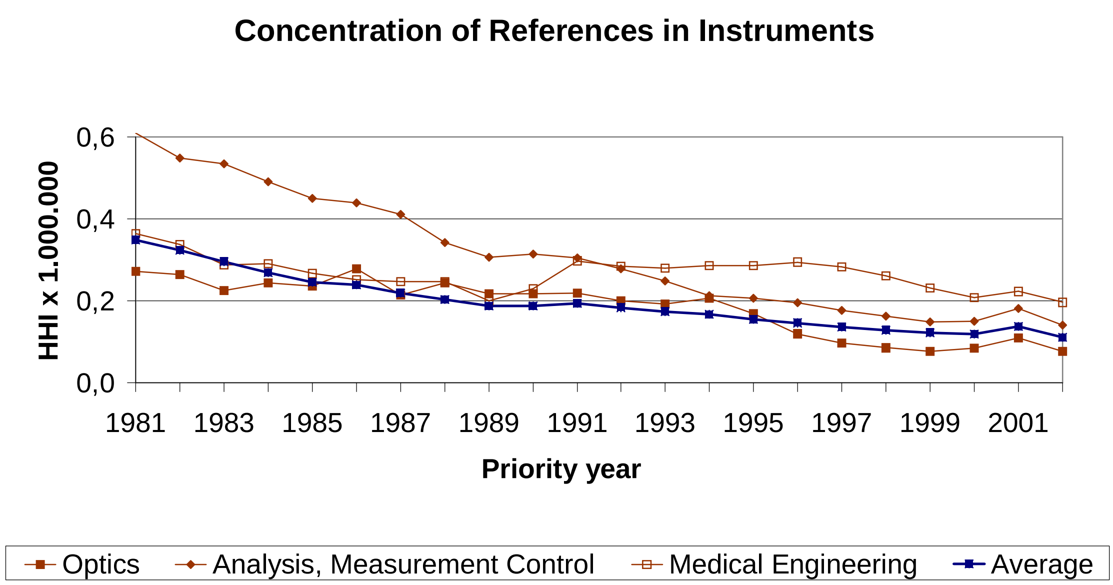
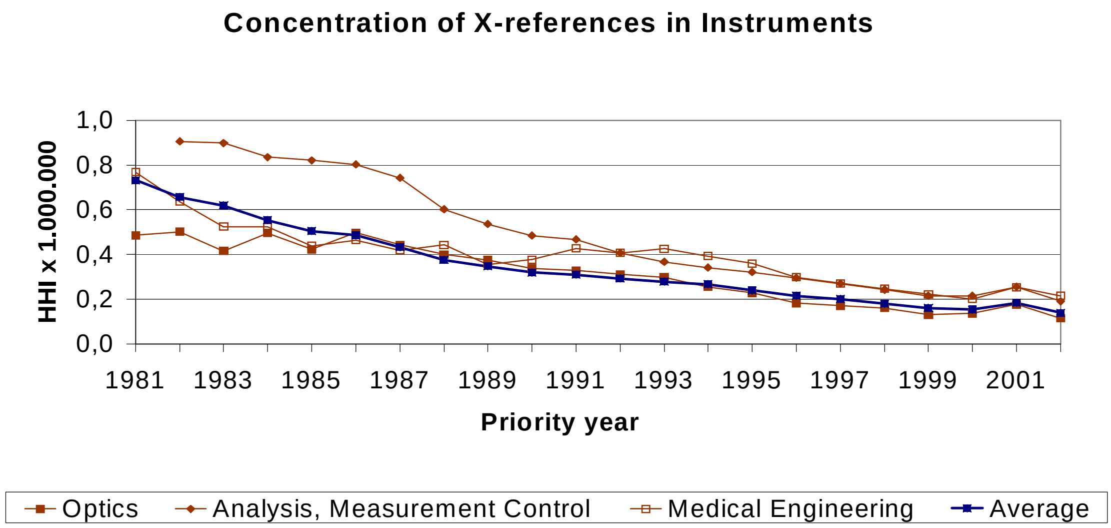


Figure 4.5.1.4



In *Medical engineering* the level of X-References was particularly high during the 1990's. The subsequent decline suggests firms a reduced dependency on similar technologies to some extent.

<u>Chemicals, Pharmaceuticals</u>

Figure 4.5.1.5

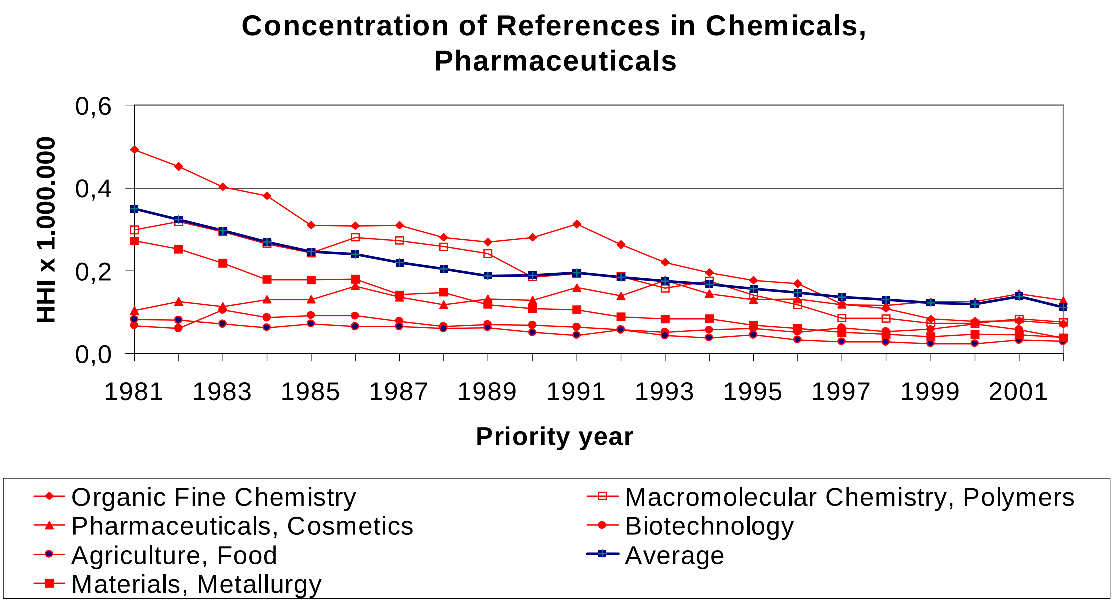
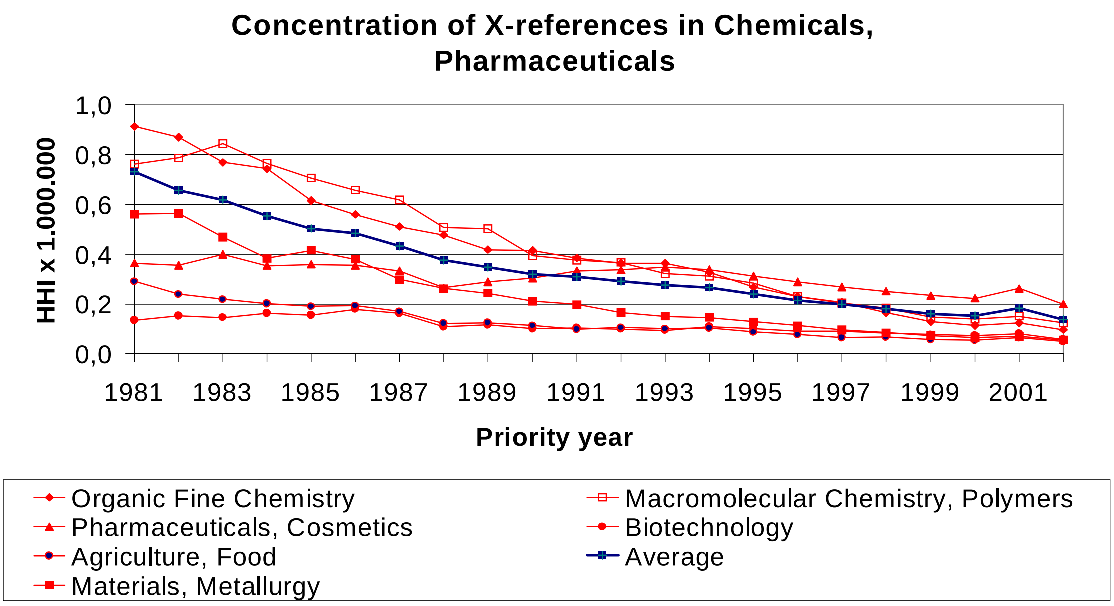


Figure 4.5.1.6



These Figures show that references in Pharmaceuticals and Cosmetics remained level while all other technology areas become less concentrated over time in line with the overall average.

Mechanical Engineering, Machinery

Figure 4.5.1.7

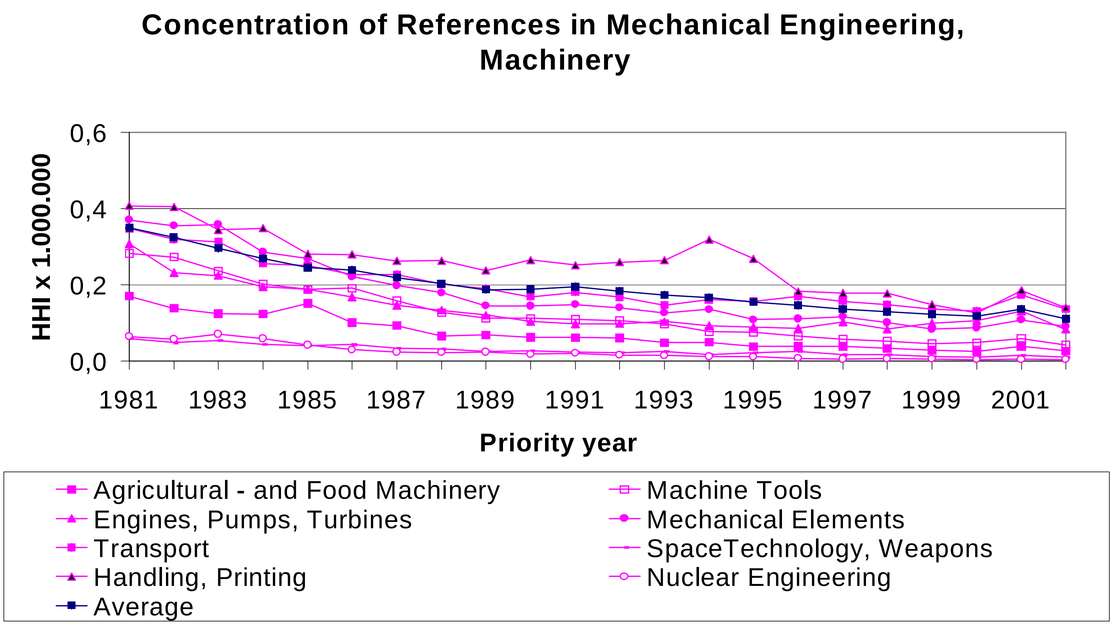
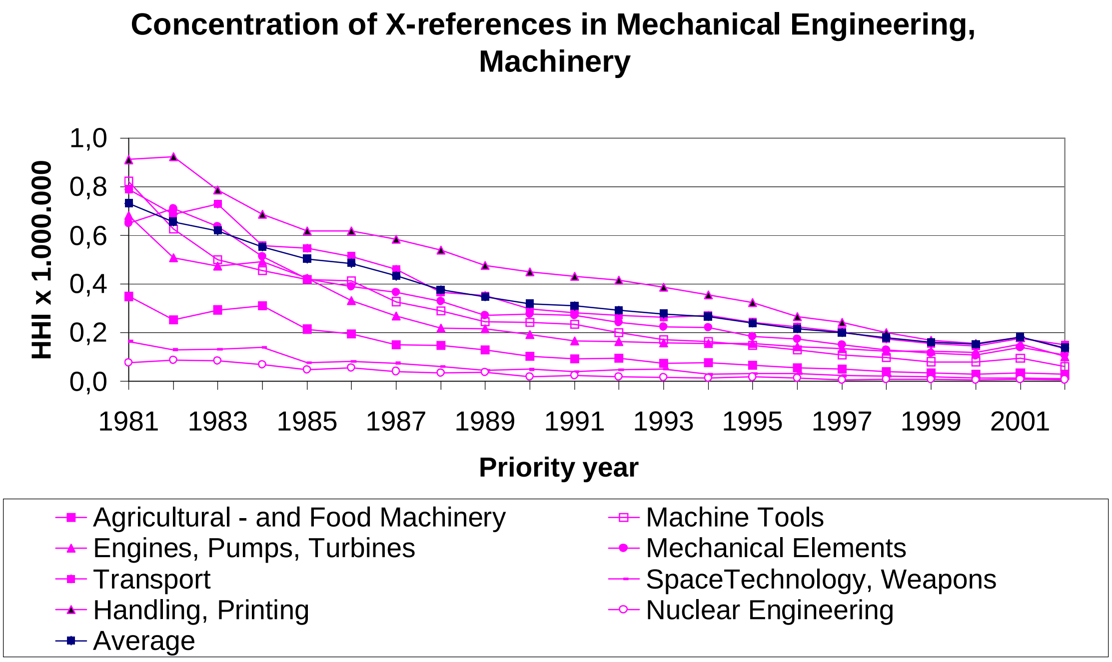


Figure 4.5.1.8



Finally Figures 4.5.7 and 4.5.8 reveal that references in all of Me chanical engineering declined in line with the trend. Only the concentration of references in *Handling and Printing* during the early 1990s suggests that firms may have encountered patent thickets in this technology area. However the subsequent developments also indicate that thi s is no longer the case.

This section has shown that in a subset of technology areas there are particularly strong signs of a patent thicket. We investigate the behaviour of firms in these technology areas in more detail in section 4.5.3 below. In the fol lowing section we turn to an analysis of opposition behaviour.

We summarize our findings from this section together with those from the following sections in 4.5.4 below.

4.5.2 Opposition behaviour at the firm level

In this section we undertake a detailed an alysis of opposition behaviour in the selected technology areas. The aim is twofold:

- first we are seeking to identify differences in the opposition behaviour of individual firms in different technology areas. This provides us with information on which fi rms are particularly aggressive in opposition and whom they target most often.
- secondly we investigate whether litigation (related to opposition) raises entry barriers for smaller firms. This question has been studied in the literature on U.S. patents by Lerner (1995), Lanjouw and Schankerman (2001) and most recently by Cockburn and Macgarvie (2006). We try to uncover whether there are differences by technology area in the likelihood that smaller firms' patents will be opposed.

In section 4.5.2.1 we employ tables which represent the most important opposed and the most frequently opposing firms by technology area. These tables also include information about the frequency with which the opposing firms op posed medium sized and small firms. In section 4.5.2.2 we employ simple descriptive regressions in order to uncover whether the size of an applicant firm's portfolio has effects on the likelihood that its patents will be opposed at the EPO.

Opposition tab les

In this section we analyze which firms oppose which rivals. In particular we focus on the top 10 opponents. We rank the opposed firms by the number of oppositions they received in total. The tables show the number of oppositions received by the top te n opposed[75] as well as the firms ranked 11th to 40th by oppositions received as well as all remaining firms. These tables show whether opposition activity is directed mainly at specific firms or whether it is widely dispersed. The tables also provide insigh ts into differences between the opposition activities of the firms who oppose others' patents most frequently. This allows us to establish whether firms that frequently oppose are focusing on specific rivals or not.

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[75] In the case of several tables we consolidated firms and their dependent firms. This is necessary whenever the tables include firms that we had not consolidated for our other analyses. In these cases the tables contain fewer than 10 names. Furthermore it should be noted that we counted all opposition cases that are connected to a technology area in the tables below. This leads to a certain degree of double counting between tables. The tables are intended to provide informatio n about the propensity of certain firms to oppose in specific technology areas. Therefore we have not attempted to ascribe opposition cases to any one technology area, which would have forced us to make random choices whenever a patent is ascribed to diffe rent technology areas in equal measure. Compare the methodlogical point made in Section 4.2 above.

To aid interpretation of the tables we provide an example:

Table 4.5.1 shows that Siemens opposed 18 patents that were applied for by Sumitomo in *Telecommunications*. In total Siemens opposed 67 patents applied for by the firms that were opposed most frequently in this technology area. Note th at Siemens opposed 91 patents that were applied for by firms ranked below 40 in terms of oppositions received. Thus Siemens were far more likely to oppose firms in this group than Alcatel, who mainly opposed patents applied for by firms in the group of the ten most frequently opposed firms.

The following tables are presented by main area.

Electronics

For Electronics we find that:

- The set of the most important opposing firms in Electronics is very homogeneous across *Information Technology*,, *Telecommunica tions* and *Audiovisual Technology*. Siemens, Philips and Bosch appear amongst the top ten in all three and many other firms appear twice.
- The set of the most important opposed firms is less homogeneous across the three technology areas. Siemens and Toshiba always appears amongst the top ten opposed firms.
- The majority of top ten opposing firms are European while the majority of top 10 opposed firms are not.
- Opposition in *Telecommunications* and *Information Technology* is highly dispersed as the total number of cases involving the least frequently opposed firms is high. In contrast, in *Audiovisual Technology* opposition is quite concentrated amongst the top ten opposing and opposed firms.
- The concentration of oppositions amongst the most important opponents is v ery high in *Audiovisual Technology* with Grundig and Philips accounting for more than 60% of all opposition cases in this technology area. Especially Grundig have focused their oppositions on the top ten opposed firms and especially on Thomson.

- Opposition is generally very weak in *Information Technology* as well as being directed towards less often opposed and most likely smaller firms. This contrasts with a level of patent applications which is much higher than that in *Audiovisual Technology* (viz. Figure 4.2.1). This suggests that *Information Technology* is an area in which the opposition mechanism is not working well. This may be partly due to the relatively lower concentration of the most important firms (C4) in this technology area (viz. Figure 4.3.1).

Table 4.5.1 **Telecommunications**

Opposed parties	Opposing parties										
	SIEMENS	IG RUNDFUNK	PHILIPS	ALCATEL	BOSCH	GRUNDIG	Océ NEDERLAND	MOTOROLA	ERICSSON	NOKIA	**Total**
MOTOROLA	9	1	12	15	1	0	0	1	4	13	56
SUMITOMO	18	3	3	8	4	5	0	0	0	0	41
SIEMENS	0	7	19	1	7	1	0	0	2	1	38
THOMSON	1	24	1	0	0	1	0	0	0	0	27
QUALCOMM	3	0	0	1	0	0	0	8	4	5	21
TOSHIBA	8	4	3	3	1	2	0	0	0	0	21
FUJITSU	5	1	7	5	1	0	0	0	0	0	19
PHILIPS	9	5	0	2	2	0	0	0	1	0	19
ALCATEL	3	2	3	0	4	0	0	2	0	0	14
THALES	11	1	0	1	0	1	0	0	0	0	14
Rank 1-10	67	48	48	36	20	10	0	11	11	19	270
Rank 11-40	44	57	23	19	9	3	24	8	6	3	196
Rank >41	91	60	57	22	39	17	6	9	7	0	308
Total	202	165	128	77	68	30	30	28	24	22	774
	26%	21%	16%	9%	8%	3%	3%	3%	3%	2%	100

Table 4.5.2 **Audiovisual technology**

Opposed parties	Opposing parties: GRUNDIG	PHILIPS	BASF	SIEMENS	BAYER	DEUT. ITT IND.	FUJIFILM	BOSCH	CANON	**Total**
SONY	35	6	8	2	1	4	3	3	2	64
THOMSON	49	1	0	6	0	2	0	0	0	58
TOSHIBA	7	24	5	9	1	3	1	0	0	50
HITACHI	9	0	6	6	1	0	7	0	1	30
PIONEER	19	2	0	0	0	0	0	3	0	24
SHARP	8	14	1	0	0	0	0	0	1	24
MATSUSHITA	17	0	4	2	0	0	0	0	0	23
SIEMENS	3	11	0	0	0	2	0	3	0	19
KONICA	0	1	9	0	1	0	5	0	0	16
EASTMANKODAK	3	2	2	1	1	0	1	0	0	10
Rank 1-10	150	61	35	26	5	11	17	9	4	318
Rank 11-40	96	59	11	11	9	11	1	2	5	205
Rank >41	60	59	21	29	14	2	1	3	5	194
Total	306	179	67	66	28	24	19	14	14	717
	43%	25%	9%	9%	4%	3%	3%	2%	2%	100

Table 4.5.3 **Information Technology**

Opposed parties	Opposing parties: ALCATEL	BOSCH	DEUTSCHE ITT INDUSTRIES	GAO	GIESECKE& DEVRIENT	IG RUNDFUNK SCHUTZRECHTE	Océ NEDERLAND	PHILIPS	SIEMENS	INFINEON	**Total**
FUJITSU	2	8	2	1	0	0	0	0	4	0	17
SIEMENS	5	0	2	3	0	1	3	0	0	0	14
TOSHIBA	2	1	4	3	1	0	1	0	2	0	14
PHILIPS	5	2	3	0	0	0	0	2	0	0	12
IBM	0	1	0	0	4	3	0	0	0	0	8
BOSCH	0	6	1	0	0	0	0	0	0	0	7
SUMITOMO	1	4	0	0	0	0	0	0	0	0	5
PITNEYBOWES	1	0	0	0	0	0	0	1	0	0	2
CITIBANK	0	1	0	0	0	0	0	0	0	0	1
Rank 1-10	16	23	12	7	5	4	4	3	6	0	80
Rank 11-40	27	20	13	10	2	9	3	0	3	5	92
Rank >41	51	43	37	29	16	4	9	7	1	3	200
Total	94	86	62	46	23	17	16	10	10	8	372
	25	23	17	12	6	5	4	3	3	2	100

Table 4.5.4 **Medical engineering**

Opposed parties	Opposing parties							
	BIOTRONIK	P & G	SIEMENS	PAUL HARTMANN	SCA HYGIENE PRODUCTS	FRESENIUS	M.LNLYCKE	**Total**
P & G	0	0	0	33	43	0	20	96
KIMBERLYCLARK	0	32	0	8	24	0	6	70
PACESETTER	51	0	0	0	0	0	0	51
MEDTRONIC	37	0	5	0	0	0	0	42
MCNEIL	0	20	0	1	9	0	4	34
ST JUDE MEDICAL	31	0	0	0	0	0	0	31
SCA HYGIENE PRODUCTS	0	20	0	10	0	0	0	30
CARDIAC PACEMAKERS	21	0	0	0	0	0	0	21
SIEMENS	16	0	0	0	0	2	0	18
Rank 1-10	156	72	5	52	76	2	30	393
Rank 11-40	25	31	15	24	1	25	5	126
Rank >41	77	37	97	26	1	44	14	296
Total	258	140	117	102	78	71	49	815
	32%	17%	14%	13%	10%	9%	6%	100%

Table 4.5.5 **Analysis, Measurement, Control**

Opposed parties	Opposing parties										
	SIEMENS	BOSCH	HOFFMANNROCHE	GIESECKE& DEVRIENT	GAO	MANNESMANN	PHILIPS	VDO	DRJOHANNES HEIDENHAIN	CARLSCHENCK	**Total**
SIEMENS	0	37	0	6	3	4	5	7	1	1	64
HITACHI	24	18	2	5	1	1	0	0	0	0	51
BOSCH	17	0	0	0	0	8	1	9	1	1	37
TOSHIBA	17	0	0	6	9	1	3	0	0	1	37
PHILIPS	12	2	0	1	0	1	0	1	0	2	19
FANUCLTD	1	14	0	0	0	0	1	0	0	0	16
THALES	10	2	0	0	0	0	0	0	0	0	12
ABBOTT	0	0	7	0	0	0	0	0	0	0	7
INVERNESS MEDICAL	0	0	1	0	0	0	0	0	0	0	1
PITNEY BOWES	0	0	0	1	0	0	0	0	0	0	1
Rank 1-10	81	73	10	19	13	15	10	17	2	5	245
Rank 11-40	49	35	8	16	11	5	8	8	13	4	157
Rank >41	217	86	102	80	50	50	39	22	24	29	699
Total	347	194	120	115	74	70	57	47	39	38	1101
	32%	18%	11%	10%	7%	6%	5%	4%	4%	3%	100%

Here we focus on *Analysis, Measurement, Control* and *Medical Engineering*. Opposition activity is high in the latter of these two technology areas (compare Figure 4.2.15). We find that:

- Patent applications are generally high in *Analysis, Measurement, Control* and grew substantially in *Medical Engineering*. The share of opposed patents is higher in the latter area. Tables 4.5.4 and 4.5.5 show that opposition in both areas is higher than in Electronics in general.

- The overlap between the opposed and the opposing firms is moderate in both areas.

- In *Medical Engineering* there is both a high level of opposition amongst the top ten opposed and opposing firms and a high level of opposition against the group of very infrequently opposed firms. The latter finding relates to the large number of small firms that operate in this industry as is shown in the first case study (5.1.1) below.

- In *Analysis, Measurement, Control* opposition is heavily concentrated amongst the less frequently opposed firms. These are likely to be smaller firms. This finding is especially interesting because this industry is dominated by larger firms (viz. Table 5.1.1). Opposition against smaller firms is likely to be an interesting issue to study in greater detail in this technology area.

Chemicals and Pharmaceuticals

Figure 4.2.16 shows that opposition activity in this main area is very high. Applications in this main area have also risen and claims per patent have increased dramatically. In this area we include an opposition table for *Chemical - , Petrol - and Basic Materials Chemistry* as many patents by Cosmetics firms are included in this technology area. Our analysis of Tables 4.5.6 – 4.5.9 shows that:

- The set of most important opposing firms is much less homogeneous across the technology areas *Agriculture, Food*; *Pharmaceuticals, Cosmetics* and *Biotechnology* than is the case across the technology areas in Electronics.
- The set of the most opposed firms is also less homogeneous than in Electronics.

- The groups of most opposed and most opposing firms by technology area are far more homogeneous than in Electronics. This is particularly true of *Biotechnology* and *Agriculture, Food*.
- Opposition is also dispersed here with even more opposition cases directed at firms not inside the top ten opposed than in Electronics.
- In *Pharmaceuticals, Cosmetics* the pharmaceuticals firms oppose a more di verse set of firms than the cosmetics firms. The latter frequently oppose one another.

Table 4.5.6 **Agriculture, Food**

Opposed parties	Opposing parties										
	UNILEVER	KRAYER WARNER DIRK	STICHTING BEHARTIGING	NVVANDE MOORTELE	P & G	NESTLE	LINDE	GIST BROCADES	NESTEC	CPCMAIZENA	**Total**
UNILEVER	2	30	12	28	18	6	0	1	5	2	104
NESTLE	17	5	3	0	0	0	1	0	0	9	35
P & G	17	0	0	0	0	0	0	1	0	0	18
CPCINT	2	0	0	0	0	4	0	2	0	0	8
MILUPA	0	0	2	0	0	1	0	0	0	0	3
CAMPINA	1	0	0	0	0	1	0	0	0	0	2
DSMNV	1	0	0	0	0	0	0	0	0	0	1
Rank 1-10	40	35	17	28	18	12	1	4	5	11	171
Rank 11-40	33	6	4	3	4	5	1	3	2	0	61
Rank >41	84	35	14	3	10	10	17	10	9	3	195
Total	157	76	35	34	32	27	19	17	16	14	427
	37%	18%	8%	8%	7%	6%	4%	4%	4%	3%	100%

Table 4.5.7 **Pharmaceuticals, Cosmetics**

Opposed parties	Opposing parties										
	HENKEL	HOFFMANN ROCHE	BASF	L'OREAL	GLAXO SMITH KLINE	MERCK	P & G	BOEHRINGER ING.	GOLDWELL	FRESENIUS	**Total**
UNILEVER	39	0	0	11	2	0	9	0	4	0	65
L'OREAL	36	0	3	0	0	1	6	5	9	0	60
P & G	30	1	0	12	6	2	0	0	4	0	55
KAO	23	0	1	4	0	0	1	0	0	0	29
GLAXO SMITH KLINE	8	0	1	1	1	4	1	0	0	0	16
HOFFMANN ROCHE	2	0	7	1	0	1	0	2	0	0	13
J&J	0	11	1	1	0	0	0	0	0	0	13
BAYER	1	1	0	0	0	6	0	1	0	0	9
SUMITOMO	3	0	0	0	0	0	1	1	0	0	5
3M	0	0	0	0	1	0	0	0	0	0	1
Rank 1-10	142	13	13	30	10	14	18	9	17	0	266
Rank 11-40	11	19	9	4	13	7	3	8	5	4	83
Rank >41	84	54	51	27	37	24	23	25	11	27	363
Total	237	86	73	61	60	45	44	42	33	31	712
	33%	12%	10%	9%	8%	6%	6%	6%	5%	4%	100%

Table 4.5.8 **Chemical - , Petrol - and Basic Materials Chemistry**

Opposed parties	Opposing parties										
	HENKEL	P & G	UNILEVER	BASF	AKZONOBEL	HOECHST	BAYER	DEGUSSA	EXXON CHEMICAL	IMPERIAL CHEM.	**Total**
UNILEVER	210	189	1	2	8	2	4	11	0	0	427
P & G	109	0	119	1	2	0	0	2	0	2	235
HENKEL	1	42	30	3	5	13	1	1	2	1	99
NOVARTIS	4	1	0	14	0	12	15	0	0	1	47
BASF	3	1	2	2	8	6	7	4	2	1	36
HOECHST	7	0	3	9	5	2	3	2	2	3	36
SHELL	2	0	0	3	16	1	1	0	5	0	28
BAYER	4	0	1	9	2	8	2	0	0	0	26
SUMITOMO	0	0	0	7	0	10	5	0	0	2	24
THE LUBRIZOL	1	0	0	1	0	0	0	0	13	2	17
Rank 1-10	341	233	156	51	46	54	38	20	24	12	975
Rank 11-40	77	41	36	39	23	15	10	17	6	10	274
Rank >41	102	26	43	82	73	24	34	29	35	18	466
Total	520	300	235	172	142	93	82	66	65	40	1715
	30%	17%	14%	10%	8%	5%	5%	4%	4%	2%	100%

Table 4.5.9 **Biotechnology**

Opposed parties	HOFFMANN ROCHE	UNILEVER	NOVARTIS	GIST BROCADES	CHIRON CORP.	HOECHST	NOVONORDISK	GENENCOR	BEHRING WERKE	MONSANTO	**Total**
	Opposing parties										
GENENTECH	7	0	1	2	2	2	1	0	4	0	19
GENENCOR	1	6	0	2	0	0	5	1	0	0	15
HOFFMANN ROCHE	2	0	0	1	3	0	1	0	3	0	10
NOVOZYME	0	1	0	0	0	0	0	8	0	0	9
GIST BROCADES	0	1	0	0	0	0	5	1	0	0	7
DOWCHEMICAL	0	1	1	0	0	0	1	0	0	3	6
SYNGENTA	0	1	1	0	0	1	0	0	0	3	6
MONSANTO	0	2	1	0	0	0	0	0	0	1	4
CALGENE	0	0	1	0	0	0	0	0	0	2	3
CHIRON CORP.	2	0	1	0	0	0	0	0	0	0	3
Rank 1-10	12	12	6	5	5	3	13	10	7	9	82
Rank 11-40	28	15	13	10	5	10	2	9	7	4	103
Rank >41	68	17	17	18	21	16	14	5	9	8	193
Total	108	44	36	33	31	29	29	24	23	21	378
	29%	12%	10%	9%	8%	8%	8%	6%	6%	6%	100

Mechanical Engineering

Figure 4.2.17 shows the incidence of opposition is also high in several technology areas of Mechanical engineering. Opposition cases have increased in recent years in *Agricultural- and Food* machinery. In contrast the share of opposed patents in *Transport* is not very high but the absolute number of cases is high. We analyze these two technology areas in detail here. We find that:

- The sets of 10 most opposed and opposing firms are entirely disconnected across these two technology areas.
- The sets of the top opposed and opposing are very homogeneous within the technology areas, this is especially true of *Agricultural- and Food Machinery*.

- In *Agricultural- and Food Machinery* opposition cases are highly concentrated amongst the top ten opposed and opposing firms. This suggests a healthy level of competition exists in this technology area.
- In *Transport* opposition is weakly dispersed here it is possible that smaller firms find that opposition affects their patenting efforts adversely.

Table 4.5.10 **Transport**

Opposed parties	Opposing parties									
	BOSCH	SIEMENS	BMW	DAIMLER BENZ	ALFRED TEVES	MANNESMANN	KNORR BREMSE	AUTOLIV	WABCO WESTINGHOUSE	**Total**
BOSCH	0	8	2	3	3	4	1	0	14	35
SIEMENS	16	0	2	3	0	3	0	1	0	25
NISSAN MOTOR	8	3	7	3	2	1	0	0	0	24
WABCO	13	2	3	0	1	0	4	0	0	23
BMW	10	1	0	4	0	4	0	1	0	20
PORSCHE	1	2	7	2	1	1	1	0	1	16
AUDI	1	1	7	1	0	0	0	0	0	10
LUCAS	3	1	0	0	5	0	1	0	0	10
SUMITOMO	3	1	1	0	2	3	0	0	0	10
BOEING	0	0	0	1	0	0	0	0	0	1
Rank 1-10	55	19	29	17	14	16	7	2	15	174
Rank 11-40	46	16	28	20	16	6	3	11	3	149
Rank >41	82	79	54	32	16	24	25	19	11	342
Total	183	114	111	69	46	46	35	32	29	665
	28%	17%	17%	10%	7%	7%	5%	5%	4%	100%

Table 4.5.11 **Agricultural – and Food Machinery**

Opposed parties	Opposing parties: AMAZONEN WERKE	C VAN DER LELY	PROLION	MAASLAND	CLAAS	DELAVAL INTERNATIONAL	ALFA LAVAL	RAUCHLAND	RABEWERK	**Total**
MAASLAND	9	0	44	0	0	29	21	0	1	104
AMAZONEN WERKE	0	24	0	21	0	0	0	22	12	79
KUHN	5	3	0	4	0	0	0	0	4	16
DEERE	3	0	0	2	10	0	0	0	0	15
C VAN DER LELY	8	0	2	0	1	0	0	0	3	14
RABEWERK	8	2	0	1	0	0	0	0	0	11
CNH GLOBAL	1	0	0	0	5	0	0	0	0	6
Rank 1-10	34	29	46	28	16	29	21	22	20	245
Rank 11-40	17	16	4	14	6	0	2	0	1	60
Rank >41	25	9	3	9	13	1	2	1	1	64
Total	76	54	53	51	35	30	25	23	22	369
	21%	15%	14%	14%	9%	8%	7%	6%	6%	100%

Descriptive regression

This section contains the results of regressions describing the probability of receiving opposition by technology area. The aim of these regressions is to establish whether the probability of a patent application being opposed at the EPO depends on the size of the applicant firm. As noted above the literature studying patenting and litigation in the United States indicates that smaller firms in certain technologies have encountered a higher probability of litigation against their patents. Lerner (1995) argues that this has affected firms' decisions in which technologies to patent their inventions.

We emphasize that our regressions are purely descriptive. This means that while the additional variables we include allow us to control for the effects of differences in the quality or value of patents, the regressions are not based on any theoretical models of opposition behaviour. While this reduces the strength of the results we present, the regressions do provide a fairly robust impression of the effects which patent portfolio size has on the probability that patents are opposed conditional on the size of the applicant firm. We have tried several different specifications for these regressions and the effect of patent portfolio size has had the same sign and the same significance throughout. The regressions show that:

- Ceteris paribus, the probability of opposition against a patent is greater for applicants with smaller patent portfolios in all the included technology areas belonging to Electronics as well as in *Engines, Pumps and Turbines*.
- Ceteris Paribus, the probability of opposition against a patent is smaller for firms with smaller patent portfolios in *Pharmaceuticals*, *Agriculture and Food* and *Medical Engineering*. The PatVal-EU case study will show that these are technology areas with a much higher share of smaller firms than the other technology areas.

In Table 4.5.12 we report the effects for the logarithm of the size of firms' patent portfolios and the significance of these effects. As this is a descriptive regression we focus on the signs of coefficients. These indicate that the probability of opposition against a patent depends in part on how large the applicant firm is. A negative sign of the coefficient indicates that a marginal increase in the size of a firm's patent portfolio reduces the probability of opposition against its patents and vice versa. These results indicate that small firms may find it harder to obtain patents in the technology areas in which the coefficients are significant and negative.

Table 4.5.12 **Effect of portfolio size on the prob ability of opposition at grant in selected technology areas**

Explanatory variables	Tele-communi–cation	Audio-visual techn.	Information-technology	Electrical devices	Pharma-ceuticals, Cosmetics	Biotech.	Agriculture, Food	Engines, Pumps and Turbines	Trans-portation	Medical engi-neering	Analysis, Measure-ment, Control
Log. Portfolio size	-0.003 (0.000)**	-0.004 (0.000)**	-0.003 (0.000)**	-0.003 (0.000)**	**0.007** (0.001)**	0.001 (0.001)	**0.007** (0.001)**	-0.002 (0.000)**	-0.000 (0.000)	**0.006** (0.000)**	-0.001 (0.000)**
Obser-vations	43295	25374	28296	52060	24491	14068	7781	22890	40826	34326	52557
Opposition Probability	0.03	0.04	0.02	0.05	0.11	0.08	0.15	0.05	0.06	0.07	0.06
	Standard errors in parentheses + significant at 10%; * significa nt at 5%; ** significant at 1%										

The last line of Table 4.5.12 presents the probability of being opposed. This line shows that the highest opposition rates arise in *Pharmaceuticals and Cosmetics*, *Biotechnology* and *Agriculture and Food*. In these technology areas smaller firms are less likely to be opposed. Rather it is the large firms that oppose one anothers' patent applications with high frequency.

4.5.3 Firm characteristics in selected technology areas

This section has two aims:

- To establish whether the patenting explosion at the EPO is due to the patenting activities of a specific group of firms.
- To determine which firms are making use of strategic patenting and what effects this has.

We investigate the patenting behaviour of selected firms. From the six areas selected in the last section we have extracted the 30 firms with the highest number of patent applications over the period 1999-2002. Of the potential 180 firms we were left with 90; this shows that all firms in this group are active in more than one technology area. In fact they are all active in at least three as we show below. The group of firms we have selected in this way accounts for 28,7 % of all patent applications made at the EPO over the period until the end of 2005.

In Table 4.5.13 below we rank all of the selected firms by the growth of patent applications between 1989 and 2003. This growth rate is calculated relative to the base period, i.e. 1989 - 1992. Table 4.5.13 also shows the three most important technology areas for each firm for the period 1999-2002. The results in table 4.5.13 are based on our consolidation of the firm names. [76]

[76] The consolidation of firm names into valid entities is complex. We have chosen to include all mergers until end of 2002 in our data. Split off firms such as Delphi, Infineon or NTT Docomo are treated as separate entities. All firm names in Table 4.5.13 were researched and we included as many large subsidiaries (>10 patents) as we found in the data.

Table 4.5.13 **Ranking of selected firms by average growth of patent applications**

Firm name	Primary technology area	Secondary technology area	Tertiary technology area	Applications filed	Applications 1989-1992	Applications 1999-2002	Growth of applications
HUMAN GENOME	Organic Ch.	Pharm., Cosm.	Biotech.	586	0	306	305,8
JTEKT	Transportation	Mech. Elements	Analysis	522	1	300	149,3
INFINEON	Semicond.	IT	Telecom	4039	16	2250	135,4
BROADCOM	Telecom	IT	Audiovisual	1116	6	759	107,5
DELPHI	Transportation	Motors	Energy	2595	31	1226	37,4
INTEL	IT	Telecom	Semicond.	1848	29	1037	33,1
QUALCOMM	Telecom	IT	Analysis	1911	34	1163	32,7
BOSTON SCIENTIFIC	Medical Eng.	Pharm.,Cosm.	Mat proc.	1364	23	731	29,5
WYETH	Organic Ch.	Pharm., Cosm.	Biotech.	658	13	336	24
RICOH	Optical	Telecom	Audiovisual	1706	39	885	21,2
NTT DOCOMOINC	Telecom	IT	Analysis	1272	27	613	21,1
SCA HYGIENE	Medical Eng.	Mat proc.	Printing	549	16	275	15,3
LG GROUP	Telecom	Audiovisual	Energy	3192	99	1143	10,4
SAMSUNG	Telecom	Audiovisual	IT	6662	242	2185	8
ERICSSON	Telecom	IT	Energy	6339	308	2582	7,3
UNICHARM	Medical Eng.	Mat proc.	Cons. Goods	764	51	422	7,2
NISSAN	Transportation	Motors	Mech. Elements	2829	128	968	6,5
NOKIA	Telecom	IT	Audiovisual	6448	474	3158	5,7
VOLKSWAGEN	Transportation	Motors	Mech. Elements	2525	179	1085	5
BEIERSDORF	Pharm., Cosm.	Medical Eng.	Polymers	992	69	406	4,9
DENSO	Energy	Motors	Transportation	1363	83	490	4,9
BMW	Transportation	Motors	Mech. Elements	2509	149	858	4,7
HONDA	Transportation	Motors	Mech. Elements	3693	271	1458	4,4
MEDTRONIC	Medical Eng.	Energy	Analysis	1761	126	632	4
SHIMANO	Transportation	Agric. Mach.	Mech. Elements	942	65	318	3,9
MICHELIN	Transportation	Mat proc.	Polymers	930	81	397	3,8
NORTEL NETWORKS	Telecom	Optical	IT	1938	146	697	3,7
DAIMLER CHRYSLER	Transportation	Motors	Mech. Elements	3315	252	1185	3,7
TOYOTA	Motors	Transportation	Mech. Elements	4745	327	1475	3,5
KIMBERLY CLARK	Medical Eng.	Mat proc.	Cons. Goods	1960	199	773	2,9

Firm name	Primary technology area	Secondary technology area	Tertiary technology area	Applications filed	Applications 1989-1992	Applications 1999-2002	Growth of applications
L'OREAL	Pharm., Cosm.	Polymers	Cons. Goods	4330	413	1503	2,6
BOSCH	Motors	Transportation	Analysis	13509	1447	5162	2,6
PHILIPS	Telecom	Audiovisual	Energy	21970	2547	8224	2,2
RENAULT	Transportation	Motors	Mech. Elements	2137	203	649	2,2
BOEHRINGER ING	Organic Ch.	Pharm., Cosm.	Biotech.	1295	181	538	2
SEIKO EPSON	Printing	Optical	IT	4148	500	1445	1,9
MATSUSHITA	Telecom	Audiovisual	Energy	15676	1968	5470	1,8
OLYMPUS	Medical Eng.	Optical	Audiovisual	974	93	255	1,7
SANYO EL.	Audiovisual	Energy	Telecom	2009	250	680	1,7
J&J	Medical Eng.	Pharm., Cosm.	Organic Ch.	5697	691	1809	1,6
DEGUSSA	Organic Ch.	Polymers	Materials	3674	429	1119	1,6
YAMAHA	Motors	Cons. Goods	Transportation	1600	187	484	1,6
P & G	Petrol Ch.	Medical Eng.	Pharm., Cosm.	7824	795	2048	1,6
PFIZER	Organic Ch.	Pharm., Cosm.	Biotech.	2746	367	925	1,5
UNIV. of CALIFORNIA	Pharm., Cosm.	Organic Ch.	Biotech.	1562	193	465	1,4
PIONEER	Audiovisual	Telecom	Analysis	2487	439	1042	1,4
HP	IT	Printing	Telecom	6947	1004	2300	1,3
DEERE	Agric. Mach.	Transportation	Mech. Elements	1996	240	543	1,3
STI MICROEL.	IT	Semicond.	Telecom	5369	737	1631	1,2
BMS	Organic Ch.	Pharm., Cosm.	Medical Eng.	1519	241	523	1,2
THOMSON LICENSING	Audiovisual	Telecom	Energy	5363	827	1744	1,1
ALCATEL	Telecom	Energy	Optical	7655	1094	2304	1,1
SONY	Audiovisual	Telecom	IT	12662	2031	4260	1,1
SIEMENS	Telecom	Energy	Analysis	32558	4138	8476	1
GOODYEAR	Transportation	Polymers	Mat proc.	1757	199	407	1
PHARMACIA	Organic Ch.	Pharm., Cosm.	Biotech.	1862	306	621	1
GLAXO SMITHKLINE	Organic Ch.	Pharm., Cosm.	Biotech.	5447	692	1374	1
BECTON DICKINSON	Medical Eng.	Biotech.	Analysis	1514	213	402	0,9
KAO	Pharm., Cosm.	Petrol Ch.	Organic Ch.	1730	275	515	0,9
FUJIFILM	Optical	Printing	Audiovisual	5801	933	1592	0,7

Firm name	Primary technology area	Secondary technology area	Tertiary technology area	Applications filed	Applications 1989-1992	Applications 1999-2002	Growth of applications
WARNER LAMBERT	Organic Ch.	Pharm., Cosm.	Agric., Foods	1360	200	335	0,7
PORSCHE	Transportation	Motors	Mech. Elements	1231	195	303	0,6
HITACHI	Energy	IT	Audiovisual	10885	1488	2213	0,5
3M	Polymers	Optical	Medical Eng.	8188	1374	2009	0,5
GE	Polymers	Energy	Motors	10246	1877	2742	0,5
PEUGEOT	Transportation	Mech. Elements	Motors	1956	291	423	0,5
TEXAS INSTRUMENTS	IT	Semicond.	Telecom	3470	651	866	0,3
HONEYWELL	Analysis	Energy	Mech. Elements	4833	937	1231	0,3
CONTINENTAL	Transportation	Mech. Elements	Analysis	2442	420	548	0,3
MERCK	Organic Ch.	Pharm., Cosm.	Petrol Ch.	5268	1016	1308	0,3
ELI LILLY	Organic Ch.	Pharm., Cosm.	Biotech.	2369	299	383	0,3
SUMITOMO	Telecom	Energy	Organic Ch.	29598	5278	6737	0,3
MITSUBISHI	Telecom	Energy	Polymers	12797	2628	3306	0,3
HOFFMANN ROCHE	Organic Ch.	Polymers	Biotech.	7294	1201	1462	0,2
SCHERING PLOUGH	Organic Ch.	Pharm., Cosm.	Biotech.	1033	189	229	0,2
UNILEVER	Petrol Ch.	Agric., Foods	Pharm., Cosm.	4068	783	931	0,2
EASTMAN KODAK	Optical	Printing	Polymers	10673	2423	2789	0,2
BASF	Polymers	Organic Ch.	Petrol Ch.	14398	2307	2582	0,1
TAKEDA	Organic Ch.	Pharm., Cosm.	Biotech.	1717	316	353	0,1
LUCENT	Telecom	Optical	IT	8409	1582	1768	0,1
MOTOROLA	Telecom	IT	Semicond.	5042	979	1039	0,1
BAYER	Organic Ch.	Polymers	Petrol Ch.	13845	2112	2110	0
FUJITSU	Telecom	IT	Semicond.	7718	1638	1601	0
SCHERING	Organic Ch.	Pharm., Cosm.	Petrol Ch.	1562	320	254	-0,2
SHARP	Audiovisual	Optical	Telecom	4670	1137	900	-0,2
TOSHIBA	IT	Telecom	Energy	9750	2049	1518	-0,3
HENKEL	Petrol Ch.	Polymers	Organic Ch.	4872	949	698	-0,3
CANON	Optical	Printing	Telecom	12694	3350	2448	-0,3
NOVARTIS	Organic Ch.	Petrol Ch.	Pharm., Cosm.	6152	1143	674	-0,4
IBM	IT	Telecom	Semicond.	13863	3543	1059	-0,7
Average				5303	775	1483	0,9

Table 4.5.13 is ranked by growth of applications. Unsurprisingly relatively new companies (Human Genome, Infineon, Broadcom, Delphi) are at the top of the list. An analysis of Table 4.5.13 shows that:

- Firms that are connected to the main area Electronics are the largest group within the 25 applicants with the fastest growing patent portfolios (Names in boldface).[77] Interestingly *Medical Engineering* and *Pharmaceuticals* firms are about as important as firms from *Transport* within this group.
- To ensure that our interpretation of Table 4.5.13 is not driven by the sensitivity of the growth rate to the definition of the firm in the earlier period (which may be affected by our treatment of mergers and divestments) we add Table 4.5.14 which ranks firms from Table 4.5.13 by total number of patent applications in the period 1999 -2002. This representation also shows that the group of firms that are patenting most heavily recently at the EPO contains a large number of firms from Electronics. The second largest group of firms in this Table is connected both to Instruments and Chemicals and Pharmaceuticals.
- Table 4.5.13 also shows that some firms which are generally cited as having been at the forefront of the shift towards strategic patenting or use of patent portfolios, such as Texas Instruments and IBM or firms which appear as frequent opponents such as Hen kel appear towards the bottom of this ranking. This suggests that these firms have built up patent portfolios of sufficient size and no longer need to patent as much as those ranked towards the top of Table 4.5.13 who may still be building up portfolios. A recent interview conducted with Beiersdorf showed that in their view L'Oreal are pursuing a strategy of flooding certain patent classes with patent applications in order to build up a large patent stock. Our ranking shows that the patent stock of Beiersdo rf is growing faster than that of L'Oreal. However L'Oreal have a patent stock which is 4 -5 times larger than Beiersdorf. They also made three times more applications over the period 1999 -2002 than Beiersdorf .

[77] JTEKT which is the result of a merger in 2006 is o mitted from further analysis as it is too new.

Table 4.5.14 Top 25 firms from the reference group ranked b y patent applications 1999 -2002

Firm name	Primary technology area	Secondary technology area	Tertiary technology area	Applications filed	Applications 1st period	Applications 2nd period	Growth of applications
SIEMENS	Telecom	Energy	Analysis	32558	4138	8476	1,0
PHILIPS	Telecom	Audiovisual	Energy	21970	2547	8224	2,2
SUMITOMO	Telecom	Energy	Organic Ch.	29598	5278	6737	0,3
MATSUSHITA	Telecom	Audiovisual	Energy	15676	1968	5470	1,8
BOSCH	Motors	Transportation	Analysis	13509	1447	5162	2,6
SONY	Audiovisual	Telecom	IT	12662	2031	4260	1,1
MITSUBISHI	Telecom	Energy	Polymers	12797	2628	3306	0,3
NOKIA	Telecom	IT	Audiovisual	6448	474	3158	5,7
EASTMAN KODAK	Optical	Printing	Polymers	10673	2423	2789	0,2
GE	Polymers	Energy	Motors	10246	1877	2742	0,5
ERICSSON	Telecom	IT	Energy	6339	308	2582	7,3
BASF	Polymers	Organic Ch.	Petrol Ch.	14398	2307	2582	0,1
CANON	Optical	Printing	Telecom	12694	3350	2448	-0,3
ALCATEL	Telecom	Energy	Optical	7655	1094	2304	1,1
HP	IT	Printing	Telecom	6947	1004	2300	1,3
INFINEON	Semicond.	IT	Telecom	4039	16	2250	135,4
HITACHI	Energy	IT	Audiovisual	10885	1488	2213	0,5
SAMSUNG	Telecom	Audiovisual	IT	6662	242	2185	8,0
BAYER	Organic Ch.	Polymers	Petrol Ch.	13845	2112	2110	0,0
PROCTER & GAMBLE	Petrol Ch.	Medical Eng.	Pharm., Cosm.	7824	795	2048	1,6
3M	Polymers	Optical	Medical Eng.	8188	1374	2009	0,5
J&J	Medical Eng.	Pharm., Cosm.	Organic Ch.	5697	691	1809	1,6
LUCENT	Telecom	Optical	IT	8409	1582	1768	0,1
THOMSON LIC.	Audiovisual	Telecom	Energy	5363	827	1744	1,1
STI MICRO.	IT	Semicond.	Telecom	5369	737	1631	1,2
Average of all 90 firms				5303	775	1483	0,9

In order to further investigate the question whether the increase in patenting is mainly due to developments in a specific technology or group of firms we calculated an additional indicator which is presented in Table 4.5.15 below. We calculated how concentrated the patenting activities of each firm were across the 30 technology areas. We used the Herfinda hl index as a measure of concentration of patenting across technology areas. If this index is higher then the firm is concentrating most of its patenting activity in a few technology areas, if the index is lower, then the firm is spreading its patenting ac tivity very widely. It is interesting to note that in the set of firms presented in Table 4.5.2 above there are firms which have begun to patent in a wider set of technology areas (these are presented in Table 4..5.3 below), but there are also firms which have begun to patent in a narrower set of technology areas.

Firms which patent with greater focus than in the past are:

- Alcatel, Qualcomm, Nokia, Nortel Networks, Motorola, Lucent, Ericsson, HP, Texas Instruments and IBM who are all connected to *Telecommunications* or *Information technology*. While this finding is not surprising in the cases of Qualcomm, Nokia and IBM it is unexpected for the remainder of the firms listed here, since they are in the group of firms that has chosen a wider focus for their pat enting activities in the United States, viz. Hall (2005). This finding presents an interesting puzzle which we have to resolve in the future.
- Additionally, we find that several firms from *Medical Engineering* have adopted a greater focus in their patenting activity: Boston Scientific, Medtronic, Becton Dickinson and Johnson & Johnson (J&J).
- Finally Boehringer Ingelheim, Schering, Schering Plough, Nov artis and Pharmacia who are all pharmaceuticals firms have also adopted a greater focus of their patenting activity. L'Oreal also adopted this approach.

We turn now to those firms that patent more widely. Table 4.18 ranks those firms with the highest increase in the dispersion of their patenting activities as measured by the difference in the measure of concentration. We measured an increase in dispersion as: HHI for 1989 -1992 – HHI for 1999-2002.

Table 4.5.15 Firms with highest increases in diversification of patenting activity in the reference set

Firm name	First technology area	Second technology area	Third technology area	Total applics. Until 2005	Conc. Of patent applic. 1980-2003	Conc. Of patent applic. 1989-1992	Conc. Of patent applic. 1999-2003	Change in conc.
INFINEON	Semicond.	IT	Telecom	4039	0,22	0,54	0,22	0,32
FUJIFILM	Optical	Printing	Audiovisual	5801	0,20	0,40	0,14	0,26
SHIMANO	Transportation	Agric. Mach.	Mech. El.	942	0,52	0,66	0,44	0,22
SCA HYGIENE	Medical Eng.	Mat proc.	Printing	549	0,43	0,56	0,36	0,20
BROADCOM	Telecom	IT	Audiovisual	1116	0,51	0,67	0,47	0,20
PFIZER	Organic Ch.	Pharm., Cosm.	Biotech.	2746	0,39	0,56	0,37	0,19
INTEL	IT	Telecom	Semicond.	1848	0,27	0,42	0,26	0,17
GLAXO SMITHKLINE	Organic Ch.	Pharm., Cosm.	Biotech.	5447	0,36	0,45	0,30	0,16
UNICHARM	Medical Eng.	Mat proc.	Cons. Goods	764	0,55	0,74	0,58	0,16
NTT DOCOMOINC	Telecom	IT	Analysis	1272	0,74	0,87	0,72	0,15
SONY	Audiovisual	Telecom	IT	12662	0,24	0,35	0,20	0,15
YAMAHA	Motors	Cons. Goods	Transportation	1600	0,17	0,27	0,14	0,13
VOLKSWAGEN	Transportation	Motors	Mech. El.	2525	0,22	0,32	0,20	0,12
MERCK	Organic Ch.	Pharm., Cosm.	Petrol Ch.	5268	0,27	0,31	0,21	0,10
DELPHI	Transportation	Motors	Energy	2595	0,14	0,24	0,15	0,09
KIMBERLY CLARK	Medical Eng.	Mat proc.	Cons. Goods	1960	0,25	0,31	0,24	0,07
SANYO EL.	Audiovisual	Energy	Telecom	2009	0,14	0,18	0,13	0,05
BAYER	Organic Ch.	Polymers	Petrol Ch.	13845	0,19	0,21	0,16	0,05
PIONEER	Audiovisual	Telecom	Analysis	2487	0,39	0,39	0,34	0,05
HONDA	Transportation	Motors	Mech. El.	3693	0,16	0,19	0,14	0,05
LG GROUP	Telecom	Audiovisual	Energy	3192	0,12	0,15	0,11	0,04
NISSAN	Transportation	Motors	Mech. El.	2829	0,18	0,22	0,18	0,04
PROCTER&GAMBLE	Petrol Ch.	Medical Eng.	Pharm., Cosm.	7824	0,17	0,17	0,14	0,03
SHARP	Audiovisual	Optical	Telecom	4670	0,13	0,16	0,13	0,03
MEDTRONIC	Medical Eng.	Energy	Analysis	1761	0,77	0,78	0,76	0,03
Average of all 90 firms				5303	0,27	0,28	0,28	0,00

This measure is greater if firms' patenting activities were more concentrated in the earlier period.

Table 4.5.15 shows that:

- Electronics and Chemicals, Pharmaceuticals companies participated in the increased dispersion of patenting activities in equal measure.
- Most of the firms that have diversified their patenting activities strongly are not amongst the firms that applied for most patents in the period 1999 -2002 as a comparison of Tables 4.5.14 and 4.5.15 reveals.

Summarising this analysis we find that firms pursue very different patenting strategies at the EPO in response to the explosion in patenting activity. Some have diversified their patenting into more technology areas whilst others have concentrated their patenting activity. Which strategy is chosen seems to have no bearing on the amount of patents applied for as a comparison of Tables 4.5.14, 4.5.15 and our discussion of the firms that have concentrated their patenting activity reveals.

Table 4.5.13 shows that firms whose patent stocks are growing very fast have lower than average size patent stocks at present , whilst those whose patent stocks are growing more slowly tend to have very large patent stocks. Many of those firms whose patent stocks are growing less quickly are also concentrating their patenting on fewer patent classes than in the past. This pattern is common to firms from both Electronics and Pharmaceuticals, Cosmetics.

We turn now to an analysis of those indicators that may tell us something about strategic uses of the patent system by firms in the reference group described by Table 4.5.13. To do this we present the 25 most active firms from this group by a series of indicators.

Growth in patents with a high level of claims relative to the average

In Table 4.5.16 we present firms who have the highest share of patents with a very large number of claims relative to the industry average. The indicator reported in the last column gives the share of patents in the overall stock of a firm's patent applications over the period 1999 -2002 which were above the 75th percentile of patent applications in a given technology area on the basis of claims. This indicator controls for technology area specific differences in the number of claims. Table 4.5.16 shows those firms that consistently apply for more complex paten ts than their rivals.

Firms that make such complex patent applications are highly likely to have strategic intentions when they make such applications. Table 4.5.16 shows that:

- The group of firms selected by this indicator is spread widely across differe nt technology areas. The Table does not show that firms from any one technology area have a consistently higher share of patents with high claims. This indictor shows us that complex patent applications are used by a wide range of firms in a similar way.
- The firms that pursue complex patenting techniques have patent portfolios that are mostly smaller than the average portfolio in the set of firms we have selected.
- Table 4.5.16 reveals that most of the firms using unusually large numbers of claims on their patents are not European. In fact the majority are U.S. firms. As Archontopulos, et al. (2006) this may have something to do with different drafting styles.

In section 4.3 we make use of divisional patent applications in order to trace strategic behaviour within the patent system. We have also calculated this indicator for the set of firms presented in Table 4.5.13. The indicator shows that Japanese f irms make particularly strong use of divisional patents. This may be a sign of strategic behaviour but it may also be a sign of an institutional specificity which we do not yet understand. Therefore we do not report this indicator at the firm level at pres ent. We are still confident that the indicator is useful at an aggregate level as here the influence of a set of firms from a specific country is less likely to distort the overall results than in a selected sample such as the one presented here.

Table 4.5.16 **Firms with the highest share of patents with high claims in the reference group over the sample period**

Firm name	Primary technology area	Secondary technology area	Tertiary technology area	Total applications Filed	Applications 1999-2002	Applications with very high claims 1999-2002	Share of appl. With very high claims 1999-2002
KIMBERLY CLARK	Medical Eng.	Mat proc.	Cons. Goods	1960	773	605	78%
UNIV. of CALIFORNIA	Pharm., Cosm.	Organic Ch.	Biotech.	1562	465	339	73%
SHIMANO	Transportation	Agric. Mach.	Mech. El.	942	318	209	66%
QUALCOMM	Telecom	IT	Analysis	1911	1163	644	55%
MICHELIN	Transportation	Mat proc.	Polymers	930	397	203	51%
CANON	Optical	Printing	Telecom	12694	2448	1251	51%
SCHERING PLOUGH	Organic Ch.	Pharm., Cosm.	Biotech.	1033	229	112	49%
LG GROUP	Telecom	Audiovisual	Energy	3192	1143	549	48%
NOVARTIS	Organic Ch.	Petrol Ch.	Pharm., Cosm.	6152	674	323	48%
SHARP	Audiovisual	Optical	Telecom	4670	900	425	47%
DELPHI	Transportation	Motors	Energy	2595	1226	578	47%
WYETH	Organic Ch.	Pharm., Cosm.	Biotech.	658	336	142	42%
BOSTON SCIENTIFIC	Medical Eng.	Pharm., Cosm.	Mat proc.	1364	731	309	42%
NORTEL NETWORKS	Telecom	Optical	IT	1938	697	279	40%
TAKEDA	Organic Ch.	Pharm., Cosm.	Biotech.	1717	353	140	40%
RICOH	Optical	Telecom	Audiovisual	1706	885	348	39%
TOYOTA	Motors	Transportation	Mech. El.	4745	1475	576	39%
PHARMACIA	Organic Ch.	Pharm., Cosm.	Biotech.	1862	621	242	39%
SONY	Audiovisual	Telecom	IT	12662	4260	1585	37%
3M	Polymers	Optical	Medical Eng.	8188	2009	744	37%
BROADCOM	Telecom	IT	Audiovisual	1116	759	272	36%
ERICSSON	Telecom	IT	Energy	6339	2582	919	36%
BEIERSDORF	Pharm., Cosm.	Medical Eng.	Polymers	992	406	142	35%
UNILEVER	Petrol Ch.	Agric., Foods	Pharm., Cosm.	4068	931	323	35%
MEDTRONIC	Medical Eng.	Energy	Analysis	1761	632	214	34%
Average of all 90 firms				5303	1482	325	22%

Having established that a strategy of using complex patents arises across different technology areas we now turn to indicators that provide information about blocking patents and about the novelty embodied in patent applications.

Table 4.5.17 below ranks firms by the share of patents which are cited by other patents as critical of the inventive step embodied in those other patents. This means that the measure captures how often these patents block others' patents. We have calculated the share of critical references to each patent in order to control for technology area specific differences in the propensity to cite patents.

Table 4.5.17 shows very clearly that:

- Blocking patents in the sense just described are most important in the Pharmaceuticals, Organic chemistry, and Medical engineering. Table 4.5.17 lists only two firms connected to Electronics – LG Group and Sharp. This finding underscores the results which we report in the PatVal-EU case study in section 5.3.1 below. This case study shows that patents are used as blocking patents most frequently in the sectors noted here. Patents have a much higher importance as bargaining chips in Electronics. This shows that in Electronics the complementarity of patents may be more strongly founded on the joint use of patents in a specific product whereas in Pharmaceuticals and Chemistry the patents will often share a direct technological link.
- The share of blocking patents in the sense described above has increased for all firms that were active in both the base period (1989-1992) and the reference period (1999-2002). This may indicate that firms are placing a greater emphasis on obtaining such patents – a strategic interpretation – or that technology has developed in such a way that patent more frequently relate to one another – a technological interpretation. The PatVal-EU case study will provide additional information regarding these two alternatives.

Table 4.5.17 Firms with the highest average share of patents that are cited as critical towards others' patents

Firm name	Primary technology area	Secondary technology area	Tertiary technology area	Applications filed	Average share of critical citations per patent	Average share of critical citations 1989-1992	Average share of critical citations 1999-2002
TAKEDA	Organic Ch.	Pharm., Cosm.	Biotech.	1717	0,43	0,41	0,65
HUMAN GENOME	Organic Ch.	Pharm., Cosm.	Biotech.	586	0,64	.	0,64
BMS	Organic Ch.	Pharm., Cosm.	Medical Eng.	1519	0,53	0,40	0,59
PROCTER & GAMBLE	Petrol Ch.	Medical Eng.	Pharm., Cosm.	7824	0,44	0,37	0,58
BOSTON SCIENTIFIC	Medical Eng.	Pharm., Cosm.	Mat proc.	1364	0,52	0,31	0,57
SCHERING PLOUGH	Organic Ch.	Pharm., Cosm.	Biotech.	1033	0,47	0,55	0,56
BOEHRINGER ING	Organic Ch.	Pharm., Cosm.	Biotech.	1295	0,43	0,36	0,56
NOVARTIS	Organic Ch.	Petrol Ch.	Pharm., Cosm.	6152	0,37	0,40	0,56
PFIZER	Organic Ch.	Pharm., Cosm.	Biotech.	2746	0,44	0,41	0,55
LG GROUP	Telecom	Audiovisual	Energy	3192	0,45	0,36	0,55
UNILEVER	Petrol Ch.	Agric., Foods	Pharm., Cosm.	4068	0,42	0,37	0,55
WARNER LAMBERT	Organic Ch.	Pharm., Cosm.	Agric., Foods	1360	0,39	0,38	0,55
SCHERING	Organic Ch.	Pharm., Cosm.	Petrol Ch.	1562	0,40	0,42	0,54
J&J	Medical Eng.	Pharm., Cosm.	Organic Ch.	5697	0,42	0,35	0,54
HENKEL	Petrol Ch.	Polymers	Organic Ch.	4872	0,35	0,30	0,54
BAYER	Organic Ch.	Polymers	Petrol Ch.	13845	0,34	0,36	0,53
BEIERSDORF	Pharm., Cosm.	Medical Eng.	Polymers	992	0,39	0,36	0,53
HONDA	Transportation	Motors	Mech. Elements	3693	0,39	0,38	0,53
PHARMACIA	Organic Ch.	Pharm., Cosm.	Biotech.	1862	0,42	0,42	0,52
FUJIFILM	Optical	Printing	Audiovisual	5801	0,43	0,41	0,52
MERCK	Organic Ch.	Pharm., Cosm.	Petrol Ch.	5268	0,39	0,42	0,52
RICOH	Optical	Telecom	Audiovisual	1706	0,44	0,28	0,52
SHARP	Audiovisual	Optical	Telecom	4670	0,35	0,31	0,52
BMW	Transportation	Motors	Mech. Elements	2509	0,44	0,39	0,51
BASF	Polymers	Organic Ch.	Petrol Ch.	14398	0,35	0,35	0,51
Average of all 90 firms				5303	0,37	0,31	0,47

Finally we provide evidence about the degree of novelty which is embodied in firms' patents. Table 4.5.18 ranks the top 25 firms out of the reference set pre sented in Table 4.5.13 which receive the highest share of critical references on their patents. Table 4.5.18 shows us which firms have a high number of patents that do not embody a very significant technological advance.

Table 4.5.18 shows that:

- Firms with a high share of patents that do not embody large technological advances come form a fairly heterogeneous set of technology areas. The results reported in Table 4.5.17 indicate that we might observe a large number of firms from the same industries that featured there, i.e. Pharmaceuticals and Chemicals. However, we find that *Information Technology* and *Telecommunications* firms also play an important role.
- A third of the firms that receive high shares of critical references to their patents also belong in the group of firms that have a high share of claims on their patents (viz. Table 4.5.16). This is perhaps not surprising, as these patents are likely to represent attempts to get very extensive protection for a given technology.
- A third of the firms that receive high shares of critical references to their patents also belong to the top 25 firms in Table 4.5.13, i.e. those whose patent stocks grew fastest. This may be an indication that the dash for patents is leading to patenting of more marginal patents. If so, then this is entirely consistent with the theory that patent portfolios are more important than individual patents in some technology areas. A comparison of Tables 4.5.13 and 4.5.18 shows that the firms represented in both Tables are not all Electronics firms.
- It is interesting that only two of the firms with the highest number of patent applications between 1999-2002 are also amongst the firms with high shares of critical references. It seems that the larger patent applicants whose patent stocks are growing at a slightly lower rate are able to produce better patents.

Table 4.5.18 Firms out of our reference set with patents bearing highest share of critical references in 1999-2003

Firm name	Primary technology area	Secondary technology area	tertiary technology area	Total appli-cations filed	Average share of critical references per patent	Average share of critical references 1989-1992	Average share of critical references 1999-2002
HUMAN GENOME	Organic Ch.	Pharm., Cosm.	Biotech.	586	0,52	.	0,67
BMS	Organic Ch.	Pharm., Cosm.	Medical Eng.	1519	0,48	0,40	0,56
TAKEDA	Organic Ch.	Pharm., Cosm.	Biotech.	1717	0,37	0,34	0,56
SCHERING	Organic Ch.	Pharm., Cosm.	Petrol Ch.	1562	0,34	0,30	0,53
SCHERING PLOUGH	Organic Ch.	Pharm., Cosm.	Biotech.	1033	0,37	0,36	0,53
UNIV. of CALIFORNIA	Pharm., Cosm.	Organic Ch.	Biotech.	1562	0,45	0,40	0,51
INTEL	IT	Telecom	Semicond.	1848	0,49	0,30	0,51
PFIZER	Organic Ch.	Pharm., Cosm.	Biotech.	2746	0,36	0,27	0,51
BOSTON SCIENTIFIC	Medical Eng.	Pharm., Cosm.	Mat proc.	1364	0,48	0,28	0,50
NOVARTIS	Organic Ch.	Petrol Ch.	Pharm., Cosm.	6152	0,28	0,26	0,50
PROCTER & GAMBLE	Petrol Ch.	Medical Eng.	Pharm., Cosm.	7824	0,37	0,30	0,50
PHARMACIA	Organic Ch.	Pharm., Cosm.	Biotech.	1862	0,35	0,31	0,49
BROADCOM	Telecom	IT	Audiovisual	1116	0,50	0,09	0,49
HENKEL	Petrol Ch.	Polymers	Organic Ch.	4872	0,28	0,22	0,48
J&J	Medical Eng.	Pharm., Cosm.	Organic Ch.	5697	0,37	0,26	0,47
HITACHI	Energy	IT	Audiovisual	10885	0,36	0,25	0,47
FUJIFILM	Optical	Printing	Audiovisual	5801	0,37	0,33	0,47
NORTEL NETWORKS	Telecom	Optical	IT	1938	0,36	0,23	0,47
QUALCOMM	Telecom	IT	Analysis	1911	0,42	0,28	0,47
MEDTRONIC	Medical Eng.	Energy	Analysis	1761	0,35	0,27	0,46
BOEHRINGER ING.	Organic Ch.	Pharm., Cosm.	Biotech.	1295	0,39	0,34	0,46
NTT DOCOMO	Telecom	IT	Analysis	1272	0,44	0,63	0,46
KIMBERLY CLARK	Medical Eng.	Mat proc.	Cons. Goods	1960	0,36	0,30	0,46
GE	Polymers	Energy	Motors	10246	0,32	0,23	0,45
BMW	Transportation	Motors	Mech. El.	2509	0,37	0,27	0,45
Average of all 90 firms				5303	0,33	0,25	0,42

This section has shown that there is evid ence for strategic patenting at the firm level. We have found that there is a lso evidence that firms are pursuing quite different types of strategies These are discussed in grater detail below.

4.5.4 Conclusions from the firm level analysis

Here we survey the evidence from the firm level analysis (4.5.1 - 4.5.3) of patenting behaviour a t the EPO. To begin with we restricted our analysis to nine technology areas chosen on the basis of indicators at the level of the technology area. These are: *Telecommunications*; *Information Technology*; *Audiovisual Technology*; *Medical Engineering*; *Biotechnology; Pharmaceuticals, Cosmetics*; *Agriculture, Food*; *Transport*; *Agriculture, Food Machinery* .

For these nine technology areas we undertake an analysis of the concentration of citations (section 4.5.1) in order to establish how likely we are to find paten t thickets in these technology areas. Our definition of strategic use of patents, introduced in section 3.2, is based on complementarities between patents. This definition implies that complementarities between patents are a precondition for the strategic use of patents. Therefore the identification of technology areas in which we are likely to observe such complementarities is an important step in our analysis.

In section 4.5.1 we show that:

- Of the nine areas we have noted above as being most likely to harbour strategic patenting behaviour three are shown to be very likely to contain patent thickets on the basis of our indicator based on the concentration of references. These are: *Telecommunications*; *Medical Engineering*; *Pharmaceuticals, Cosmetics*. Additionally the data show fairly high levels of concentration in *Information Technology* and in *Transport*.
- The data also suggest that the concentration of references and X -References is not very high in *Biotechnology* ; *Agriculture, Food*; *Agriculture, Food Mac hinery*.

- The data show high levels of concentration for references in *Analysis, Measurement and Control* a technology area which we did not include in our selection of the nine technology areas most likely to harbour strategic patenting behaviour. On the b asis of the concentration of references indicator we also inspected this technology area in the following section.

After this analysis we turned to a firm level analysis of oppositions in section 4.5.2. This analysis complements the preceding analysis in two ways: it shows us in which areas firms are availing themselves of opposition in order to try and stem the increase in new patents and it shows us whether there are areas in which larger firms are more likely to oppose smaller firms.

In section 4.5.2 we provide opposition tables for a large set of technology areas (11) in order to ensure that we are focusing on the most interesting ones. This allows us to double check the results we have obtained from the preceding analysis. The analysis of firm level o pposition data shows that:

- In Electronics opposition is very weak and dispersed in *Information Technology* while it is moderate in *Telecommunications* and slightly stronger in *Audiovisual Technology*. In these technology areas opposition is also more concent rated amongst the most opposed and opposing firms. In our firm level analysis we have therefore concentrated on these last two technology areas. As the opposition data show and as the firm level tables show many of the firms which are investigated in Secti on 4.5.3 are also active in *Information Technology*.
- In Instruments opposition activity in *Medical Engineering* is very different from opposition activity in *Analysis, Measurement, Control*. This is confirmed by our regression in Section 4.5.2.2. We find that opposition activity in the latter area should be studied in greater detail as it is very highly concentrated on a diverse and probably small set of firms. The main opposing firms here are Siemens and Bosch. We analyze the behaviour of firms form both are as in Section 4.5.3.

- In Chemicals, Pharmaceuticals we find the opposition activity is very strongly associated with large cosmetics firms who oppose one another. This indicates a very healthy level of competition. We focus mainly on firms from this techno logy area in Section 4.5.3 due to the concentration of references which indicate that there may be a patent thicket in this technology area.
- In Mechanical Engineering we find that opposition is dispersed in *Transport* whereas it is highly concentrated amon gst the top ten opponents and opposed in *Agricultural- and Food Machinery*. Therefore we include *Transport* in the set of technology areas for which we analyze firms' behaviour more closely.

As a result we focus on the following six technology areas in our analysis of the patenting behaviour of large firms in Section 4.5.3: *Telecommunications*; *Audiovisual Technology*; *Medical Engineering*; *Analysis, Measurement, Control*; *Pharmaceuticals, Cosmetics* and *Transport*.

We proceed by selecting the 30 top applicants at the EPO in the period 1999-2002 from these technology areas. Their patenting behaviour is then analyzed in greater detail on the basis of a number of firm level indicators. The firm level analysis shows that:

- A prominent group of firms is seeking to b uild patent portfolios and is patenting more marginal patents in the process. This strategy is not restricted only to firms from Electronics as one might have expected based on the existing literature surveyed in section 3.
- Some of the firms building paten t portfolios are also patenting more complex patents.
- While one set of firms is seeking to patent in more technology areas another set of firms is specializing in fewer.
- Blocking patents are used most extensively in the Pharmaceuticals and Chemicals industries.

- Firms with large patent portfolios that also feature frequently in opposition cases, such as Siemens or Philips, do not feature strongly in any of the tables set out above. The same is true of firms that led the patenting explosion in the United Sta tes such as IBM or Texas Instruments. This suggests that they are part of a group of firms that have already established sufficiently large patent portfolios to exist comfortably in an environment in which patent portfolios are an important strategic asset . The firms we have found to be building patent portfolios actively are still building this asset.

In sum we have found evidence for strategic patenting behavior using indicators at the level of the technology area and the firm level. In Section 5 below w e introduce additional analysis to establish whether the indicators we have developed provide a reliable picture of strategic patenting at the EPO. We comment on the implications of our findings in Section 5.2 below.

5. Assessment of Empirical Results: Identification of Criteria

In this section of the report we provide an assessment of our results from Section 4. The main element of this section consists of two case studies which seek to validate and evaluate the results we have derived there. The first case study presents an analysis of data generated in the PatVal-EU survey. In this survey firms were surveyed about specific patents and their uses. We employ the results to validate our findings about firms' patenting behavior which are based on patent data. This validation provides a unique opportunity to match the results of our patent data analysis with survey data. The second is a comparison of the patenting behavior of Pharmaceuticals and Cosmetics firms based on the work of Harhoff and Hall (2003) on the Cosmetics industry and our analysis of firms' behavior in sections 4.5.2 and 4.5.3 of this report. Finally in section 5.2 we provide an assessment of firms' behavior and discuss whether or not there are competition policy implications of this behavior.

5.1 Case studies

5.1.1 Case study: evidence on strategic patenting by using the PatVal-EU survey

Section 4 of the report identified a set of technology areas characterized by changes in patenting activities, particularly with respect to the changing behavior of patentees and their attitude towards strategic patenting. This section further explores these issues. It focuses on strategic behavior in patenting and the strategic use of patents by using information drawn from the PatVal-EU survey of inventors in EPO patents. PatVal-EU interviewed the inventors of 9,550 patents with priority years between 1993 and 1998 and granted by the European Patent Office (EPO)[78]. The inventors of these patents are located in Denmark, France, Germany, Hungary, Italy, the Netherlands, Spain, and the United Kingdom. Details of the survey are reported in

[78] The questionnaire was submitted to the inventors of about 28,000 patents granted by the EPO with inventors located in the eight countries listed above. This sample was drawn from a population of about 50,000 patents. Since the survey over-sampled "important" patents, we corrected for the stratification by computed sampling weights for the hypothetical unbiased sample. Sampling weights also control for the representativeness of the sample of patents for which we received a response with respect to the selected sample of patents/questionnaires that have been sent to inventors. All descriptive statistics reported in this section have been computed by using these sampling weights.

Giuri, *et al.* (2005)[79]. A unique feature of the PatVal-EU survey is that it provides information on the patentees, the characteristics of the invention, the invention process, the motivations for patenting and the actual use of patents.

In order to study strategic behavior in patenting we build a series of indicators based on the following characteristics of patents and patentees by technology area:

1. the complementarity of patented inventions with other related inventions produced by the patentee or by other external actors;
2. the size of the patent applicant;
3. the proportion of X-References in the patent;
4. the economic/strategic value of patents;
5. the strategic motivations for patenting (i.e. blocking competitors, cross-licensing) and the use or non-use of patents.

We focus on three main technology areas, which in turn comprise the following technology areas identified earlier in this report as most likely to be affected by strategic use of patents:

- Electronics: *Electrical Devices*; *Audiovisual Technology*; *Telecommunication*; *Information Technology* and *Semiconductors*.
- Instruments: *Optics; Analysis-Measurement-Control*, and *Medical Engineering*
- Chemicals, Pharmaceuticals: *Organic Fine Chemistry*; *Macromolecular Chemistry; Polymers*; *Pharmaceuticals; Cosmetics*; *Biotechnology; Materials, Metallurgy* and *Agriculture, Food*.

We compute all indicators for each technology area and, as a reference point, for the total sample of patents in all 30 technology areas.

79 Details on the methodology and results of the survey are also reported in (European Commission 2005a, 2005b, 2006).

We proceed as follows:

- First, we identify a set of *preconditions that suggest strategic patenting* behavior. These are the patenting of interrelated inventions, the large size of the patent applicant, the production of patents requiring low man months in the research process, and the share of X-References.
- Second, we identify a patent that a*s having strategic uses* if it is not used by its applicant and the invention is patented for blocking competitors or for use in cross-licensing negotiations.
- Third, we check the preconditions suggesting strategic patenting with our indicators of the actual strategic use of the patents. This allows us to assess for each technology area whether patents have strategic uses and to figure out which preconditions are associated with the strategic use of patents.

For example we will look at the share of X-References for the sub-groups of used and unused patents and for the sub-groups of unused patents for blocking rivals in order to show differences in the strategic use of less original patents across technical classes.

We use indicators on patents with priority dates between 1993-1998, which means that on average these patents were granted by the EPO between 1997 and 2001.[80] Given the short time-period, we build indicators and descriptive statistics for the pooled years.

Patents and related inventions

A first precondition of strategic patenting is based on the extent to which patents are related to other inventions developed or in progress within the applicant organization or by external actors. By using this information we can identify areas in which complexity in patent activities is more frequent, and thus cross-validate the results obtained earlier in this report.

[80] As noted earlier, the time lag between priority data and granting date is on average more than 4 years (Harhoff and Wagner (2005)).

We show descriptive statistics by technology areas based on the following indicators:

- Family of patents and number of patents in the family;
- Related inventions: separate internal inventions and inventions by competitors in the specific field;
- Cumulative inventions.

Family of patents

The first set of indicators that we use is the share of patents that are part of a broader "family of patents" and the size of the patent families by technological classes. The indicators are built from the answers to the following PatVal -EU question:

> "We define a "family of patents" as a group of patents which crucially depend on each other in terms of their value, or in a technical way. Was the patent in question part of a family of patents? (Y/N). If yes, please indicate how many patents were part of the patent family."

This information may reveal strategic behavior of patent applicants that build patent thickets to strongly protect their inventions. Moreover, a patent belonging to a family of intertwined patents is likely to be a complement of the other patents.

Figure 5.1.1 reports for each technology area and for the total sample of patents in the 30 technology areas the percentage of patents belonging to a family. For the patents belonging to a family, Figure 5.1.1 shows in parenthesis the average number of patents of the family.

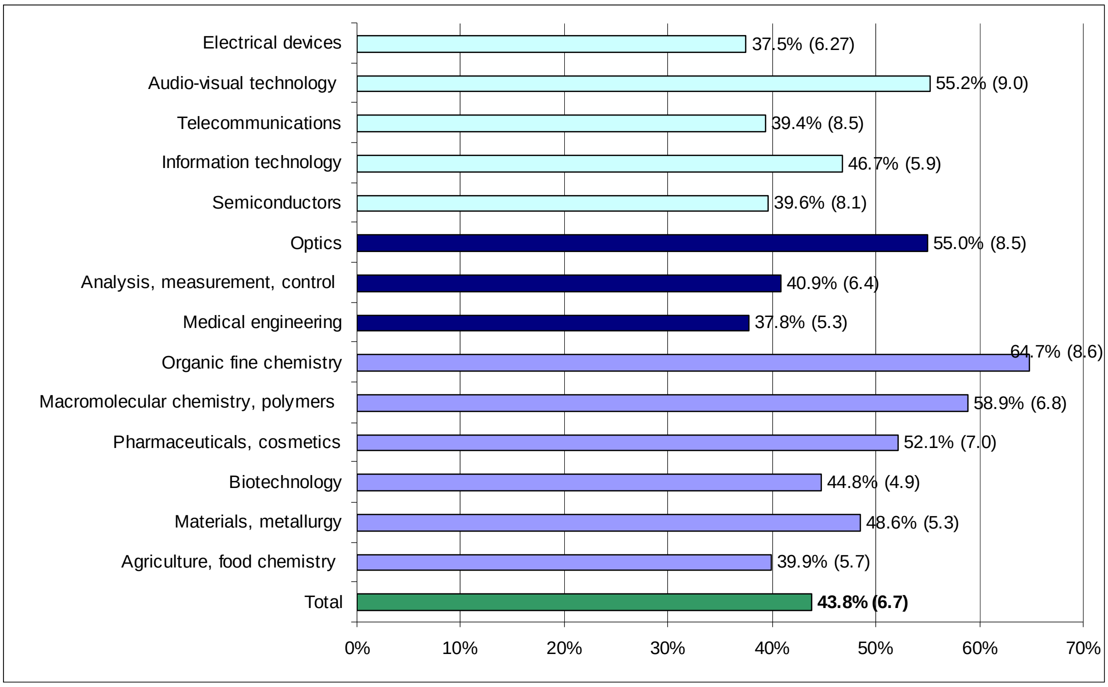
We show that:

- On average 43.8% of patents belong to a family and the average size of families is 6.7 patents.
- With the exception of *Agriculture, Food Chemistry* in all the technology areas of Chemicals/ Pharmaceuticals the proportion of patents that are part of a family are high (between 52 and

65%) in *Organic Fine Chemistry*, *Macromolecular Chemistry* and *Pharmaceuticals, Cosmetics*.

- In the other main technology areas only in *Audiovisual Technology*, *Information Technology* and *Optics* the shares of patents in families are also quite high. Moreover, the size of the patent families is also large compared to the other classes. While in *Organic Fine Chemistry*, *Macromolecular Chemistry* and *Pharmaceuticals, Cosmetics* each family is composed of about 7-8 patents, in *Audiovisual Technology* the average family comprises 9 patents and in *Optics* 8.5 patents.
- In *Telecommunications* and *Semiconductors* the percentage of patents belonging to a family is not large if compared with the total average (about 39%), but when patent s are part of families, these families are broad, as they comprise on average more than 8 patents. This mirrors heterogeneous inventions and patenting behavior, comprising both the production of many autonomous inventions and large families of interrelated patents.

Figure 5.1.1.1 Family of patents: shares and number of patents in family



Note: Total is computed over all patents in the 30 technological classes.

Related inventions

A second set of indicators stems from the following question of the PatVal-EU survey:

> "Why was it decided to patent the invention as it was, as opposed to developing it further by devoting additional resources?
>
> 1. Further improvements (could have) resulted in another invention that could be patented separately.
> 2. The invention had to be patented quickly, because your organization was aware of other inventors, research groups or firms that were working on inventions in the same field" [81].

The first answer suggests that there can be strategic considerations in patenting behavior when the research leading to the patent produces several related outcomes. Improvements of the patented invention are not included in the patent if it is possible to separate the related inventions into different patents. However, the novelty of the additional separate patents may be narrow and therefore the resulting overall increase in patent applications might be associated to a decreasing average quality of the patents.

According to the second answer, applicants may patent quickly if they are aware of the presence of competitors in the same technical field. This does not necessarily indicate strategic patenting behavior but healthy technological competition that may accelerate the production of inventions.

Figure 5.1.2 shows for each technology area the proportion of inventions patented without devoting additional resources (i) because the applicant could patent a separate invention, or (ii) because of the presence of competitors in the field.

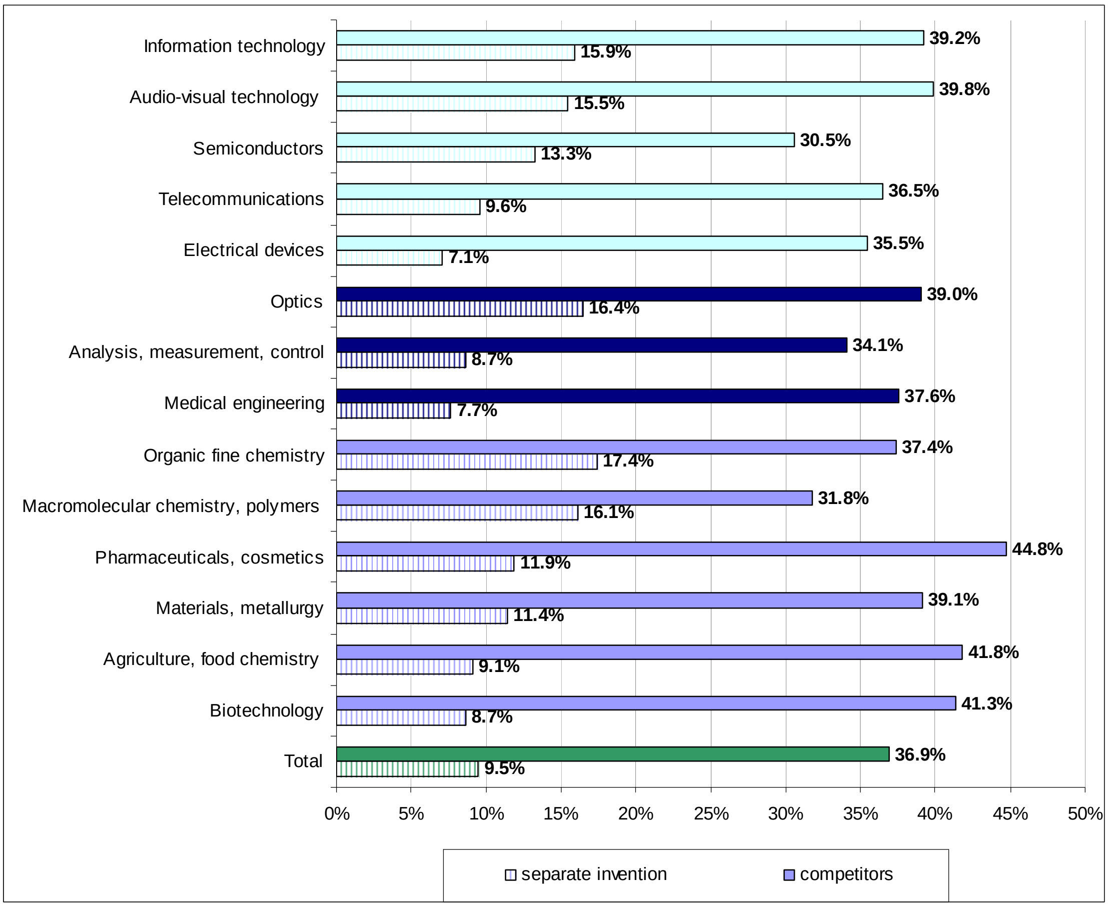
On average 9.5% of the inventions are patented incrementally because improvements could be included in separate inventions. This suggests that this potentially strategic behavior of patentees is not diffused. However in many technology areas the share of potential separate inventions is

[81] The PatVal-EU questionnaire included other possible answers that were related to the achievement of research goals or the scarcity of resources for continuing the research activities. We do not show the results here as they are less relevant for the purposes of this analysis.

larger than the average and reaches 16-17% of the total inventions. Specifically, the share of patented inventions is high in Electronics (with the exception of *Electrical devices*), in Chemicals/ Pharmaceuticals (with the exception of *Biotechnology* and *Agriculture, Food*) and in *Optics*.

Figure 5.1.2 shows that more than one third of the inventions (about 37%) are patented quickly because of competitors in the field. Again, the share of these patents is larger in our three main technology areas, viz. Electronics, Instruments and Chemicals/Pharmaceuticals.

Figure 5.1.2 **Share of inventions patented without additional resources because of: 1) potential patenting of a separate invention, 2) presence of competitors in the field.**



Note: Total is computed for all patents in the 30 technological classes.

Cumulative inventions

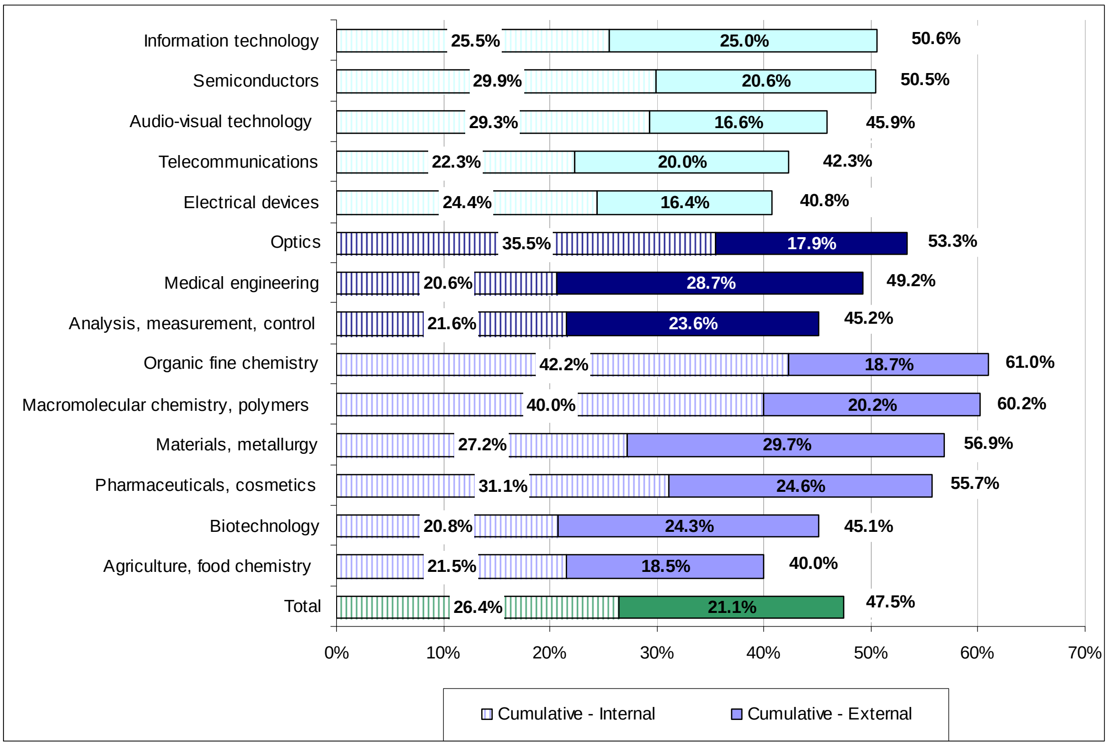
The final set of indicators in this section examines whether the patented invention is "cumulative", in the sense that it builds on previous inventions developed within the applicant organization or by other external actors.

The PatVal-EU questionnaire asked the inventors whether the patented invention was built in a substantial way on other inventions that they knew, and, if yes, it also asked if this previous invention had been made in the same organization or not.

Figure 5.1.3 shows that almost half of the patented inventions are "cumulative" in nature. About 26% of patents build on previous inventions of the same organization ("Cumulative - Internal") while about 21% build on external inventions. It also confirms the presence of interrelated inventions, mainly internal, in Chemicals/Pharmaceuticals, as we observed in the case of patent families and separate inventions. Between 55 and 61 % of patents are cumulative in Chemicals/Pharmaceuticals, with the exception of *Biotechnology* and *Agriculture, Food*. In all these areas patents build on internal inventions, but the linkages with external inventions are frequent in *Materials, Metallurgy* and in *Pharmaceuticals, Cosmetics*.

In Electronics the largest percentages of cumulative inventions are in *Information Technology* and *Semiconductors*. In *Audiovisual Technologies* the share of patents that build on internal inventions is also high. In Instruments, *Optics* shows large shares of cumulative inventions, both internal and external, while in *Medical Engineering* patents mainly build on external inventions (28.7%).

Figure 5.1.3 Share of cumulative inventions: Internal and external



Note: Total is computed for all patents in the 30 technological classes.

Size of patent applicants

The information on the size of companies identifies technical fields dominated by large firms and where anti-competitive or collusive behaviors is more likely to take place, as well as fields populated by small firms. This data complements the analysis developed in Section 4.3.1.1 on the concentration of technology areas.

We report the average size of firm patentees by technology area in terms of their number of employees, and the share of large, medium and small firms. We obtained data on the number of employees by matching the name of the firm applicants in the PatVal -EU survey with the Amadeus and Compustat databases (years 1993 -1998). Applicant firms were first consolidated at the level of the parent company by using the Who Owns Whom 1997 database.

Table 5.1.1 **Size of patent applicants by technology area**

	Average number of employees	Large Firm (>250 empl.)	Medium Firm (100-250 empl.)	Small Firm (<100 empl.)
Electronics				
Electrical Devices	**140342**	**86.4%**	5.2%	8.4%
Audiovisual Technology	**146770**	**88.3%**	3.6%	8.1%
Telecommunications	**147506**	**96.7%**	1.3%	2.0%
Information Technology	**115051**	**87.6%**	3.1%	9.2%
Semiconductors	**178187**	**95.1%**	0.0%	4.9%
Instruments				
Optics	**113732**	**89.2%**	4.7%	6.2%
Analysis, Measurement, Control	**102950**	81.1%	**7.2%**	**11.6%**
Medical Engineering	25316	62.7%	3.8%	**33.5%**
Chemicals / Pharmaceuticals				
Organic Fine Chemistry	66003	**93.7%**	1.7%	4.6%
Macromolecular Chemistry, Polymers	74192	**92.6%**	3.4%	4.0%
Pharmaceuticals, Cosmetics	36272	78.9%	6.0%	**15.2%**
Biotechnology	49777	79.2%	2.1%	**18.7%**
Materials, Metallurgy	56858	**92.2%**	2.9%	4.9%
Agriculture, Food Chemistry	**97230**	73.6%	**13.3%**	**13.1%**
Total average (30 tech classes)	75774	81.8%	7.0%	11.3%

Note: Values above the total average are reported in bold. Total average is computed for all patents in the 30 technological classes.

Table 5.1.1 shows that the average number of employees in th e total sample is about 75,000. the large firms cover 81.8% of our patentees, while 7% are medium firms and 11.3 % are small firms. Differences by technical classes are sizable:

- In all technical areas within Electronics the average number of employees is very large and consistently the share of large firms is high. It is the largest in *Telecommunications* and *Semiconductors* in which the percentages of large firms are respectively 96.7 % and 95.1%.
- In Instruments the average number of employees is high in *Optics* and *Analysis, measurement, control*. By contrast, it is low in *Medical Engineering*, where it is the smallest across all 30 technological classes. Consistently, the share of small firms is largest (33.5 %).
- In Chemical / Pharmaceuticals the average size of employees is smaller than the average in all technical fields with the exception of *Agriculture, Food*. The percentages of small and medium firms are high in *Pharmaceutical, cosmetics*, *Biotechnology*, *Agriculture and Food*.

Table 5.1.2 summarizes our findings on patents and related inventions and on the size of patent applicants by technical areas.

Table 5.1.2 **Summary of results regarding patents and related inventions and the size of patentees**

	Patent family	Size of family	Separate invention	Competitors in the field	Cumulative internal	Cumulative external	Size of patentees
Electronics							
Electrical Devices	-	-	-	-	-	-	+++
Audiovisual Technology	+	++	++	+	+	-	+++
Telecommunications	-	+	+	o	-	-	+++
Information Technology	+	-	+++	+	-	+	++
Semiconductors	-	+	++	-	+	-	+++
Instruments							
Optics	+	+	+++	+	++	-	++
Analysis, Measurement, Control	-	-	-	-	-	+	++
Medical Engineering	-	-	-	o	-	++	---
Chemicals / Pharmaceuticals							
Organic Fine Chemistry	++	+	+++	o	++	-	-
Macromolecular Chem., Polymers	++	+	+++	-	++	-	o
Pharmaceuticals, Cosmetics	+	+	+	+	+	+	--
Biotechnology	+	-	-	+	-	+	--
Materials, Metallurgy	+	-	+	+	+	++	-
Agriculture, Food Chemistry	-	-	-	+	-	-	+/--

Table 5.1.2 shows that there are important differences in firm size between Electronics and Instruments, Chemicals/Pharmaceuticals. Furthermore, we have found that patent families and cumulative inventions are most important in Chemicals /Pharmaceuticals. Nonetheless the incentive to generate additional separate inventions is strong across all three main areas. However, this incentive is restricted to specific technology areas such as Information Technology or Organic Fine Chemistry.

X-References and economic/strategic value of patents

Another precondition suggesting strategic patenting behavior is the share of X-References per patent. In section 4.3.2 we showed that the share of X-References, which suggests that patents may not be that novel, is increasing per patent and more importantly per claim. A higher proportion of X-References may then reflect strategic behavior because it indicates that firms are pursuing a strategy of building portfolios made up of more marginal patents.

Table 5.1.3 X-References in Top 25% and Bottom 75% patents for economic and strategic value

	Share of X-references Top25 (1)	Share of X-references Bottom75 (2)	Difference (2)-(1)	Number X-references per claim Top25 (3)	Number X-references per claim Bottom75 (4)	Difference (4)-(3)
Electronics						
Electrical devices	0.151	0.137	0.014	0.078	0.078	*0.001*
Audio-visual technology	**0.216**	**0.197**	0.018	0.099	0.084	*0.015*
Telecommunications	**0.187**	0.137	0.050	0.059	0.053	*0.006*
Information technology	**0.194**	0.173	0.022	0.069	0.057	*0.012*
Semiconductors	**0.400**	0.127	0.273	**0.217**	0.093	*0.124*
Instruments						
Optics	**0.229**	**0.201**	0.027	0.097	0.076	*0.021*
Analysis, measurement, control	0.139	0.127	0.013	0.062	0.069	*-0.007*
Medical engineering	0.127	**0.201**	-0.074	**0.166**	0.097	*0.068*
Chemicals / Pharmaceuticals						
Organic fine chemistry	0.166	**0.206**	-0.040	0.076	0.079	*-0.003*
Macromolecular chemistry, polymers	**0.269**	**0.237**	0.031	**0.110**	**0.114**	*-0.004*
Pharmaceuticals, cosmetics	**0.299**	**0.283**	0.016	**0.292**	**0.107**	*0.185*
Biotechnology	**0.442**	**0.218**	0.224	0.046	0.066	*-0.020*
Materials, metallurgy	0.151	0.166	-0.015	**0.112**	0.099	*0.012*
Agriculture, food chemistry	**0.347**	**0.256**	0.091	**0.173**	**0.215**	*-0.042*
Total average (30 tech classes)	**0.180**	**0.174**	0.006	**0.109**	**0.100**	**0.009**

Note: Values above the total average are reported in bold. Total average is computed for all patents in the 30 technological classes.

As a first check of the association between share of X-References and strategic uses of patents we investigate if the share of X-References and the number of X-References per claim are greater for patents with high or low economic and strategic value [82].

To compare the share of X-References in patents with high and low strategic value we use the PatVal-EU questions asking the inventors to rate, in comparison with other patents in their industry or technological field, the economic and strategic value of their patent as Top 10%, Top 25%, Top 50%, Bottom 50%.

[82] In order to verify if there is a relation between X-references and the "effort" put in the research process we checked if the share of X-References and the number of X-References per claim are greater for patents whose research process requires less man-months with respect to patents requiring higher man-months. We denoted as "low-effort" patents that required up to 6 months. We did not find a clear association across technical fields between a large share of low-effort patents and a large share of X-References or of X-References per claim. Only in some technological areas the share of X-References in low-effort patents is larger that in high-effort patents and this is more evident when we compare the number of X-References per claim in low- and high-effort patents. This pattern is observable in *Audiovisual Technology*; *Telecommunications*; *Information Technology*; *Optics*; and in most *Pharmaceutical, Cosmetics*; *Biotechnology* and *Agriculture, Food* suggesting that in these areas low effort patents are more likely to draw on less novel or original patents.

Table 5.1.3 compares the share of X-references and the number of X-references per claim in the top 25% and bottom 75% patents. In almost all the technology areas the share of X-References is larger in the top 25% than in the bottom 75% patents. The pattern is similar for the number of X-References per claim. Moreover, the differences are more marked in *Semiconductors* and *Pharmaceuticals, Cosmetics*[83].

Unfortunately we cannot distinguish between the economic and strategic value of the patents. Therefore, these indicators may only suggest that patents citing poor patents are likely to be more valuable in a broad economic or strategic sense. A better exploration of the relation between X-References is developed in the next section.

Motivations for patenting and use of patents

The PatVal-EU survey offers the unique opportunity to identify inventions that have been patented mainly for strategic reasons like blocking competitors. We can also check whether these inventions have been used for industrial or commercial purposes by the applicants.

By using this information we identify patents having *strategic uses* as the patents that have been patented for blocking competitors or for cross-licensing and that have not been used by their applicants.

We can then identify technology areas in which strategic reasons for patenting are important, and in which patents are used less intensively than in other classes. A major concern from a policy perspective is to understand whether strategic patents are used or not. In fact, strategic patents are not always harmful. If the owners are willing to use them in cross licensing agreements, patent pools or patent thickets, they may reduce fragmentation of patent ownership and thus reduce transaction costs in technology markets (Shapiro (2001)). However, firms still behave strategically by patenting as much as possible to acquire bargaining power against their partners in these agreements. If these patents are eventually used or exchanged, from a social welfare

83 These patterns are confirmed if we compare Top10% and Bottom 90% patents.

perspective anti-competitive collusive behavior can be mitigated or compensated by the increasing diffusion and use of technologies, and by more rapid technological progress stemming from innovation races among rivals (Shapiro (2001);).

Yet, patents for substitute products can be harmful for society not only because they are not used by firms, but also because they may not be used in agreements that facilitate the u se and diffusion of knowledge (Shapiro (2001)). This is often the case in discrete industries, in which patents protect substitute inventions, and firms aggressively patent around their invention to prevent that they are fenced in by competitors in their market. Firms therefore patent technologies that can be integrated in substitutes of their core products even if they do not ultimately use them (Cohen, Nelson and Walsh (2000); Reitzig (2004)).

In this section we first assess the strategic uses of p atents for different technological areas by showing the following indicators:

- the importance of strategic and other motivations for patenting;
- the proportion of unused patents, and the proportion of unused patents in which blocking competitors (that we define "Unused-Blocking") and cross-licensing are important reasons for patenting ("Unused Cross Licensing").

Second, we cross tabulate the indicators of the preconditions suggesting strategic patenting with our indicators of the *strategic uses* of patents. We carried out all combinations of our measures of relatedness across patents with the strategic uses of the patents. However in some cases, particularly for patents belonging to families and for cumulative inventions, we did not find interesting or clear-cut results and do not show them here.

With respect to the relation between size of the patent applicants and strategic uses of patents, previous work (Giuri, *et al.* (2005)) has found that large firms are less likely to use their patents, and are more likely to patent to block competitors. We do not expect that these patterns change significantly across technology areas. These results are not reproduced here.
In this section we illustrate:

- the share of used and unused patents that have or do not have related inventions that can be patented separately;
- the share of used and unused patents where competitors are active in the specific technological field of the patented invention;
- the share of X-References and the number of X-References per claim in used and unused patents, and in Unused-Blocking and Unused-Cross Licensing.

Motivations for patenting

To assess the relevance of strategic motivations for patenting we first use the PatVal -EU question that asked the inventors to rate from 0 to 5 the importance of the following motivations for patenting: commercial exploitation of the innovation, licensing, cross -licensing, prevention from imitation, and blocking competitors.

Table 5.1.4 illustrates the average importance of the motivations for patenting by technical areas. On average, commercial exploitation and prevention from imitation are the most important reasons for patenting, followed by blocking competitors (the average level of importance ranges between 3 and 3.8). Licensing and cross-licensing are on average less important reasons for patenting.

Table 5.1.4 **Motivations for patenting**

	Blocking competitors	Cross Licensing	Licensing	Commercial Exploitation	Prevention from Imitation
Electronics					
Electrical devices	**3.107**	**2.163**	**2.057**	3.787	**3.982**
Audiovisual technology	**3.223**	**2.808**	**2.458**	3.596	3.478
Telecommunications	**3.047**	**2.936**	**2.319**	3.327	3.339
Information technology	2.997	**2.990**	**2.510**	3.531	3.520
Semiconductors	2.800	**2.963**	**2.249**	3.344	3.578
Instruments					
Optics	**3.049**	**2.561**	**2.395**	3.650	**3.794**
Analysis, measurement, control tech.	2.790	**1.911**	**2.140**	3.665	3.652
Medical engineering	2.805	1.725	**2.170**	**3.905**	3.633
Chemicals / Pharmaceuticals					
Organic fine chemistry	**3.069**	1.729	**2.199**	**3.959**	3.541
Macromolecular chemistry, polymers	**3.056**	1.634	2.015	**3.833**	**3.894**
Pharmaceuticals, Cosmetics	**3.137**	**2.000**	**2.560**	**3.844**	3.616
Biotechnology	2.090	1.602	**2.588**	3.786	2.723
Materials, metallurgy	2.819	1.694	**2.166**	3.771	3.531
Agriculture, food chemistry	**3.376**	1.150	1.856	3.786	3.689
Total average (30 tech classes)	***3.016***	***1.792***	***2.044***	***3.795***	***3.752***

Note: Values above the total average are reported in bold. Total average is computed for all patents in the 30 technological classes.

However, there are differences across technology areas:

- Blocking competitors is a particularly important reason for patenting in *Electrical Devices*, *Audiovisual Technology*, *Telecommunications*, *Optics* and in most areas of Chemicals/Pharmaceuticals (the only exceptions are *Biotechnology* and *Materials, Metallurgy*).
- The importance of licensing is higher than average in almost all technical classes while patenting for cross licensing is particularly relevant in all Electronics areas, in *Optics*, *Analysis, Measurement, Control* and *Pharmaceuticals, Cosmetics*.
- Commercial exploitation and prevention from imitation are not particularly relevant in most technical areas. Above average values are mainly observable in the other areas not shown in this section (Mechanical Engineering, Process Engineering and Consumer goods and equipment).

Strategic use of patents

Table 5.1.5 **Used and unused patents by technical area**

	Unused	Unused *Blocking*	Unused *Cross Licensing*	Unused *Other*	Used *Blocking*	Used *Cross Licensing*
Electronics						
Electrical devices	33.0%	17.9%	**10.5%**	11.8%	**33.6%**	**14.4%**
Audio-visual technology	30.5%	13.8%	**15.2%**	9.7%	**38.2%**	**26.6%**
Telecommunications	**47.1%**	**22.7%**	**24.1%**	12.3%	25.7%	**24.8%**
Information technology	**41.4%**	18.2%	**18.1%**	**16.6%**	26.0%	**23.7%**
Semiconductors	**51.3%**	17.6%	**30.1%**	**17.5%**	17.5%	**16.9%**
Instruments						
Optics	**44.5%**	18.0%	**16.1%**	**16.2%**	28.7%	**18.2%**
Analysis, measurement, control tech.	34.3%	12.8%	**7.2%**	**17.0%**	28.2%	**12.4%**
Medical engineering	25.8%	12.8%	3.1%	12.5%	**31.2%**	**12.1%**
Chemicals / Pharmaceuticals						
Organic fine chemistry	**69.4%**	**36.2%**	**9.0%**	**30.6%**	13.7%	4.5%
Macromolecular chemistry, polymers	**46.6%**	**23.7%**	5.3%	**20.3%**	23.9%	4.7%
Pharmaceuticals, cosmetics	**45.4%**	**24.2%**	**8.2%**	**18.2%**	23.4%	**15.8%**
Biotechnology	**39.9%**	9.3%	3.1%	**30.6%**	22.3%	**15.2%**
Materials, metallurgy	**42.1%**	16.8%	**8.0%**	**19.8%**	25.8%	6.4%
Agriculture, food chemistry	31.6%	16.9%	3.4%	12.9%	**40.4%**	6.9%
Total average (30 tech classes)	**36.9%**	**18.4%**	**7.2%**	**15.6%**	**29.3%**	**9.6%**

Note: Values above the total average are reported in bold. Total average is computed for all patents in the 30 technological classes.

The previous results pointed out that strategic motivations for patenting like blocking rivals a re particularly significant in several technical areas, but did not tell us anything about the actual use of these patents. The PatVal -EU questionnaire also asked the inventors if the patent applicant used or not their patents in commercial or industrial a pplications or for licensing.

This information is used in Table 5.1.5 , which shows the proportion of unused patents, and the shares of used and unused patents when blocking competitors and c ross licensing are “important” reasons for patenting, where “imp ortant” means that inventors reported a score 4 or 5 to these reasons. We show the results on the use of patents only for blocking and c ross licensing, because in these cases strategic behavior is more likely. These are the patents that we identify as havi ng *strategic uses*. For example companies may not only hoard patents in their portfolio to block competitors, but also to increase their bargaining power for cross -licensing agreements. We finally grouped in "Unused Others" all the patents that are not used and such that the score of blocking and cross licensing is smaller than 4.

Table 5.1.5 shows different patterns across technical areas. The main findings are:

- About 37% of patents are not used on average. However, the share of unused patents is higher in *Telecommunications*; *Information Technology*; *Semiconductors*; *Optics*; *Organic Fine Chemistry*; *Macromolecular Chemistry; Polymers*; *Pharmaceuticals, Cosmetics*; *Biotechnology* and *Materials, Metallurgy*. Among these classes the share of unused patents reaches almost 70% in *Organic Fine Chemistry*. By contrast, it is the lowest in Medical engineering (25.8%), where there is a large presence of small firms who tend to use and license more their patents with respect to large firms (Gambardella, Giuri and Luzzi (2007), Giuri, *et al.* (2005)).
- Unused Blocking patents are frequent in *Organic Fine Chemistry*; *Macromolecular Chemistry; Polymers*, *Pharmaceuticals, Cosmetics*; and *Telecommunications*. Values close to the total average are observed in *Information Technology*; *Semiconductors* and *Optics*.
- We find many areas in which the share of unused patents is higher than the average when cross licensing is an important motivation for patenting. The largest share (30%) is in *Semiconductors*. This finding is in line with Hall and Ziedonis (2001) who point out that "manufacturers appeared to be 'harvesting' more of their latent inventions and explicitly 'ramping up' their patent filings in order to amass more sizeable patent portfolios". The percentages are also very high in *Telecommunications*; *Information Technology*; *Audiovisual Technology* and *Optics*.
- The share of unused patents for other reasons (which may be considered as being "sleeping" patents) is also high in many technology areas. These patents may be worthless, or may be sleeping in patent portfolios of companies that do not have the assets for investing in production activities or that are unable to license their patents even if they are willing to do it (Gambardella, Giuri and Luzzi (2007)).

Finally, we checked whether patents used for commercial exploitation or licensing score high for blocking competitors or for cross-licensing. On average the share for blocking competitors is high (29.3%), but only in *Electrical Devices*; *Audiovisual Technology*; *Medical Engineering* and *Agriculture, Food* this share is higher than the overall average. In these areas the share of unused patents and the importance of cross -licensing are also lower.

The share of patents used for commercial exploitation and in which cross licensing was an important motivation for patenting is higher than average in all the subfields in Electronics and Instruments and in *Pharmaceuticals, Cosmetics* and *Biotechnology*.

Unused patents and related inventions

An informative exercise is to compare the share of unused patents in the case of patents having related inventions that could be patented separately and of inventions patented quickly for the active presence of competitors in the specific technical field. This allows to check if this precondition for strategic patenting results in a less intensive use of patents.

The results in Table 5.1.6 show that apart from a few areas, the share of unused patents that could have separate inventions is higher than the share of patents without separate invention. This suggests that strategic behavior in patenting activities leading to separation of inventions in different patents can produce a negative impact on the actual use of the paten ts.

In unreported tables we also compare the shares of “Unused blocking” and “Unused Cross Licensing” patents that could have separate inventions respectively with the shares of “Unused blocking” and “Unused Cross Licensing” patents without a separate in ventions and these patterns are confirmed. These results also point out that this precondition for strategic patenting is in several technology areas associated to strategic uses of patents.

Table 5.1.6 Unused patents and related inventions

	Unused *No separate invention* (1)	Unused *Separate invention* (2)	Difference (2)-(1)	Unused *No competitors* (3)	Unused *Competitors* (4)	Difference (4)-(3)
Electronics						
Electrical devices	32.1%	44.0%	**11.8%**	33.3%	32.1%	**-1.2%**
Audio-visual technology	28.7%	38.8%	**10.1%**	31.9%	27.6%	-4.3%
Telecommunications	**46.3%**	**57.1%**	**10.8%**	**50.9%**	**37.7%**	-13.2%
Information technology	**40.3%**	**47.1%**	6.8%	**43.8%**	**35.9%**	-7.9%
Semiconductors	**51.1%**	**52.3%**	1.1%	**48.3%**	**60.7%**	**12.4%**
Instruments						
Optics	**49.4%**	24.7%	-24.7%	**50.4%**	33.2%	-17.3%
Analysis, measurement, control	32.6%	**52.0%**	**19.4%**	35.1%	32.5%	-2.7%
Medical engineering	25.5%	30.3%	4.8%	29.3%	19.0%	-10.2%
Chemicals / Pharmaceuticals						
Organic fine chemistry	**67.8%**	**77.2%**	**9.4%**	**71.1%**	**66.4%**	-4.7%
Macromolecular chemistry, polymers	**44.6%**	**55.4%**	**10.8%**	**47.0%**	**44.8%**	-2.2%
Pharmaceuticals, cosmetics	**45.7%**	44.1%	-1.6%	**47.7%**	**41.7%**	-6.0%
Biotechnology	**42.0%**	29.1%	-12.8%	**40.0%**	**41.4%**	**1.3%**
Materials, metallurgy	**43.2%**	33.7%	-9.4%	**42.5%**	**41.3%**	**-1.2%**
Agriculture, food chemistry	29.6%	**48.8%**	**19.2%**	36.5%	23.7%	-12.9%
Total average (30 tech classes)	**35.9%**	**44.5%**	**8.6%**	**37.2%**	**35.7%**	**-1.5%**

Note: Values above the total average are reported in bold. Total average is computed for all patents in the 30 technological classes.

By contrast the share of unused patents that are quickly patented because of the presence of competitors in the field is almost always lower than in the case in which there are less competitive pressures. This suggests that the actual use of patents may benefit from competition. The main exception here is in *Semiconductors*, where when competitors are active, firms try to obtain many patents but most often do not use them. As noted previously, it is more likely that they keep patents in their portfolio for maintaining the possibility of using them in cross -licensing agreements.

In unreported tables we compare shares of “Unused blocking” and “Unused Cross Licensing” patents in the presence of absence of competitive pressures. Results are quite interesting as they show that the share of unused patents for blocking rivals is larger when competitors are active in the technological field. The same is observable for unused patents for cross licensing. This shows that competition may produce beneficial effects on the use of patents, but when there are competitive purposes it is more likely that unused patents have strategic uses.

Table 5.1.7 Unused patents and share of X -references

	Share of X-references *Used* (1)	Share of X-references *Unused* (2)	Difference (2)-(1)	Share of X-references *Unused - Blocking* (3)	Difference (3)-(2)	Share of X-references *Unused – Cross Lic* (4)	Difference (4)-(2)
Electronics							
Electrical devices	0.133	0.139	0.006	0.125	-0.013	0.120	-0.018
Audio-visual technology	0.207	0.177	-0.030	0.101	-0.076	0.152	-0.025
Telecommunications	0.157	0.122	-0.036	0.140	0.018	0.153	0.032
Information technology	0.185	0.148	-0.037	0.227	0.079	0.167	0.019
Semiconductors	0.169	0.131	-0.037	0.088	-0.043	0.194	0.063
Instruments							
Optics	0.213	0.182	-0.031	0.163	-0.018	0.173	-0.008
Analysis, measurement, control	0.113	0.156	0.043	0.158	0.002	0.213	0.057
Medical engineering	0.174	0.195	0.021	0.186	-0.009	0.342	0.147
Chemicals / Pharmaceuticals							
Organic fine chemistry	0.197	0.197	0.000	0.178	-0.019	0.176	-0.021
Macromolecular chemistry, polymers	0.260	0.215	-0.045	0.216	0.001	0.351	0.137
Pharmaceuticals, cosmetics	0.290	0.319	0.029	0.251	-0.068	0.460	0.141
Biotechnology	0.295	0.156	-0.140	0.229	0.073	0.290	0.135
Materials, metallurgy	0.183	0.121	-0.063	0.129	0.009	0.144	0.024
Agriculture, food chemistry	0.263	0.292	0.029	0.298	0.006	0.441	0.149
Total average (30 tech areas)	**0.171**	**0.179**	**0.009**	**0.185**	**0.006**	**0.193**	**0.013**

Note: Total average is computed for all patents in the 30 technological classes.

Unused patents and X -References

We observe the difference in the share of X-References and the number of X -References per claim between used and unused patents, and between unused Blocking or Cross Licensing patents and all unused patents. The aim is to explore differences in quality of patents in unused patents. The main findings are the following:

- Only in a few classes the share of X-References in unused patents is larger than in used patents, suggesting that unused patents have lower quality (Table 5. 1.7). This is observable in *Electrical Devices*; *Analysis, Measurement, Control; Medical Engineerin; , Pharmaceuticals, Cosmetics* and *Agriculture, Food*.
- Interestingly, the share of X-References in unused patents for cross-licensing is almost always larger than in all unused patents.

- The share of X-References in unused patents for blocking competitors is larger than in all unused patents in *Information Technology*; *Semiconductors* and *Biotechnology*.

Similar results are observable in Table 5. 1.8 where we compare the number of X -References per claim in the same categories of used and unused patents.

Table 5.1.8 Unused patents and number of X-references per claim

	Number X-references per claim *Used* (1)	Number X-references per claim *Unused* (2)	Difference (2)-(1)	Number X-references per claim *Unused - Blocking* (3)	Difference (3)-(2)	Number X-references per claim *Unused – Cross Lic* (4)	Difference (4)-(2)
Electronics							
Electrical devices	0.072	0.081	0.009	0.058	-0.022	0.052	-0.029
Audio-visual technology	0.084	0.089	0.004	0.072	-0.016	0.100	0.011
Telecommunications	0.053	0.061	0.008	0.059	-0.002	0.077	0.015
Information technology	0.073	0.038	-0.034	0.057	0.019	0.045	0.006
Semiconductors	0.147	0.096	-0.050	0.108	0.012	0.143	0.047
Instruments							
Optics	0.078	0.080	0.001	0.085	0.005	0.096	0.016
Analysis, measurement, control	0.061	0.070	0.008	0.067	-0.003	0.101	0.031
Medical engineering	0.089	0.214	0.126	0.067	-0.148	0.075	-0.139
Chemicals / Pharmaceuticals							
Organic fine chemistry	0.069	0.082	0.012	0.064	-0.018	0.040	-0.042
Macromolecular chemistry, polymers	0.111	0.116	0.005	0.138	0.022	0.142	0.026
Pharmaceuticals, cosmetics	0.174	0.151	-0.024	0.070	-0.081	0.186	0.035
Biotechnology	0.057	0.050	-0.007	0.082	0.032	0.124	0.074
Materials, metallurgy	0.110	0.095	-0.015	0.152	0.057	0.060	-0.035
Agriculture, food chemistry	0.224	0.187	-0.037	0.181	-0.006	0.291	0.104
Total average (30 tech classes)	**0.099**	**0.106**	**0.007**	**0.112**	**0.006**	**0.115**	**0.008**

Note: Values above the total average are reported in bold. Total average is computed for all patents in the 30 technological classes.

Summary of findings

Table 5.1.9 reports the summary of findings on unused patents. Together with Table 5.1.2, these findings highlight, through the use of different indicators, evidence of strategic patenting in several technology areas that we investigated.

The main results are the following:

- A large share of patents protect inventions that are closely related to other inventions of the patent applicant. This may not only depend on natural technical or economic complementarities among inventions, but also on strategic separations of minor inventions into different patents.
- Low quality of patents (as measured by the share of X-References) is associated with patents that have high strategic and economic value for their owners.
- A large share of patents is not strategically used by applicants for reasons that are different in different areas: blocking competitors is main motive in Chemicals/Pharmaceuticals, increasing bargaining power against competitors is a motive for cross-licensing negotiations mainly in Electronics.
- In several technology areas inventions are less likely to be used when they are the results of strategic separations into different related patents.
- The presence of competitors in the specific field of the invention positively affects the use of patents.
- The quality of unused patented inventions that are used in cross-licensing negotiations is lower than the quality of all unused patents. This is also apparent for unused blocking patents only in a few areas.

Table 5.1.9 Summary of findings on unused patents

	Blocking competitors	Cross Licensing	Unused patents	Unused *Blocking*	Unused *Cross Licensing*	Unused *Other reasons*	Unused *Separate inventions*	Unused *Competitors in the field*	Unused *X-references*	Unused Blocking *X-references*	Unused Cross Licensing *X-references*	Share X-references Top-Bottom Value	Number X-references per claim Top-Bottom Value
Electronics													
Electrical devices	+	+	-	-	++	-	+	+	-	-	-	+	o
Audio-visual technology	+	++	-	-	+++	--	+	-	-	-	-	+	+
Telecommunications	+	++	+	+	+++	-	+	-	-	+	+	++	+
Information technology	o	+++	+	-	+++	+	-	-	-	+	+	+	+
Semiconductors	-	++	++	-	+++	+	-	+	-	-	+	++	++
Instruments													
Optics	+	++	+	-	+++	+	-	-	-	-	-	+	+
Analysis, measurement, control	-	+	-	-	o	+	+	-	+	-	+	+	o
Medical engineering	-	-	-	-	--	-	-	-	+	-	+	-	++
Chemicals / Pharmaceuticals													
Organic fine chemistry	+	-	+++	+++	+	+++	+	-	-	-	-	-	o
Macromolecular chem., polymers	+	-	+	+	-	+	+	-	-	-	+	++	o
Pharmaceuticals, cosmetics	+	+	+	+	+	+	-	-	+	-	+	+	++
Biotechnology	-	-	+	--	--	+++	-	+	-	+	+	++	-
Materials, metallurgy	-	-	+	-	+	+	-	+	-	+	+	-	+
Agriculture, food chemistry	+	--	-	-	--	-	+	-	+	+	+	++	-

We also find that the combination of these patterns varies by technology areas as summarized below:

- In **Chemicals/Pharmaceuticals** there is evidence of complementarity in patenting activities and cumulative processes of inventions that result in patents. This occurs in *Organic Fine Chemistry*, *Macromolecular Chemistry, Polymers*, and *Pharmaceuticals, Cosmetics*. All these technology areas are characterized by higher-than-average shares of small firms, suggesting that complementarity is less likely to induce anti-competitive or collusive behaviors among large firms. However, if interrelated patents are substitutes and not complements, they may represent patent thickets that may block others to enter the technical field. This is confirmed by the large share of unused patents, especially for blocking competitors. Moreover, the presence of competitors in the field seems to affect positively the speed of the patenting process and the use of the patents. In *Biotechnology* and *Agriculture, Food* there is scarce evidence of strategic separation of inventions in different patents and of blocking patents, but for blocking patents, the patent quality is lower than for less strategic patents.

- In **Electronics** patents are more frequently interrelated with other inventions of the same applicant mainly in *Audiovisual Technology* and *Information Technology*. There is also evidence of separation of inventions in different patents in *Telecommunications* and *Semiconductors* in which the size of patent families is also above average and there are many unused patents. However, in all these areas patents are mainly held unused not to block rivals, but to have the possibility to exchange them in cross-licensing agreements by very large firms. Although cross-licensing might in principle facilitate the use of patented inventions by rivals, we find that very frequently patents aimed at this purpose are often not used and they have lower quality than other unused patents.

- In **Instruments** we find two very different patterns: in *Optics* the pattern is very similar to the Electronics areas, with many interrelated patents especially within the applicant organization, a marked presence of very large firms and large percentages of unused patents for cross licensing. In *Medical engineering* we do not find evidence of strategic patenting. When patents are related to other inventions, they mainly build on inventions produced by external actors. The presence of small firms is comparatively very strong and they tend to use patents more than in other sectors mainly for commercial exploitation and for licensing.

5.1.2 A closer look at the patenting behavior of the Pharmaceutical and Cosmetics Industry

Based on the results of previous sections, the patenting behavior of the Pharmaceutical and the Cosmetics industries will be analyzed more closely. The main aim of this section is to establish whether there are differences between the patenting activities of Pharmaceuticals and Cosmetics firms. Since both types of firms are analyzed jointly in the rest of this report we attempt to separate them out here. Additionally, we discuss whether patenting activities in both industries reveal anticompetitive behavior. The Pharmaceutical and the Cosmetics industries in particular are characterized by (1) strong increases in application figures over time, (2) increasing complexity of patent applications, (3) slightly decreasing opposition activity and (4) overall decreasing patent quality. These aspects do not automatically imply increasing strategic patenting behavior. Therefore, in the following, the patenting activity and, foremost, the opposition behavior of these two industries is analyzed more closely.

Figure 4.2.3 above shows that the patent applications in Pharmaceuticals and Cosmetics grew substantially after 1985 and remained relatively stable afterwards. Nevertheless, Pharmaceuticals and Cosmetics are among the top 3 technology areas in Chemicals and Pharmaceuticals over the whole period under consideration.

Table 4.5.1 ranks firms by the average growth rate of patent applications between 1989 and 2002. As already pointed out earlier, the growth rate was calculated as the difference between application counts between 1989-1992 and 1999-2002 divided by the average number of patent applications in three years for the sample period. Results reveal that pharmaceutical and cosmetics firms are among the firms showing high growth rates.

Table 5.B.10 Ranking of selected firms by average growth of patent a pplications

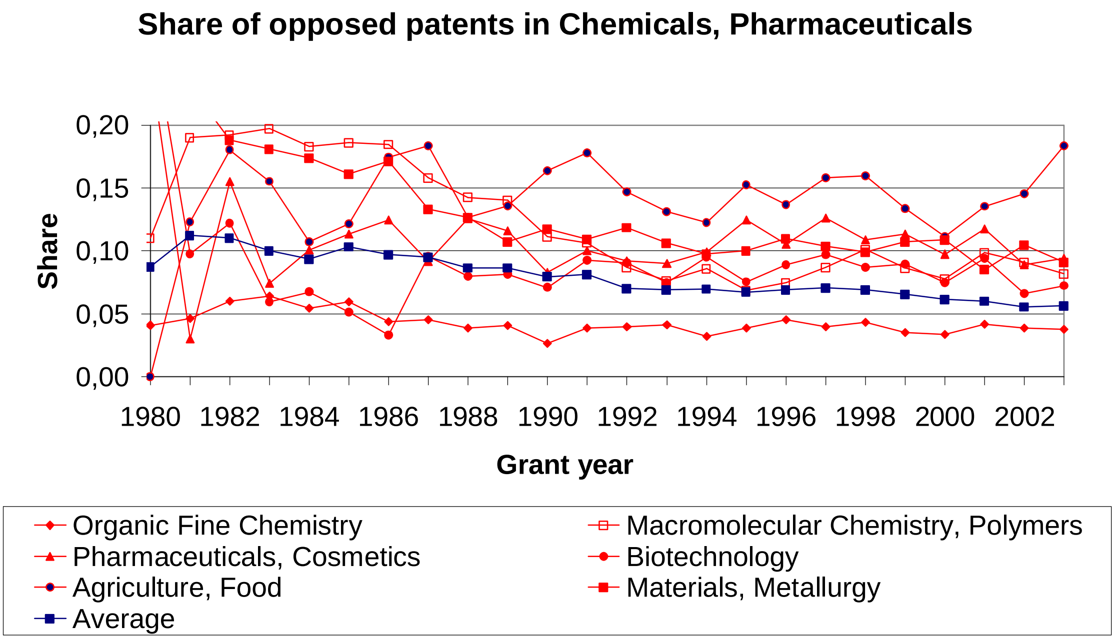
Firm name	Primary technology area	Secondary technology area	Tertiary technology area	Total appli-cations filed	Appli-cations 1989-1992	Appli-cations 1999-2002	Growth of appli-cations
Human Genome	Organic Ch.	Pharm., Cosm.	Biotech.	586,0	0,0	305,8	305,8
Infineon	Semicond.	IT	Telecom	4039,2	15,5	2249,9	135,4
Intel	IT	Telecom	Semicond.	1848,4	29,5	1037,2	33,1
Qualcomm	Telecom	IT	Analysis	1910,5	33,5	1162,5	32,7
Boston Scientific	Medical Eng.	Pharm., Cosm.	Mat. proc.	1364,3	23,0	731,3	29,5
Wyeth	Organic Ch.	Pharm., Cosm.	Biotech.	658,5	12,5	335,9	24,0
Ricoh	Optical	Telecom	Audiovisual	1706,2	39,0	885,2	21,2
Nokia	Telecom	IT	Audiovisual	6448,2	474,0	3157,7	5,7
Volkswagen	Transportation	Motors	Mech. Elements	2524,6	178,8	1084,6	5,0
Beiersdorf	Pharm., Cosm.	Medical Eng.	Polymers	992,0	68,5	406,0	4,9
BMW	Transportation	Motors	Mech. Elements	2508,7	149,2	857,9	4,7
Honda	Transportation	Motors	Mech. Elements	3693,3	271,4	1457,8	4,4
Toyota	Motors	Transportation	Mech. Elements	4744,8	326,9	1475,5	3,5
Bosch	Motors	Transportation	Analysis	13509,3	1446,5	5162,1	2,6
Philips	Telecom	Audiovisual	Energy	21970,2	2546,7	8223,8	2,2
Renault	Transportation	Motors	Mech. Elements	2137,2	202,6	649,1	2,2
Boehringer Ing.	Organic Ch.	Pharm., Cosm.	Biotech.	1295,2	180,6	537,5	2,0
Seiko Epson	Printing	Optical	IT	4148,1	500,0	1445,4	1,9
Degussa	Organic Ch.	Polymers	Materials	3674,3	428,9	1119,0	1,6
Yamaha	Motors	Cons. Goods	Transportation	1599,5	186,8	484,0	1,6
Procter & Gamble	Petrol Ch.	Medical Eng.	Pharm., Cosm.	7823,9	794,9	2047,8	1,6
Pfizer	Organic Ch.	Pharm., Cosm.	Biotech.	2745,7	367,0	924,5	1,5
Univ. of California	Pharm., Cosm.	Organic Ch.	Biotech.	1561,8	193,4	465,5	1,4

It is well known that patents play a major role in the Pharmaceutical industry. In particular, patents provide incentives to invest in R&D, which is of particular interest due to (1) high R&D expenses and costs for clinical studies and (2) since pharmaceutical products can be imitated rather easily. However, it is surprising that in t he Cosmetics industry patents also play such an important role. Table 5.1.10, for instance, shows that Beiersdorf exhibits a growth of applications comparable to BMW or Volkswagen. Procter & Gamble shows a growth rate of applications that is only slightly lower than that of Degussa and Yamaha.

Especially, since the R&D intensity in the Cosmetics industry is much lower than in the Pharmaceutical or the Automobile industries, one could assume that patents are used differently by firms active in the Cosmetic s industry compared pharmaceuticals companies. This assumption proves true when comparing the opposition behaviour of firms active in these industries.

As discussed earlier, opposition activity has been above average in almost all areas within Chemicals and Pharmaceuticals (Figure 5.1.4). During the 1980s the Pharmaceutical and Cosmetics industries are characterized by the largest share of opposed patents (between 20% and 25%). The opposition rate reached its minimum in 1995 and has again been increasing afterwards.

Figure 5.1.4



A more differentiated picture is provided by Table 5.1.11. The table contains the top 10 opponents in Pharma and Cosmetics. The opposed firms were ranked by the number of oppositions they received in total. The table shows that opposition activity is strongly concentrated among a small number of firms, both with respect to the opponents and opposed parties.

Table 5.1.101 Pharmaceuticals, Cosmetics

Opposed parties	Opposing parties: HENKEL	HOFFMANNROCHE	BASF	L'OREAL	GLAXOSMITHKLINE	MERCK	PROCTER & GAMBLE	BOEHRINGERINGELHEIM	GOLDWELL	FRESENIUS	Total
UNILEVER	39	0	0	11	2	0	9	0	4	0	65
L'OREAL	36	0	3	0	0	1	6	5	9	0	60
PROCTER & GAMBLE	30	1	0	12	6	2	0	0	4	0	55
KAOCORPORATION	23	0	1	4	0	0	1	0	0	0	29
GLAXOSMITHKLINE	8	0	1	1	1	4	1	0	0	0	16
HOFFMANNROCHE	2	0	7	1	0	1	0	2	0	0	13
J&J	0	11	1	1	0	0	0	0	0	0	13
BAYER	1	1	0	0	0	6	0	1	0	0	9
SUMITOMO	3	0	0	0	0	0	1	1	0	0	5
3M	0	0	0	0	1	0	0	0	0	0	1
Total	**142**	**13**	**13**	**30**	**10**	**14**	**18**	**9**	**17**	**0**	**266**
Share	53.38	4.89	4.89	11.28	3.76	5.26	6.77	3.38	6.39	0	100

Table 5.1.11 further shows that pharmaceutical firms oppose a more diverse set of firms than the cosmetics firms (highlighted in the table). The latter frequently oppose one another. Overall, Henkel filed the largest number of oppositions. In particular, Henkel is responsible for 50% of all oppositions filed by the top 10 opposing firms. Taking all firms into account, Henkel is still responsible for more than 30% of all oppositions. The patents of Unilev er, L'Oreal and Procter and Gamble received most of the oppositions, more than twice as much as the opposed party ranked fourth, which is KAO Corp.

These results confirm the findings of Harhoff and Hall (2003). Analyzing the opposition behavior in the Cosmetics industry, the authors find that Henkel, Goldwell and Wella account for the major part of the oppositions filed and that oppositions are mostly directed to patents of Procter & Gamble, Unilever and L'Oreal. Although, oppositions occur also between pharmaceutical companies, both, the frequency of opposition and the concentration ar e much lower.

Table 5.1.12 displays a cross -tabulation of opposed and opposing firms containing the top 14 patent holders in the cosmetics industry. The figure stems from Harhoff and Hall (2003) and comprises oppositions filed against granted patents that were filed before December 31, 1995. Oppositions are mostly directed to L'Oreal (120 oppositions received). One third of these oppositions were filed by Henkel. L'Oreal itself files 35 oppositions, interestingly, not directed to Henkel but mainly to the patents of Procter & Gamble and Unilever. The second largest opponent is Goldwell (74 oppositions filed). Again, L'Oreal, Procter & Gamble and Unilever receive most of the oppositions, i.e. 75%.

Table 5.1.12 Cross-tabulation of Opposed and Opposing Firms

Patent holder	Opponent														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**Total**
1 L'Oreal	0	6	1	39	0	25	4	3	0	0	4	0	27	11	**120**
2 Procter & Gamble	12	0	8	28	0	2	0	0	6	0	0	0	11	0	**67**
3 Unilever	10	7	0	29	0	4	0	0	4	0	0	0	18	0	**72**
4 Henkel	1	0	3	0	0	2	1	0	0	0	0	0	6	0	**13**
5 KAO	4	1	2	22	0	5	0	1	1	0	1	0	0	0	**37**
6 Wella	4	0	0	2	0	1	0	0	0	0	0	0	6	0	**13**
7 Beiersdorf	1	0	1	2	0	1	0	0	0	0	1	0	1	0	**7**
8 BASF	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**1**
9 Colgate-Palmol	0	5	1	3	0	0	0	0	0	0	0	0	1	0	**10**
10 Shiseido	0	1	0	3	0	0	0	0	0	0	0	0	1	0	**5**
11 Cognis	0	1	0	0	0	0	0	1	0	0	0	0	1	0	**3**
12 Dow Corning	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
13 Goldwell	2	0	0	7	0	6	0	0	0	0	0	0	0	0	**15**
14 Bristol-Myres	1	0	0	3	0	1	0	0	0	0	0	0	2	0	**7**
Total	**35**	**21**	**16**	**139**	**0**	**47**	**5**	**5**	**11**	**0**	**6**	**0**	**74**	**11**	**370**

Harhoff and Hall (2003) argue that more valuable patents are more likely to be attacked and that oppositions can also be a means to increase uncertainty and strategic d elay in order to weaken the position of competitors in the market. However, as Harhoff (2005) finds in an extended analysis, the most frequent opponents also have an above -average success rate in getting opposed patents invalidated. This particular finding suggests that there are distinct differences in opposition capabilities, and that the above-average frequency of attacks is caused by earlier investements in such capabilities.

These results suggest that while oppositions in the cosmetics industry may indeed be used for strategic reasons, for instance, to build a reputation of being tough on imitators or potential competitors entering the market, the success patterns suggest a different explanation. Similarly, pharmaceutical firms act rather inconspicuously in terms of anticompetitive behavior. These firms rather seem to use patents to protect their investment in R&D and act accordingly.

5.2 Assessment of firms' behaviour from a competition policy aspect

5.2.1 Comparison of the patent data analysis and survey results regarding strategic use of patents.

Here we review the results of the indicators analyzed in Section 4 of the report in light of the findings from the PatVal-EU study set out in Section 5.1.1 above.

We can separate the indicators investigated in Section 4 as follows:

- Indicators that capture overall patenting activity: counts of patent applications, information of patent grant rates, on the number of claims on each patent, on entry and exit into technology areas and on concentration of applicants;
- Indicators for the development of patent quality: information on the number of critical citations per patent and per claim;
- Indicators for strategic behaviour: information on the number of divisionals and on the number of shared priorities;
- Indicators of patent thickets: measures of the concentration of patent citat ions by cohort;
- Indicators for opposition activity: measures of the share of opposed patents and information on which type of firms are opposed.

The PatVal-EU study is particularly helpful in providing firm level information about the importance of complementarities between patents, which we emphasized in our definition of strategic patenting (Section 3.2). Additionally it is useful in providing supporting evidence about the difference in the way in which Electronics and Chemicals and Pharmaceuticals firms make use of patents.

In providing evidence about complementarities between patents the survey helps us to validate the indicators in Section 4.5.1 regarding concentration of references. We used these to try to identify technology areas in which patent thickets are likely to have arisen. We identified the following technology areas: *Telecommunications*; *Information Technology*; *Medical Engineering*; *Pharmaceuticals, Cosmetics*; and *Transport*.

In the PatVal-EU study there are several indicators which can be used to try and assess whether patent thickets are likely in a given technology area. These are the questions relating to whether firms patented in order to generate a separate invention, the share of patents which are cumulative and based on external inventions, the degree to which firms develop patents for blocking purposes and the extent to which firms have high shares of unused patents. All of these indicators jointly point to a slightly larger and more diffuse set of technology areas than our measures. All of the technology areas we have identified above are included in this set. The likelihood of a patent thicket is not so strongly supported in *Medical Engineering* by the PatVal-EU survey. In general the PatVal-EU survey provides much evidence for the fact that complementarities between patents are an important reason for the patenting activities we observe.

The survey also shows very clearly that there are important differences between firms in the Electronics main area and firms that patent in the technology areas connected to medical, pharmaceutical and chemicals research. This is very clear if we look at the questions regarding the motivation for patenting and also if we look at which types of patents go unused. The conclusion of that study draws out the most important differences between the patenting strategies pursued by firms in Electronics and in the Chemicals, Pharmaceuticals. We have also found that these areas differ, particularly when we look at the likelihood of opposition against patent applications but also when we look at the quality indicators we have constructed (X-References per claim). The quality indicator suggests that the share of claims that do not represent an inventive step is higher in Chemicals, Pharmaceuticals than in Electronics. Also the likelihood of opposition is higher. We have yet to understand how the causality between these different patterns runs. This will be a topic of future research.

5.2.2 Competition policy implications of our findings

Table 3.2 sets out the stages of the patent application process and notes which competition policy issues may be associated with each stage. Our analysis in this report represents the attempt to develop a set of indicators which will show whether patents are being used strategically and if so whether competition policy has a role to play in rectifying potential anticompetitive effects.

In general we reach the following broad conclusions:

1. There is clear evidence that firms are patenting at an increasing rate at the EPO and that this coincides in many cases with patent applications that are more complex (involve more claims) and are more questionable (have a higher number of X -References).
2. Furthermore we find clear evidence that some firms make greater use of the opportunities afforded them by the patent system to create uncertainty about their patents by making patents complex, by introducing divisional patents and by rearranging the content of patents between the stage at which patents are applied for at national patent offices and the application at the EPO (measurable via shared priorities). We interpret this as strategic behaviour where firms engage in such activities in a regular fashion (e.g. Table 4.5.17) .
3. Our firm level analysis also suggests that there are important differences between firms, depending on the technology which is being patented. Our evidence is consistent with the existence of patent portfolio races in Electronics (Hall and Ziedonis (2001)) . In the technology areas that belong to this main area firms are building up large patent portfolios and often these patents represent only minor technological innovations (viz. Table 4.5.18). However, there are also differences amongst the firms in these technology areas. We find that those which already possess large patent portfolios are less likely to patent low quality patents and that some of these firms are pursuing a strategy of greater focus of their patenting activities. The results of the PatVal -EU survey indicate that firms in these technology areas are likely to cross-license patents in order to avoid conflicts over intellectual property. This

might also explain the rather low incidence of patent opposition in these technology areas; there is less reason to oppose patents if cross -licensing reduces the likelihood that they will ever be used to exclude rivals from certain technologies.

4. In the field of Chemicals, Pharmaceuticals and in parts of Instruments we find that firms are also behaving strategically. Here the growth in patents is also noticeable. However firms in these technology areas seem to focus more on the use of patents as stumbling blocks for one another, i.e. to block. As a result opposition activity is much greater in these areas and firms are far more likely to own patents that reduce the validity of riva ls' patents (viz. Table 4.5.17).
5. Smaller applicants are likely to face more opposition from rivals in the technology areas that are more concentrated and in which patent portfolio races are taking place it seems. Our analysis of opposition suggests that op position in the following technology areas should be studied in greater detail in order to establish whether small firms are systematically disadvantaged: *Information Technology* and *Analysis, Measurement, Control* .

Are there implications for competition p olicy?

The extensive analysis of indicators based on patent data shows that there are no indicators which would show exactly where to look for anticompetitive behaviour by individual firms. We have built up a large number of indicators and sought to analyz e in detail how each indicator has developed. By themselves the indicators are all amenable to alternative interpretations. In sum they are more reliable and provide a consistent impression of firms' patenting activities.

In our view the results point to three different kinds of implication for competition policy in Europe:

1. The number of patent applications is strongly increasing, patents are often more complex and more of them are questionable. Additionally, patents are increasingly part of a set of complementary patents that jointly cover a technology. This indicates that uncertainty about the scope and validity of patents has increased. As Tom and Gilman (2003) argue uncertainty about the validity and the scope of patents affects competition policy whenever firms license patents. The rules regarding what is permissible in patent

licensing are based on a distinction between horizontal and vertical relationships between firms. In the case of a horizontal relationship the rules are more restrictive. The question whether a particular patent is valid or how far its scope extends often determines whether the firms in question are regarded to be competitors or not. Here increases in uncertainty regarding the scope of patents have direct implications for competition policy because they create more uncertainty about the application of competition policy rules.

2. The opposition mechanism at the EPO has been shown to be less effective than it was in the past. Two issues arise:
    a. Too few patents are opposed;
    b. Smaller firms seem to be opposed too often in certain technology areas.

The first issue relates directly to our conclusion above that the quality of patents has decreased. The fact that patents are not opposed frequently is adding to this problem. The analysis we have undertaken does not suggest that large firms have agreed explicitly not to oppose each other's patents. However there seems to be a tacit understanding which leads to lower opposition rates in some concentrated technology areas. It is not clear that competition policy is the right policy instrument with which to alter this state of affairs. However it is clear that competition policy makers should have a strong interest that it is changed.

We also find that opposition seems to be directed to a more dispersed and most likely smaller set of firms in a few technology areas than is true on average. Here it should be investigated whether small firms are facing barriers to entry into the patent system that are higher than in other technology areas. This is an area in which competition policy might be developed into a more forceful instrument. However, much stronger evidence than that which we have found is needed to make a case for such intervention.

3. We find that many firms patent strategically to build up patent portfolios which are used to block rivals or to negotiate with them. In our view this is a highly inefficient development which should be reined in as far as is possible. We find some evidence that firms which have built up large patent portfolios reduce the growth rate of these portfolios. Even if this were a general pattern it implies that the number of patents within

the patent system will continue to grow for quite some time and that the average quality of these patents will continue to diminish. Our literature review in Section 3 of this report has shown that large patent portfolios may be used to achieve anticompetitive aims (viz. Rubinfeld and Maness (2005)). Where this is the case competition policy should intervene. The strategic use of patent portfolios should be taken into account if it can be proven. In such cases the view that individual patents are important innovation incentives should not be given undue weight.

Overall it would be desirable if the patent system could be rebalanced in such a way as to make opposition more frequent and to raise the barriers for patent applicants somewhat.

6. Key Findings and Policy Conclusions

The European Patent Office was established in 1973 by the Convention on the Grant of European Patents (EPC). The EPO describes itself as follows. " The mission of the European Patent Office (EPO) – the patent granting authority for Europe – is to support innovation, competitiveness and economic growth for the benefit of the citizens of Europe. "[84]

This study has documented that the service provided by this patent office has undergone important changes in the past decade. These changes result in part from the way the European Patent Office operates and in part from the way in which applicants' behaviour has changed and is changing. As a consequence of these changes it is highly likely that the European Patent Office is not in a position to fulfil its mission as fully as it might in the absence of these developments.

In this chapter we reflect on the most important challenges facing the European Patent Office and the patents it administers.[85] The empirical analysis documented in Chapter 4 of this study indicates that current trends in firms' patenting behaviour are changing the uses and the value of patents for firms and for society. We summarize these developments in Section 6.1. Next we discuss the implications of these developments from a public policy perspective (Section 6.2). We draw out challenges which developments in patenting have for enterprise policies, for competition policy and for the institutions that constitute the patent system. In Section 6.3 we discuss policy measures which might be adopted in each of these areas in order to improve the effects of granting patents for society. Section 6.4 concludes.

The analysis of policy implications in this chapter is based on two general principles of economics that should guide public policy intervention in general: First, we seek to identify the source of the changes we identify within the patent system and propose policy measures that are

[84] See http://www.epo.org/about-us/office/annual-reports/2005/mission-statement.html (last visit July 9, 2007).
[85] Our policy conclusions focus on the EPO as our data analysis in Chapters 4 and 5 is based on data describing patenting at the EPO. We expect that other national patent offices in Europe are broadly affected by the same trends we observe here. Interviews with practitioners suggest that there are also differences between the national offices and the EPO.

as closely targeted to these sources as possible. [86] Second, we follow the guideline that complexity of economic incentive systems should be reduced to the minimum necessary in order to avoid unwanted side effects that arise when different parts of the incentive system interact in unforeseen ways.

In the context of this study the first principle implies that patenting behaviour which is found to be detrimental to social welfare should be addressed within the patent system if at all possible. Attempts to remedy patenting behaviour which reduces social welfare more indirectly through competition policy or enterprise policy will introduce additional complexity into the incentive structure provided by the patent system in Europe. It is highly likely that such complexity would have unforeseen and unwanted consequences. Therefore, we will focus some of our attention on policy measures which would improve the value of patents administered by the European Patent Office. Our discussion will clarify that the patent office can introduce measures which will eliminate most of the changes in firms' patenting behaviour. However such changes may not be implemented due to present governance structures at the EPO. Therefore, we also address enterprise and competition policies that can mitigate effects of strategic patenting.

6.1 Main findings

In this study we have undertaken a thorough empirical analysis of developments in the patent system administered by the European Patent Office. Our findings indicate that the patenting behaviour of firms whose production is based on specific technologies (outlined below) is being affected by an **escalation mechanism**. This means that firms are increasingly forced to increase expenditure on constructing patent portfolios which leads to higher costs of entry into technologies affected by high rates of patenting. This mechanism is discussed in greater detail in Section 3.1 .

Escalation mechanisms become effective if the returns to fixed outlays on a specific strategic variable are high. The theoretical (Chapter 3) and empirical (Chapter 4) evidence that we collect

[86] This may be taken to correspond to the *Intervention Principle* as described by Grinols (2006): " .. the most efficient way to accomplish a desired objective is to identify the margin to be influenced and impose a tax or subsidy narrowly at that margin at the minimal level needed to accomplish the objective. "

in this report indicates that expenditure on the management of intellectual property has become such a strategic variable. The race to build up patent portfolios documented by Hall and Ziedonis (2001) is one element of the process of escalation of spending on patents. So is the increase in patent litigation that we observe in the United States. This is illustrated in the report on patent system reform by the National Academy of Sciences (2004). In this report the number of patent law suits (Figure 2-3) and patent attorneys in the United States (Figure 2-4) are plotted. Both series show strong increases, indicating that the legal profession has benefited strongly from the increases in patent applications.

There is copious anecdotal evidence that large high technology firms are focusing their efforts on building stronger management capabilities for intellectual property rights. For instance, Grindley and Teece (1997) report that Texas Instruments turned to licensing revenues to make up for shortfalls in other fields. Rubinfeld and Maness (2005) report on how Yamaha concentrated on the exploitation of their patent portfolio and Parchomovsky and Wagner (2004) provide several case studies of firms constructing patent portfolios.

Where these efforts are leading to better utilization of underutilized patents, this will be a productive activity. However, the investigation by the Federal Trade Commission Federal Trade Commission (2003) into the patent system in the United States showed that many practitioners believe these efforts to be excessive. The following quote from the hearings illustrates this view:

"*My observation is that patents have not been a positive force in stimulating innovation at Cisco. Competition has been the motivator; bringing new products to market in a timely manner is critical. Everything we have done to create new products would have been done even if we could not obtain patents on the innovations and inventions contained in these products. ….. The only practical response to this problem of unintentional and sometimes unavoidable patent infringement is to file hundreds of patents each year ourselves, so that we can have something to bring to the table in cross-licensing negotiations. …..The time and money we spend on patent filings, prosecution, and maintenance, litigation and licensing could be better spent on product development and research leading to more innovation.* "

Quotation from statement by Robert Barr, formerly Cisco Patent Counsel at the FTC hearings in 2002.

In the context of the patent system in Europe we identify factors which suggest that many firms are over-investing in patent management in response to inefficiencies inherent in the patent system itself.

As we show in Chapter 4, the European Patent Office is currently affected by an explosion of patenting activity as well as increases in strategic patenting behaviour. These developments are concentrated on a few technologies, specifically: *Telecommunications, Information Technology, Audiovisual Technology, Medical Engineering, Pharmaceuticals and Cosmetics, Biotechnology and Transport*. Empirical analysis of this phenomenon reveals that firms in affected industries recognize the need to grow their patent portfolios in or der to compete with their rivals. For the United States, this mechanism is identified by Hall and Ziedonis (2001) and Ziedonis (2004b). It is further confirmed by Schankerman and Noel (2006) and Hall and Macgarvi e (2006). The evidence presented in Chapter 4 (e.g. Table 4.5.13) is consistent with the operation of such a mechanism within the patent system administered by the European Patent Office. The table shows that many of the more important patent applicants i n the technology areas cited above have grown their patent portfolios significantly between 1989 -1992 and 1999-2002. Additionally, our interviews with several important patent applicants from Germany support this view.

Chapter 4 also shows that specific strategic behaviour in the application process is increasing. Not only do firms make patent s more comprehensive, longer and more complicated by adding claims (4.2.3). They also increase the number of divisional patents (4.3.3.2) and the number of patents that share the same priority (4.3.3.3). Both of these measures provide an indication that patent applicants are making it more difficult for rivals to determine the precise content of their patents and thereby the degree of protection which firms will enjoy . Box 1 below provides two specific examples of patent filings that exemplify this development.

Patent portfolio races which lead to competition by many firms for larger patent portfolios resemble an arms race. The management of patent portfolios for stra tegic purposes requires important fixed outlays in legal expertise. In industries where patent portfolios have become important, these outlays, respectively the resulting patent portfolios, provide strategic advantage over time as they will constitute a barrier to participation for competitors.

Box 1 – Extreme applications

Case1 – WO2005/051444 A2

This application is belongs to a group of 7 PCT-applications which are all characterized by a particularly large number of claims. The PCT-application WO2005/051444 A2 contains a total of 19,368 claims, WO2005/046746 A2 a total of 10,247 claims and WO 2005/046747 contains 1,738 claims. The remaining four applications also contain more than 1,000 claims each.

The applicant filed more than 50 USPTO patent applications based on these 7 WO/ PCT applications and reduced the number of claims per USPTO application significantly (about 100 claims per USPTO application). For example, in the case of the USPTO application US2005/0182468 which originally contained 13,305 claims, the USPTO fee for additional claims totaled to 1,3 billion USD. As consequence the applicant reduced the number of claims to less than 70.

The EPO declined to examine the application WO2005/051444 ("no search decision"). However, a "no search decision" enables the applicant to derive priority rights from their filing until a reduction of the number of claims takes place and an examination by the EPO is finally initiated. This situation is advantageous to the applicant as it enables them to defer search and examination processes as well as opening the possibility for a division of the application in a number of separate applications. Moreover, this application might become a viable starting point in suing other applicants infringing a critical claim (hidden in 19,368 claims).

Case 2 – US19920991074

Based on the USPTO priority filing US19920991074 (Set Top Terminal for Cable Television Delivery Systems, 91 claims, 183 pages) a total of 7 separate applications had been filed at the EPO. All 7 applications were granted by the EPO. More over, the applicant divided these applications leading to an additional 16 divisional patent applications. Three of these divisional filings were again divided. Hence, one priority filing led to 26 EPO patent applications (18 thereof granted so far).

There is some evidence in the literature Lerner (1995), Lanjouw and Schankerman (2001), Lanjouw and Schankerman (2004) that such barriers to participation have particularly strong impacts on SMEs. Patent portfolio races advantage firms which have the organizational capability to obtain large numbers of patents and to ensure that these patents are enforced through the courts or opposition proceedings.

Previous research on patenting activity in the United States and in Europe (Hall and Ziedonis (2001)) does not suggest that the competition to increase patent portfolios is leading firms to increase spending on research and or development. Rather, this process is operating mainly through spending on legal and administrative capabilities. As we set out in more detail below (Section 6.2) the escalation mechanism operating within the patent system administered by the EPO is unlikely to be welfare enhancing. We conclude that policy intervention to curb this development is highly desirable.

Our analysis of the patent system in Chapter 4 demonstrates that firms' patenting behaviour in many technology areas remains unaffected by the logic of patent portfolio races. However, in those technology areas which are affected by this logic, the problem is serious. This finding, points to an important conclusion: any policies that are adopted in response to the patenting explosion should be targeted at specific sectors or technical fields if they cannot be targeted directly at the underlying causes of specific problems within the patent system itself.

In this section we review the evidence we provide in Chapters 3 and 4 which supports our conclusion that an escalation mechanism is operating within the European patent system.

Evidence of strategic patenting

Our empirical analysis contained in Chapters 4 and 5 of this study gives rise to the following observations:

1. There has been a very **large increase in the volume** of patent applications. This increase in volume has the direct effect of greatly increasing the workload for the European Patent

Office. The increase in volumes that we observe is a confirmation of research by Archontopoulos, *et al.* (2007) and Zeebroek, Guellec and Pottelsberghe (2006). In particular we find that:

i. Patent applications have increases strongly in the following technology areas: *Telecommunications; Electrical devices; Information technology; Analysis, Measurement and Control; Pharmaceuticals, Cosmetics; Organic fine chemistry; Biotechnology; Agricultural and Food Machinery; Transport*.
ii. The number of claims per patent has increased strongly in the following technology areas: *Information technology; Pharmaceuticals, Cosmetics; Organic fine chemistry; Biotechnology*. These technology areas are a proper subset of those in which patent applications rose strongly.
iii. The number of divisional applications has increased very strongly in the following technology areas: *Telecommunications; Information technology; Audiovisual technology; Medical engineering; Pharmaceuticals, Cosmetics; Biotechnology; Agricultural and Food Machinery; Handling and printing*. This set of technology areas overlaps partly with those characterized b y strong growth of patent applications.

2. There is an increase in the use of **patenting strategies** which make patent applications more **complex** and decrease the transparency of firms' patenting strategies:

i. Increased complexity derives partly from the length of a patent and from the number of claims made on a patent. We list the technology areas affected by increased complexity in this sense under 1.ii above.
ii. Rival firms will find it harder to determine the extent of protection enjoyed by a patent applicant if the applicant makes frequent use of divisional applications. The technology areas affected by complexity in this sense are listed at 1.iii above.
iii. Finally complexity also increases if the applicant applies for very similar patents at the EPO. We measure th is using the share of patents with shared priorities. Our results show that this practice is frequently used in the

following technology areas: *Pharmaceuticals, Cosmetics; Organic fine chemistry*.

3. The **quality of patent applications** in certain technology areas and by specific firms has **decreased noticeably**. We attach the interpretation that quality decreased to measures of novelty or inventive step incorporated in patent application documents. This interpretation is supported by independent evidence from inside the European Patent Office – compare footnote 1. We also interpret the decrease of the rate of oppositions to granted patents in several technology areas as troubling. In view of the general upward trend of the share of critical references to patents per claim (4.3.2) it is highly likely that the decline of opposition is contributing further to a reduction in the quality of patents granted by the EPO. In summary we find that:
    i. Our measures of quality of patent applications (share of critical references per claim) in technology areas show that quality thus measured declined significantly, relative to a declining overall trend, in the following technology areas: *Semiconductors; Medical engineering*; *Pharmaceuticals, Cosmetics; Organic fine chemistry*.
    ii. Our measures of opposition activity in the technology areas show that opposition declined significantly in the following technology areas: *Telecommunications; Information technology; Semiconductors; Audiovisual technology; Optics; Organic fine chemistry; Space Technology, weapons.*
    iii. It is important to note that opposition activity did not decrease (in contrast to the general trend) in the following technology areas noted at 3.1 above: *Pharmaceuticals and Cosmetics.* This indicates that here opposition activity may be helping to undo the problem of a decrease in the strictness of patent examination at the EPO.

4. Firms that are patenting more heavily adopt one of **two distinct patenting strategies**: the first focuses on the use of patents as bargaining chips, the second focuses on the use of patents as blocking devices. Firms adopt these strategies depending on which type of

technology area they patent in. This provides confirmation that the strength of complementarities between patents determines firms' patenting behavio ur.

i. Our firm level analysis in Chapter 4 shows clearly that blocking patents are most important for firms in the following technology areas: *Pharmaceuticals*, *Cosmetics*; *Organic chemistry* and *Medical engineering*. We discuss this finding in Section 4.5.3, co mpare also Table 4.5.17. This finding is supported by the results of our analysis of the PATVAL data in Chapter 5. In particular, Table 5.1.4 shows that cross -licensing does not matter for firms in these technology areas very much (in comparison to firms from the main area Electronics), whereas licensing and commercial exploitation do. The high level of opposition activity in these technology areas (noted above in 3.iii, not the case for Organic chemistry) also fits in with this patenting strategy. If firms do not cross-license very much it matters more to prevent rivals' blocking patents from remaining on the patent register.

ii. Our case study analysis in Chapter 5 shows that the use of patents as bargaining chips matters most for firms in the main area Electr onics. This can be most clearly demonstrated in Table 5.1.4. Additionally, we find that firms from this group dominate the group of firms that patented most heavily in the period 1999-2002 and whose patent portfolios grew fastest over the period 1990-2000. This is documented in Tables 4.5.13 and 4.5.14 in the firm level analysis in Section 4.5.3 of Chapter 4.

From these observations we conclude that in many technical areas, firms are increasing the degree to which they patent for strategic reasons. Indep endently of the particular patenting strategy adopted, firms are under pressure to build up larger patent portfolios in order to by able to keep up with their direct competitors in technology markets. This type of behaviour is consistent with an escalation of spending on patents. It does not imply a higher rate of innovation, nor does it indicate that innovation efforts have increased.

6.2 Implications of findings

Our investigation of patenting behaviour in Europe demonstrates that firms dependent on specific technologies are building large patent portfolios in a process of patent portfolio racing. We argued above that this development is an instance of an escalation mechanism. Such mechanisms have been previously identified to affect the increase in R&D outlays or advertising spending in specific industries.[87] Escalation of spending on fixed outlays has the implication that industries become more concentrated as barriers to entry increase.

In the context of spending on patenting portfolios the welfare effects of the escalation mechanism are quite clear. Costs of competition to build large patent portfolios derive from increased transactions costs affecting all firms that patent in a technology area affected by such competition. Additionally, the substantial increase in patent applications that is associated with the escalation of spending on patenting leads to increased backlogs at patent offices – this is certainly true of the EPO as Archontopoulos, et al. (2007) show in Figure 2 of their paper. Uncertainty about the extent of patent protection enjoyed by firms increases as the speed decreases with which a patent office processes patent applications. This in turn affects firms' incentives to innovate, to the extent that these incentives depend on obtaining patent protection. It may also reduce the effort which patent offices put into the scrutiny of each patent application and thereby contribute to a decrease in the quality of the average granted patent. Such decreases in patent quality, which signal a lower patentability threshold, may increase the level of patent applications as more marginal inventions are put forward by applicants. Thus the inelastic supply of examination capacity and of legal expertise together with increased demand for examinations caused by the escalation mechanism may lead to a feedback loop which leads to steadily decreasing quality of granted patents.[88]

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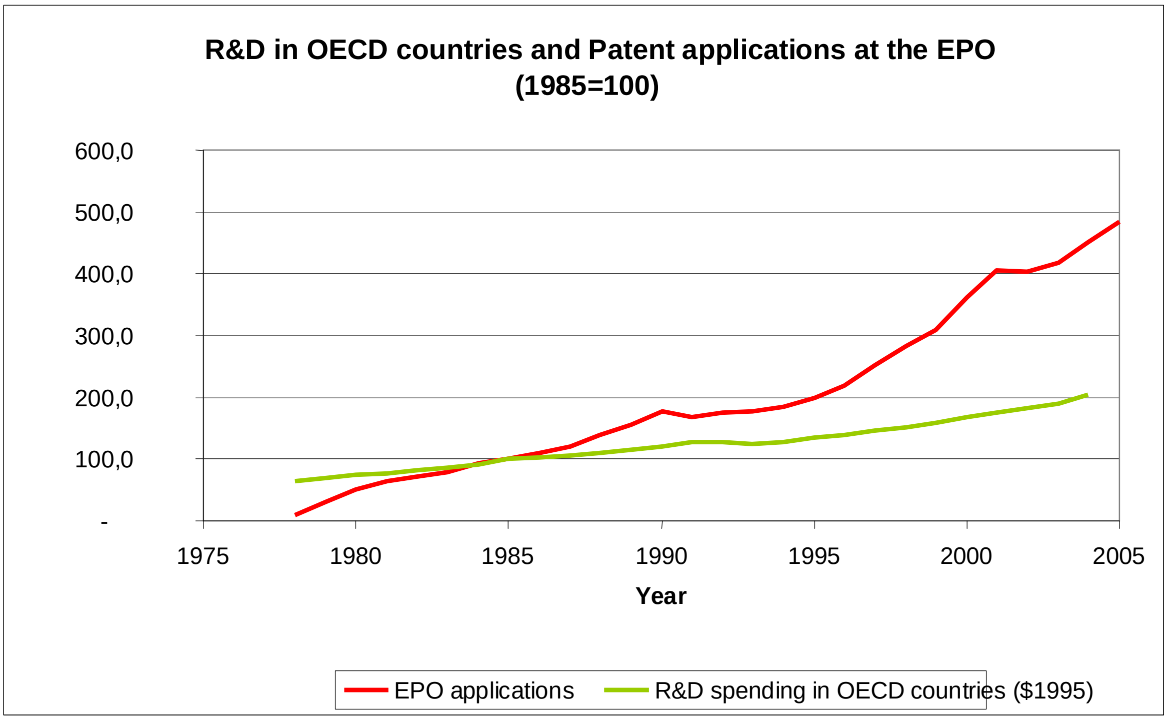
[87] The pioneering work undertaken on such mechanisms by John Sutton (1991, (1998, (2002) has recently found additional support in the work of Siotis and Marin (2004).

[88] The problem of decreasing quality of patents granted by the EPO is highlighted by comments from a recent internal report at the EPO (Epo (2007)). The report states: "There is a strong belief amongst staff that the financial benefits to the Member States arising from the renewal fees motivate the Administrative Council, and consequently the EPO administration, to focus on the quantity rather than the quality of the granted patents."

Which benefits does increased expenditure on the management of patents provide in the context of the patenting explosion? There is no evidence that an escalation of expenditure on building patent portfolios is leading to more spending on innovation in Europe. The growth of patent applications and –grants at the EPO has outstripped the growth of R&D spending in OECD countries. This is demonstrated in Figure 6.1 below.

Figure 6.1



Source: EPO Annual reports (various years) as well as own calculations based on the EPOLINE-Data provided by the European Patent Office.

Figure 6.1 shows that patent applications at the EPO grew from 70.955 to 145.241 (Corresponding to an annual growth rate of 7,4%), whilst real expenditure on R&D (relative to 1995) grew from $398 to $555 billion (corresponding to an annual growth rate of 3,4%). This implies that the number of applications is growing twice as fast as aggregate R&D investments. Studies of comparable trends in the United States (Hall and Ziedonis (2001) and Ziedonis and Hall (2001)) have shown that this development is not the result of greater R&D productivity but reflects changes in firms' patenting activities.

Preliminary evidence from ongoing research by Hall, Thoma and Torrisi (2006) suggests that the average ratio of patent applications at EPO to R&D expenditure per firm in different industries has increased between 1991 and 2000. This is further evidence that the aggregate trend illustrated in Figure 6.1. reflects developments at the firm level.

Escalation mechanisms increase the costs of participating in a market. In the context of patenting the increase in patent portfolios is leading to higher costs of competing against rivals in those technology areas in which patent portfolios are being ramped up. Our analysis of entry and exit rates as well as of C4 concentration rates for those technology areas in which patent applications grew very strongly shows little evidence that the patent portfolio races we uncover are affecting concentration or entry and exit into technology areas at present (4.3.1.1 and 4.3.1.2). Whether there is an effect in the product markets is impossible for us to determine using our data sources. This finding can be explained if the patentability threshold at the EPO is decreasing. Such lower thresholds will induce increases in patent applications, counteracting the effects of patent portfolio races that would lead to concentration of patenting amongst fewer firms.

Therefore, the main social cost of the escalation mechanism leading to firms ramping up their patent portfolios is to overload the patent office with applications, to increase the duration of examination and lower the novelty embodied in granted patents. These developments cannot be in the interest of society as they increase the likelihood that markets are monopolized even though firms have not provided society with innovations.

If aggregate R&D investments have not increased and the productivity of patenting is also not improving it must be the case that the escalation of expenditure on patenting has led to increases in efficiency and effectiveness of firms' intellectual property departments. Investments in these departments may well deliver benefits where they lead to better exploitation of patent rights owned by firms. Presently, there is no evidence that the benefits that are available from such efficiency gains are large enough to outweigh the tangible costs of inefficiencies in patenting which are discussed above.

Therefore, we conclude that there is ample evidence that strategic patenting behaviour, such as we have documented it in this study, is having effects on firms' behaviour that are highly likely welfare decreasing. Most importantly we can see that these developments are affecting the ability of the European Patent Office to fulfil its mission. We now turn to a review of policy responses that are available to weaken the incentive mechanisms leading to the observed escalation in spending on patenting.

6.3 Policy responses

The growing importance of patent portfolios for firms in specific technology areas has bee clearly documented in Chapter 4. In this section we focus on policy measures that could be adopted to reduce socially costly impacts of these developments that we anticipate (Section 6.2). In keeping with the Intervention Principle these policy measures are always focused on specific goals which we outline below. In this way we seek to identify precisely how the different policy measures we outline will contribute to an improvement of the challenge posed by increased strategic patenting in Europe.

The tender document requested that we focus specifically on enterprise and competition policy measures. Therefore we begin by discussing policy measures outside of the patent system that can complement attempts from within the patent system to weaken the escalation mechanism we identify. However, we note that the latter policy measures are likely to be far more effective and efficient in weakening the escalation mechanism.

6.3.1 Enterprise Policies

Strategic use of patents challenges smaller firms if the escalation mechanism is in effect. These firms will find it difficult to match the legal and administrative clout of firms owning large patent portfolios. Where firms owning large patent portfolios derive advantages mainly from patent portfolios that consist of patents with low or questionable novelty, support for smaller firms seems warranted. The problem that enterprise policies directed at smaller firms will seek to rectify is the possible reduction in innovative effort by smaller firms in specific technology areas. To do this the enterprise policy must be targeted at the root of the problem. Thus enterprise policy should be targeted at the profitability of using large patent portfolios consisting of patents with questionable novelty to exclude smaller firms from certain markets.

We have found some evidence that is consistent with a negative effect of the escalation in spending on patenting overall on small firms' patenting activities (Chapter 4.5.2). Additional evidence on the effects of the patenting explosion on small firms' access to and use of patent protection should be sought. If such evidence confirms our findings, small firms will require support in making use of patent protection in those technology areas we identify as being affected by the escalation mechanism in patenting (Section 6.1.1). The need for such support derives from small firms' inability to finance patent protection to the same extent that larger firms are able to do this. Here the constraint on small firms arises if these firms are capital constrained. Any support directed to small firms on this basis should therefore be part of a larger set of policies that seek to overcome this disadvantage.

Enterprise policies directed towards the patenting explosion broadly fall into two separate groups:

1) Policies which strengthen the hand of SMEs in building up their own patent portfolios.
2) Policies which seek to support SMEs faced with patent litigation threats or concerted efforts by rivals to raise their costs of patenting and their use of patents.

Policies of the **first type** respond to the build-up of patent portfolios by larger firms by providing smaller firms with support for similar activities.

Examples would be any policy which provides extra incentives for small firms to patent, such as reductions in the costs of patent examination or in the fees charged for patent renewal. Clearly such policies fall into the remit of the patent office and we comment further on them in Section 6.3.3 below. However, equivalent policies implemented by institutions outside of the patent system such as national governments or the European Commission can be envisaged. The simplest schemes would consist of subsidies for patent applications filed by smaller firms or for the costs of preparing patent applications.

Policies of the **second type** respond to the build up of large patent portfolios by providing additional protection to smaller firms against patent litigation threats. Furthermore, they support small firms seeking to challenge low quality patents that hamper their business. Such policies are more likely to reduce the value of large patent portfolios where these are created with the intention to exclude smaller rivals. These policies may contribute to a softening of the escalation mechanism outlined above. They would do this by reducing the benefit to a ccrual of large numbers of patents with low novelty value.

Examples for this type of policy include:

1) *A centralised register of intellectual property disputes* . The European Commission is uniquely placed to collect information regarding intellectual prope rty disputes and to provide information to small businesses on how they might protect themselves against misuse of intellectual property rights. Such a register would provide the Commission with the best possible information about the incidence of problems with intellectual property rights, about their causes and about the importance of such problems for small businesses. In order for such an institution to work the Commission would need to collect information that is distributed in national courts througho ut the European Union at present. Additionally, the office housing the register might provide expert advice to small businesses on how to deal with a specific problem. A register of intellectual property disputes would provide a unique database on which to build such a service. The main benefit of this policy is to increase transparency of problems arising within the realm of intellectual property. Additionally, it might strengthen the hand of small businesses in opposing specific abuses of intellectual pro perty rights and might provide them with the ability to seek out others affected by the same problem. This would eliminate a public goods problem that arises when many parties are affected by a similar issue, each waiting for another to tackle the problem. The register could also capture excessive settlement, i.e. in cases where parties seek to keep patents in force although one of the parties has sufficient information to have the patent revoked or annulled.

2) *Patent litigation insurance*. This policy is promoted by Lanjouw and Schankerman (2004) who argue that smaller firms face systematically higher risks of being involved in patent litigation and therefore also significantly higher costs of enforcing their intellectual property. They show this using data on patent litigation from the United States. In their view risk sharing mechanisms such as patent litigation insurance might provide a mechanism that reduces the expected costs for such smaller firms of enforcing their own patents. This in turn could reduce the pressure on such smaller firms to build up patent portfolios, while simultaneously reducing the benefit of such portfolios for individual firms. The Commission has investigated the idea of patent litigation insurance before (C.J.A. Consultants (2006)). The results of the investigation and the responses from stake-holders are mixed at best. From a theoretical perspective, it is not clear to what extent patent litigation insurance could lead to adverse selection and moral hazard problems. Moreover, industry experts have voiced concerns that due informational problems, insurance rates may be too high, in particular for SMEs.

3) *Incentives for opposition*. We have documented in Chapter 4 that the rate of opposition against patents has decreased substantially over time at the European Patent Office (4.2.4). The effectiveness of the opposition procedure in correcting errors made by the examiners at the European Patent Office has been demonstrated in several studies (Hall, *et al.* (2003) and Hall and Harhoff (2004)). Therefore, the decrease in the rate of patent opposition must have the effect of leaving more questionable patents in the pool of patents granted by the European Patent Office if the intensity of examination of patents by this office has not increased. Archontopoulos, et al. (2007) confirm that patent examination intensity has not increased at the EPO. One possible explanation for the decrease in patent oppositions is a reduction in incentives for individual firms to oppose poor patents. A subsidy to firms that provide evidence showing that patents were granted erroneously and that is related to the value of the market protected by such patents could have important effects. Such a policy can be implemented by institutions outside of the patent system. In fact, for the policy to work it is important that the provision of this incentive is not

financed out of the budget of the patent office affected. Better review of low quality patents will already have negative effects on the earnings of the European Patent Office as it reduces the pool of patents from which the office derives renewal fees. If the patent office is financing an institution that decreases its revenue it may not support the effectiveness of the institution as much as it should.

4) *Peer to patent review*: The USPTO has recently opened up its patent review process to outside reviewers who can provide information on prior art affecting patents that are being examined by the USPTO (Noveck (2006)). The model of allowing third parties to provide evidence about the validity of patent applications early on is extremely attractive as it has the potential to reduce errors in the examination process. Clearly there are strategic considerations to be taken into account. It is not clear that all applicants will open their applications for peer review if they fear imitation of their patents by rivals. Nonetheless this model of collecting information from third parties for patent review is important and its application in Europe should be considered. Such a policy cannot be implemented without the support of the European Patent Office however. Therefore it can only be partly considered to be an enterprise policy. Nonetheless, the policy is also related to the suggestion we make at 1) above and is likely to benefit smaller firms in particular as it offers a lower cost mechanism to prevent poor patents from being issued.

In sum we find a role for enterprise policies that are directed at strengthening the ability of SMEs to participate in the scrutiny of intellectual property rights that are granted erroneously. If such scrutiny can be strengthened this creates incentives for patent applicants to focus their efforts on patents embodying higher novelty. This in turn can only be beneficial to society as it simultaneously reduces administrative burden created by marginal patent rights, reduces complexity of patent rights covering any given technology and promotes a greater focus on innovation in place of efforts to protect existing rents through legal obfuscation.

6.3.2 Competition Policy

Competition policy authorities have traditionally attempted to avoid actions that reduce the protection enjoyed by holders of intellectual property and most notably patent owners (Encaoua and Hollander (2001)). The main rationale underlying this behaviour has been the danger that incentives to undertake R&D provided by intellectual property rights should not be undermined by competition policy acting on a case by case basis.

In Chapter 3 of this report we made a distinction between the traditional view of patents and an analysis of patenting in complex technologies which recognizes the very different role that a patent right has there (Section 3.1.1). We argued there that in the context of complex technologies innovation incentives are not derived from individual patents. The reason being that appropriation of rents from a new complex technology cannot be achieved on the basis of individual patents. Rather firms need to secure whole patent portfolios in order to secure rents from a complex technology. This point is best illustrated by the example of Qualcomm Inc. who have derived considerable rents from their patent portfolio covering CDMA technology.

Empirical evidence suggests that firms in complex technologies view patent rights as largely irrelevant in the process of securing co mpetitive advantage (Cohen, Nelson and Walsh (2000) and Arundel (2001)). Rather firms using complex technologies prefer to rely on lead time and secrecy to secure such advantages. The importance of patent portfolios in such industries is derived mainly from their role as bargaining chips in negotiations for access to technology held by rival firms and as a defence against hold-up by such rivals or by patent trolls (Grindley and Teece (1997), Hall and Ziedonis (2001) and Shapiro (2001)).

Two implications for competition polic y follow directly from these observations:

1. Patents do not have the same role in all technology areas or for all firms. Therefore, the regulation of firms' competitive behaviour must take note of the specific role of patents in each case, if patenting beha viour forms part of an inquiry. In particular the distinction between complex and discrete technologies should be borne in mind. This finding

supports the importance of a sectoral approach to the regulation of competition as such approaches are better able to take account of the specific context of technology competition which a group of firms is engaged in.

2. In the context of a complex technology, patent rights determine which firms are able to negotiate access to or use of which technologies. This affects firms' overall profits. In this setting competition policy measures that weaken a firm's ability to exclude others from a technology on the basis of its patents may affect the overall division of rents amongst firms. However, this does not imply that the incentives to innovate, which derive from the marginal benefits a firm receives from more R&D investment are also undermined. More specifically, in those complex technologies in which firms derive rents from lead time advantages, the marginal benefit to ex tra R&D spending will derive from the additional lead time which a firm obtains by spending more. In this context patent rights may simply determine whether another firm is able to threaten hold -up of production on the basis of its own patents. Such threats of hold-up can lead to licensing contracts being signed between firms. Whether changes to such contracts, which result from interventions of a competition authority regarding the validity of patent rights or access to specific patent rights affect innovation incentives depends on the detail of the licensing contracts. If such contracts involve the exchange of access to patent portfolios and the payments of a fixed fee, then competition policy intervention into the validity of specific patents is unlikely to affect R&D incentives. This is in contrast to industries where individual patents have direct effects on firms' marginal costs of production or on the quality of service that firms may offer. In such "traditional" settings challenges to the validity of patents will affect R&D incentives directly.

From these observations follow two additional implications:

3. Our empirical analysis has shown that there are clear differences between the escalation of patent applications in the main area Electronics and in o ther technology areas (Section 6.1). We have found that patent thickets resulting from complementarities between patents are most likely in the main are Electronics, whereas strategic patenting to build

fences around own technologies and to block rivals' technologies is more concentrated in the main areas Instruments and Chemistry. These findings imply that the regulation of licensing will have particularly strong effects in particular sectors. This should be taken into account in sectoral reviews of industries whose patenting activity is connected to the main area Electronics. In such reviews the role of licensing contracts should be very carefully studied. Licensing practices are not well understood as it is difficult to obtain reliable data on licensing contracts. Licensing contracts are necessary to disentangle patent thickets and therefore have an increasingly important role to play as these thickets become larger. This role also needs to be acknowledged and taken into account when considering future modifications and reforms of the EU's Technology Transfer Block Exemption (TTBE) regulation.

4. Additional importance is added by the observation that uncertainty about the validity of patents is increasing at the EPO, due to decreasing patent quality. As Tom and Gilman (2003) note, increased uncertainty about patent validity will affect firms' ability to implement competition regulations on licensing correctly. Greater scrutiny of such practices is therefore warranted. Leaving aside the need for a careful inspection of licensing practices in various industries, increased uncertainty about the legal status of patents should also be taken into account when considering future modifications and reforms of the EU's Technology Transfer Block Exemption (TTBE) regulation. The strong distinction made in the TTBE regulation between horizontal and vertical relationships between licensor and licensee become blurred whenever the validity of a patent is uncertain. If the patent is valid, then technology transfers would fall under the provisions of the less critical vertical cases. But the loss of validity (e.g., through revocation in opposition or courts) would immediately make the transfer a horizontal one in which case the more restrictive TTBE provisions apply. A firm relying on the assumption that a valid patent exists could find itself ex post in violation of the TTBE regulation. The apparent simplicity of the distinction between vertical and horizontal transfers is no longer existent. There are apparently no simple solutions to this problem (cf. Tom and Gilman (2003)), but the increasing uncertainty regarding the validity of patents would make this topic a particularly important one for further study, both in legal and economic terms.

Finally we note that sectoral reviews which focus on the way that problematic developments we have identified in specific technology areas affect product markets would be very useful. Such studies would provide us with important insights into the concrete effects of the patent system on product market competition. In particular it would be very important to uncover whether the decreases in opposition activity together with the large increases in firm s' patent portfolios in the main are Electronics and particularly in the technology area *Telecommunications* are having detrimental effects on product market competition.

6.3.3 Patent System reform

As noted in the introduction the Intervention Principle implie s that many of the problems identified in Section 6.2 are best dealt with through policy measures within the patent system administered by the European Patent Office. Proposals as to how the European patent system ought to be reformed have been presented b y a number of policy advisory bodies, for example:

- the Advisory Council at the German Federal Ministry of Economics and Technology (Bowie) has issue a report title "Patentschutz und Innovation." [89]
- the European Parliament's Scientific Technology Options Assessment[90] group issued the draft version of a report titled " Policy options for the improvement of the European patent system".

Both reports assess potential problems in the European patent system and come to conclusions that are similar to those described in this report. However, the current report presents considerably more detailed data and empirical evidence. Both reports propose a number of reform steps that would help to alleviate the current problems at the EPO. We summarize some of these proposals briefly in order to reflect correctly and completely the current discussion.

Patent examination is cross-subsidized by fees from later stages, in particular renewal fees. This creates an immediate incentive in favour of granting patents, since the EPO and th e EPC countries profit from patent grants. Renewal fees also have very productive effects (such as

[89] The report is available at http://www.bmwi.de/BMWi/Navigation/Ministerium/beiraete,did=161984.html .

[90] See the report at http://www.europarl.europa.eu/stoa/events/workshop/20070614/background_doc_en.pdf

creating incentives to let a patent lapse). But the allocation of the fees to the patent office also creates dysfunctional incentives that need to be taken i nto account.

While it is true that a reduction of fees would help SMEs in getting access to the patent system, such fee reductions are also likely to increase the demand for strategic patenting. Therefore, a general reduction of patenting costs should not be attempted. Rather, the problem of SME access should be solved more directly, either by subsidizing patenting by SMEs or by introducing spezial fees for SME applicants. These exist in the US and apparently, there is little abuse of that system.

The governance structure of the EPO supports the negativ e incentive effect. The highest decision - making body, the Administrative Council, makes decisions regarding the examination practices of the office. Votes in the Council are cast by representatives of the EPC countries and national offices which directly profit from renewal fess which are split equally between the EPO and the respective national offices. The delegates have little incentive to vote for more stringent patent examination practices.

Criteria for granting patents should be enforced strictly and if need be, should become more demanding. It is the EPO's obligation to influence examination practice in such a way that higher hurdles w.r.t. inventive step and novelty are enforced. Intervention by the leg islative is not necessary here.

The incentives of examiners at the EPO need to be realigned. Currently, the refusal of an application causes considerably more effort, but does not get the examiner in charge the same recognition as a patent grant. As long a s such biases exist, the EP O implicitly supports a quantity-oriented patent policy.

The fee structure at the EPO should be modified such as to discour age strategic and wil fully deficient patent filings. An excessively high number of claims or of mul tiple, very similar filings should be subjected to substantial increases in fees.

Patent offices should have some leeway to correct obvious errors. Currently, the EPO cannot on its own motion correct mistakes, but has to rely on third parties to step forward and file an opposition. The President of the EPO should have the power to initiate an opposition.[91]

Control mechanisms such as opposition should be strengthened, e.g. by streamlining the process and allowing for less strategic manoeuvring and filing of extensions. We recommend that patents with high similarity should be subject to opposition under one proceeding, thus lowering the cost of attack for the opponents.

When rival patent owners are associated in a patent pool or in reciprocal licensing agreements, the incentives to oppose patent grants will be reduced. In such cases, there may be no third party whose incentives are well-aligned with those of the public at large. The report recommends introducing the position of an Ombudsman at the EPO with the right to initiate opposition proceedings. Such a function exists in German administrative courts (§ 36 VwGO).

6.4 Conclusion

This final chapter of the study provides a discussion of policy conclusions derived from a thorough empirical assessment of strategic patenting activity within the patent system administered by the EPO.

These policy conclusions affect three main areas of policy making: Enterprise - and Competition Policy as well as Patent Policy. We seek to derive policy implications that respect the Intervention Principle, i.e. that are targeted as closely as possible at the source of inefficiency within the patent system.

We summarize the main findings of our empirical analysis in Chapters 4 and 5. Drawing on this summary we conclude that specific technology areas within the patent system are affected by competition between large patenting firms to build large patent portfolios. In our view the resulting patent portfolio races lead to increases in transactions costs and socially wasteful

[91] That occurred in the case of the so-called Edinburgh patent EP 0695351. Vgl. http://www.european-patent-office.org/news/pressrel/pdf/backgr_3_d.pdf (last visit on 12.1.2007).

investments in the management of patent portfolios. We briefly discuss additional evidence in support of this view. We also discuss evidence which shows that these activities do not lead to socially desirable increases in R&D investments. Consequently we come to the conclusion that public policy should seek to reduce the incentives of large patent applicants to patent innovations of questionable novelty value.

It is our view that incentives within the patent system are currently such that firms will continue to patent heavily. Therefore, we discuss a number of changes that would improve the functioning of the patent system administered by the European Patent Office. In recognition of the fact that the European Commission is not in a position to implement such policy interventions directly we also discuss a number of independent policy measures which would complement necessary changes within the patent system administered by the European Patent Office. These policy measures include support for small and medium sized enterprises in their efforts to patent and to counteract bad patenting and patent litigation by rival firms. We also discuss changes in the practice of Competition Policy towards patents that are warranted in the context of patenting of complex technologies. It is in these technologies that we see firms patenting heavily and therefore it is here that competition policy must adapt its treatment of patent rights.

Perhaps the most salient conclusion from our work is the heterogeneity of firms patenting behavior within. We find evidence of an escalation of firms patenting activities only in a subset of the technologies covered by patent protection by the EPO. Within these technology areas we find evidence of two distinct patenting behaviors. The first being directed towards cross-licensing of patent portfolios and the second focusing more on protection of own technologies and blocking of rivals. In consequence reviews of competition and enterprise policy need to recognize the difference between technology sectors. This is best achieved in sectoral reviews that take into account the competitive interaction of firms both in technology- and product markets.

This study has provided important evidence on firms' patenting behavior based on patent data. We have made no attempt to connect patenting and product market competition. However our study provides a good indication which technology areas are important candidates for integrated studies of this kind. These will be necessary to establish whether patent portfolio races also have effects on product market competition.

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8. Appendix

8.1 Data sources and routines used

The PATSTAT and EPASYS databases

Our analysis of about the 1,76 Mio. patent applications filed at the EPO between 1978 and 2005 combines two different data bases: (i) PATSTAT and (ii) EPASYS. While PATSTAT is a publicly available database (for non-commercial use) EPASYS, is an administrative database of the EPO and not available to the public. This database is used by patent examiners and contains much confidential, procedural information. It also forms the basis of the publicly available EPOLINE and ESPACENET databases. We are grateful that the EPO provided some of the information contained in the EPASYS database like the number of claims contained in a patent application and procedural data on the patent application.

PATSTAT was developed by patent information experts at the EPO's Vienna sub-office, and includes patent data from 73 patent offices world-wide as well as post-grant data from about 40 offices. Before the existence of PATSTAT different data sets from various and disparate sources had to be matched which required extensive "cleaning" of the data at considerable cost and time. The PATSTAT dataset addresses these issues, efficiently harmonising data, resolving issues over patent family members and addressing such problems as applications from one applicant appearing under several different names. The database also contains related information on citations, procedural information and legal status, which are all of interest to statisticians. In particular, the structure of PATSTAT makes citation analyses more reliable since it allows for the identification of the original priority application of any cited patent.

Updates to the PATSTAT database are released twice a year (in March and September). For the following analyses we used the PATSTAT release of September 2006. This contained a patch in which a problem relating to applicant names was resolved.

8.2 Additional graphs and tables

8.2.1 Applications

Figure 8.2.1.1

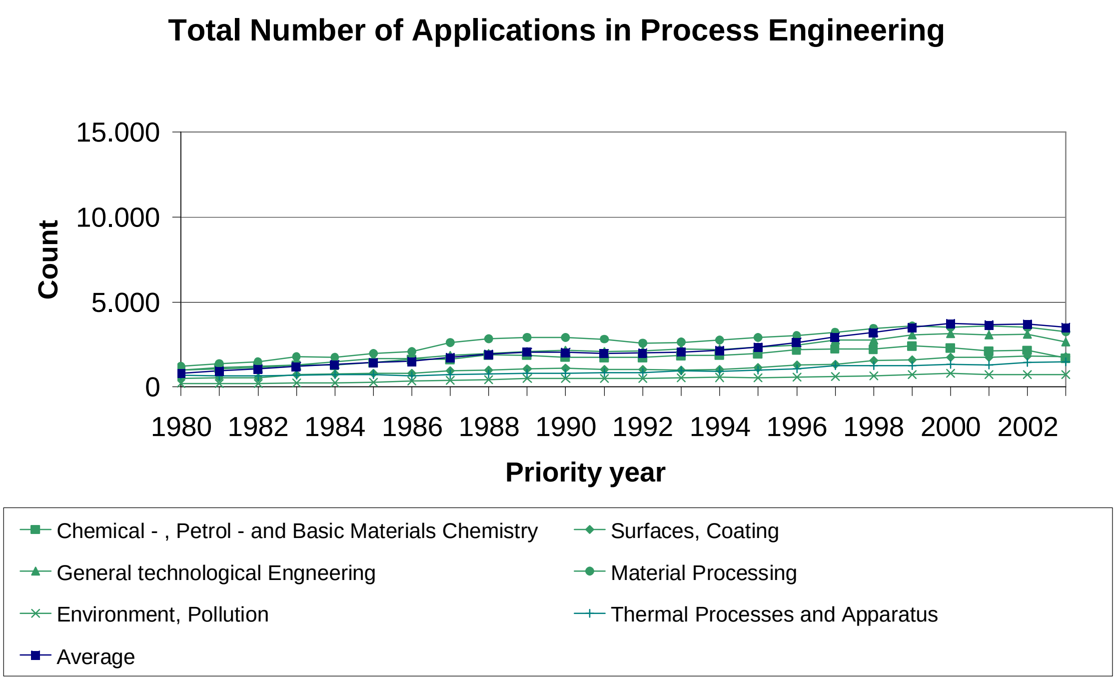
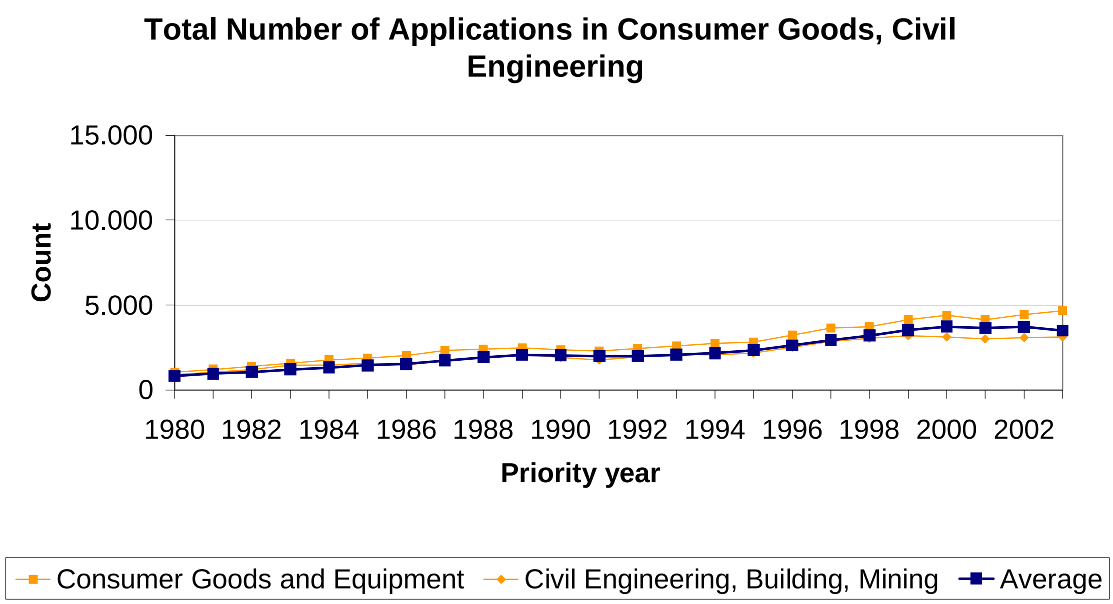


Figure 8.2.1.2



8.2.2 Grants

Figure 8.2.2.1

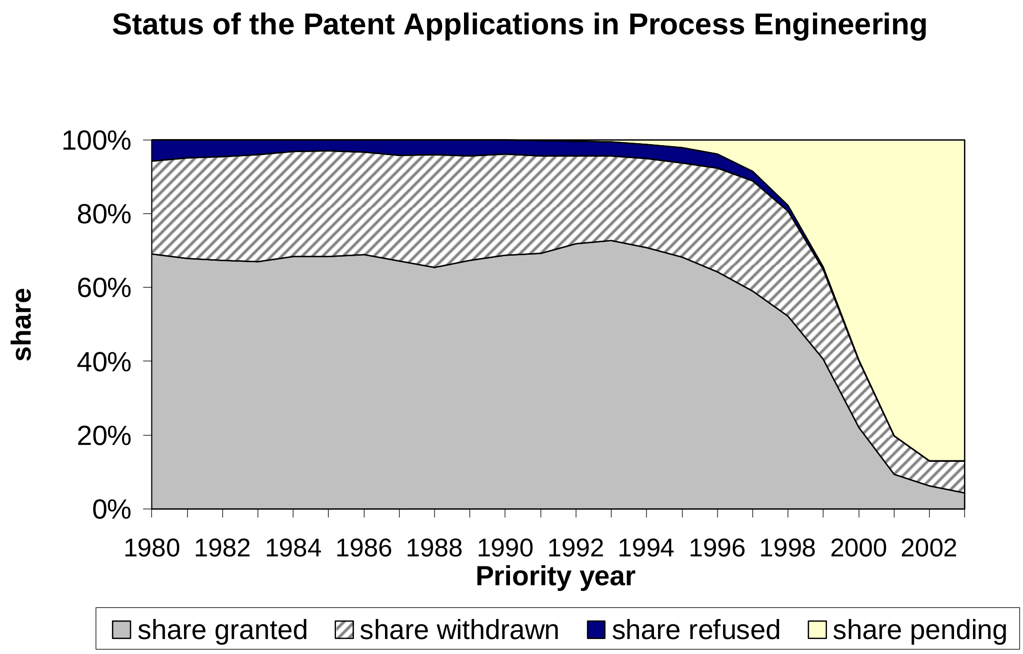
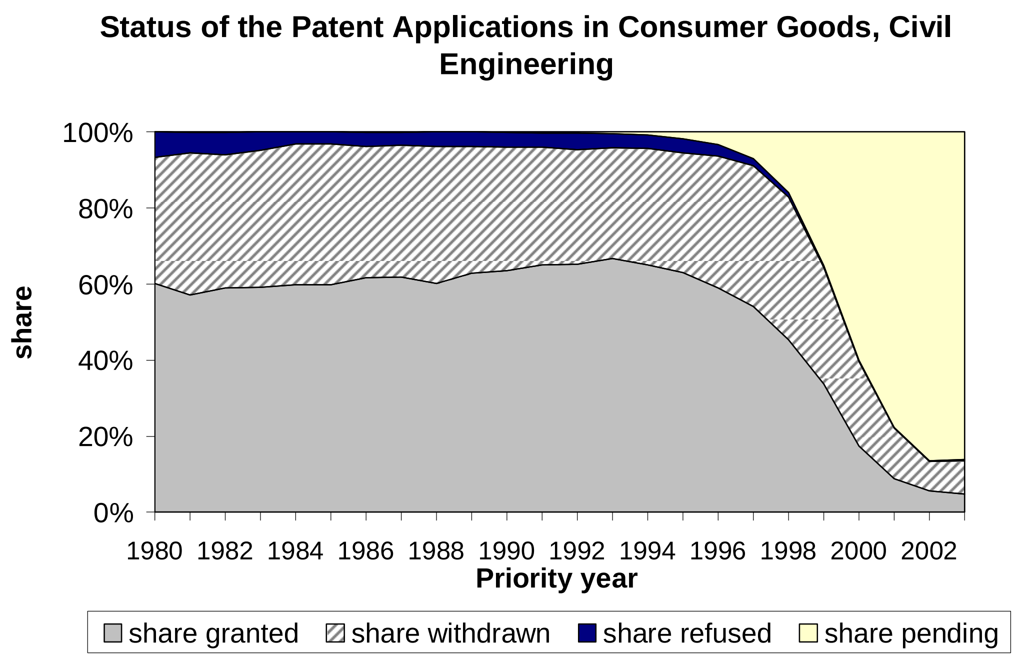


Figure 8.2.2.2



8.2.3 Claims per patent

Figure 8.2.3.1

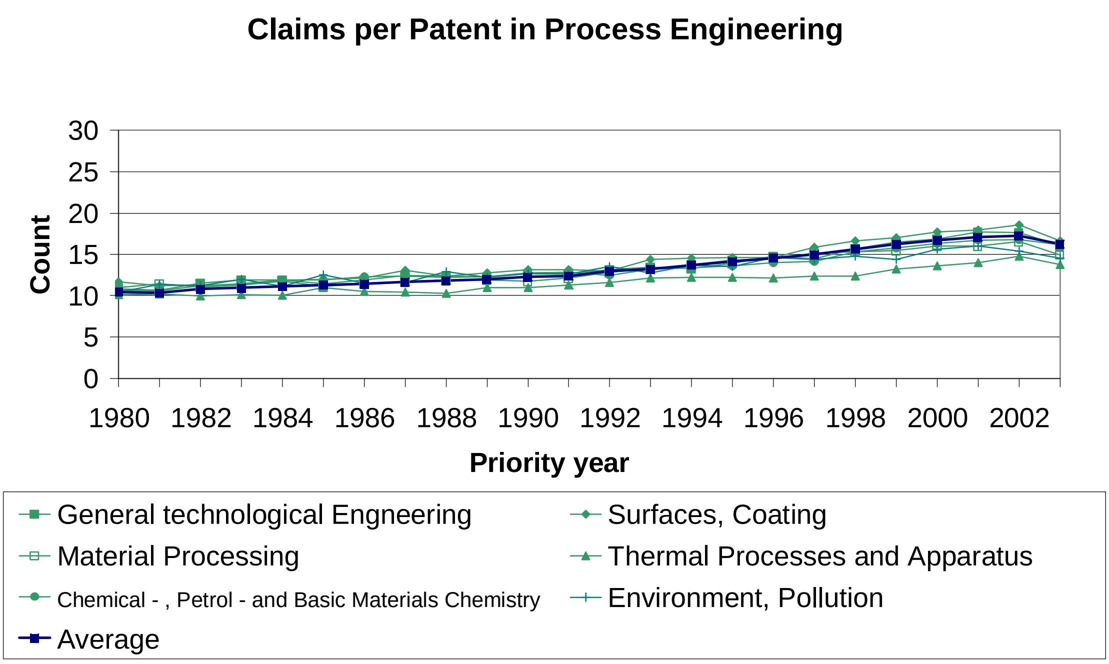
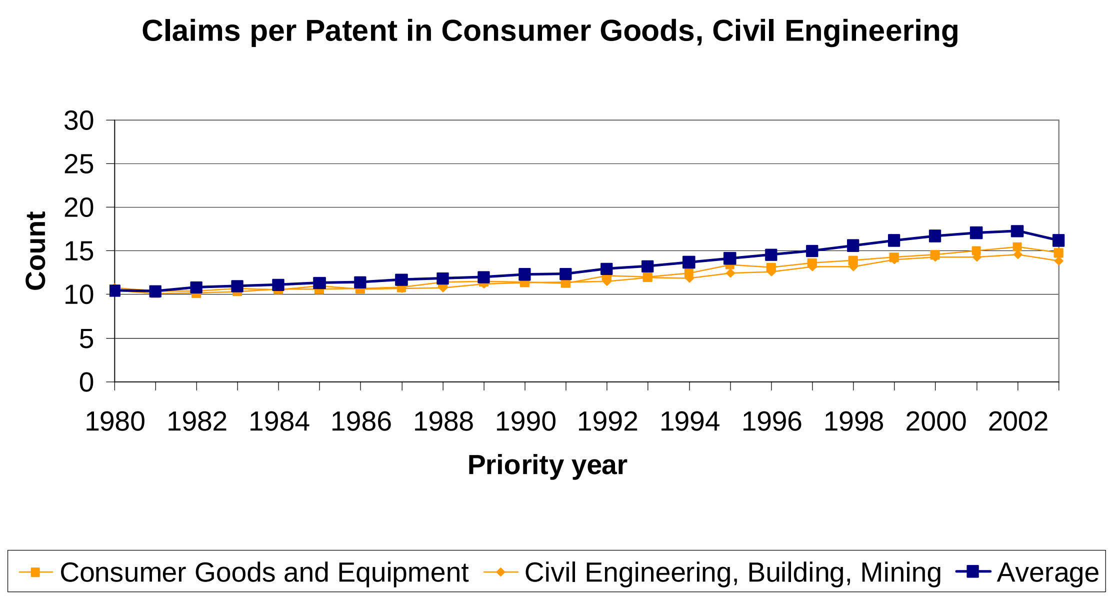


Figure 8.2.3.2



8.2.4 Share of opposed patents by main area

Figure 8.2.4.1

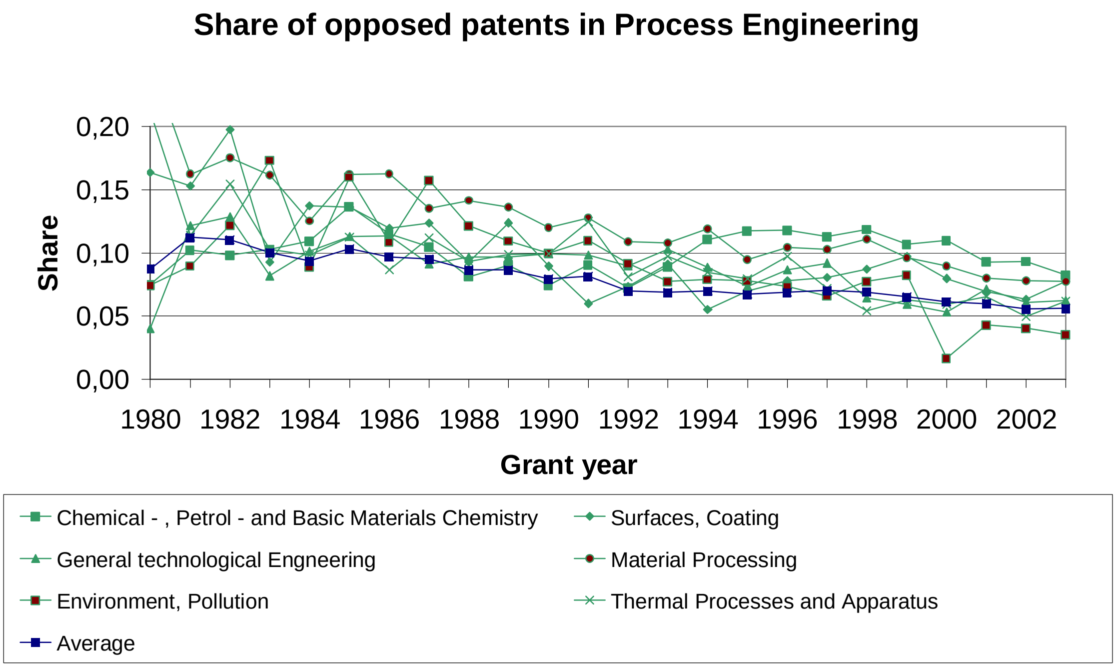
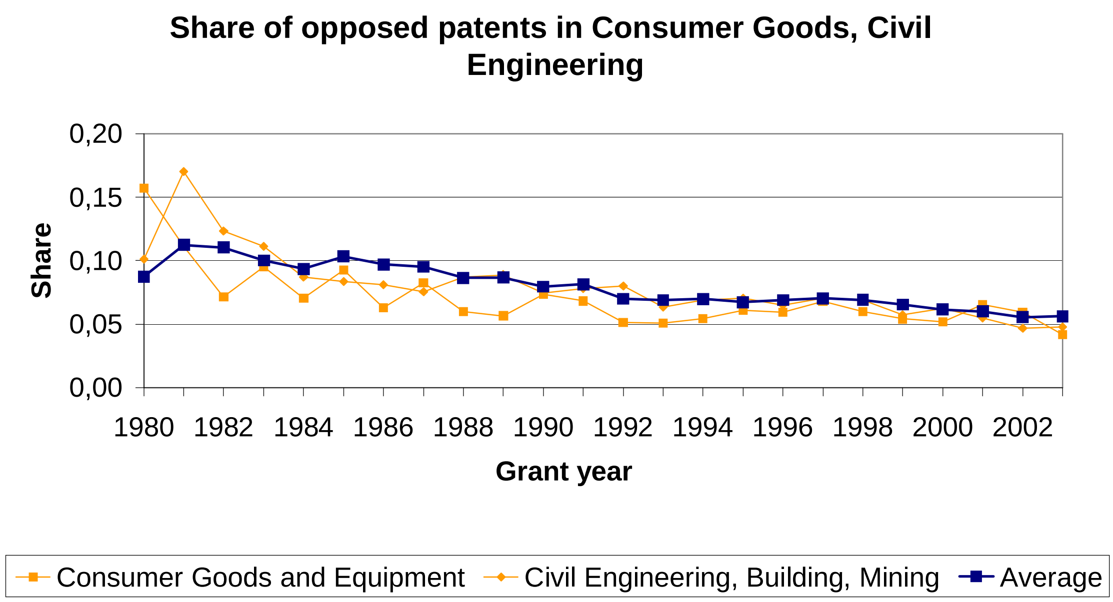


Figure 8.2.4.2



8.2.5 Concentration of applications

Figure 8.2.5.1

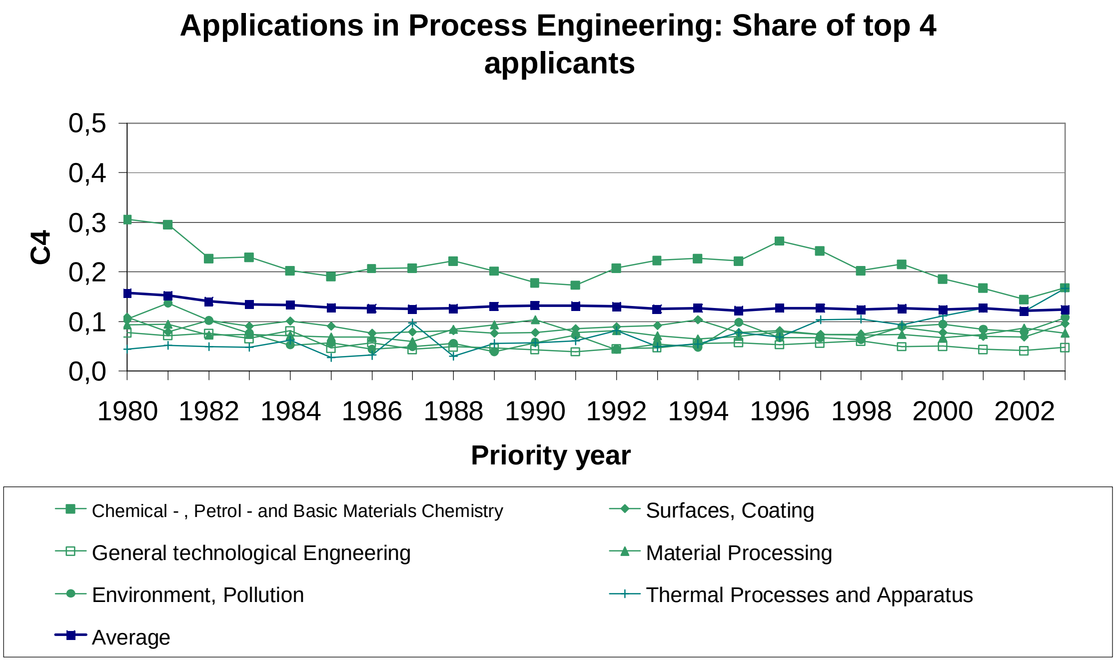
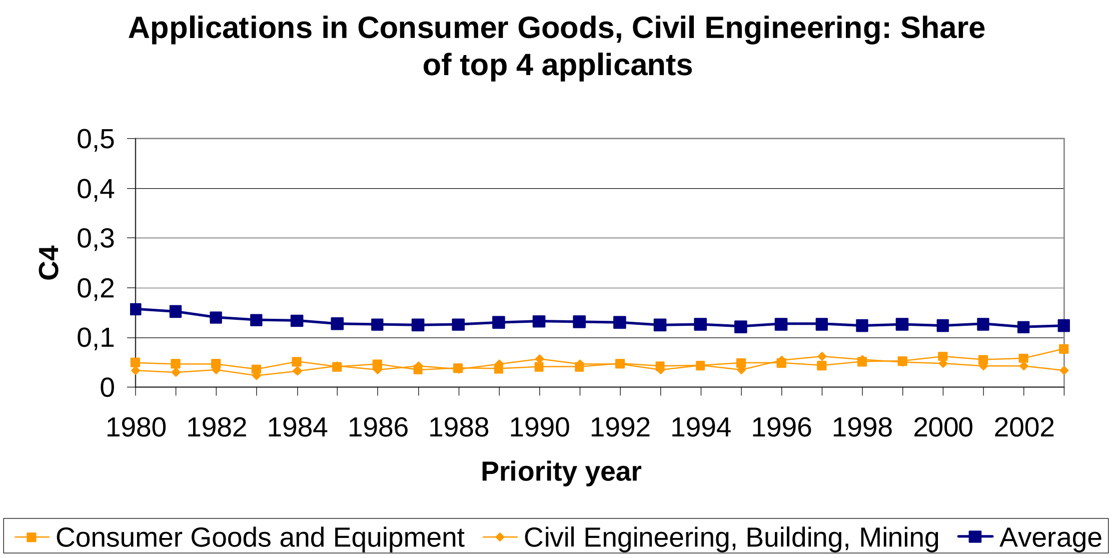


Figure 8.2.5.2



8.2.6 Entry and Exit

Process Engineering

Figure 8.2.6.1

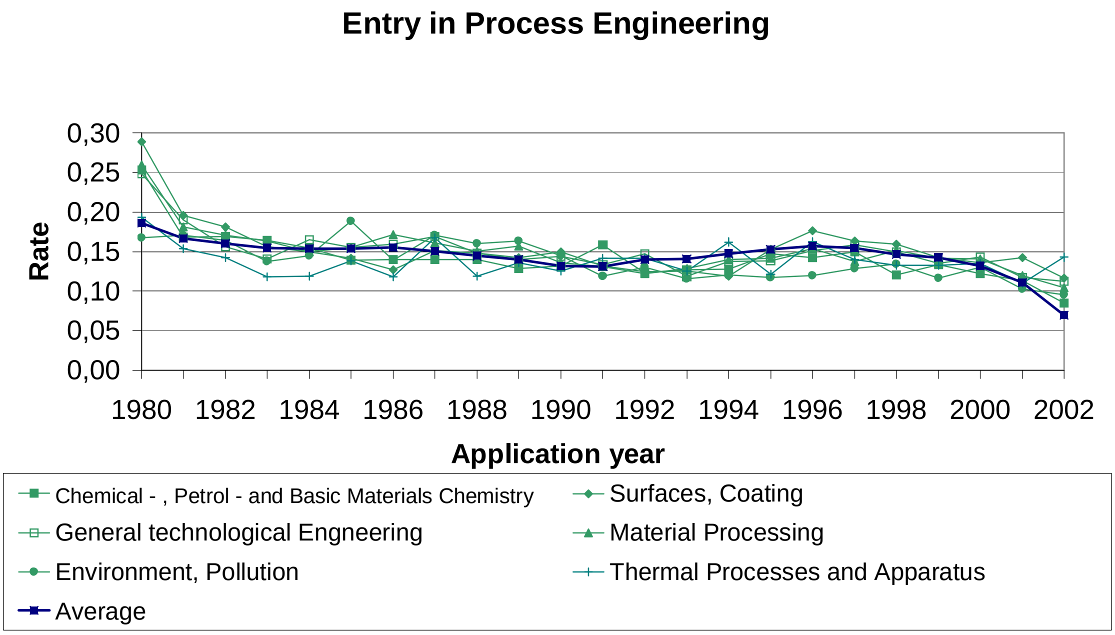
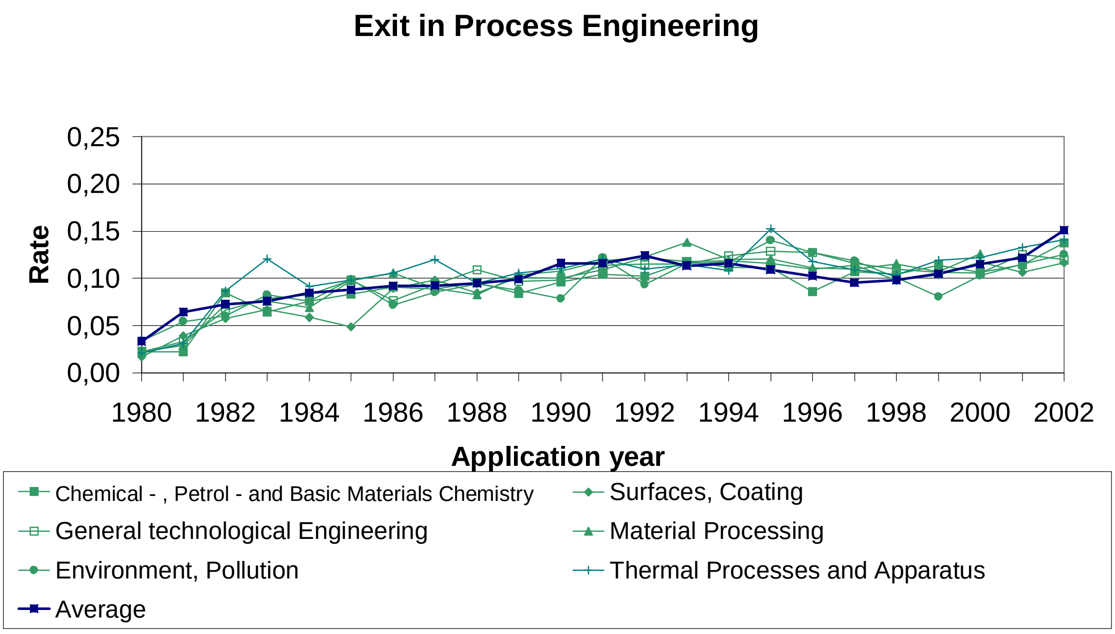


Figure 8.2.6.2



Consumer Goods

Figure 8.2.6.3

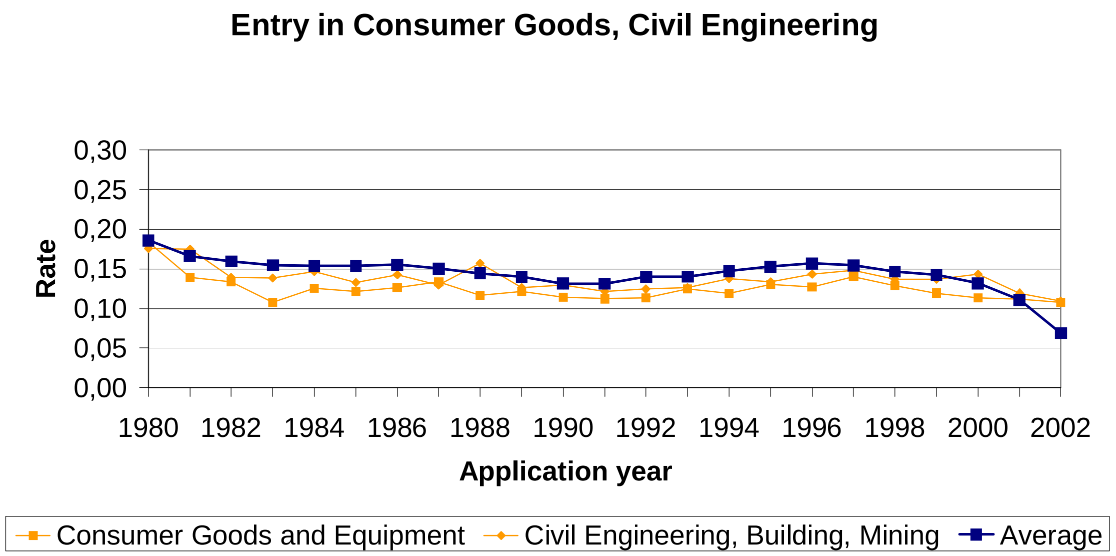
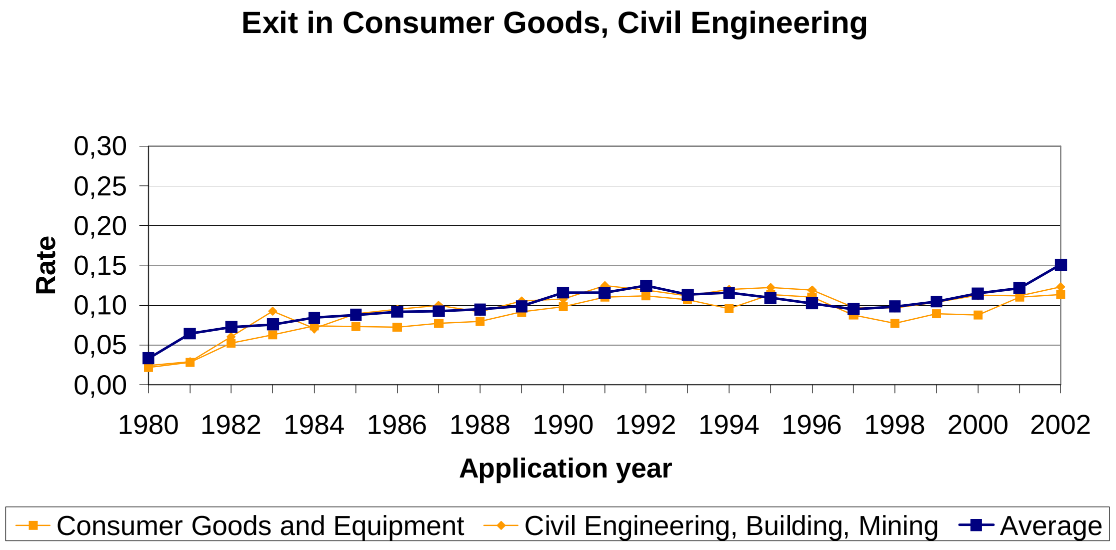


Figure 8.2.6.4



8.2.7 Share of X-References per Patent

Figure 8.2.7.1

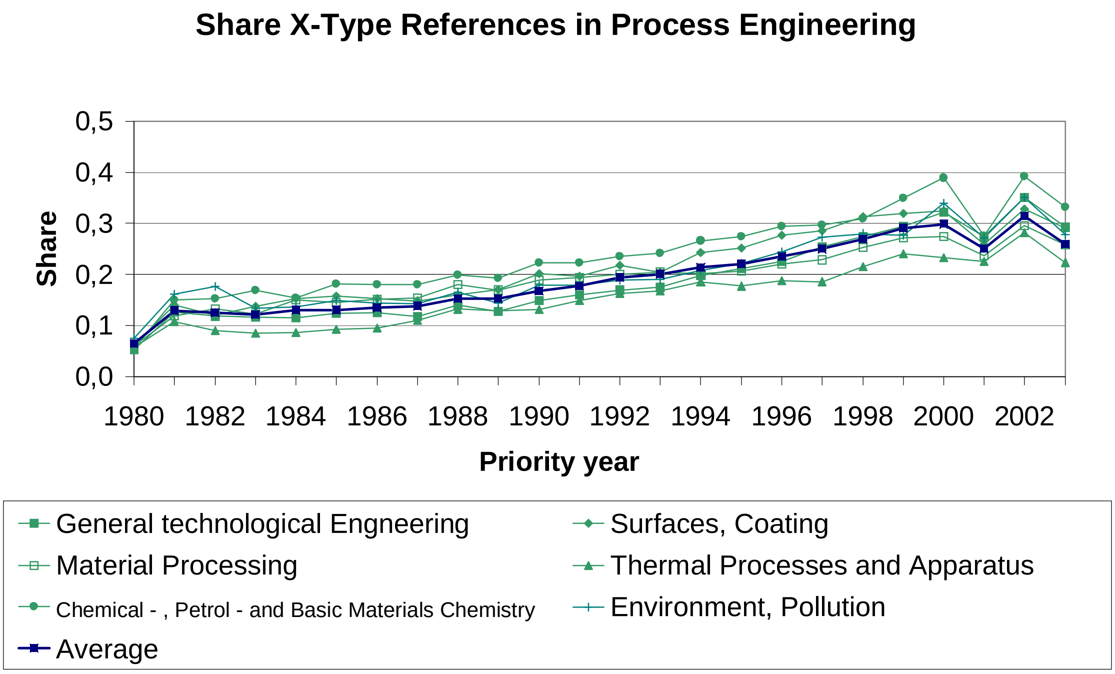
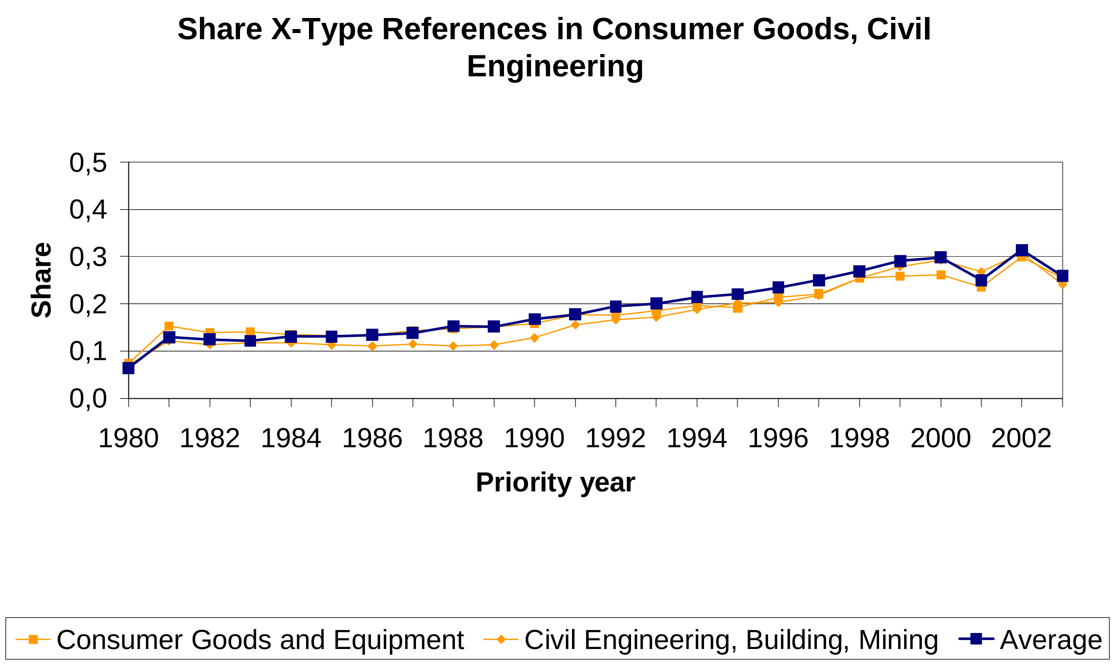


Figure 8.2.7.2



8.2.8 Share of X-References per Claim

Figure 8.2.8.1

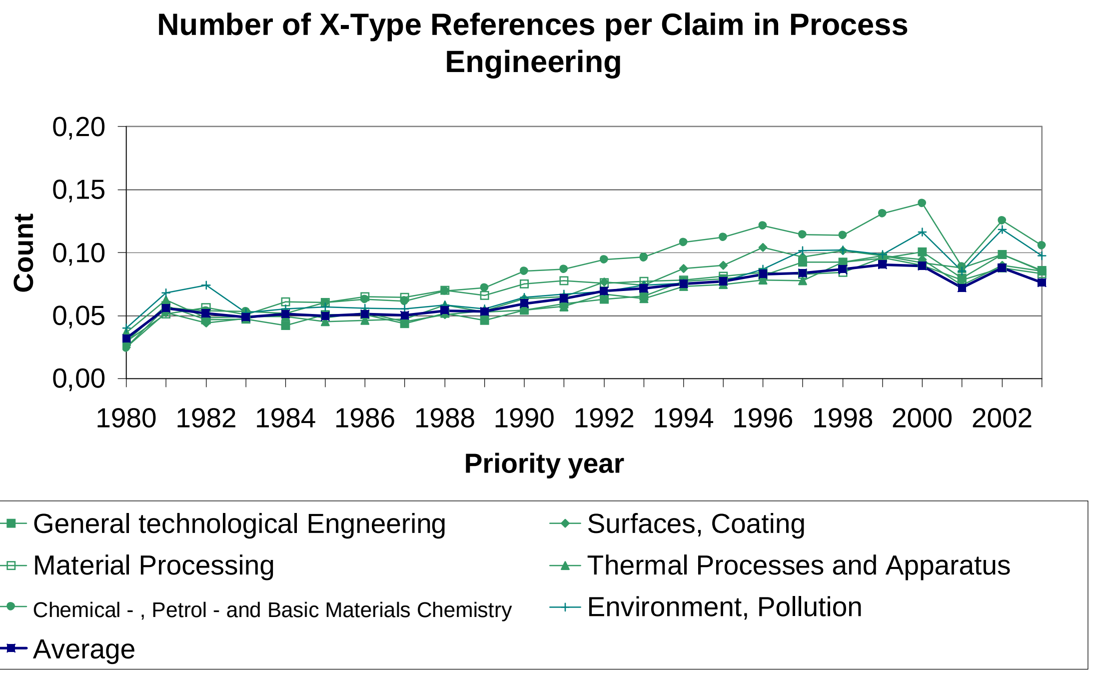
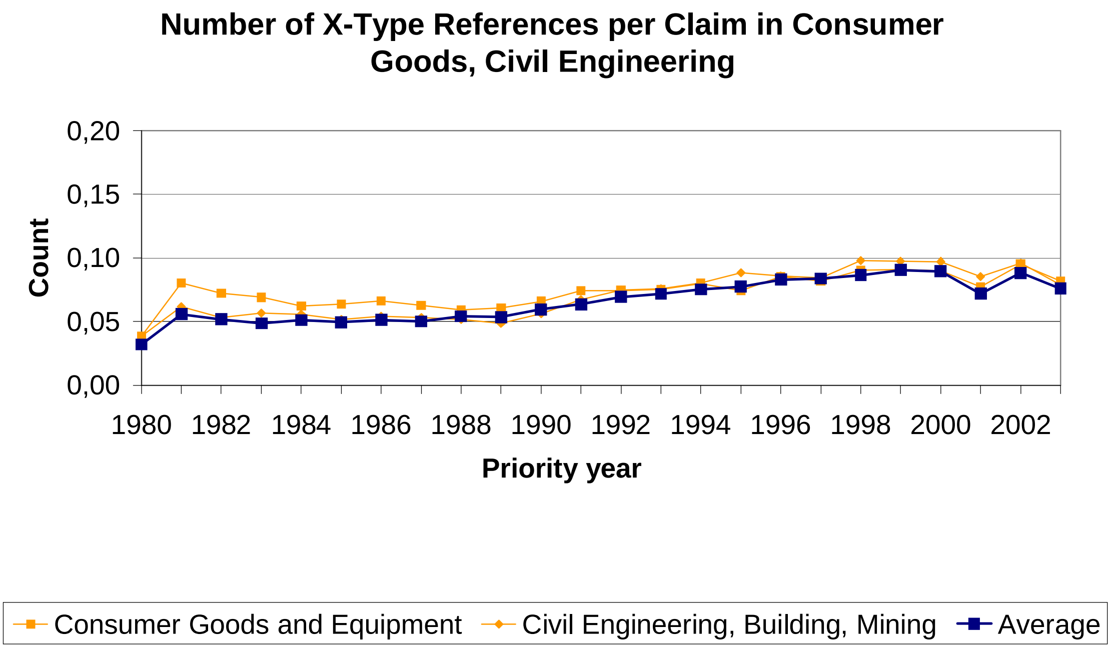


Figure 8.2.8.2



8.2.9 Divisionals

Figure 8.2.9.1

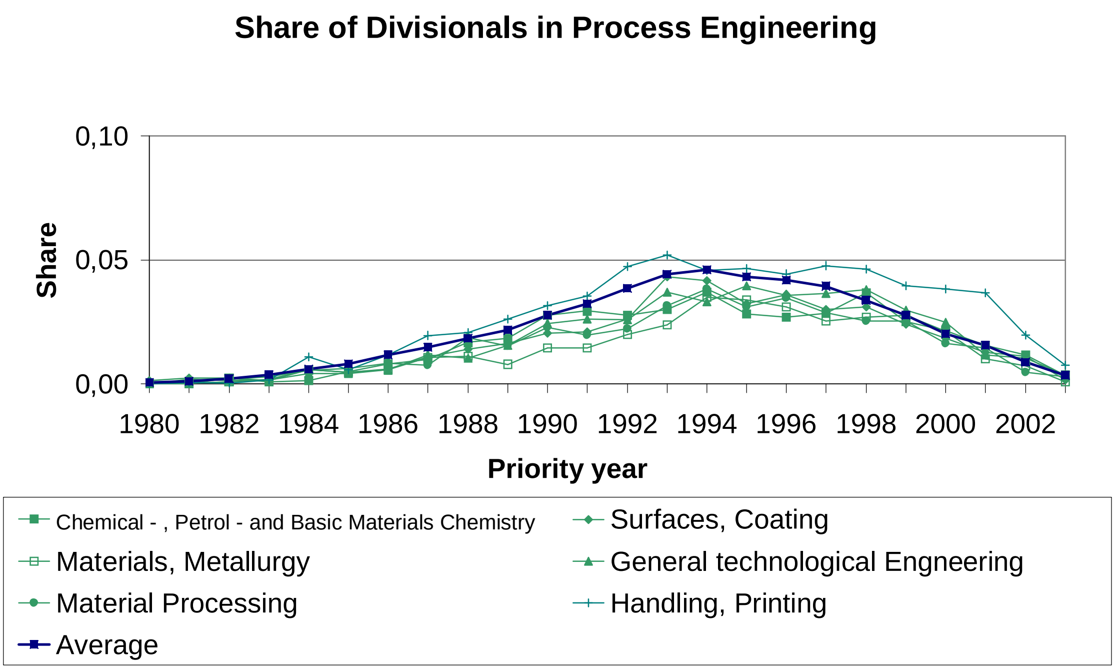
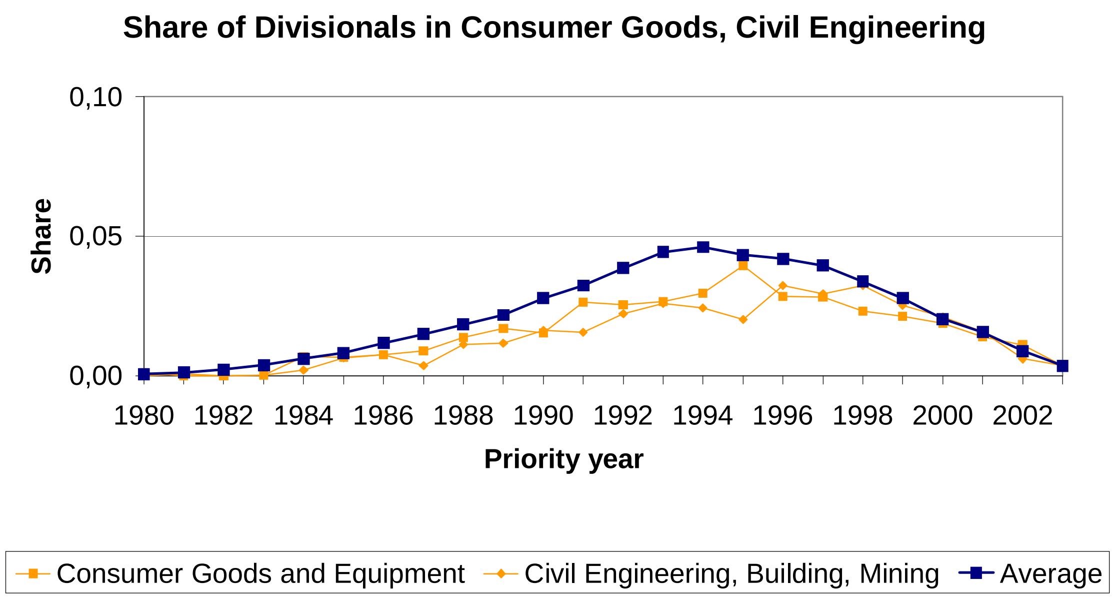


Figure 8.2.9.2



8.2.10 Shared priorities

Figure 8.2.10.1

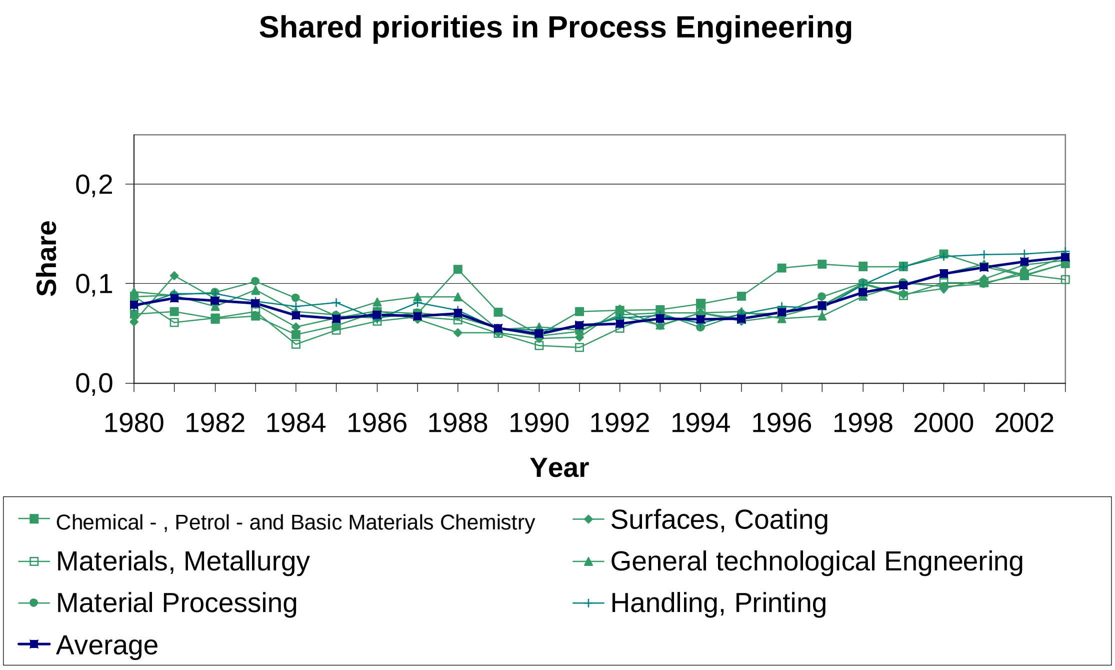


Figure 8.2.10.2