Eidgenössisches Institut für Geistiges Eigentum
Institut Fédéral de la Propriété Intellectuelle
Istituto Federale della Proprietà Intellettuale
Swiss Federal Institute of Intellectual Property

SME-IP · 2nd Report

Economic Focus Study on SMEs and Intellectual Property in Switzerland

Publication/Publikation No 5 (06.09)

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Foreword

How does a company optimize the protection and use of its intellectual property? The answer to this question is particularly difficult for small and medium-sized enterprises (SMEs), as long as they are not sufficiently familiar with the intellectual property protection system. In order to remedy this situation, to foster knowledge, and to motivate SMEs to deal with intellectual property in a confident manner, the Swiss Federal Institute of Intellectual Property started the project SME-IP in March 2007.

The publication presented here is the second study carried out within the framework of this project. This econometric study aims to analyse how Swiss SMEs deal with their intellectual property.Therefore, it was investigated whether, and if they do so, how and to what extent SMEs utilise the Swiss intellectual property protection system. Alongside the formal protection means (trademarks, patents, designs, etc.), informal protection mechanisms such as secrecy were also included.

We commissioned two research teams from the University of St. Gallen (HSG) and the Ecole Polytechnique Fédérale de Lausanne (EPFL) to carry out the study. The teams were provided with two large data records for the econometric analysis that included the results of an initial survey on the attitude of Swiss SMEs to intellectual property protection – a survey the Institute carried out with 7,000 companies at the start of the SME-IP project in 2007. Additional findings on the attitude of SMEs towards patent protection could be obtained through the linking of existing data with the patent database PATSTAT. The results of this survey allow a more specific response to the needs of Swiss SMEs with regards to optimising existing support services and creating new ones.

Other studies are being carried out within the framework of our SME-IP project. They will likewise be published in this series.

I would like to express my sincere appreciation to the two research teams from St. Gallen and Lausanne for carrying out this demanding collaborative research project. My thanks also go to all those Swiss SMEs who participated in our initial survey in 2007 and who supplied information concerning their attitude to intellectual property protection. They provided us with important data and information for this publication and for the SME-IP project.

Roland Grossenbacher
Director General of the Swiss Federal Institute of Intellectual Property

Berne, June 2009

Vorwort

Wie schützt und nutzt ein Unternehmen seine geistigen Leistungen optimal? Die Antwort auf diese Frage fällt besonders kleinen und mittleren Unternehmen (KMU) schwer, solange sie mit dem immaterialgüterrechtlichen Schutzsystem nicht ausreichend vertraut sind. Um Hilfe zu bieten, Wissen zu fördern und KMU zu einem bewussten Umgang mit ihrem Geistigen Eigentum zu motivieren, haben wir im März 2007 im Eidgenössischen Institut für Geistiges Eigentum das Projekt KMU-IP gestartet.

Die vorliegende Publikation stellt die zweite Studie dar, die im Rahmen dieses Projektes durchgeführt worden ist. Das Ziel dieser ökonometrischen Studie ist es, den Umgang von Schweizer KMU mit ihrem geistigen Eigentum zu analysieren. Untersucht wurde dazu, ob und wenn ja, wie und in welchem Umfang KMU das Schweizerische Schutzrechtssystem nutzen. Einbezogen wurden neben den formellen Schutzmöglichkeiten (Marken, Patente, Designs, etc.) auch informelle Schutzmechanismen wie z.B. Geheimhaltung.

Mit der Durchführung der Studie haben wir zwei Forscherteams der Universität St. Gallen (HSG) und der École Polytechnique Fédérale de Lausanne (EPFL) beauftragt. Den Teams standen für die ökonometrische Analyse zwei grosse Datensätze zur Verfügung, darunter die Ergebnisse einer Vorbefragung über das Schutzrechtsverhalten bei Schweizer KMU, welche das Eidgenössische Institut für Geistiges Eigentum zum Auftakt des Projektes KMU-IP im Jahr 2007 bei 7'000 Firmen durchgeführt hatte. Zusätzliche Erkenntnisse zum Patentierungsverhalten der KMU konnten dank der Kopplung der vorhandenen Daten mit der Patentdatenbank PATSTAT gewonnen werden. Die Ergebnisse der vorliegenden Untersuchung ermöglichen es, bei der Optimierung bestehender und der Gestaltung neuer Unterstützungsangebote gezielter auf die Bedürfnisse der Schweizer KMU einzugehen.

Derzeit laufen noch weitere Studien im Rahmen unseres Projektes KMU-IP. Diese werden nach ihrer Fertigstellung ebenfalls in vorliegender Publikationsreihe veröffentlicht werden.

Den beiden Forscherteams aus St. Gallen und Lausanne spreche ich meinen Dank für die Durchführung dieses anspruchsvollen gemeinsamen Forschungsprojektes aus. Mein Dank geht aber auch an all jene Schweizer KMU, die sich im Jahr 2007 an unserer Vorbefragung beteiligten und über ihr Schutzrechtsverhalten Auskunft gaben. Damit haben sie uns wichtige Daten und Informationen für die vorliegende Publikation und das Projekt KMU-IP geliefert.

Roland Grossenbacher
Direktor des Eidgenössischen Instituts für Geistiges Eigentum

Bern, im Juni 2009

Avant-propos

Comment une entreprise peut-elle protéger et utiliser de manière optimale ses biens immatériels ? Cette question pose bien souvent du fil à retordre aux petites et moyennes entreprises (PME) tant qu'elles ne se sont pas suffisamment familiarisées avec les systèmes de protection des droits de propriété intellectuelle. C'est pour contribuer à la diffusion du savoir dans ce domaine, mais aussi pour apporter un soutien aux PME et aiguiser leur conscience de la gestion de leurs biens immatériels que l'Institut Fédéral de la Propriété Intellectuelle a lancé le projet PME-PI au mois de mars 2007.

La présente publication constitue la deuxième étude réalisée dans le cadre de ce projet. Il s'agit d'une étude économétrique dont le propos est l'analyse de la gestion des biens immatériels par les PME suisses. Pour ce faire, on a examiné si celles-ci utilisent le système suisse de protection et, dans l'affirmative, de quelle manière et dans quelle mesure. L'étude ne s'est pas limitée aux possibilités formelles de protection (marques, brevets, designs, etc.), mais inclut également les mécanismes informels comme le maintien du secret.

Nous avons confié cette étude à deux équipes de recherche de l'Université de St-Gall (HSG) et de l'Ecole Polytechnique Fédérale de Lausanne (EPFL). Pour l'analyse économétrique, deux importants ensembles de données étaient à la disposition des équipes, parmi lesquels les résultats d'une enquête préliminaire sur le comportement des PME suisses en matière de protection de leurs biens immatériels que l'Institut Fédéral de la Propriété Intellectuelle avait réalisée auprès de 7000 sociétés lors du lancement du projet PME-PI en 2007. La combinaison des données disponibles avec celles de la base de données PATSTAT a permis de tirer d'autres conclusions sur le comportement des PME en matière de brevets. Les résultats de cette seconde étude fournissent des pistes pour répondre de manière plus ciblée aux besoins des PME suisses grâce à l'optimisation des mesures actuelles de soutien et au développement de nouveaux services.

D'autres études sont en cours d'élaboration dans le cadre de notre projet PME-PI. Elles seront publiées dans la présente collection dès leur achèvement.

J'adresse mes sincères remerciements aux deux équipes de chercheurs de St-Gall et de Lausanne pour la réalisation de cet ambitieux projet commun. Je remercie également toutes les PME suisses qui ont eu la gentillesse de participer, en 2007, à ladite enquête préliminaire en nous informant sur leurs comportements en matière de protection de leurs biens immatériels. Ce faisant, elles nous ont fourni des données et des informations précieuses qui ont servi à la présente publication et au projet PME-PI en général.

Roland Grossenbacher
Directeur de l'Institut Fédéral de la Propriété Intellectuelle

Berne, juin 2009

Prefazione

Come deve comportarsi un'azienda per proteggere la sua proprietà intellettuale? Rispondere a questa domanda è difficile soprattutto per le piccole e medie imprese (PMI) che non conoscono sufficientemente il relativo sistema di protezione. Per fornire un aiuto, promuovere la diffusione del sapere e motivare le PMI a gestire meglio la loro proprietà intellettuale, nel marzo 2007 l'Istituto Federale della Proprietà Intellettuale ha dato il via al progetto PMI-PI.

Questa pubblicazione presenta il secondo studio condotto nell'ambito del progetto. Si tratta di un'analisi di tipo econometrico tesa ad approfondire il rapporto tra PMI svizzere e proprietà intellettuale. Ai fini dello studio si è esaminato se e, in caso affermativo, secondo quali modalità e in quale misura, le PMI utilizzano il sistema di protezione svizzero. Oltre agli strumenti formali di protezione (marchi, brevetti, design, ecc.) si è tenuto conto anche di alcuni meccanismi informali come ad esempio quello della segretezza.

Lo studio è stato affidato a due gruppi di ricercatori dell'Università di San Gallo (HSG) e del Politecnico federale di Losanna (EPFL) cui è stato messo a disposizione un importante volume di dati tra cui i risultati di un'indagine preliminare sul comportamento nell'ambito della protezione della proprietà intellettuale da parte delle PMI svizzere che l'Istituto Federale della Proprietà Intellettuale ha condotto al momento del lancio del progetto PMI-PI nel 2007 presso 7000 aziende. Un raffronto dei dati disponibili e delle informazioni contenute nella banca dati brevettuale PATSTAT ha inoltre consentito di trarre altre conclusioni relative al comportamento delle PMI in ambito brevettuale. I risultati del presente studio permettono di rispondere in maniera più mirata alle esigenze delle PMI svizzere nel quadro dell'ottimizzazione degli strumenti di sostegno esistenti e della creazione di nuove proposte.

Nel contesto del progetto PMI-PI sono in atto altri studi, che una volta conclusi saranno pubblicati in questa collana.

Ringrazio i due gruppi di ricerca di San Gallo e Losanna per aver portato a termine questo ambizioso progetto comune. Ci tengo poi a ringraziare anche tutte le PMI che nel 2007 hanno partecipato all'indagine preliminare fornendo informazioni sul loro rapporto con la proprietà intellettuale e contribuendo così in modo significativo alla presente pubblicazione e al progetto PMI-PI.

Roland Grossenbacher
Direttore dell'Istituto Federale della Proprietà Intellettuale

Berna, giugno 2009

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Preface by the Steering Committee

Small and medium-sized enterprises (SMEs) account for over 98% of all firms in Switzerland, and export-oriented high tech SMEs are the main driver for Switzerland's economic growth. Therefore, an important and challenging task of the Swiss Federal Institute of Intellectual Property (IPI) is to better understand how SMEs adopt and use intellectual property rights (IPRs), and what conditions and procedures may impact this usage. Moreover, a second task is to identify those companies that do not use IPRs at all to try to understand the reasons why they remain outside of the IPR system although they are performing well in terms of innovation, exportation and growth.

This report is an ambitious attempt to provide answers to both tasks. It identifies a number of ways in which micro-level and sectoral understanding of the strategies and attitudes of SMEs toward IPRs is important, alongside the more macro-level insights. These insights are crucial for informing governments (federal and cantonal), the economic sectors and professional associations about the main policy issues raised by the diagnosis of an "IPR deficit" among SMEs. The insights are also critical for those SMEs which seek to improve their innovation performance as well as their ability to capture the benefits from their innovations.

This report is in seven parts, including a literature review, three chapters presenting statistical and econometric results, one chapter which aims at connecting these quantitative results with the qualitative in-depth analysis done in parallel and one final chapter dealing with the policy implications. Together, these chapters emphasise that appropriate policy action is needed to help SMEs in Switzerland to be better informed about IPRs and to assist them in designing efficient and sustained IPR-based strategies for innovation and growth.

While these policies may be discussed controversially, the problems of innovative performance of SMEs and their ability to capture the benefits of their innovation are too important to neglect, and the positive externalities associated with the development of a more effective innovation climate and incentive structures are too clear to not discuss appropriate policy measures. Thus, we sincerely hope that the sound base of evidence built and presented in this report will pave the way towards a more "SMEs-friendly" system of IPRs in Switzerland.

This publication results from a collective effort by two teams (located at the University of St.Gallen and the Ecole Polytechnique Fédérale de Lausanne EPFL). As members of the Steering Committee, it is our pleasure to congratulate all members of the two teams who have achieved successfully a very ambitious and complex research program and to thank the IPI for support and continuous intellectual stimulations in the course of the project. Our special thanks go to Prof. Dr. Felix Addor, Deputy Director General, and Dr. Alban Fischer, Vice Director General, and the project management team: Dr. Claudia Mund, Dr. Frank Langlotz, Dr. Christian Soltmann, and Dr. Hansueli Stamm.

Prof. Dr. Dominique Foray (EPFL)
Prof. Dr. Oliver Gassmann (University of St. Gallen)

Executive summary

This report contains the results of a study jointly commissioned by the Swiss Federal Institute of Intellectual Property (IPI) to the Institute of Technology Management (ITEM) at the University of St. Gallen (HSG) and the Chair of Economics and Management of Innovation (CEMI) at the College of Management of Technology, Ecole Polytechnique Fédérale de Lausanne (EPFL).

The purpose of this study is to analyze how, why, and to which extent Swiss small and medium-sized enterprises (SMEs) use or do not use the intellectual property rights (IPRs) the Swiss IP system offers, and to elaborate policy recommendations on the basis of these analyses.

The report proposes:

- a comprehensive literature review,
- an econometric analysis of the Swiss Innovation Survey conducted by the Konjunkturforschungsstelle at ETH Zurich (henceforth denominated "KOF data"),
- an econometric analysis of a survey of SMEs conducted by IPI itself,
- an analysis of patent portfolios of the SMEs from the IPI survey,
- an integrative analysis that comments on the commonalities and differences of these analyses and explores them in greater detail by using additional qualitative analyses,
- policy recommendations on the basis of these analyses.

The main findings of this report can be summarized according to the following four major themes.

(1) **Firm heterogeneity.** Rather than there being one type of "small firm", there are a number of different types of SMEs, each of which has a different approach of how to use IPR protection measures (i.e., patents, trademarks, industrial designs, and copyrights) to appropriate the economic benefits from their innovations. An SME's propensity to use these measures is contingent on firm size and industry sector. In general IPR users are able of capturing a higher proportion of their innovative efforts, compared to SMEs that are non-IPR users.

(2) **Need for information.** The level of information about IPRs differs greatly from firm to firm. Firms that are well informed about a particular IPR protection measure are also more likely to use that measure. Further, with the exemption of micro-firms, the IP strategy of a firm that already uses any of the IPR protection measures (or a combination thereof) is highly likely to be shaped by the competitive situation of its environment and its product-market strategy, rather than by resource consideration. Thus, any policy attempt to inform SMEs about the IP system should be made contingent on an SME's prior exposure to the use of IPR protection mechanisms, asking whether a specific group of SMEs is likely to demand information at all and if so what type of information.

(3) **IPR behavior.** SMEs use a combination of IPRs to protect their innovation. We find a first group of SMEs which is intensively using a combination of trademarks and industrial designs. A second group of firms is focusing on patents. And a third group of firms is mainly applying for trademarks. In all cases the main reason for SMEs to apply for IPRs is protection from competition.

In the case of patents we are able to study their evolution over time. We observe that the total number of SMEs that patent has decreased, whereas the patenting intensity of those SMEs that do patent has increased. This seems to point to a specialization effect, in that the number of patent applications concentrates among fewer and fewer SMEs applying for a greater number of patents. Further, micro firms are very strong in patent networking.

(4) **Internationalization.** The IPR protection activities of Swiss SMEs are not confined to the national level alone. However, SMEs' knowledge of the national patent system is higher than the knowledge of the international system, so that information about how to patent internationally would be desirable. SMEs apply for patents on a national level for contract negotiations, whereas international applications are important to give publicity to the innovation. SMEs that do business on an international level from an early point in their history ("born globals") are very keen with respect to IP protection and are unlikely to demand special information, as they use external service providers (such as consultancy services or patent lawyers) to manage the protection of their IP professionally.

Based on these findings, four central policy implications are derived:

1) IPR policy-making has to be adapted to the heterogeneity of Swiss SMEs. Given the considerable size and industry sector differences, it is likely that policies that focus on overcoming barriers to use an IPR-based strategy in specific industries and certain types of firms will be more effective than those which promote more generalized encouragement to use IP.

   To achieve this tailored response, cooperation with professional associations or economic institutions in charge of economic development at the local level may be necessary to customize information and training to the different types of SMEs.

   The IPI should also inquire what could be done to offer IP services or adapt the IP system to specific groups of firms. In the past, such measures have been implemented for biotech firms. We believe similar policy instruments could be extended to other specific categories of Swiss SMEs.

2) While the specific type of public promotion programs we analyzed had no effect on SMEs' use of either protection measure, and while the qualitative analysis suggested that SMEs do not make their IP decisions on the basis of monetary incentives, public promotions may still induce effects on firms' IP strategy we could not measure. This especially applies to effects from public promotion on a firm's R&D spending which may only be visible after a considerable time lag.

   Although SMEs often suffer from resource shortages, our findings suggest that IP decisions are not primarily made on the grounds of resource endowments, but on the grounds of each measure's efficacy to protect the respective innovation.

3) Training should be offered to SMEs that patent abroad extensively in order to augment completely their ability to use the international IPR system. As this offer discriminates on the locus of patent filing, it should be specifically targeted towards internationally active SMEs and not be combined with services for SMEs that file patents in Switzerland only.

   Swiss SMEs should receive support when they use IPRs as a negotiation tool or collaborate with other firms. It would be particularly useful for them to receive training about how to negotiate on IPRs with other agents (firms, banks, governments) –

e.g., regarding IP in R&D cooperative agreements, or IP licensing from and to third parties.

The very active role of micro-firms' activities in patent networks should be supported by facilitating information, and maybe by considering a reduction of patent fees.

4) IPI's dissemination of information should be contingent on an SME's experience: General information is only of interest to firms completely unaware about IP issues, whereas more experienced firms are more likely to want to foster IP awareness amongst their employees.

Regarding the different measures, information about patenting should be exclusively directed towards the non-user group, whereas information about trademarks and industrial designs may be of use to both users and non-users.

1 Introduction

The reader may wish to understand why it is relevant to study the question of how small firms protect and appropriate economic benefits from their innovations. This important problem is relevant for academics, practitioners, and policy-makers alike. In particular, these questions are very important for the Swiss economy which is characterized by many innovation - and R&D -intensive SMEs which often have considerable international involvement and serve highly specialized industry segments and niche markets (Gassmann and Keupp, 2007; Foray and Lhuillery, 2006). Specifically, Swiss SMEs have a high export intensity (OECD, 2005). Moreover, Switzerland ranks first in Europe for its innovative SMEs. It is the only country with an innovative rate of SMEs over 50% (OECD, 2005: 39). Very small Swiss companies have a significant productivity and create jobs faster than other companies (OFS, 2004), especially when they are operating in the fields of high technology. Moreover, these firms are dominant in all industry sectors, have R&D activities more often than other SMEs, and commit more funds to R&D than their European counterparts (KOF, 2004).

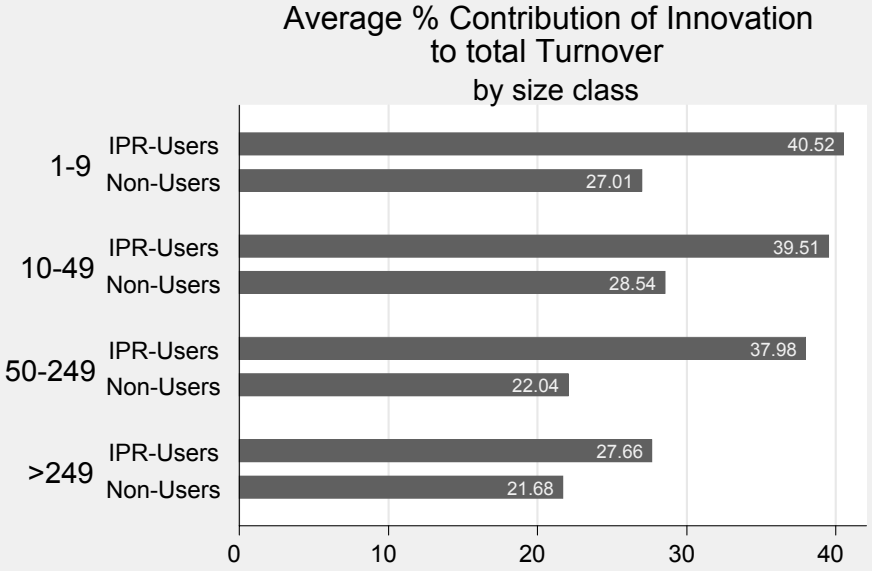
This flattering picture leaves room for an important issue: R&D and innovation are useful and successful if firms succeed to get returns from their investments and particularly if they succeed to protect themselves from imitators. Little is known about the use or non-use of IPRs by Swiss SMEs. A few insights suggest that the Swiss use of IPRs may be different from its use in other countries. However, it is insightful but difficult to rely on results obtained for SMEs in foreign countries.

The decision to use IPRs is generally a "positive" decision of an individual SME, as it influences its ability to perform in the market. A first look at the figures reports indeed that, in general, IPR users are able to gather higher proportions of their innovative efforts[1]. Figure 1[2] suggests that IPRs are even more influential for Swiss SMEs than for Swiss large firms, since the distance between users and non-users is smaller as firm size increases. A micro firm (less than 10 employees) reports on average a 40% contribution of the total turnover related to the innovative effort if the firm is an IPR user, compared to only a 27% if the firm does not apply for IPRs. In the case of big firms (more than 250 employees) there is only a 5% difference between users (27%) and non-users (21%).

[1] This link should always be interpreted carefully, since we do not know the causality of the effect. We do not know if firms which are more successful (i.e. they have higher returns to innovation) are applying more for IPR or if the use of IPRs makes them more able to gather higher returns to their innovation. However, neither of the two causal relations should be disregarded.

[2] In the questionnaire elaborated by the KOF (a detailed description of the questionnaire will be presented in chapter 3) firms are asked to report what proportion of their turnover is due to new products (question 2.2.a.1), what is the proportion due to significantly improved products (question 2.2.a.2), and to what extent process innovation has reduced the production costs (question 2.4.b). The sum of these three percentages is defined as the total return to innovation, expressed as a total proportion related to the firms' turnover. The average contribution is presented by size class and by separating the firms that use IPRs from those which do not. A firm is considered as a user if it has reported either to apply for a patent, a trademark, an industrial design or a copyright. If the answer is negative for all of them, then the firm is considered as a non-user.

Figure 1 IPR users and non-users. Returns to innovations



Source: KOF. Switzerland 2002-2005.
Note: We calculate the returns to innovation that SMEs have (see footnote 2).

Using data over time, the next two figures shed more light on the patenting activities. Figure 2 reports that over the periods, the proportion of patenting SMEs has been decreasing. Suggesting that there is a rising proportion of firms that are not protecting their innovation through patents. However when we look at Figure 3 where the average number of patent applications has been analyzed, we understand that although the percentage of firms using patents has been decreasing, those firms that are patenting are filing a higher number of patent applications. The combination of these two previous figures speaks of an increasing specialization of SMEs applying for patents. On the other hand, comparing Swiss (KOF) data with data from the fourth Community Innovation Survey, Swiss firms may have been more likely to switch to other means of protection such as trademarks (cf. Figure 4).

These results can be interpreted in several ways which can overlap to some extent. One is that Swiss innovating SMEs have been increasingly protecting their innovation by other IPRs (trademarks, industrial designs). The European innovation surveys show indeed that Swiss innovating firms may be more likely to register trademarks (see Figure 4). It also suggests that Swiss innovating SMEs are less likely to protect their innovations by patents than other European SMEs. The limit of this interpretation is that it neglects the fact that Swiss SMEs innovate more frequently than their European counterparts according to these same surveys.

This last remark puts forward a second interpretation, which is that Swiss SMEs are less and less at the technological frontier as they are caught up by other European leading SMEs (see KOF, 2004 for such an argument) inducing lower rewards for patent protection. A third interpretation is that Switzerland, as many OECD countries, is over time more and more specialized into services where patents are less likely to be efficient. A fourth effect may occur: Swiss SMEs became innovators without using any IPRs but protecting themselves with informal or non-IPR means (e.g., secrecy, product-related services). The last explanation is however very difficult to deal with. Besides, a final and rather methodological argument here is that innovating firms are counting the

number of patents and not the number of filed inventions introducing an upward bias likely to explain the rising size of patent portfolio of applicants.

Figure 2 Share of innovative firms applying for patents

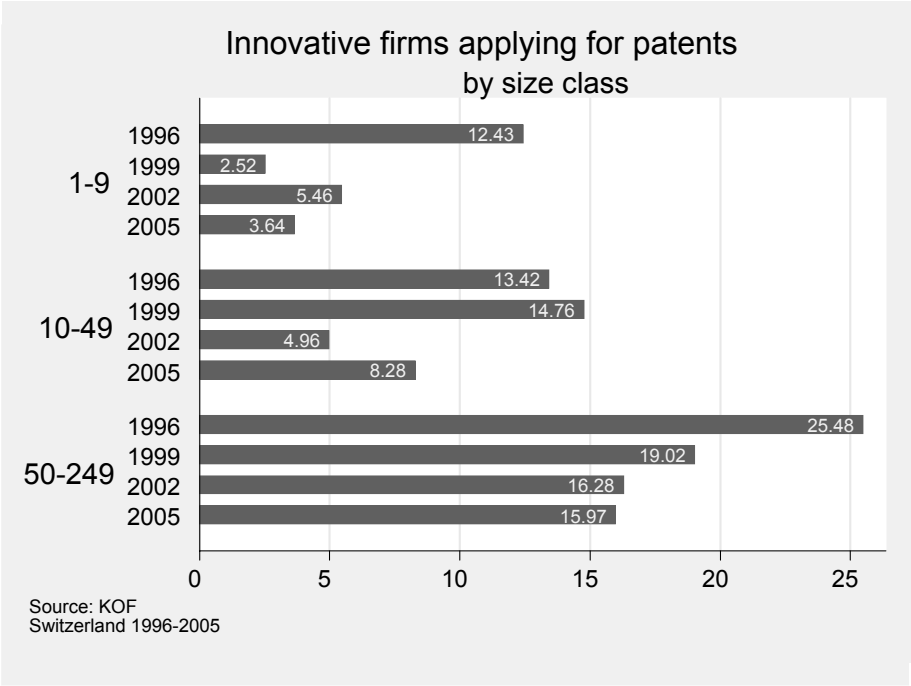


Figure 3 Average number of patents per firm

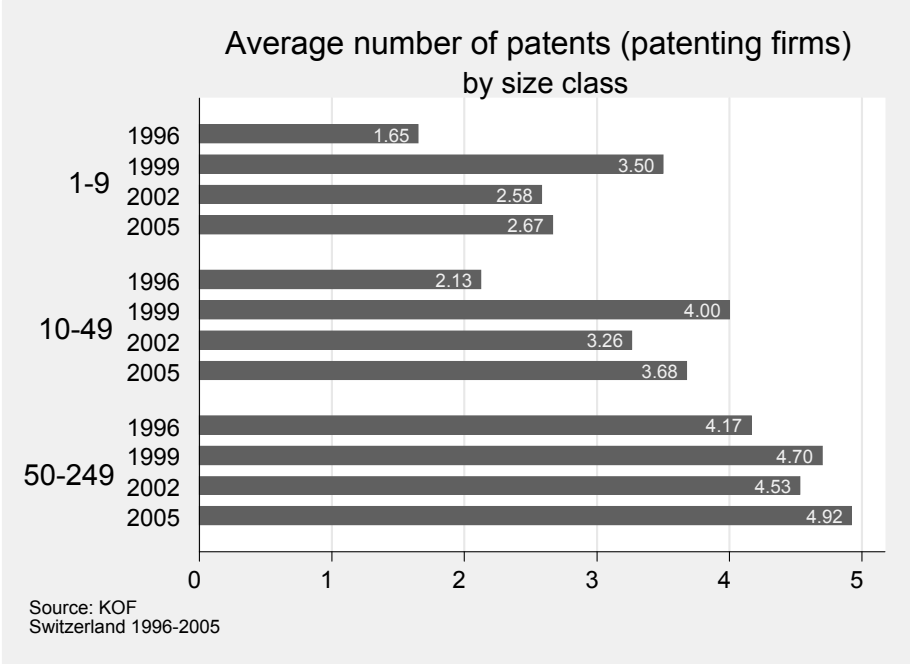
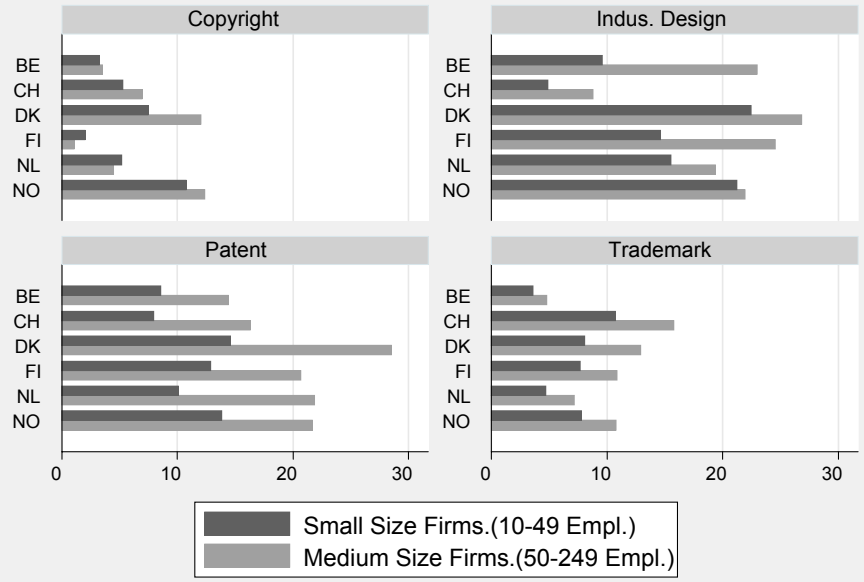


Figure 4 The use of different types of IPRs, as a percentage of innovating firms



Source: Using CIS4 data (Eurostat) and KOF survey, for 2002-2005

All of these possible effects mirror the significant challenges for SMEs when they try to protect the economic benefits from their innovatory and international activities. Among all possible strategies, the question of how, why, and to which extent Swiss SMEs use the different IP measures the Swiss IP system offers is therefore all the more relevant. Yet, little is known about these questions. Answers to this question might significantly affect Switzerland's ability to take appropriate policy measures, and to ensure SMEs an appropriate protection of their IP.

Therefore, the subsequent analyses in this report attempt to provide answers to these questions and to elaborate policy implications on the basis of the results it offers. In the following, we divide the analysis into six additional chapters: A comprehensive literature review (chapter 2); an econometric analysis of the Swiss Innovation Survey conducted by the *Konjunkturforschungsstelle* at ETH Zurich (henceforth denominated "KOF data") (chapter 3); an econometric analysis of a survey of SMEs conducted by IPI itself (chapter 4); an analysis of patent portfolios held by the SMEs from the IPI survey (chapter 5); an integrative analysis that comments on the commonalities and differences of these analyses and explores them in greater detail by using additional qualitative analysis (chapter 6); and a final chapter that elaborates policy recommendations on the basis of the previous analyses (chapter 7).

At the beginning of each chapter, we provide an overview that summarizes what this specific chapter is analyzing, and which shows how these analyses are connected to the other chapters. At the end of each chapter, a summary draws up the main findings of the respective chapter, shows how these findings relate to those from other sections and how they are used in conjunction with other findings.

2 IPRs and SMEs: A literature review

Exposition of this chapter and connections to other chapters

The main contribution of chapter 2 is to make a link between the ideas raised in the literature and the research conducted in this report. We review the most important arguments and findings in the literature that can drive the analysis of IPR strategies by Swiss SMEs.

The review is structured following the three main forms of IPRs that are discussed in this study: patents, trademarks and industrial designs.

Concerning patents, the review discusses the heterogeneity of use done by SMEs belonging to different industries; it summarizes the relevance of patents as a protection means for SMEs but also alternative utilizations of the patent system. Later, we consider the main factors that determine the use of trademarks by SMEs. We finish then with industrial designs.

The mode of use of intellectual property rights (IPRs) and particularly of patents by small and medium-sized enterprises (SMEs) is largely influenced by economies of scale and the peculiar nature of costs associated with running an IPR division or desk within the company. The development of an in-house IPR service is an activity which is characterised by strong indivisibilities and a source of economies of scale: the cost of such a service is at least partly independent of scale; it is partly indivisible with respect to output and more precisely to innovation. As the relevant dimensions of scale are increased (in our case R&D for instance), indivisible costs can be spread over a larger output and the cost per unit is therefore reduced. Such indivisibility is therefore a major reason why small firms will avoid rationally to internalise IPR services. Other sources of economies of scale - economies of specialisation, superior techniques of organizing activities, learning effect - are obviously characterizing to a certain degree any investment in an IPR service. However, to the best of our knowledge there is no empirical literature on the sources of economies of scale in IPR activities within firms. Nevertheless, we conjecture that these issues are important when small firms ponder whether or not they should start using patents and other IP appropriation means.

The nature of costs associated with such use is also an important factor impeding internalization, as these costs[3] are sunk costs[4]. The distinction between sunk and other costs is important because other costs can be "transferred" through a second-hand market in case of failure. Sunk costs cannot be transferred and have to be entirely borne by the firm even if the corresponding capacity remains underused. Indivisibilities as a source of economies of scale and sunk costs are therefore two major characteristics of any investment into an IPR service which makes the economic case of investing in an in-house IPR capacity quite difficult for micro firms and SMEs. Of course, strong

[3] Pottelsberghe de la Potterie and François (2006) make an average calculation for the cost of patenting in Europe for the year 2003. The filing process protecting the innovation in the three biggest countries (Germany, UK and France) is on average 20'570 Euros. In the case of protecting the innovation in 13 EU countries, the total filing cost raises to 39'675 Euros. The biggest share of the cost goes into translations.

[4] Sunk costs are expenditures by a firm which do not result in assets for which there is a market. A definition of the technical concepts is available at the end of the report (glossary).

variations across sectors as well as more subtle size effects are expected and will be surveyed below where relevant material is available.

Beyond the usual cost explanation, we propose in the following sections to concentrate on the special characteristics of SMEs and on the difficulties and advantages they have when using IPRs. The literature review covers mostly academic research dealing with SMEs and IPRs. We have also included, when the results were relevant for our discussion, some reports published by the European Commission or by some national IP agencies, including policy initiatives aiming at providing assistance to SMEs with respect to IPR-related issues.

In the first part of the review (2.1) we concentrate on papers that focus on SMEs and patents. Our goal is not to make a general survey of the literature dealing with patents but a review addressing the specific features related to SMEs (for a general understanding of the academic discussion on patents see Hanel, 2006). Afterwards, we focus on trademarks (2.2). As the literature is scarce, we scan papers that discuss trademarks for all kind of firms, trying to see how SMEs could be affected by the different problems raised in the papers. A short mention is made at the end of the literature concerning industrial designs (2.3).

The different aspects of the survey are linked to the results we obtain in the next chapters. Precise links are done in italic inside each subsection of the present chapter.

2.1 Patents and their multipurpose use by SMEs

One of the principal drivers of growth in any modern society is technological change. New products and new ways of producing are key factors in the general dynamic evolution. A large proportion of innovations introduced by firms are not the result of casual invention but the consequence of investments in systematic research and development (R&D) activities. These investments are associated with high risks, since the outcomes of R&D activity are *a priori* uncertain. Patents and other legal appropriation measures were originally created to protect inventors from imitation and to guarantee that firms which undertook the effort to conduct R&D can appropriate the returns from it.

If a firm wants to be granted a patent, enough information should be disclosed in the application to permit another skilled person to replicate the result. The idea is to protect part of the invention while disseminating the knowledge in such a way that another firm (without copying it) can make use of it. If the system would work, the rights of the innovator will be granted at the same time that new knowledge is spread across the society allowing further inventions.

In this section, we focus on the five different dimensions of patent use by SMEs[5]. We first show the heterogeneity of firms using patents (2.1.1); patents often provide a loose protection against imitators due to high litigation costs (2.1.2). However, SMEs can use the patent system in alternative ways than invention protection: they can search patents for information in order to produce further inventions (2.1.3), signalling their technological capabilities to others (2.1.4). A last important dimension is the strategic use of patents by SMEs in order to block competitors or to negotiate with them (2.1.5).

[5] Our survey on the use of patents by SMEs excludes "spin-offs" from universities, because in the case of such "spin-offs", the patent can belong to the institution. The dynamics of these infrequent cases are very different from the goal of the study (see also Radauer and Streicher 2008 on this aspect).

2.1.1 The heterogeneity of SMEs using the patent system

The available literature shows that the patent system is not used in a homogenous way by firms. The likelihood to patent invention depends on the size of firms but also on the industry they belong to.

Empirical research suggests that one of the most important variables when explaining the use of IPRs is firm size. When we refer to size, we also imply that implications of sunk costs and externalities (considered in the introduction of this paper) are present. Also, general problems concerning factors dampening innovation (Baldwin and Lin, 2002; Galia and Legros, 2004; Tourigny and Le, 2004) might be strongly affecting SMEs. All these reasons might come to the fact that the propensity to use IPRs increases with firm size (Arundel and Steinmueller, 1998; Davis and Kjaer, 2003; Hanel, 2001; Byma and Leiponen, 2007; Allegrezza and Guarda-Rauchs, 1999; Greenhalgh et al., 2001a).

Davis and Kjaer (2003) also discuss the idea that, due to the nature of the invention, a patent might not be the right appropriation method since the technology could be developing so fast that patent protection would not make sense. In their work, they study SMEs from three sectors: biotechnology, telecommunications and software. One of their main conclusions is that the patenting strategies of Danish SMEs are sector-specific. For telecommunications, they find that products are more patented than processes; in software there is a very limited use of the patent system and for biotech, patents are used very often by the firms and judged the best way to appropriate innovation.

The heterogeneity among industries is confirmed by Arundel and Steinmueller (1998). Using the Community Innovation Survey (CIS thereafter) data for ten European countries and calculating sectoral differences for 14 high-tech sectors, conclude that the propensity to patent[6] is related to the value of the patent in that sector. The advantage of these studies is that they focus only on SMEs. Therefore, their results are relevant for this review.

The use of IPRs by SMEs is thus highly dependent on the industry sector. Such a conclusion is supported by several other empirical studies (Hanel, 2001; Byma and Leiponen, 2007; Greenhalgh et al., 2001a; Thumm, 2001; Mainwaring et al., 2004; Radauer and Streicher, 2008).

An explanation for the variation in the use of IPRs across sectors might come from the differences among product life cycles. As suggested by Davis and Kjaer (2003), industries with short product life cycle might get lower rewards from costly IPR strategies (see Cohen et al., 2000; Levin et al., 1987; Teece, 1986; Mansfield, 1986; Sattler, 2003).

The effect of size on patenting is consistent with the different descriptive and econometric results of this report (see chapters 1, 3 and 4) even if micro-firms may be more active in co-patenting (chapter 5). Our study is also highly concerned with sectoral differences. Mainly chapter 3 and chapter 4 will analyze them in detail confirming that sectoral differences are a cornerstone when explaining differences in patent strategies. Such differences are also emphasized by the qualitative analysis done in chapter 6.

[6] The propensity to patent is normally defined in the literature as the proportion of inventions that are patented.

2.1.2 A loose protection due to high litigation costs

Comparing legal means of appropriation (patents, trademarks and copyrights) to informal ways of appropriation (speed, secrecy, learning curve, product-related services), the empirical literature finds evidence that firms in general prefer informal means (Levin et al., 1987). This affirmation has been confirmed for Finish SMEs by Byma and Leiponen (2007). The authors focus on whether or not patents are preferred by SMEs when they need to protect an innovation. Studying a database of more than 300 Finish SMEs, they compare the use of patent versus measures such as speed and secrecy as a method of appropriation. They conclude that patents are the options used least. Specifically, studying the case of a firm that has vertical collaboration agreements, they show that in such cases firms only rely on speed; since, when there is a vertical collaboration agreement secrecy is not an option.

The importance of litigation costs is a main difficulty for SMEs aiming at protecting themselves against imitators. Since the resources SMEs can devote to patenting are scarce, the fact that a patent can potentially be litigated might discourage SMEs. Lanjouw and Schankerman (2001) show that the cost of IP asset litigation reduces both patent value and the incentive to invest in research. Their paper investigates the characteristics of patent litigation by joining information from the patent case filing from the U.S. district courts with detailed data from the USPTO. Combining this data, they conclude that the risk for litigation increases with the value of the patent, especially if the patent is cited much. In a related article, they also analyse questions of litigation and SMEs (Lanjouw and Schankerman, 2004).

Using a similar database as in the previous article and focusing on US SMEs, they observe that the firms with a large patent portfolio have a lower probability of being litigated. They also comment that repeated litigation facilitates future collaboration among firms. Another interesting result of their research is that the portfolio of patents held by large firms[7] normally affects the way in which a small firm is conducting its R&D efforts by trying to be as far away as possible from this portfolio.

This last idea was studied in more detail by Lerner (1995). Analysing 419 US biotech firms, he provides empirical evidence that firms with high litigation costs tend to patent as far away as possible from subclasses with many awards. Consistent with Lerner's finding that the cost of patent litigation dissuades smaller firms from patenting, Cohen et al. (2000) – using the Carnegie Mellon Survey[8] and controlling for industry effects – show a positive and significant relation between firm size and the cost of defending a patent in court as a reason for not applying for a patent. These findings may suggest that larger firms are better able to spread the fixed costs of defending patents over greater levels of output.

To these problems are added the difficulties SMEs have to monitor the use of their IPRs in the market and to enforce them (Cordes et al., 1999; Koen, 1992). Empirical literature finds that small firms' patents are infringed more often than large firms' patents (Koen, 1992). In order to get more detailed results, the European Commission analysed in 2001, the ways of how small firms can enforce IPRs. Their study collects data from 600 European SMEs, concluding that:

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[7] For an interesting review of the work done on firms and the propensity to patent see Makinen (2007) or Arundel and Kabla (1998).

[8] The Carnegie Mellon Survey is also called the Yale II survey and follows the Yale survey done by Levin et al. (1987).

- Most of the firms that have patented an innovation made at least one prototype of the patent invention. In two thirds of the cases, they were manufactured by firms themselves and in one fifth by licensing.

- Two thirds of the firms have experienced attempts to copy their innovation, only 25% of these firms have problems in learning about this.

- More than a quarter of the copying was done by big firms. In one third of the cases the infringing firm was about the same size as the respondent. 11% of the cases reported that they had been copied by firms in both size categories.

- Half of the firms considered the financial damage done by copying as bearable. However, it was very serious for 21% of them.

- When using the courts to defend their patents, only one fifth went as far as trial.

- Two fifths of the responding firms reported that investments in invention were not affected at all by fear of the cost of litigation to defend patents. Only 13% of all firms considered the fear of litigation as a serious impediment.

In chapter 4, we will discuss the strategies used by SMEs to protect their innovations by non-IPRs and informal means of appropriation (speed, secrecy, learning curve, product-related services). We will mainly focus on product-related services and ISO normalization as possible strategies enhancing appropriation capacities of SMEs. The reviewed results still suggest the limited scope of an analysis of IPR strategies for innovative SMEs. Trying to compensate the restrictions with data we face, the report analyses litigation costs in the qualitative analysis done in chapter 6. The enforcement difficulties concerning IPRs will be discussed in sections 4.4 and 4.5, when we exploit the information contained in the IPI survey.

2.1.3 Patents as an underutilised source of information for SMEs

Since almost the beginning of the Community Innovation Survey (CIS) and precedent surveys about appropriation (like Policies, Appropriability and Competitiveness for European Enterprises (PACE) or the "Yale" survey during the 1980s (Levin et al., 1987)), economists have investigated the role and importance of various sources of technological information as an input to the innovation process. Patents, as a source of information, have always been assessed against other sources and the results are quite persistent over time. Bosworth and Stoneman (1996) explain that with the exception of Portugal, all countries show a positive relationship between firm size and the use of patent disclosures. In the majority of countries this was not only a strong relationship, but also a monotonically increasing one. Small firms make less use of patents as a source of information than larger firms. The regression analyses done by these authors confirm the fact that larger firms are more likely to search patent databases, and they are consistent with the general pattern of use of the patent system with respect to firm size.

Bosworth and Stoneman showed also important differences in the use of patent disclosure across different industries. Of all manufacturing sectors, the chemical industry (including pharmaceuticals) ranks top with respect to patent disclosures, followed by medical and precision instruments, manufacture of machinery and equipment and manufacture of radio, television and communication equipment.

In a study exploiting the CIS survey, Arundel and Steinmueller (1998) argue that patent databases can be used to develop second-generation products or processes, to solve

technical problems in completely unrelated fields or to identify areas where existing patents block new entrants from entry into a technological field. Apart from the use of this knowledge for the innovation process, the information contained in the databases can be used for other purposes: to monitor innovative activities of competitors, to acquire legal information that might help in the management of the patent portfolio, or to check for patent infringements. Using the CIS data of 1990-1992 for ten European countries (Germany, France, Italy, Netherlands, Belgium, Luxembourg, Ireland, Denmark, Spain and Norway), and calculating sectoral differences for 14 sectors, they conclude that the propensity to patent in each sector is related to the value attributed to patents in each sector. Their results also reflect on the fact that the use of patents as a source of information is correlated with the use of patents as an effective method for appropriation. They detail their findings further by conducting a survey among Dutch SMEs in five high-tech sectors: information technologies, precision instruments, non-civil engineering, environmental technologies and agricultural biotechnology. Analyzing the results of the surveys, they comment that SMEs mostly use the information of patent databases for legal purposes, followed by checking on competition and the acquisition of technological information. They study further the reasons of this low use of the information contained in databases by SMEs with a technological intention and they comment that most of the information contained in the patents is disseminated by other means like conferences and trade fairs. To use the data from patent database, highly skilled labour is needed which is very costly in terms of time and resources. The only exception to this finding was that firms in the biotechnology sector used information contained in patents because it was not available in any other format. Most SMEs also reported that they did not use patents due to the high level of information disclosure a patent stipulates. On the other hand, most SMEs also state that most of the information contained in the databases is not relevant since they believe that no firm will provide information that may harm itself. The paper gives the policy suggestion to reduce the information cost of using patent databases (see also Radauer and Streicher, 2008).

In this report the use of patent databases will be analyzed by section 5.4.3. In this section, we will use as a proxy for the use of patent databases the number of backward citations made in patent documents filed by Swiss SMEs.

2.1.4 Patents as a signal of the value of SMEs' technological effort

Most new firms start out as small firms, and new small firms have to cope with the financial challenges as well as with uncertainty and information asymmetries. In contrast to large firms, which are able to finance their R&D, marketing assets, as well as human and organisational capital from internal cash-flow, new small firms have to rely on external sources of funding to finance their growth.

But even if the small firm's manager is motivated to maximise shareholder value, informational asymmetries may make raising external capital more expensive or even preclude it entirely. With respect to R&D and other innovatory activities, the asymmetric information problem refers to the fact that an inventor or a manager has better information about the likelihood of success than potential investors. As argued by Hall (2007), the marketplace for financing the development of innovative ideas is similar to the "lemons market" (Akerlof, 1970). The lemon's premium for high-tech start-up firms will be higher than that for ordinary investment because investors have more difficulty distinguishing good projects from bad ones. In the most extreme version of the lemons model, the market for "start-up-related R&D projects" may disappear entirely if the asymmetric information problem is too great. Reducing information asymmetry is therefore a key issue. Full disclosure of innovative ideas - which could be the most obvious signalling mechanism devised to mitigate the information asymmetry problem with in-

vestors - may not work here because of the risk of rapid imitation. Indeed, firms are reluctant to reveal their innovative ideas to the marketplace.

To address the information problem that precludes investors to invest in small high-technology firms, potential partners employ a variety of mechanisms. One of these is to carefully scrutinize the patent portfolio. In that case, patents can play a new role which is "signalling" the future value of the technological effort. As patents are used to draw attention to resources and establish a reputation, patent portfolios are becoming an essential element in the evaluation of intangible assets by financial markets; it is particularly critical in the case of new firms which have no other intangibles to show. Such signalling mechanism may be so central in the growth strategy of the new firm that they counterbalance the shortcomings associated with patenting for small firms as documented above. This is why the propensity to patent is likely to be far higher for small new firms than for other small existing firms.

If theoretical aspects are clear, statistical evidences are scarce on the signalling aspects. On Danish SMEs belonging to three industries, Davis (2006) reports: ”The signalling role of patents was frequently emphasized, not only to warn of potential competitors, but also (similar to respondents in the two other industries) to attract the interest of customers and potential business partners. [..] Our respondents declared that applying for a patent showed that the firm was seriously committed to a particular line of research. It was a way to get one's name in the databases, where others searched to find out who was doing what”.

The IPI survey offers us the possibility to understand the relevance of applying for a patent in order to access financial support. We will discuss this issue in sections 4.3 and 4.6, even if a small proportion of the firms in our sample considers finance as the main reason to apply for an IPR.

2.1.5 The strategic use of IPRs by SMEs: to block and to negotiate

The patent system can be used "strategically" in that the SME can use it to block its competitors. A firm can indeed, through patents, orientate the competitors' R&D activities or preserve itself from competitors' strategies. The "strategic" use of the patent system is difficult for SMEs due to the costs induced by the accumulation of blocking or sleeping patents filed in order to deter competitors to enter into the field or to preserve future opportunities. Davis and Kjaer (2003) show that some Danish SMEs use patents as a strategic signal to block competitors from investing in a given area. Statistical results are however very scarce on these strategic behaviours. Nevertheless, a recent paper by Giuri and Mariani (2007) reports that large firms are much more likely to play strategically with the patent system (representing 40.8% of patents) than SMEs (18.4% of patents). The result holds either for blocking patents[9] or sleeping patents[10].

SMEs can also manage interactions with other firms using their patent portfolio for negotiation purposes. Patents are indeed useful at protecting SMEs from monopsonic power on markets for technology or opportunistic behaviour during cooperation agreements. On the former, Giuri and Mariani (2007) show that SMEs are more likely to use patents as a mean to sell a license, to obtain cross-licensing or to sell a license keeping the use of the invention. On the later, Davis and Kjaer (2003) confirm that, apart

[9] A blocking patent is a patent filed by a firm (or a researcher) in order to block the entry in the field of other firms, preserving its dominant position.

[10] A sleeping patent is a patent granted on a technology where the patent-holder does not exploit it, despite market potential.

from protecting the innovation from imitation, a patent is an excellent tool for Danish firms to establish the legal basis for cooperation.

Even if the available data do not allow us to tackle directly the first strategic use, the present report suggests that patents filed in Switzerland are indeed a means for Swiss SMEs to facilitate contract negotiation (section 5.4). In chapter 6, a qualitative analysis further explicit the complexity of the different patent strategies implemented by Swiss SMEs.

2.2 Trademarks and SMEs

2.2.1 Trademarks as a neglected IPR tool

A trademark can be broadly defined as "a distinctive sign, which identifies certain goods or services as those produced or provided by a specific person or enterprise" (WIPO, 2004). This IPR is similar to patents, in that it gives the owner of trademark a legal protection by granting an exclusive right to use the trademark to identify its products or services, or allow others to use this trademark by licensing agreements. The analysis is similar to the one done on patents since it is costly to register and to renew the trademark rights; firms have to pass a national examination process (although this process is shorter than that for patents). An original trait is the establishment of a European trademark with the establishment of the Office of Harmonization for the Internal Market (OHIM) in 1994. Similar to patents, trademarks can be filed nationally or internationally. Unlike patents, the owner can renew trademarks for an indefinite time. A trademark can be granted fast, and the national channel often dominates the international one (OHIM, 2007).

Despite the fact that trademarks are an important and growing source of revenues for national and international agencies (Doern, 1999), the discussion of trademarks as an IPR appropriation mechanism is often neglected by the literature. However, some works give direct insights (2.2.2) and indirect views (2.2.3) on the differences between trademarks and patents for SMEs.

2.2.2 Trademarks as an IP measure tailored for SMEs?

Even if one can argue that trademarks are more easily available and cheaper than patents, there are few econometric studies that use trademark data in order to directly analyse firms' characteristics and especially firm size as a determinant to use trademarks. Most studies are rather using these data as explanatory variables to show the impacts of trademarks on firms' size, growth, productivity and market value (Bosworth and Mahdian, 1999; Bosworth and Rogers, 2001; Greenhalgh et al., 2001b; Seethamraju, 2003; Griffiths et al., 2005; Greenhalgh and Rogers, 2007). The few results available for the effect of firm size have the same shortcomings than studies dealing with patents. On this topic, we found only four references in the literature. We now comment them with more details.

The study by Allegrezza and Guarda-Rauchs (1999) seeks to explain the mechanisms underlying a firm's decision to deposit a trademark. A logit regression done on 1862 Benelux firms relates the likelihood to deposit at least one trademark to different explanatory variables such as R&D intensity, exporting capacity, industry dummies, country of operation and size. Interestingly, the regression results emphasise the central role of the entrepreneur's personal awareness of trademark protection. The results give evidence that larger firms are more likely to register a trademark. Despite a large sample size, results are not that interesting since the dependent variable does not measure the number of trademarks but rather the likelihood to file at least one trademark. The

authors admit then that their results are "not surprising". The authors also underline the lack of robustness of their results showing that the size effect is not significant anymore when only the most recent applying firms are considered. The results are in some way confirmed by Greenhalgh et al. (2001a) who implement a rigorous econometric model on UK firms, showing that trademark participation increases for firms with up to 250 employees but does not significantly rise for larger firms.

A descriptive exercise, done on Norwegian firms, gives some clues on SMEs' likelihood to use trademarks. Gathering several thousands of applicants, including micro firms and SMEs, Iversen (2003) underlines that less than 30% of the smallest firms identified were involved in two or more trademark applications whereas the percentage rises to 90% for large enterprises. This rough analysis suggests a positive correlation between size and the number of trademark applications. The idea is confirmed by a more detailed analysis done by Greenhalgh et al. (2001a). The authors find that smaller financial firms in the UK are proportionally more active in filing trademarks. The number of trademarks per employees is found to be growing with firm size. Here, the size effect is however not controlled for other aspects such as industry differences. To our knowledge, only one serious and reliable study has been done here by Mainwaring et al. (2004). Applying a zero-inflated Poisson model to explain trademark counts on 3500 firms located in three British regions and Ireland, the authors find that trademark counts increase with firm size. The specification does not directly estimate the impact of firm size on the intensity of using trademarks. However, marginal effects suggest that large firms could be using trademarks more intensively.

In general, the report confirms that trademarks are relatively more used by SMEs in Switzerland, and that SMEs, especially large ones, are also more keen to use trademarks rather than other IPRs (section 3.4, section 4.2, Figure 11, section 4.6 with appendix A.6 and A.7).

2.2.3 Special effects for exporting, innovative and service SMEs

The trademark boom (Velling, 2002; Mendonça et al., 2004; OHIM, 2007) brought some scholars to analyze the role of this IPR. Three aspects can be found in the scattered literature. First, some papers insist on trademarks as an indicator approximating useful categories of economic analysis. In trade or industrial economics, trademarks approximate the different strategies of differentiation, specialisation or protectionism of firms, industries or nations (Baroncelli et al., 2004a; Fink et al., 2003; Baroncelli et al., 2004b). This literature is not interesting for us *per se*. It suggests however that differentiated firms and exporting firms are more likely to use trademarks, which is consistent with theorems belonging to the industrial organisation literature dealing with differentiation and market size (e.g., Tirole, 1988). The relation between the international projections of the firm will be discussed in section 6.2, when a qualitative study is carried out on Swiss SMEs with a strong international specialization.

A second and recent strand of the literature on trademarks insists on trademarks as a feasible indicator of innovation (Velling, 2002; Schmoch, 2003; Godinho et al., 2003; Mendonça et al., 2004; Malmberg, 2007) by relying on the firm-level correlation between innovation and trademarks. Furthermore, the descriptive statistics shown by Mendonça et al., (2004) also suggest that innovating firms use trademarks more often than patents. Here, a convincing idea is that service innovations cannot be measured well neither by innovation surveys nor by patent data whereas trademarks are filed primarily for new services (Velling, 2002).

Finally, we need to point out the idea that trademarks can be an IPR that is more likely to be used by micro firms or SMEs of the service sectors. This conjecture is reinforced

by the fact that the number of trademarks related to services is growing rapidly (Greenhalgh et al., 2001a; Loundes and Rogers, 2003; Godinho et al., 2003; Schmoch, 2003; Jensen and Webster, 2004). Note that such indirect clues on the link between firm size and trademarks is also provided by studies showing that trademarks are found more frequently in the consumer goods sector than in the intermediate goods sector (see Greenhalgh et al., 2001a; Mainwaring et al., 2004). *A similar result to what we find in this report (section 4.2).*

In a nutshell, these results suggest that innovative SMEs active in a foreign market, in the service, or in manufactured goods industries are likely to file trademarks. As a conclusion, we can add two remarks on this literature. First, the scarcity of economic studies is a problem when the link between the different IPR measures is considered. To our knowledge, no paper really explores the complementarity or the substitutability among the different IPRs available for firms. *The issues of complementarity and/or substitutability among different types of IPRs will be addressed in chapter 3 and in the cluster analysis (section 4.6).*

Second, the scope of the studies is limited to the filing of trademarks when such IPR can also be costly if litigation becomes an issue. Even if this aspect is difficult to deal with due to a lack of data, it deserves to be mentioned. To the best of our knowledge, a qualitative French survey (Pfister, 2007) is the only reference which provides robust results on trademark litigation by showing that larger firms are less likely to litigate than small ones. *This issue will be discussed in the qualitative analysis of section 6.2.*

2.3 Industrial designs and SMEs

To our knowledge, there is no specific paper that concentrates on the causal relationships between firm size and the use of industrial designs. Some general analysis on firm characteristics and the use of industrial designs have been highlighted by Jensen and Webster (2006). Basically, they find that the use of industrial designs is mainly explained by sectoral differences. A general description of what industrial designs are and of their historical use since they were created can be found in a European Commission report (2007). In this report, the use or non use of an industrial design is explained by the novelty of the design and by product cycles. They conclude that especially SMEs are not aware of the way in which an industrial design can protect them.

Chapter 3 and chapter 4 will try to identify the firm characteristics, sectoral and size effects that determined the use of industrial designs. The report also considers the complementarity of this IPR with other IPRs.

2.4 Important ideas and insights from the review

From the surveyed literature, several conclusions will be particularly kept in mind when studying the different aspects of the IPR strategies of Swiss SMEs.

Summary of this chapter and connections to other chapters

The main findings of this chapter can be summarized as follows:

- The use of IPRs by SMEs is highly dependent on the industry sector.
- The most important variables when explaining the use of IPRs is firm size. SMEs are less likely to use IPRs than large firms.
- Exporting SMEs are, to some extent, more likely to use IPR protections.

- SMEs are loosely protected by the different legal means of appropriation (patents, trademarks and copyrights), even if they can combine them. For SMEs, enforcement may be difficult due to high litigations costs. SMEs may thus rely more on informal ways of appropriation (speed, secrecy, learning curve, product-related services).
- Even for SMEs, IPR strategies can be complex and go beyond the protection from imitators (including information acquisition, signalling, blocking patents or negotiation purposes).

The different points have been reviewed in detail in this chapter and they will be discussed in the whole report.

3 Econometric analysis of the KOF data

Exposition of this chapter and connections to other chapters

Given the results from the literature review (chapter 2), the knowledge about how SMEs protect their IPRs, and why they may prefer one means of protection over another is limited and fragmented. To provide such information, the report makes a number of econometric and qualitative explorations. This chapter is the first of these explorations. It uses data from the 2005 wave of the Swiss Innovation Survey which was implemented by the *Konjunkturforschungsstelle* (KOF) of ETH Zurich. For the sake of simplicity, these data are henceforth labelled as "KOF data". The analyses performed in this chapter comprise:

- to determine the extent to which SMEs use or do not use IPR protection measures;
- to determine the impact of covariates such as public subsidies, R&D investment, etc. on SMEs' propensity to use IPR protection measures.

The findings and results from these analyses are summarised in the box at the end of this chapter, as well as an explanation of how these results relate to the other chapters in this report.

3.1 Background

To produce a large-sample analysis on an SME's use or non-use of IPR protection measures with which IPI's own survey (cf. chapter 4) can be compared and contrasted, we analysed data from the Swiss Innovation Survey led by KOF-ETHZ. The questionnaire by which this data is collected is available online from http://www.kof.ethz.ch/surveys/structural/panel/inno_2005.

We will refer to this questionnaire repeatedly in the following explanations, and all question numbers mentioned in the following refer to this questionnaire. Although this data is collected every three years, only the very recent dataset collected in 2005 contains the vital question 7.1 which collects data on firm's use of patents, trademarks, industrial designs, and copyrights. Therefore, the analyses are restricted to using these data and are therefore of a cross-sectional nature. Thus, all necessary econometric techniques have been applied to guarantee robust estimates and to control for unobserved heterogeneity as far as possible.

3.2 Data and methods

The 2005 KOF survey data were extracted into a separate data set and analysed with the statistical package STATA Vol. 10. We estimated models that related the propensity of the firm to use either measure of IP protection (patents, trademarks, industrial designs, and copyrights) to the presence or absence of specific factors in the respective SME, such as the extent of its international activities, or its innovatory behaviour (cf. chapter 3.3.1). Thus, four models were created, one for every IP measure. These models were estimated simultaneously by estimating a multivariate probit model – i.e., we estimate the firm's propensity to use either patents, trademarks, industrial designs, or copyrights *simultaneously*, rather than running separate models. We used this method because we cannot rule out the possibility that there is endogeneity in the data. This means we cannot say for sure that there are only unidirectional relationships between the independent variables and the predictors. For example, sales of innovative products could be dependent on the firm's ability to protect its IP from imitation. Esti-

mating all models simultaneously allows to control for such possible endogeneity and also takes into account possible interdependencies in the firm's choice for either measure.

All models only used data on firms that had less than 250 employees (i.e., from SMEs). Micro-firms with less than 10 employees were excluded from the analysis as there were very few such firms which had patents or other institutionalised forms of IP protection.

In a second (different) model, we also exploited the KOF data information on how many patents an SME has applied for in the period 2003-2005. Using this information allows to model how intensely an SME uses the IP system. This model used the same set of predictors as described below and was subject to the same robustness checks.

3.3 Variables

3.3.1 Dependent variables

There are four dependent variables, one for every model. Each dependent variable describes the firm's propensity to use or to not use the respective measure. Thus, the dependent variables are dichotomous indicators of the form "We use patents for IP protection (yes/no)", "We use trademarks for IP protection (yes/no)" and so forth. This "yes/no" information is then related to the following independent (explanatory) variables.

3.3.2 Independent variables

In the following, we describe the independent variables (predictors) which, according to previous literature on intellectual property, could be responsible for the effect that some firms use a specific IP measure[11] for protection whereas others do not. Thus, these independent variables explain the variation of the above-described dependent variables. The numbering of questions mentioned in the following relates to the question as it was included in the 2005 KOF questionnaire.

* *Foreign ownership* (modelled from question 1.2). SMEs that are controlled by foreign entities could be expected to have a different IP behaviour. For example, such firms possibly receive funds from their overseas parent and are thus more able to apply for patents on a larger scale.

* *Share of sales from new-to-the-firm innovations* (modelled from question 2.2a_1). One can expect that SMEs that earn a lot of sales from new-to-the-firm products which can be considered highly innovative use patents to protect their innovatory advantages.

* *Share of sales from improved innovations* (modelled from question 2.2a_2). One can also expect that SMEs that earn a lot of sales from improved innovations use patents to protect such improvements over time.

* *Product life cycle* (modelled from question 2.3). Previous literature suggests that in industries characterised by short product life cycles, patents are of lesser importance.

[11] By "IP measure", we mean any of the four major formal means available to a firm to protect its IP (patents, trademarks, industrial designs, and copyrights).

* *Foreign R&D activity* (modelled from question 3.1_2). Switzerland is characterised by a strong presence of so-called "born globals", i.e. SMEs that have international activities. If SMEs do R&D outside of Switzerland, e.g. by international alliances, one could expect that they are more likely to use institutionalised forms of IP protection such as patents to safeguard their know-how.

* *Externalisation of R&D* (modelled from question 3.4a). SMEs are often characterised by resource shortages, so they are likely to engage in alliances with other (larger) firms to co-develop innovations. One could expect that they are more likely to use institutionalised forms of IP protection such as patents to protect themselves against unlawful appropriation of their IPRs by the partnering firm.

** Funding from national and EU public promotion programmes* (modelled from questions 5.1 and 5.2). A dominant argument in literature is that patents are costly and thus often infeasible for SMEs to protect their IPRs. However, if SMEs receive funding from public promotion programmes, this might help them to finance patenting costs.

** External knowledge sourcing.* We used the information from question 9.1 that asks whether or not SMEs use external third parties (such as customers, suppliers, universities, etc.) as a knowledge input for their innovatory activities. As these third parties are likely to collaborate with the firm on a close basis, the firm may be unable to rely on informal mechanisms such as secrecy to protect its IP and may therefore be more prone to use patents. Factor analysis suggested that three variables can be formed from question 9.1:

- *Knowledge from external customers (scale computed from questions 9.1a_1 and 9.1c_2).*
- *Knowledge from purveyors (scale computed from questions 9.1a_3 and 9.1a_4)*
- *Knowledge from institutions (scale computed from questions 9.1b_1, 9.1b_2 and 9.1b_4)*

* *Impediments to innovation.* Literature suggests that impediments to innovation such as adverse regulatory systems, high taxes, shortage of resource etc. has a negative impact on the firm's propensity to innovate (Galia and Legros, 2004; Baldwin and Lin, 2002; Tourigny and Le, 2004). Thus, one could expect that firms that experience such impediments are less likely to innovate and therefore, *ceteris paribus*, less likely to use patents to protect their innovations. We used information from question 10 to construct variables to measure these impediments. Factor analysis suggested that the following variables can be formed:

- Financial impediments (scale computed from questions 10b_1 to 10b_3)
- Work-related impediments (scale computed from questions 10c_1 to 10c_3)
- Cost-related impediments (scale computed from questions 10a_1 to 10a_4.1)
- Regulation-related impediments (scale computed from questions 10g_1 to 10g_6)

3.3.3 Control variables and additional robustness checks

All estimations use robust standard errors to control for possible heteroscedasticity. We further included controls for firm size by measuring the log-natural of the number of the firm's employees, and a series of 18 industry dummies to control for the different industries the firms pertained to (as some industries, like biotechnology, are characterised by a very high rate of patenting, whereas other industries are not).

The estimation also took into account that the KOF survey may be non-representative of innovative firms. Therefore, possible problems of sampling non-representativeness

were countered by using KOF's own probability weights that adjust for sample non-representativeness and selection effects of innovativeness.

Finally, in the process of estimating the models, we conducted robustness checks regarding a number of possible additional sources of variation. These checks included testing for potential biases regarding innovating vs. non-innovating firms, and for the firm's perceived competitive intensity of its environment. However, none of these effects was significant.

3.4 Results: Propensity to use either measure

Table 1 below shows the results from the simultaneous estimation of all four equations by a multivariate probit model (sample size: N = 516). The model is valid to explain the variance in the data (Wald chi-square = 2157.41 (128 d.f.), $p < 0.001$). The table shows coefficients, standard errors in parentheses, and uses star notation to identify significance (*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$). For better readability, significant effects are printed in bold font.

Table 1 Results of KOF data estimations

	Propensity to use patents	Propensity to use industrial designs	Propensity to use trademarks	Propensity to use copyrights
Foreign ownership	-.0919 (.1623)	.3361 (.1956)	-.3222 (.1794)	-.2120 (.2055)
Sales from radical innovation	.0059 (.0041)	.0074 (.0046)	**.0086*** **(.0041)**	.0076 (.0046)
Sales from incremental innovation	**.0065*** **(.0024)**	.0029 (.0040)	.0039 (.0033)	**.0085*** **(.0036)**
Product life cycle	.0229 (.4360)	.0527 (.0472)	**.1396**** **(.0413)**	-.0198 (.0515)
Foreign R&D activity	**.6560***** **(.1869)**	**.4633*** **(.2091)**	.1899 (.1880)	.3920 (.2110)
Externalisation of R&D mandates	**.3447*** **(.1367)**	.2360 (.1733)	.4655 (.1462)	.2104 (.1713)
Subsidies from national bodies	-.1334 (.2275)	-.2643 (.2568)	.2214 (.2521)	.2666 (.2592)
Subsidies from international bodies	.4508 (.3504)	-.0340 (.3596)	.0909 (.3518)	.3458 (.3431)
Use knowledge from customers for innovation	-.0438 (.0807)	**.1811*** **(.0920)**	-.0890 (.0787)	-.0702 (.0984)
Use knowledge from suppliers for innovation	-.0702 (.0806)	-.0896 (.0922)	-.0738 (.0712)	.0179 (.0952)

Use knowledge from institutions for innovation	**.1942*** **(.0896)**	-.0136 (.0972)	.0727 (.0826)	.0424 (.1114)
Finance-related impediments	.0078 (.0874)	.1043 (.0929)	**-.2089*** **(.0902)**	-.1107 (.0968)
Work-related impediments	-.0157 (.0943)	**-.2268*** **(.0967)**	.0395 (.0793)	**-.2263*** **(.1076)**
Cost-related impediments	**.1960*** **(.0963)**	**.2278*** **(.1078)**	-.0117 (.0903)	**.3011*** **(.1203)**
Regulation-related impediment	-.1082 (.1245)	-.2060 (.1327)	**.2999*** **(.1200)**	.0618 (.1257)
Logged firm size	**.2604**** **(.0869)**	**.2669**** **(.0930)**	**.1945*** **(.0807)**	-.0438 (0927)
Industry dummies	Yes*	Yes*	Yes*	Yes*
Constant term	**-3.2234***** **(.5277)**	**-3.4329***** **(.5920)**	**-2.5519***** **(.4568)**	**-1.7906***** **(.5381)**

* To avoid inflation of the table, the single industry dummies are not shown but commented in the subsequent description of results.

Interpreting these results, we can infer the following with regards to the propensity to use patents:

(1) The Wald chi-square test suggests that the model as such is valid.

(2) The propensity to use patents increases with the share of sales earned from significantly improved (incremental) innovations, although the effect is small. This effect is significant with an error probability of less than 5%.

(3) Firms that have foreign R&D outside of Switzerland are 1.93 times more likely to use patents to protect their IP than firms that have national R&D only. This effect is significant with an error probability of less than 0.1%.

(4) Firms that have externalised R&D activities to third parties are 1.41 times more likely to use patents to protect their IP than firms that have national R&D only. This effect is significant with an error probability of less than 5%.

(5) Firms that use institutions (universities, research institutes, etc.) as a source for external knowledge sourcing are 1.21 times more likely to use patents to protect their IP than firms that do not use institutions as external knowledge sources. This effect is significant with an error probability of less than 5%.

(6) Firms that report that high costs and risks are impediments to their innovatory processes are 1.21 times more likely to use patents to protect their IP than firms that do not report these impediments. This effect is significant with an error probability of less than 5%.

(7) The propensity to use patents to protect IP strongly increases with firm size. For every one-unit increase in the logged firm size, the propensity to use patents for IPR protection increases by a factor of 1.31. This effect is significant with an error probability of less than 0.1%.

(8) The propensity of an SME to use patents for IPR protection significantly varies with its industry affiliation. SMEs active in the fabricated metal tools, machinery, electronic technology, electronic instruments, and automotive industries have a significantly higher propensity to use patents than SMEs in other sections.

Regarding a firm's propensity to use industrial designs, we can infer the following:

(1) The Wald chi-square test suggests that the model as such is valid.

(2) Firms that have foreign R&D outside of Switzerland are 1.59 times more likely to use industrial designs to protect their IP than firms that have national R&D only. This effect is significant with an error probability of less than 5%.

(3) Firms that use customers as a source for external knowledge input into their innovation processes are 1.20 times more likely to use industrial designs to protect their IP than firms that do not use institutions as external knowledge sources. This effect is significant with an error probability of less than 5%.

(4) Firms that report that work-related impediments such as the lack of qualified staff are only 0.8 times as likely to use industrial designs to protect their IP than firms that do not report these impediments. In contrast, firms that report that high costs and risks are impediments to their innovatory processes are more likely to use industrial designs to protect their IP than firms that do not report these impediments. These effects are significant with an error probability of less than 5%.

(5) Again, the propensity to use industrial designs to protect IP strongly increases with firm size. For every one-unit increase in the logged firm size, the propensity to use industrial designs for IP protection increases by a factor of 1.31. This effect is significant with an error probability of less than 1%.

(6) The propensity of an SME to use industrial designs for IPR protection significantly varies with its industry affiliation. SMEs from the paper and the graphical industry are significantly less likely to use industrial designs for IPR protection, whereas SMEs active in the automotive industries have a significantly higher propensity to use patents and industrial designs.

Regarding a firm's propensity to use trademarks, we can infer the following:

(1) The Wald chi-square test suggests that the model as such is valid.

(2) The propensity to use trademarks increases with the share of sales earned from new-to-the-firm (radical) innovations, although the effect is small. This effect is significant with an error probability of less than 5%.

(3) An SME's propensity to use trademarks increases with the length of the product life cycle of its products. For every one-year increase in the product life cycle, the firm's propensity to use trademarks increases by a factor of 1.15. This effect is significant with an error probability of less than 1%.

(4) Firms that report that finance-related impediments such as the lack of funding are an impediment to their innovation processes are less likely to use trademarks. In contrast, firms that report regulation-related impediments (such as strict governmental regulation of innovatory efforts) are 1.35 times more likely to use trademarks than firms that do not report such impediments. Both effects are significant with an error probability of less than 5%.

(5) Again, the propensity to use trademarks to protect IP strongly increases with firm size. For every one-unit increase in the logged firm size, the propensity to use trademarks for IP protection increases by a factor of 1.21. This effect is significant with an error probability of less than 5%.

(6) The propensity of an SME to use industrial designs for IP protection significantly varies with its industry affiliation. SMEs from the wood processing industry are significantly less likely to use trademarks for IP protection, whereas SMEs active in the machinery industry have a significantly higher propensity to use patents and industrial designs.

Regarding a firm's propensity to use copyrights, we can infer the following:

(1) The Wald chi-square test suggests that the model as such is valid.

(2) The propensity to use copyrights increases with the share of sales earned from significantly improved (incremental) innovations, although the effect is small. This effect is significant with an error probability of less than 5%.

(3) Firms that report that work-related impediments are less likely to use copyrights. In contrast, firms that report cost-related impediments (such as strict governmental regulation of innovatory efforts) are more likely to use trademarks than firms that do not report such impediments. Both effects are significant with an error probability of less than 5%.

(4) Interestingly, an SME's propensity to use copyrights for IP protection does not depend on firm size. Firms from the graphical and electrotechnical industry are less likely, firms from the automotive industry are more likely to use copyrights.

Overall, it is obvious that firms' choices for each measure are driven by very different criteria. This points to significant behavioural differences between firms with respect to their propensity to use either measure of protection, a fact we will explore further in chapter 4.

3.5 Results: What determines how intensely SMEs apply for patents?

The previous four models have discussed the propensity of firms to use either measure of IP protection on a yes-or-no basis. Thus, it is only possible to determine whether or not a firm uses either of these measures, but it cannot be determined how *intensely* these measures are used. For example, a firm could apply for a "killer application" patent only once and then not apply for any patent during the next 20 years. Other firms, in contrast, may continuously apply for patents. Therefore, it would be desirable to determine how intensely firms use either measure of protection.

To carry out this type of analysis, information on the absolute number of patents, trademarks, designs, and copyrights each firm has applied for is needed. Unfortunately, the KOF data only provide such information for patents (by asking for the num-

ber of patents the firm has had registered over the period 2003-2005), so that the following analysis is limited to those firms that have already used patents.

We carried out the analysis on how intensely SMEs use patents to protect their IP as follows. From question 7.1a_2 that asks for the number of patents a firm has registered in the period 2003-2005, we modelled the dependent variable as a count variable to enable the estimation of special models specifically designed for such variables (Poisson models and derivatives). We then regressed the same set of predictor variables as above on this dependent variable and checked the fit of each possible model to find a best-fitting model between the choices of Poisson, negative-binomial, and zero-inflated models. Model comparison tests revealed that the zero-inflated negative binomial model fitted the data best, so that the following implications are based on this model. The fact that a zero-inflated model is preferred points to the structural effect that there are many firms with a zero count of patents (i.e., firms that do have no patent at all), whereas a few number of firms have a very large number of patents.

Table 2 below shows the results of the model estimation by a zero-inflated negative binomial with a logit-based inflation model (sample size: N = 597). Note that incidence rate ratios, not coefficients, are reported in order to allow for a probabilistic interpretation of results. The model is valid to explain the variance in the data (Wald chi-square = 151.02 (28 d.f.), $p < 0.001$). The table uses star notation to identify significance (*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$) and shows incidents rate ratios, standard errors are printed in parentheses. For better readability, significant effects are printed in bold font.

These results suggest the following conclusions:

(1) The Wald chi-square test suggests that the model as such is valid.

(2) Those firms that report government-related impediments to their innovatory activities have 1.32 times as many patents as firms that do not report these impediments. This effect is significant with an error probability of less than 5%.

(3) Those firms that report work-related impediments to their innovatory activities only have 0.95 times as many patents as firms that do not report these impediments. This effect is significant with an error probability of less than 5%.

(4) The number of patents held by an SME varies significantly with firm size (larger SMEs have 1.42 times as many patents as smaller firms) and with industry: Firms from the food and beverage, textile, wood processing, and plastics industries have a significantly lower number of patents than firms in other industries. These effects are significant with an error probability of less than 1%.

Table 2 Results of estimating the intensity of patenting

	Number of patents
Sales from radical innovation	.9952 (.0085)
Sales from incremental innovation	.9944 (.0092)
Product life cycle	.8475 (.0763)
Foreign R&D activity	1.0604 (.1995)
Externalisation of R&D mandates	1.7493 (.5893)
Subsidies from national bodies	.9864 (.2332)
Subsidies from international bodies	1.1818 (.3227)
Use knowledge from customers for innovation	.9040 (.1556)
Use knowledge from suppliers for innovation	.9749 (.1959)
Use knowledge from institutions for innovation	**1.3204*** **(.1655)**
Finance-related impediments	.9460 (.1209)
Work-related impediments	.7223 (.0837)
Cost-related impediments	1.0412 (.1730)
Regulation-related impediments	.9709 (.1888)
Logged firm size	**1.4239**** **(.1636)**
Industry dummies	Yes*

* To avoid inflation of the table, the single industry dummies are not shown but commented in the subsequent description of results.

The effects of this model are surprisingly "negative" – almost none of the predictor variables are significant in explaining the number of patents held by an SME. This points to the fact that other explanatory variables need to be explored – a point to which we will recur in section 4.6.1 were we give advice to the sister project "Case Studies on SMEs and Intellectual Property in Switzerland" (Friesike, Jamali, et al., 2009).

Summary of this chapter and connections to other chapters

This chapter has analysed the KOF data in order to identify and to determine the extent to which SMEs use or do not use IPR protection measures, and how diverse covariates may influence this choice. The results suggest that this decision is contingent on a number of factors, such as

- whether the firms innovates radically, putting a lot of completely new innovations on the market, or whether it innovates little;
- whether or not the firm experiences impediments to innovation (i.e., factors that can significantly delay, hamper, or completely abort innovation processes within a firm (Baldwin and Lin, 2002; Galia and Legros 2004);
- whether or not the firm has foreign R&D activity;
- the extent to which the firm uses knowledge from external partners for its innovations;
- firm size and industry;
- a further finding is that a firm that receives funding from public promotion programmes is not significantly more likely to use any IPR protection measure than a firm that does not.

Given that our results were based on a cross-sectional dataset, these results should be interpreted carefully. There may be time-lag effects in a firm's R&D where an effect in one period does not have implications until one or several time periods in the future. Therefore, the other chapters in this report analyse additional sources of data to provide a multi-faceted picture of how and why SMEs use or do not use IPR protection measures. One of these additional sources of data is the IPI survey which will be analysed in chapter 4. Another source is the qualitative exploration featured in chapter 6, where the preliminary findings from chapters 2 and 3 will be explored in more detail.

4 Statistical analysis of the IPI survey

Exposition of this chapter and connections to other chapters

This chapter presents three main parts.

In the first one we extract as much information as possible from the IPI survey. This is done in two steps. Firstly, the sample is weighted to make it representative of the Swiss economy. The information is presented in figures and discussed in the text (sections 4.1 to 4.4). In a second step, we present contingency tables to further understand the information of the survey (section 4.5).

In the second part (section 4.6.1), we conduct a cluster analysis to understand the different strategies that SMEs have when using not a single IPR but a combination of them. This approach is parallel to the one conducted in the first part of chapter 3. There, the combined use of IPRs was explored by using a multivariate probit on KOF data; here, the structure of the survey does not allow for such approach and we use a cluster analysis to classify differential strategies when using or not using IPRs.

In the last part (section 4.6.2), we try to solve a shortcoming of both databases: none of them offers us the possibility to study informal ways of protecting IP. Therefore, we look at service innovation and application for ISO norms as alternatives strategies that firms have to the application of a formal IPR.

In this chapter we analyze the different strategies that SMEs use to protect their innovations in Switzerland, focusing on the reasons and difficulties that SMEs have using these strategies. We will differentiate our analysis regarding a firm's choice to use or not use the IP system, and we will also consider ISO norms and service innovation as a strategy for SMEs to appropriate economic benefits from innovation without using formal measures to protect IPRs.

Since our most important source of information is the IPI questionnaire, we think it is worth introducing it to the readers. The questionnaire is shown in appendix A.1. We also point the reader's attention to appendix A.2, where we describe how our analyses were subject to certain difficulties since the questionnaire design was not specifically made for this project, and how we dealt with these difficulties to guarantee reliable analyses.

The questionnaire is divided in six relevant questions, plus a final one on general remarks and suggestions done by the respondent. Question 1 deals with innovation, question 2 with appropriation means used by SMEs. This second question divides the population of firms: if the firm is "always" or "often" using one of the three appropriation means it is asked to answer question 4, otherwise it is asked to answer question 3. Question 3 deals with the reasons for not using the IPR system, and question 4 with the reasons for using it. Question 5 deals with suggestions on what should be improved; this question was answered by all firms. And the last question informs us about what should be improved from the perspective of the respondent. The sixth question had to be answered by all firms.

We are interested in a first general exploration of the results of the questionnaire that will be later on reinforced with other specific analysis. A distinction between patents, trademarks and industrial designs will be done where we have the information. We first present the sample and IPR use by Swiss SMEs. Then, we analyse the reasons to use

or not use IPRs. Finally, we comment on appropriation of economic benefits by non-IPR measures.

4.1 Size categories and count analyses

Consistent with the EU's definition of an SME, we only consider for analysis those firms that employ 250 or less. This sampling frame is further subdivided into:

- Micro firms (less than 10 employees)
- Small firms (10-49 employees)
- Medium-sized firms (50-249 employees)

After cleaning the data, we have a total of 1006 firms for which we have information on firm size. Since most of the literature refers to firm size as an indicator for the capacity to file for IPRs, we have subdivided small and medium-sized firms into further categories. The division is presented in Figure 5. Our intention is to have an in-depth look into the dynamics of SMEs, and it is easier to observe effects if we group them in several classes. With five size categories, it will also be easier to understand the effect of size just by looking at graphs. A similar count of firms by sector is presented in Figure 6. These results are simple counts of how many firms we have in each sector. Sectoral classification is based on NACE codes. The figures are still not weighted, since we only want to give to the reader an impression of the distribution of our sample. The rest of the analysis will be done on the weighted population. (see appendix A.3 for the technical description of the weighting procedure).

Figure 5 Number of firms in the IPI sample by size

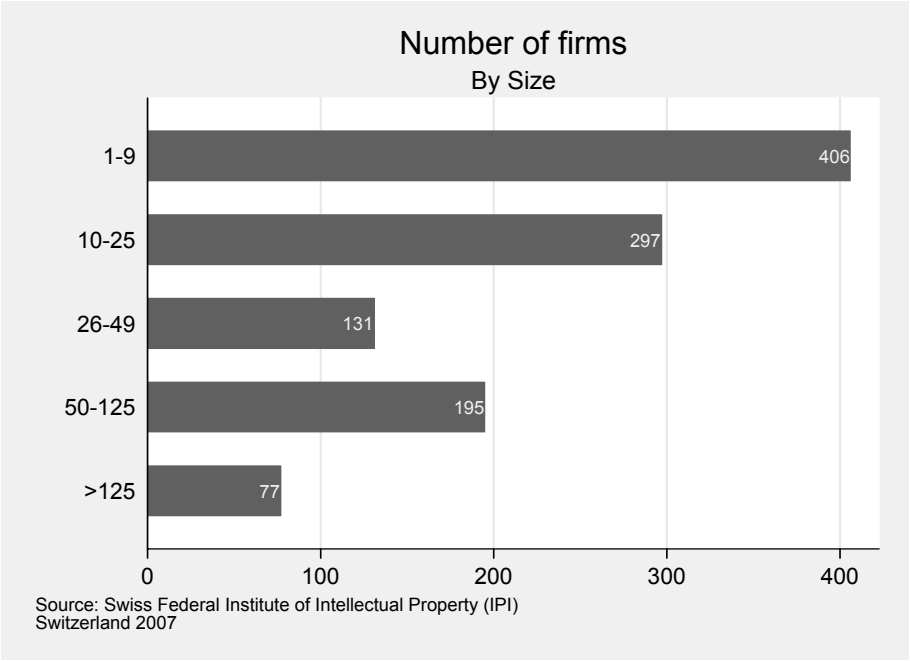
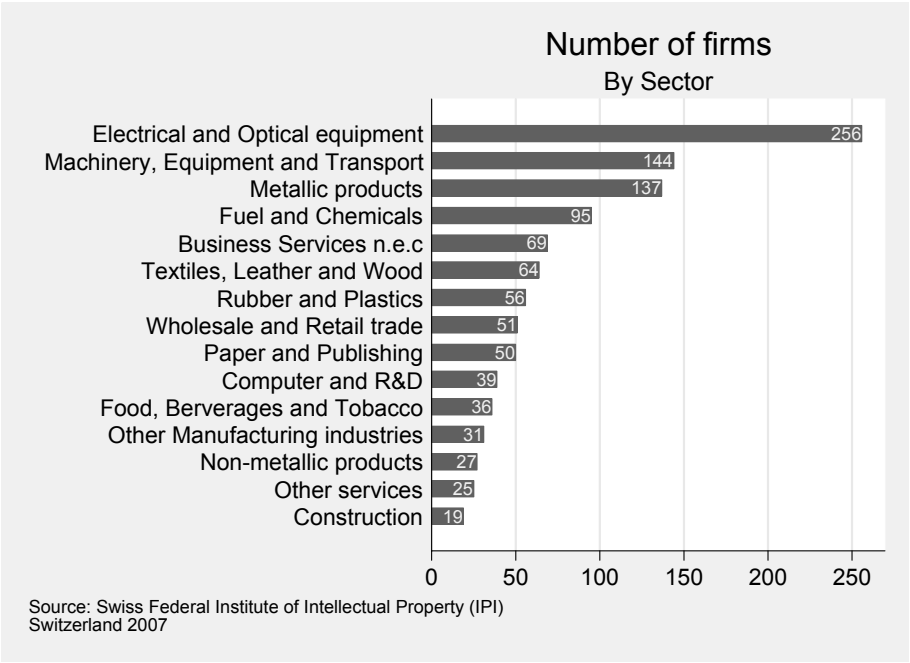


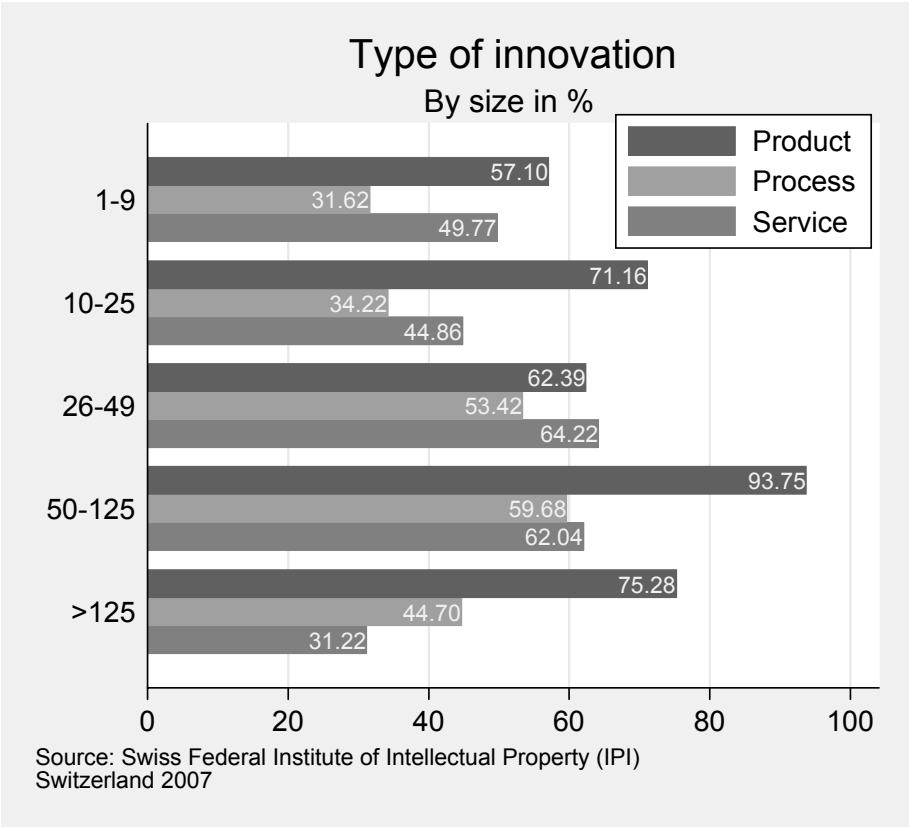
Figure 6 Number of firms in the IPI sample by sector



The first interesting information the questionnaire reveals is the type of innovation done by SMEs. Question 1 asks about the type of innovation (new products, processes, or services). It is also asking whether the fact of having an innovation represents some kind of market advantage. After analyzing this question, we realize that most of the firms which state that they innovated also state to have a market advantage. This question is not interesting *per se,* since it is highly correlated with the previous answer on innovation. Therefore, we only concentrate on the first part of question 1, i.e. the type of innovation.

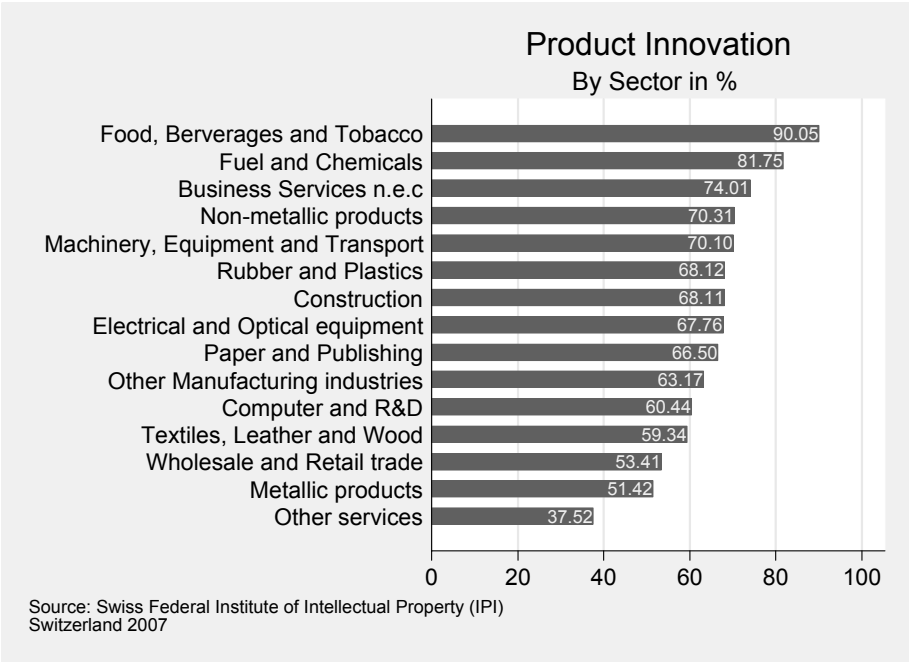
Figure 7 presents the answers to this question subdivided by size categories. We observe that 94% of the firms, whose size is between 50 and 125, have reported to be product innovators. It is here where we find the highest number of product innovators across all five size categories. They are followed by firms with more than 125 employees. Almost 60% of the micro firms (i.e., those with less than 10 employees) also answered they have introduced new products. It is easy to observe that the percentage of product innovators increases on average as the size of firms increases. For process innovators, we find almost a parallel scheme to product innovation. However, when we consider service innovation, we can see that micro firms play quite an active role.

Figure 7 Firms reporting to have introduced an innovation



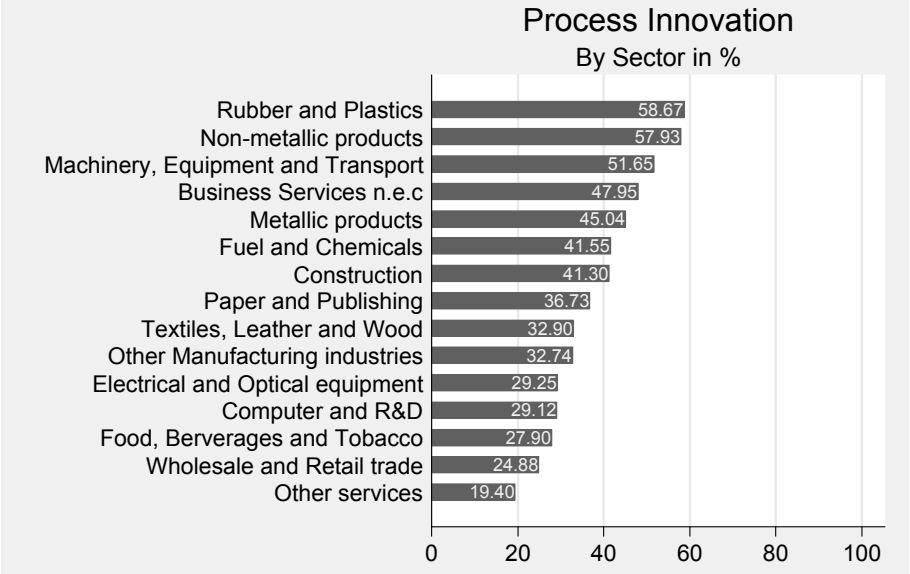
When we consider sectoral differences, the most product innovative sectors are food, chemicals, and services to business. This result is presented in Figure 8. When we compare this figure with the next one, we see that although normally we have product and process innovation in each sector, some sectors are more specialized in process and some others in product innovation. For example, rubber and plastics ranks first in process innovation but only sixth in product innovation. This just gives us some general information on the average behaviour of the sector. In general, there is a higher number of firms reporting to have innovated in product rather than in process innovation. When it comes to service innovation, other services and services to business report a higher rate of service innovation. This is not surprising since we expect to have more service innovation in the tertiary sector than in machinery. Sectoral service innovation is presented in Figure 10.

Figure 8 Firms with product innovation by sector



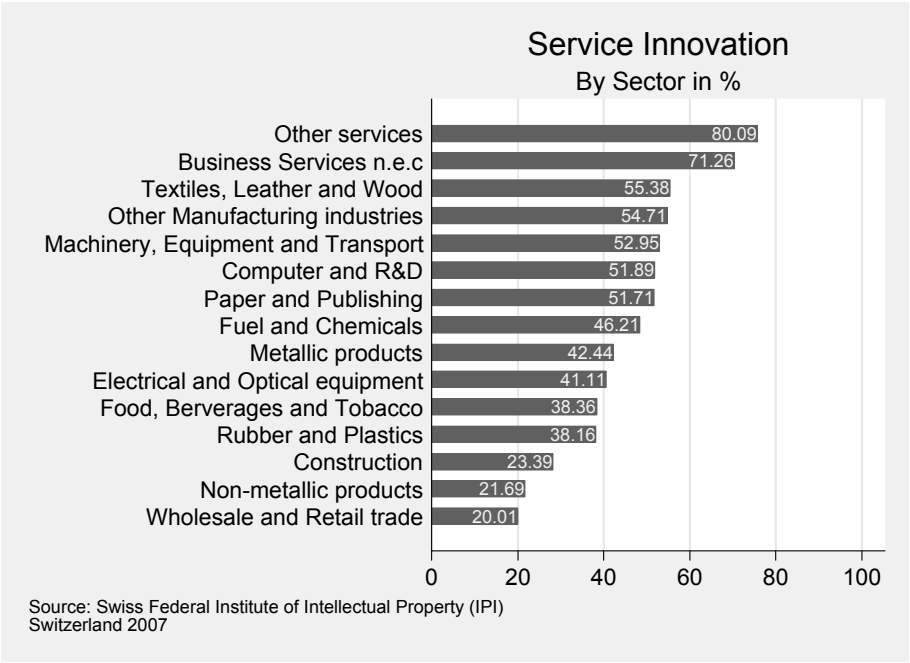
Source: Swiss Federal Institute of Intellectual Property (IPI)
Switzerland 2007

Figure 9 Firms with process innovation by sector



Source: Swiss Federal Institute of Intellectual Property (IPI)
Switzerland 2007

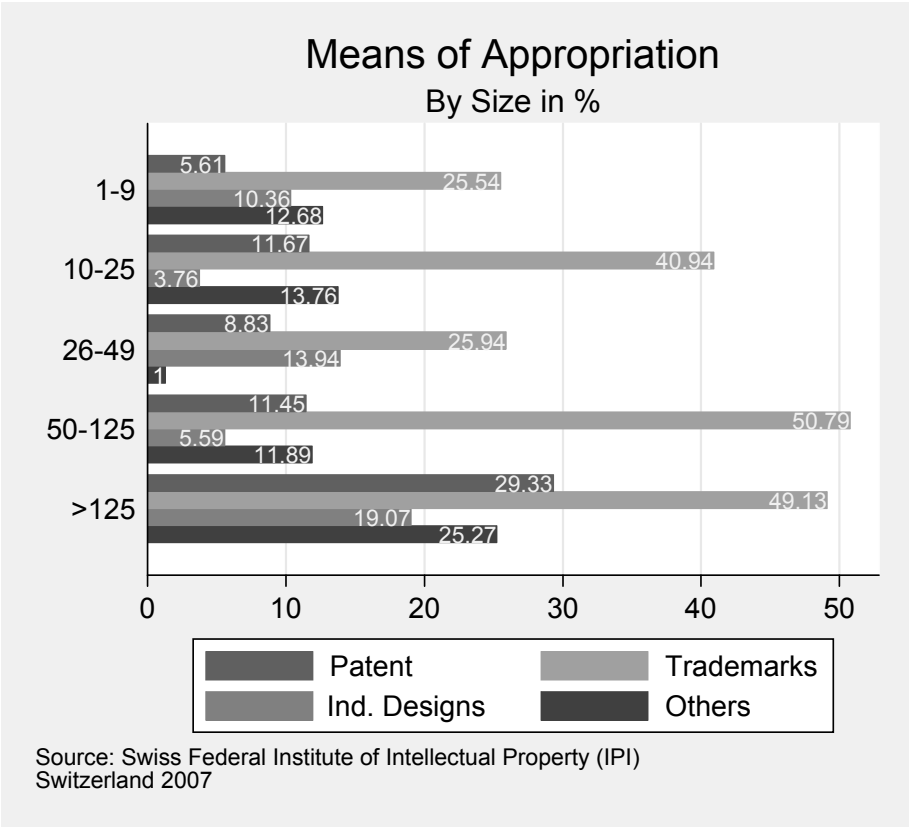
Figure 10 Firms with service innovation by sector



4.2 Descriptive analysis: Swiss SMEs' use of IPRs

The second question asks the respondent what means of appropriation (and how often) Swiss SMEs use. This question has been transformed into a dichotomous variable with value 1, if the firm answers either "often" or "always", and 0 in any other cases. Therefore, when the variable takes the value 1 the firm can be interpreted as a regular user of IPRs. Figure 11 summarises the use of the different appropriation means by firm size.

Figure 11 Users of IPRs by firm size

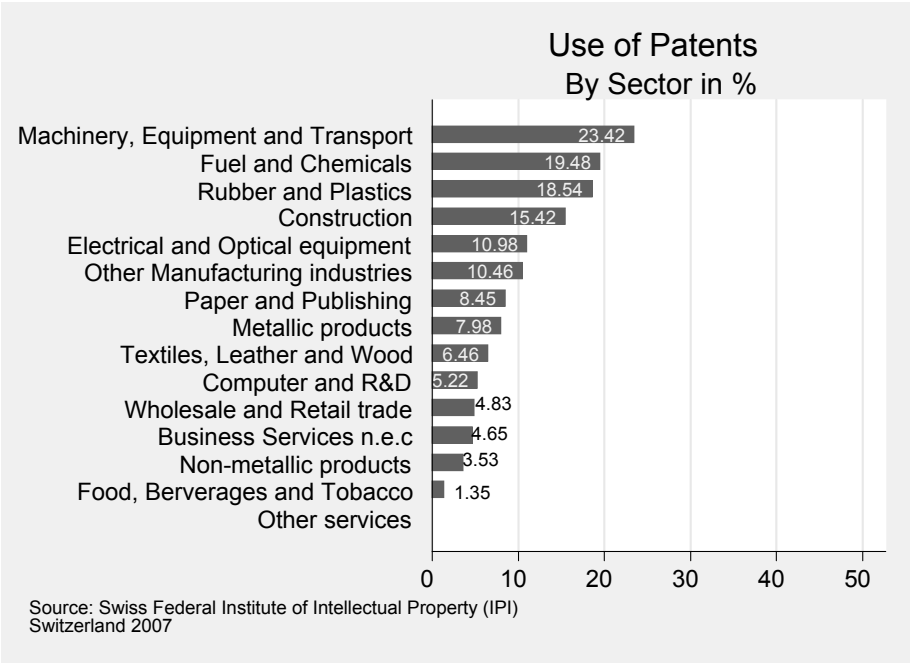


Source: Swiss Federal Institute of Intellectual Property (IPI)
Switzerland 2007

We see that 29% of the firms with more than 125 employees are regular users of patents. Firm size explains a large share of the patent activity of the phenomena. Firms with 10-125 employees (which accounts for three of our five size categories) patent in a very similar way; on average they are around the 10%, while micro firms are closer to half of it. Out of these graphs we conclude that 1 out of 3 firms with more than 125 employees is regularly filing a patent, only 1 out of 10 if they have between 10 and 125, and only 1 every 20 firms if they have less than 10 employees.

When we observe trademarks the dynamics are not so clear. First, we see that on average in all size categories trademarks are much more used than any other IPR. The intensive use of trademark is a characteristic of the Swiss economy. (This result was shown in the introduction, by Figure 4). The range varies between 25% and 50% of the total population. For industrial designs, the range of use varies between 4% and 19%. The effect of size in this case is not so clear since 10% of micro firms are using industrial designs while only 4% of firms which have between 10 and 25 employees use them. These small numbers in the use of industrial designs seem to be correlated with the results found by the report presented by the European Commission (2007), where it is suggested that SMEs in general are not aware of the advantages of applying for industrial designs.

Figure 12 Patent users by sector



Also in this case, sectoral distinctions bring interesting insides into IPR uses and the dynamics that SMEs have when applying for patents. Around 20% of firms in the machinery, fuel and rubber sectors are regular users of patents. When we consider trademarks, we see from Figure 13 that food, fuel and other services are the most intensive users of trademarks. The food industry is the leading sector in the use of trademarks, since they likely need to protect consumer-oriented brands. In the case of industrial designs, the sectors of other services, other manufacturing industries, and food are the primary users of this means of protection in Switzerland. The several uses of different legal means of appropriation in sectors probably reflect the different natures of innovation and different product cycles that are found in these sectors. The fact that trademarks are intensively used by Swiss firms can also be observed: when we compare the figures across all sectors, trademarks are more used than patents or industrial designs.

Figure 13 Trademark users by sector

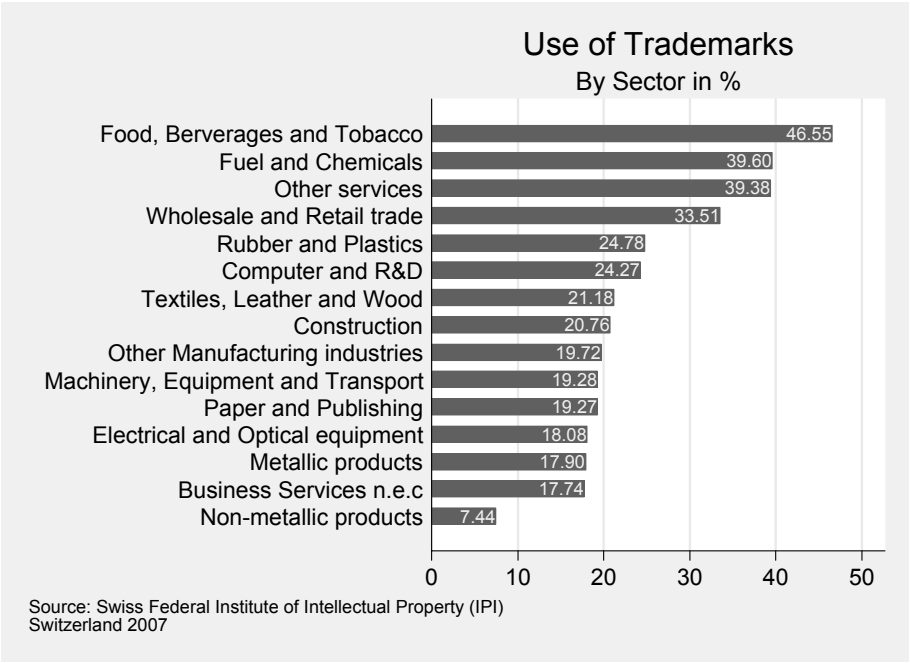
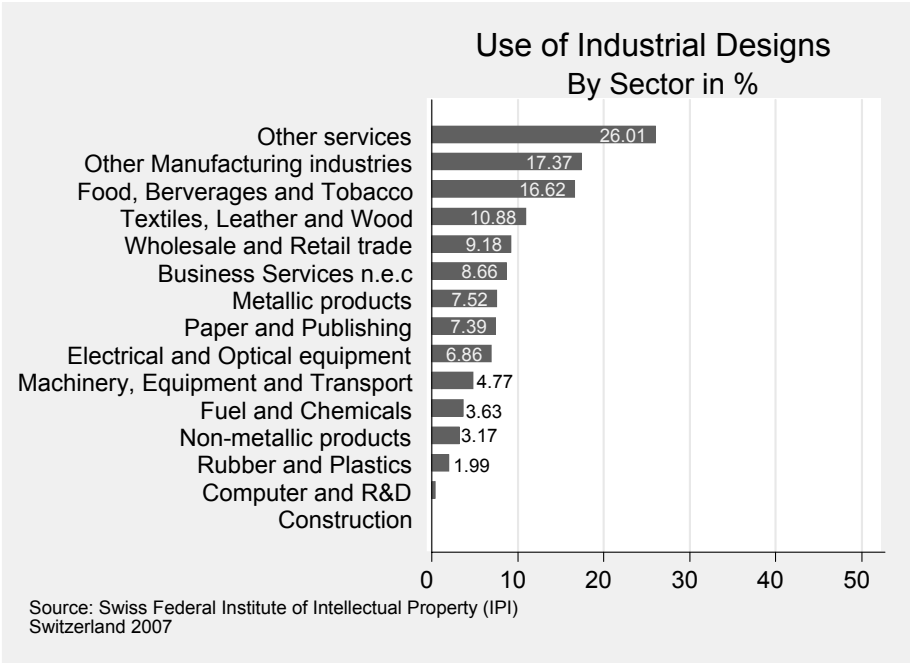


Figure 14 Industrial design users by sector



4.3 Descriptive analysis: Reasons why SMEs use formal IPR protection

In question 4, the firms which answered that they are regular users of the IPR system are asked for the main reason to apply for either a patent, a trademark or an industrial design. In order to analyse the motives of use, we subdivide the answers according to the respective means of protection.

4.3.1 Reasons for SMEs to use patents

Figure 15 presents a first look on the average patenting behaviour of Swiss SMEs. We can see that more than 90% of the firms that have applied for a patent in Switzerland did so with the main intention of seeking protection from the competitors. 58% of the firms report they sought protection from piracy, and in 44% of the cases patents were applied for because of contract negotiations. This finding is consistent with the literature (see section 2.1.5). Only 14% of the firms in the sample considered important the role of patent as a way to signal a potential value, which might facilitate to get financial support from potential investors (see section 2.1.4).

Figure 15 Reasons to apply for a patent (for users of patents)

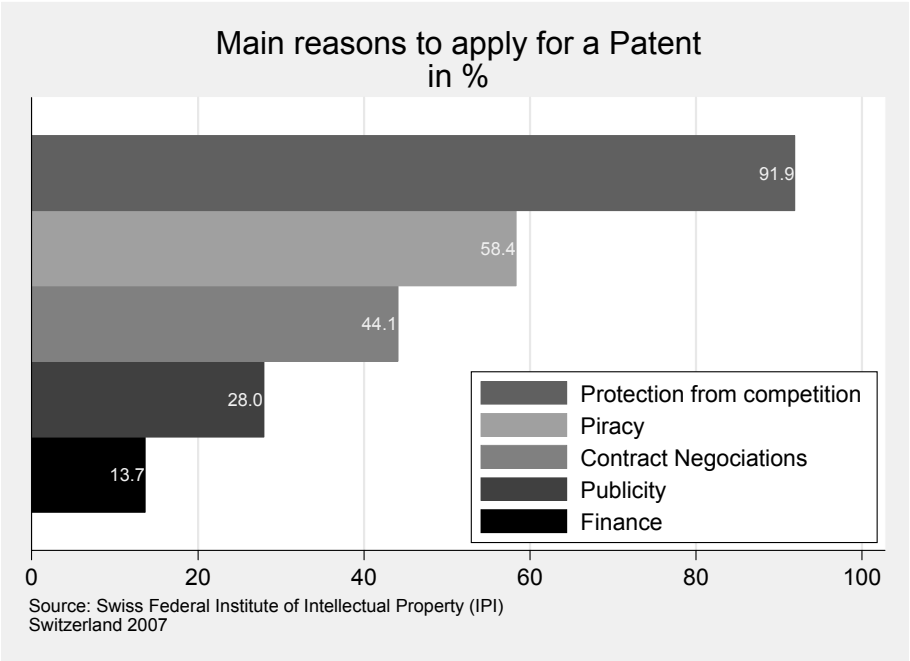


Figure 16 Reasons to apply for a patent (for users of patents) by size

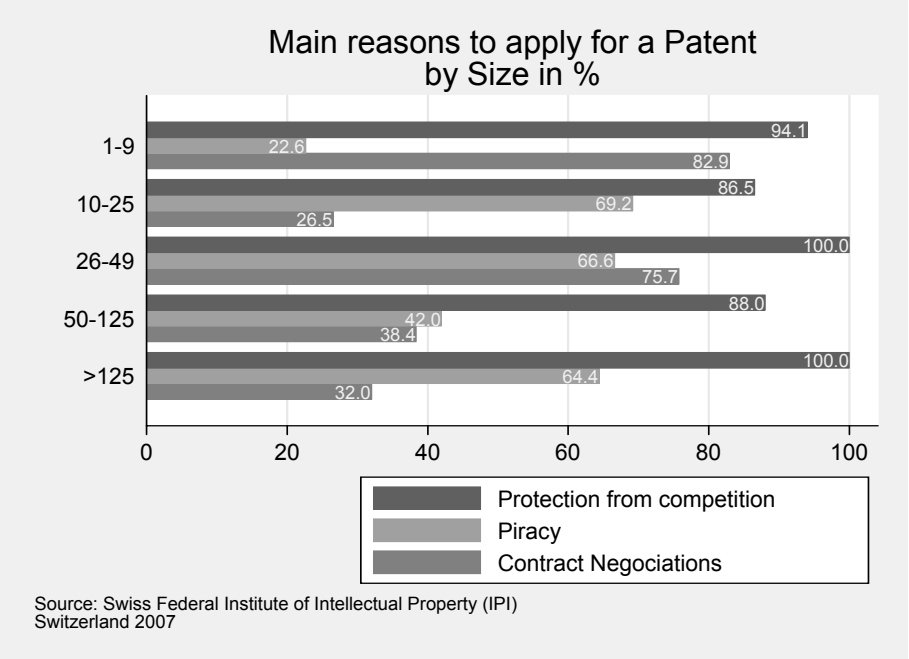


Figure 16 extends the analysis of Figure 15 by stratifying the information by size categories and concentrating on the three most important reasons to apply for a patent. Here, we also observe that the principal reason to apply for a patent is to be protected from competition, irrespective of the size category. In the case of contract negotiation, patent protection is a very important motivation among micro firms (average of 83%); while for firms with more than 125 employees, only in 32% of the cases contract negotiation is an important factor for patent application. We thus conclude that contract negotiation is a relevant reason for a firm to patent. The reasons, as discussed by Giuri and Mariani (2007), are that a patent is protecting SMEs from monopsonic power on markets and opportunistic behaviour during cooperation agreements. We find that the protection offered by the patent becomes more important as the firm size decreases. In this sense, the results found in the Swiss economy are similar to the situation in other countries (see section 2.1.1).

4.3.2 Reasons for SMEs to use trademarks

The following analysis is restricted to those firms which are normally using trademarks. Figure 17 shows that protection from competition and publicity are the most cited reasons to apply for trademarks. As can be expected from the nature of trademarks, publicity and the protection of marketing costs are related to the use of this means of protection. We also detailed these results focusing on the three principal reasons, by stratifying them across size categories, as shown by Figure 18. When we look at this figure, we see that the relevance of the protection from competition given by a trademark increases as size of firms increases. We could conclude that the protection for competition is more important, on average, for medium sized firms than for small firms. With the relevance of publicity we observe the opposite effect: it is indeed very important for small firms and important for micro firms, but less relevant for medium sized firms.

Figure 17 Reasons to apply for a trademark (for users of trademarks)

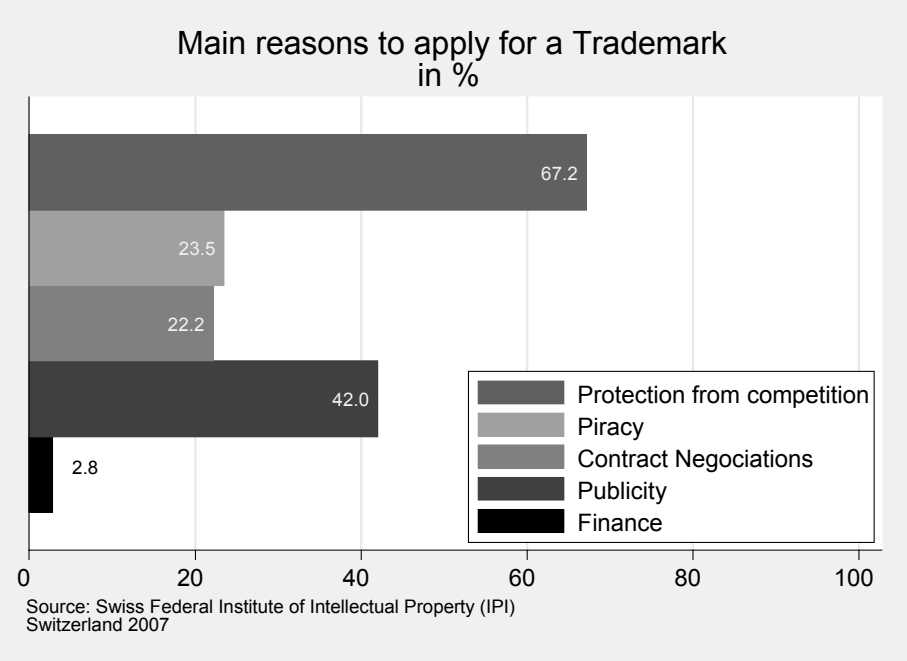
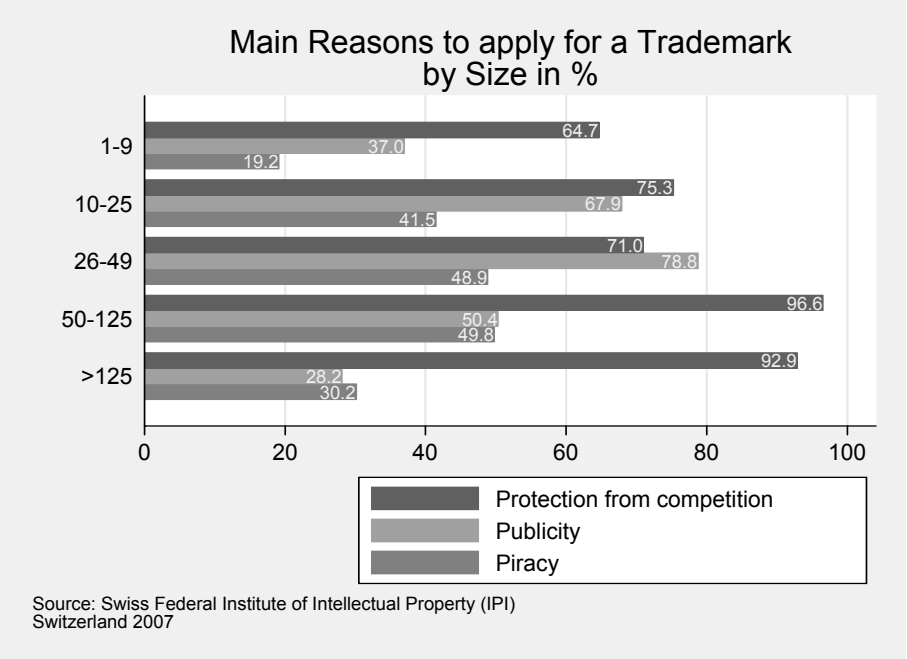


Figure 18 Reasons to apply for a trademark (for users of trademarks) by size



4.3.3 Reasons for SMEs to use industrial designs

As in the cases of patents and trademarks, the most important reason for applying for industrial design is protection from competition, although compared with patents and trademark, the share of firms which competition an important reason to apply for an industrial design is smaller. For industrial designs we see that 45% of the firms applying for industrial designs consider protection from competition as an important reason; for trademarks we find 67% of the firms, and 92% for patents. The second important reason is to try to protect the firm's designs from piracy. Stratifying these results by firm size, Figure 20 shows that in general there is no clearly observable effect of firm size on the propensity to apply for industrial designs, as there is great variation depending on the relative size strata. All in all, SMEs do not have a high level of information regarding industrial designs, which could constitute a possible explanation. We will return to this point when we analyse question 6.

Figure 19 Reasons to apply for an industrial design (for users of industrial designs)

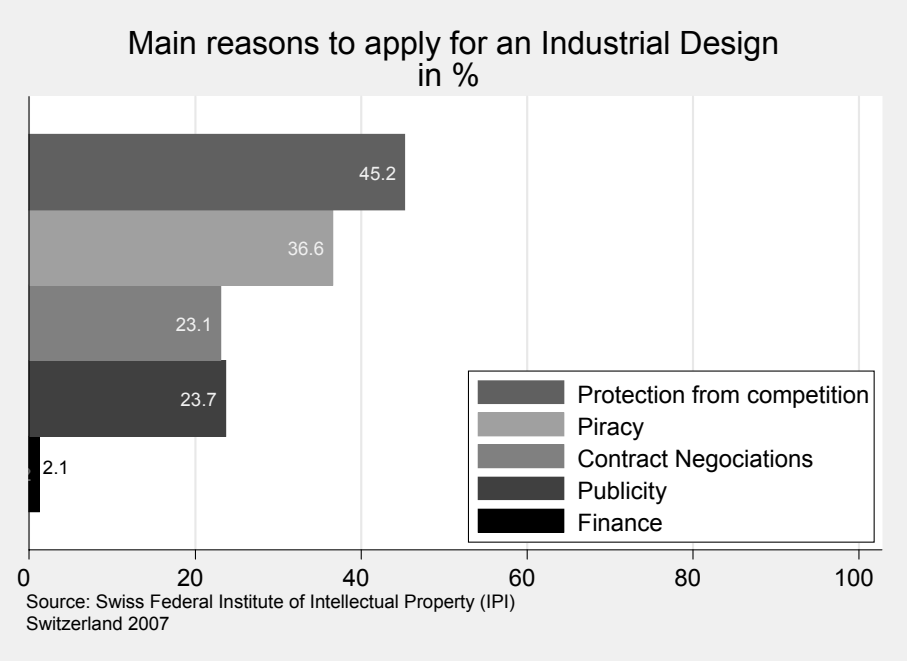
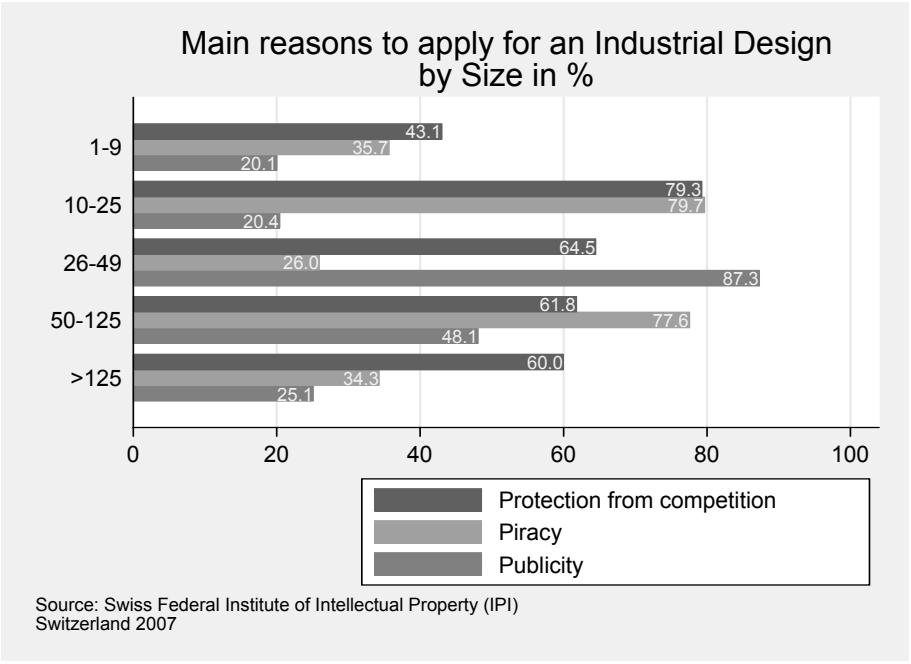


Figure 20 Reasons to apply for an industrial design (for users of industrial designs) by size



Source: Swiss Federal Institute of Intellectual Property (IPI)
Switzerland 2007

4.4 Descriptive analysis: SMEs' reasons for *not* using IPRs

4.4.1 Firms' cited needs for improvement to increase the use of IPRs

Figure 21 shows the reasons that firms answered for not filing patents. The main reason is that the SMEs have no innovation to be protected; it is also the main reason for trademarks and industrial designs. The second problem is that the procedure of filing a patent is perceived to be too complicated. Also in the case of trademarks (see Figure 22), the complication of filing is the second main reason for not applying for such an IPR. For industrial designs, the main problem is similar: SMEs do not have an innovation that could be protected by and industrial design. Respondents also comment that they have a limited knowledge about industrial designs. In fact, almost 26% of firms have reported not to have enough information about the rights that an industrial design gives to a firm (Figure 23). For all forms of IPRs, the non-user firms always rank the official fees as the second last reason for not applying for an IPR.

Figure 21 Reasons for not applying for a patent (for non-users of patents)

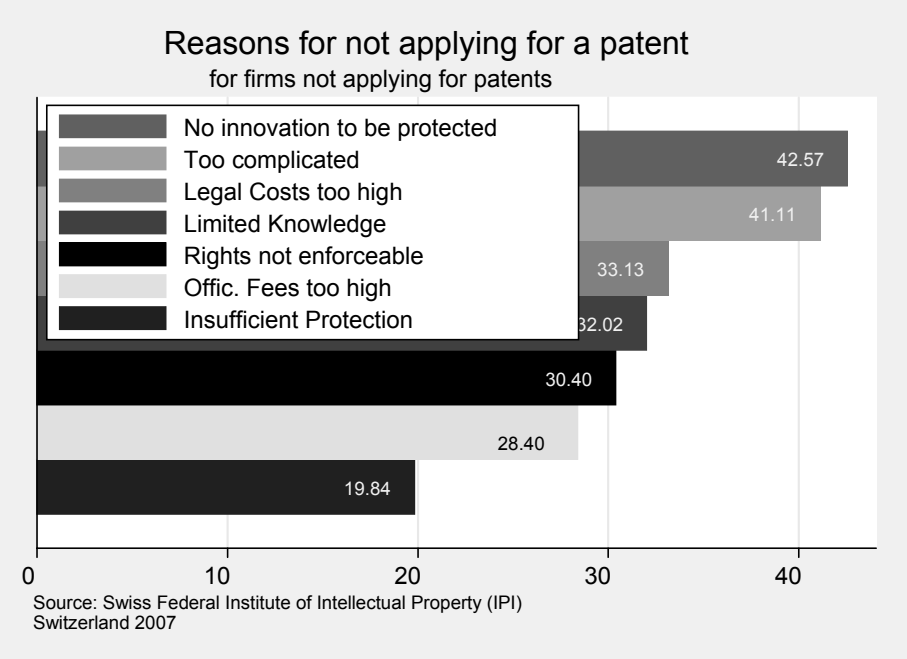


Figure 22 Reasons for not applying for a trademark (for non-users of trademarks)

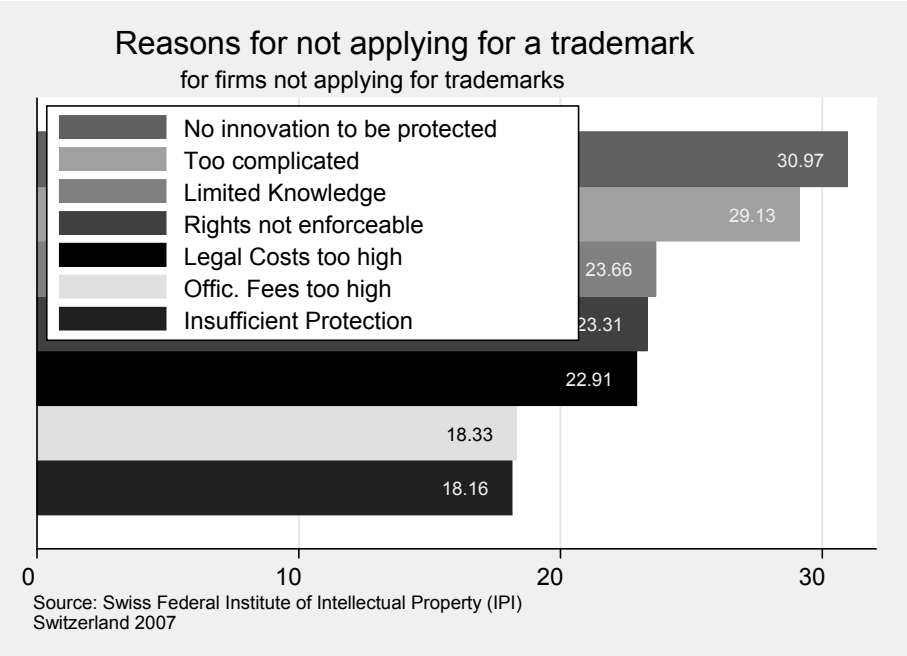
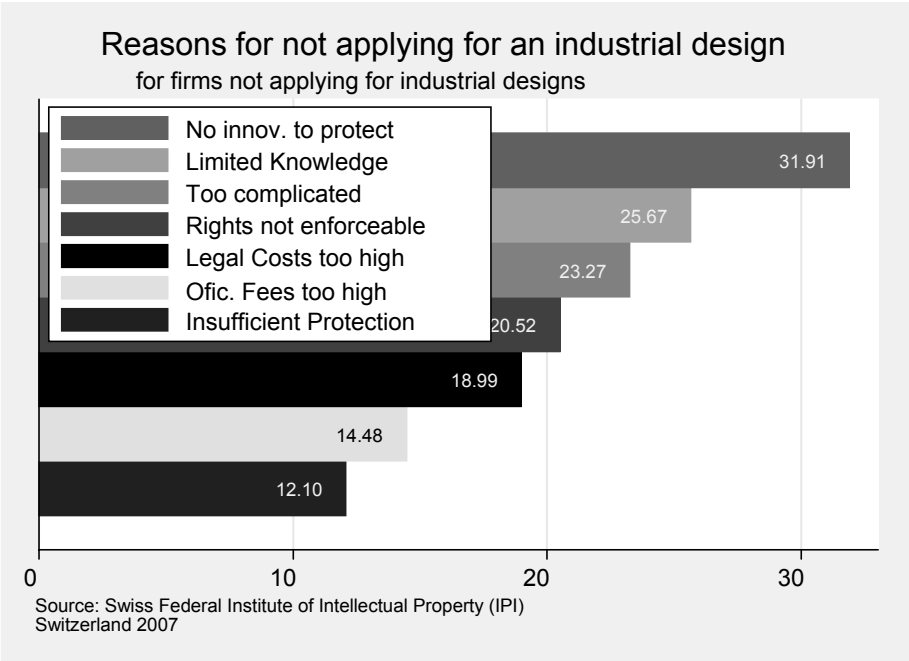


Figure 23 Reasons for not applying for an industrial design (for non-users of industrial designs)



Next, we describe the suggestions of all firms regarding what should be improved about IPRs. Data on this point was collected by question 5 which has been answered by all firms (regardless of whether or not they were IPR users).

Figure 24 shows that 88% of the firms cited total application fees as the main issue to be improved for patents. While in the previous question firms not applying for IPRs are asked whether the application fee was a problem (and we saw that in general it was only a problem listed in the second last place), now they are asked to consider total application fees or the total cost of applying for an IPR. Total fees or cost include translation costs, fees paid to IP attorneys and also the official fee. When firms are asked for total fees, almost 90% of them consider it as the main improvement needed. It is followed by the lack of training in applying for a patent (81%) and by the complications with enforcing the rights that a patent gives to the SME (79%).

Figure 24 Needs for improvements in patent applications

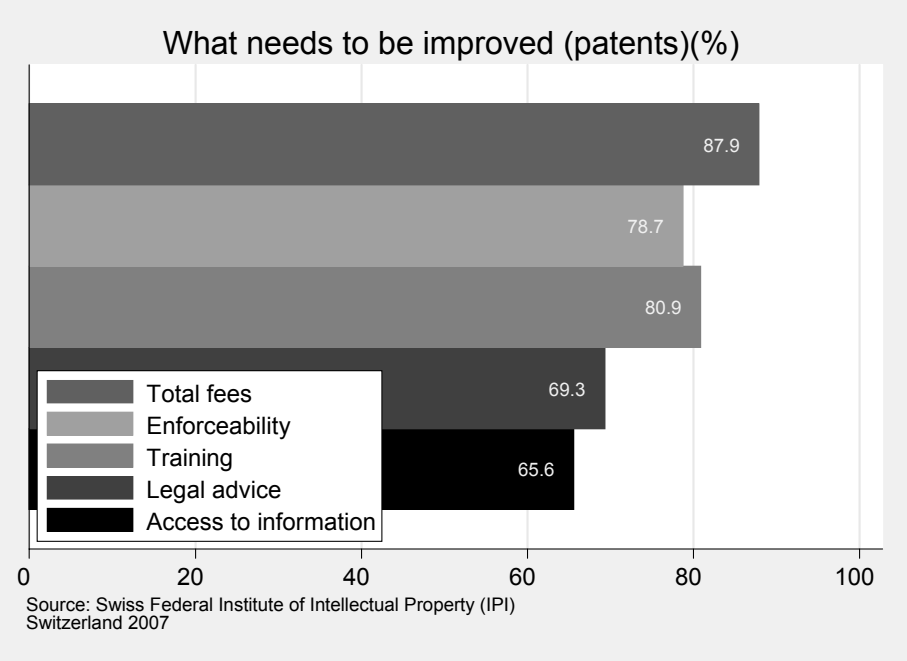
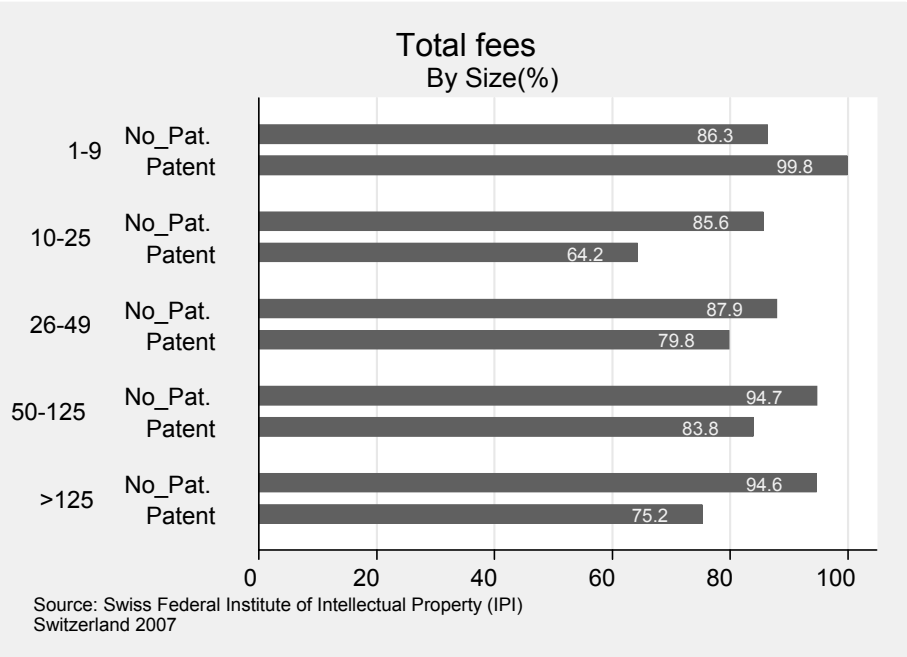


Figure 25 Need for improvement in the total fees, by size and for users (Patent) and non-users (No_Pat.)



We are interested in seeing if size is an issue when dealing with the total costs of a patent. Figure 25 tries to question whether application costs are a problem for real patent applicants or for potential patent applicants. The average has been calculated splitting the sample by size and by the fact of having or not having applied for a patent. This figure shows very interesting results. For micro firms, the actual patent applicants have a higher average than non patenting firms. This means that the real cost experienced by a micro firm is higher than expected, as it can be seen in the difference between these two sub-samples. For small and medium sized firms, the average is bigger for potential users than for the real users. This means that although the total fees are considered initially as a problem, when a firm decides to patent and becomes a real user the total fees are not as high as expected.

Figure 26 Need for improvements in trademark applications

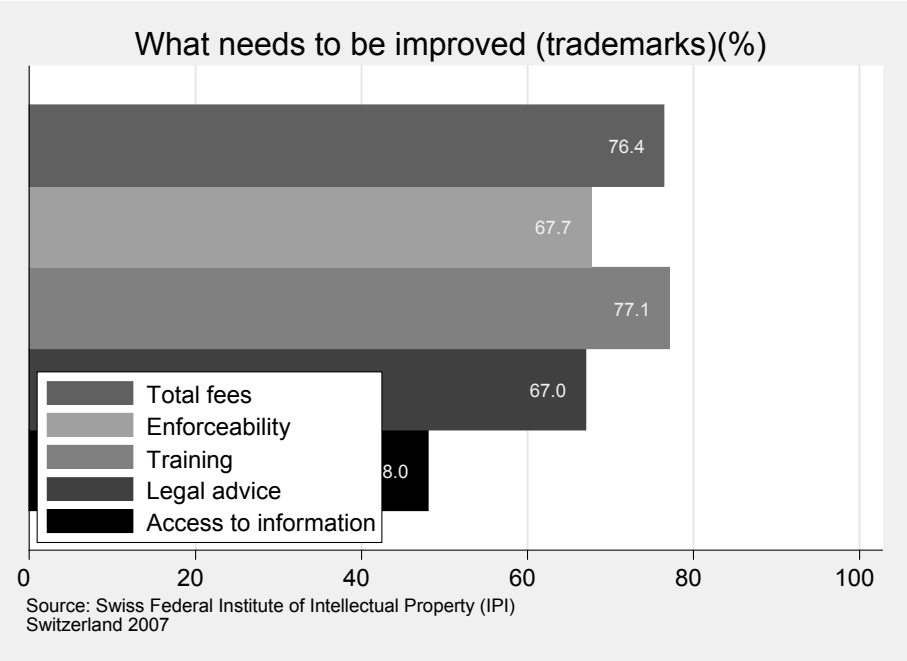
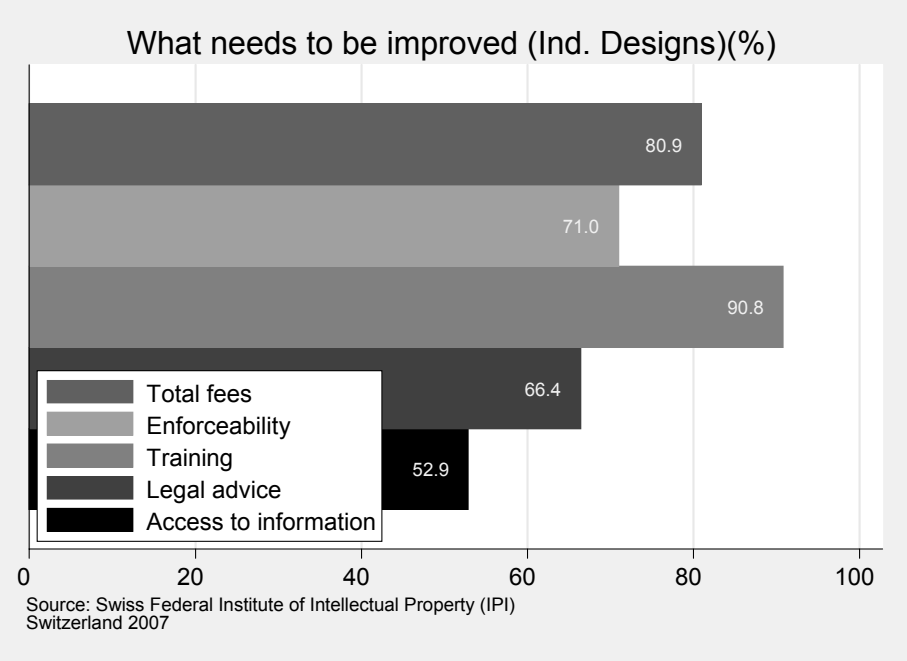


Figure 26 shows that in the case of trademarks we see that firms cite the lack of training as the most important area to be improved, followed by total fees. Figure 27 shows that also in the case of industrial designs there is a general feeling among SMEs that they are lacking training. In the specific case of industrial designs, we have in total 90% of the population considering that they do not have sufficient knowledge in the area. This is the highest value when it is compared to the average of firms that lack training in applying for patents and trademarks.

Figure 27 Need for improvements in industrial design applications



4.4.2 Lack of information about the IPR system

One of the most important reasons for a low use of IPRs could be that SMEs are not aware of the existence of such means to protect their innovation. In this subsection we therefore deal with the factors that explain the level of information that SMEs have for each of the three sorts of IPRs. Figure 28 calculates the average number of firms that have reported to feel that they are well informed about each sort of IPR. The information is presented according to firm size. When we only consider their answers, the proportions show that firms are mostly well informed about trademarks, followed by patents. Industrial designs are known but little. We finally further analyse these answers by grouping them by users and non-users of each IPR. By doing this, we try to understand if the firms which already have experience in applying for each type of IPRs are the same which are reporting to be well informed about the given IPR.

Figure 28 Firms reporting to be well informed about each IPR by firm size

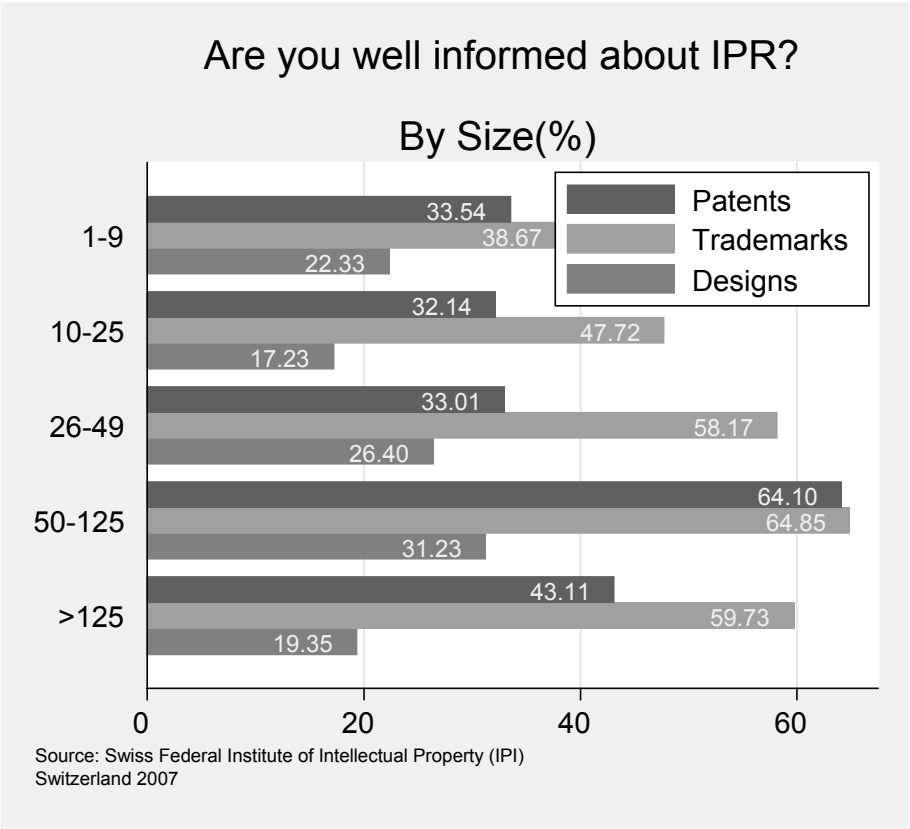
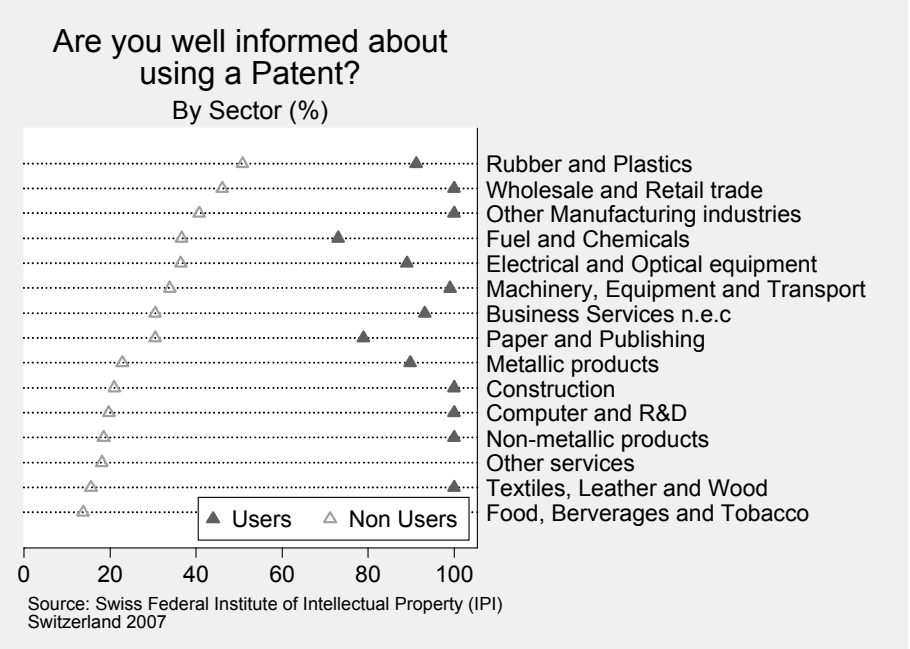


Figure 29 Level of information on the use of patents, for users and non-users by sector



We begin with commenting the situation for patents. Figure 29 analyses whether or not SMEs' knowledge about patents is the same for users and non-users. The grey triangle shows the average level of information among those who consider themselves to be normally applying for patents, thus being regular users. The white triangle represents the average for those who are non-users. The figure demonstrates that the level of information strongly differs with the usage of the IP system. This figure also suggests that disseminating information among non-users could improve the propensity to patent among SMEs.

The next two figures deal with trademarks (Figure 30) and industrial designs (Figure 31). We can see that in both cases, the level of information is in general higher for users. However, the distinction is not as clear as it is for patents.

Figure 30 Level of information on the use of trademarks, for users and non-users by sector

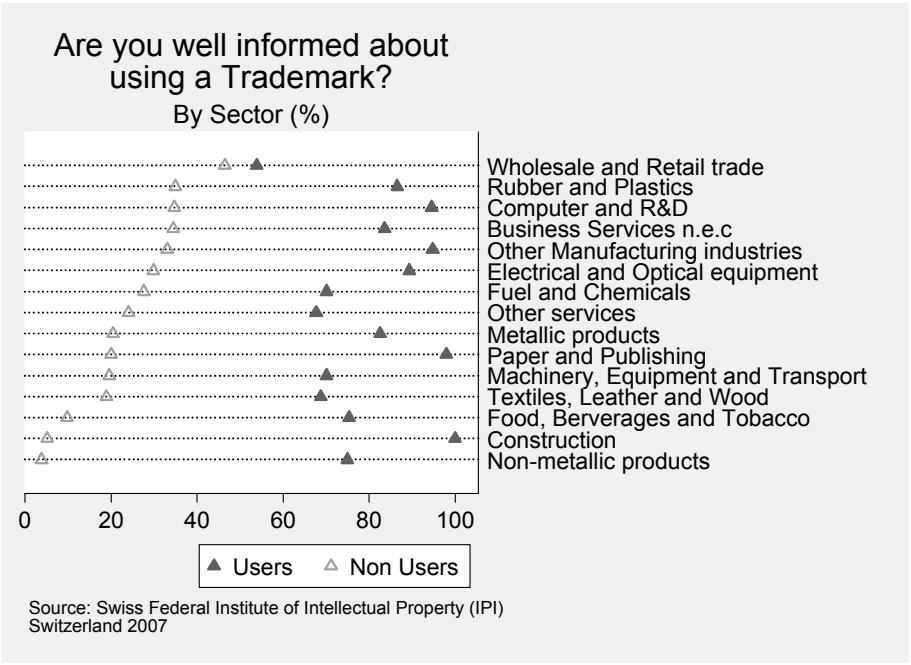
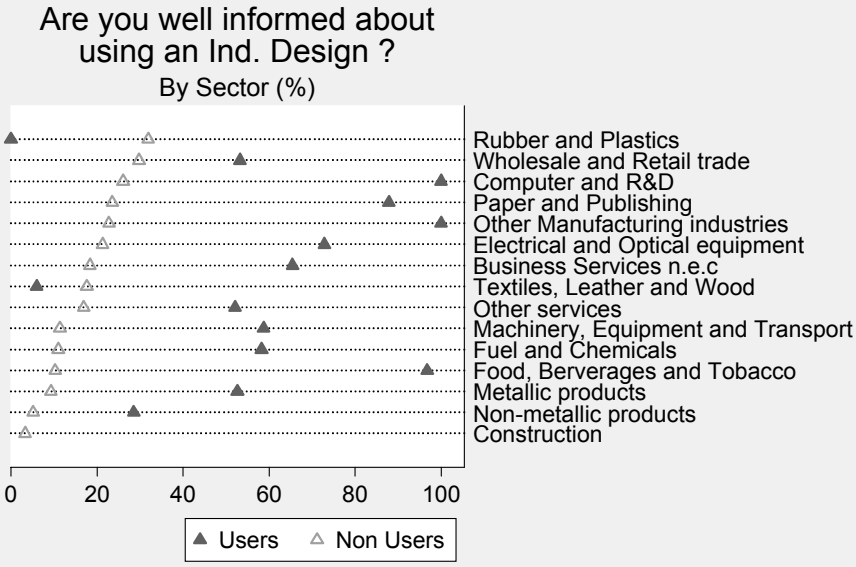


Figure 31 Level of information on the use of industrial designs, for users and non-users by sector



In the case of industrial designs the situation is even more confusing, with some users reporting to have less information than non-users[12]. This situation is reinforced by previous figures, where respondents complained about the level of training they have in applying for each IPR.

4.5 Inferential analysis: Generalised linear model (GLM) estimations

Given the restrictions with the IPI data described in appendix A.2, we used generalised log-linear models to test for patterns of significant association. These models tabulate the data as they are in simple contingency tables[13] according to the criteria that are of interest, and then determine whether or not the tabulation shows significant group differences, and identify the factors that cause this difference (Agresti, 2002). All following contingency tables use the weighted and restricted sample of innovating firms (i.e., only those 957 firms that have ticked at least one innovation category of question 1). All models are implemented as Poisson models with a logarithmic link function.

For a better readability of the tables, please note that they contain actual counts of firms, not predicted values. For example, the first cell in Table 3 (56 firms) comprises all firms that have answered *both* that they use patents always or often, *and* that they feel access to information should be improved. The goal of all tables is to find out whether or not the differences between the counts across groups are due to coincidence, or whether there are significant differences between the counts which signal patterns of association in the data.

[12] In the case of Rubber and Plastic there is only one industrial design user, and this firm reported no to be well informed. Therefore, the result should be interpreted with caution. In the case of textiles we have six users, four of them are reporting to feel that they are not well informed and two are reporting to be well informed. As usual, the average has been calculated using the weighting procedure presented in appendix A.3.

[13] For a short description how a contingency table analysis "works" see appendix D.

4.5.1 Relationship between IP measure use and need for improvement

We first analyse the relationship between the use of each of the three IP measures (patents, trademarks, and industrial designs) and the need for improvement SMEs feel. Table 3 to 5 show the contingency tables for this relationship, i.e., they show the number of firms that can be attributed to each category.

Table 3 Counts of firms' use of patents and their needs for improvements

	Use patents always or often	Use patents rarely or never
Improve access to information	56	201
Improve training	47	144
Improve legal counselling	47	178
Improve fees	94	230
Improve enforceability	79	223
Improve other	9	12

Table 4 Counts of firms' use of trademarks and their need for improvements

	Use trademarks always or often	Use trademarks rarely or never
Improve access to information	76	135
Improve training	55	103
Improve legal counselling	64	116
Improve fees	116	141
Improve enforceability	74	128
Improve other	6	12

Table 5 Counts of firms' use of industrial designs and their need for improvements

	Use industrial designs always or often	Use industrial designs rarely or never
Improve access to information	32	106
Improve training	15	99
Improve legal counselling	19	98
Improve fees	28	111
Improve enforceability	22	119
Improve other	1	8

The econometric analysis suggests that:

(1) For all three IPR protection measures, there is a significant difference with respect to the two user groups. This means that it is not due to coincidence that SMEs that use the respective measure little or never are more numerous with respect to citing needs for improvement regarding the measure. Those firms that rarely or never use patents, trademarks, or designs have a significantly higher need for improvement about the respective measure. In other words, if firms cite the need for improvement regarding a particular measure, they are less likely to use the measure. While all effects are highly significant, this effect is strongest for industrial designs (coefficient [standard error in parentheses] for patents: -1.09 (0.063), $p < 0.001$; for trademarks: -0.48 (0.064), $p < 0.001$; for industrial designs: -1.53 (0.10), $p < 0.001$).

(2) All five needs for information are significant predictors for the emergence of the two groups (coefficients range between 2.00 and 2.73, $p < 0.001$). This implies that there is no "primary" need for a single type of improvement, but firms seem to require all types of improvements.

4.5.2 Relationship between IP protection measure use and current information level

To substantiate the above findings, we analysed the simple hypothesis that if SMEs have a good level of knowledge about a certain IP protection measure (patents, trademarks, or industrial designs), they are more likely to use that measure. Tables 6 to 8 show the respective contingency tables.

Table 6 Counts of firms' use of patents and information about patents

	Always or often use patents	Never or rarely use patents
Well or adequately informed about patents	144	277
Little or not informed about patents	12	426

Table 7 Counts of firms' use of trademarks and information about trademarks

	Always or often use trademarks	Rarely or never use trademarks
Well or adequately informed about trademarks	227	169
Little or not informed about trademarks	51	400

Table 8 Counts of firms' use of industrial designs and information about industrial designs

	Always or often use industrial designs	Rarely or never use industrial designs
Well or adequately informed about industrial designs	52	119
Little or not informed about industrial designs	30	541

The econometric analysis of these models suggests:

(1) "Knowledge about patents" is a clear predictor of the use of patents - i.e., the more a firm knows about patents, the more likely it is to use them for IP protection. (coefficient [standard error in parentheses]: 2.524 (0.300), $p < 0.001$).The analysis also confirms that there are two sharply distinct groups of patent users and patent non-users (coefficient[standard error in parentheses]:-1.51 (0.08), $p < 0.001$). These results confirm the above descriptive analyses.

(2) For trademarks and industrial designs, this effect is replicated. The more firms know about trademarks and designs, respectively, the more likely they are to use these measures (coefficient [standard error in parentheses] for trademarks: +1.623 (0.154), $p < 0.001$; for industrial designs: +1.756 (0.229), $p < 0.001$). Again, both analyses suggest that two distinct groups of "users" and "non-users" for either measure is not due to coincidence (coefficient [standard error in parentheses] for trademarks: -0.72 (0.07), $p < 0.001$; for industrial designs: -2.09 (0.12), $p < 0.001$).

4.5.3 Relationship between current level of information and need for improvement

Finally, we analysed whether or not there is a connection between SMEs' need for improvement and their level of information about each measure. To this purpose we tabulated these two dimensions in the three contingency tables as shown by Tables 9 to 11.

Table 9 Firms' information about patents and needs for improvement

	Well or adequately informed about patents	Little or not informed about patents
Improve access to information	142	126
Improve training	116	79
Improve legal counselling	134	96
Improve fees	225	107
Improve enforceability	205	103
Improve other	16	5

Table 10 Firms' information about trademarks and needs for improvement

	Well or adequately informed about trademarks	Little or not informed about trademarks
Improve access to information	91	126
Improve training	77	84
Improve legal counselling	91	95
Improve fees	160	100
Improve enforceability	119	88
Improve other	11	6

Table 11 Firms' information about industrial designs and needs for improvement

	Well or adequately informed about industrial designs	Little or not informed about industrial designs
Improve access to information	39	100
Improve training	27	88
Improve legal counselling	36	85
Improve fees	57	84
Improve enforceability	60	86
Improve other	4	4

The econometric analyses regarding these tables suggest:

(1) First, from the counts of the single tables it is obvious that a large number of firms have the need for further improvement about the respective IP protection measures, although they are well or adequately informed about them. This may signal that although these SMEs have informed themselves about the measures, they are unhappy with the current state of these measures.

(2) With respect to patents and industrial designs, there is a significant difference with respect to the need for improvement: Those SMEs that cite a need for improvement of patents are more likely to be badly or not at all informed about patents and industrial designs, respectively (coefficient for patents [standard error in parentheses]: -0.48 (0.05), $p < 0.001$; coefficient for industrial designs [standard error in parentheses]: -0.695 (0.082), $p < 0.001$).

(3) However, for trademarks, there is no significant difference with respect to the need for improvement as a function of prior knowledge. This means that SMEs use trademarks irrespective of the need they cite for further improvement – probably because they have no other choice but to use the measure in its current form, even if the need for improvement is felt (coefficient [standard error in parentheses]: -0.09 (0.61) not significant).

(4) For all measures, all five needs for improvement are significant predictors for the emergence of the two groups (coefficients range between 1.32 and 2.85, $p < 0.001$). This implies that there is no "primary" need for a single type of improvement, but firms seem to require all types of improvements.

4.6 Complementary strategies of Swiss SMEs for protecting innovation

The appropriation strategies implemented by firms are complex since they articulate several appropriation means which can be based on property rights or not. In order to deal with these complex strategies, we first propose an exploration of appropriation strategies considering the use or non-use of IPRs using the IPI survey. This first investigation allows us to look at the implementations of several types of IPRs taking into consideration their possible complementarity.

In a second sequence, we consider non-IPR strategies focusing on two appropriation strategies that are the normalization strategy or the product-related services strategy.

4.6.1 Users that combine different types of IPRs versus non-user archetypes

Different types of innovation require the implementation of different IPRs. Some inventions in the watch industry require both protection from patent and design, whereas the pharmaceutical companies rely more on patents and trademarks. For High Tech microfirms, patents are only critical to negotiate licences. However, the use of IPRs (and their combination) is far from being straightforward. As a matter of fact, it requires that firms have the capacity to implement such strategies including informational capacities, administrative capacity and financial capacity information.

A cluster analysis performed on the SMEs of the IPI survey (see appendix A.4 for a technical descriptions of the analysis) led to the identification of three classes of Swiss SMEs which are users of IPRs (see Table 12 below for a statistical description of the classes)[14]. The cluster analysis revealed three "user" types that combine different types of IPRs:

- The first class of users (labelled "Multiple" in Table 12) comprises firms using industrial designs and trademarks, while they use patents less frequently. These firms are quite well informed about the three measures. They use industrial designs and trademarks for the same three reasons: to protect themselves against competitors, to protect themselves against counterfeiters, and to promote their brand or design.

- The second category of users ("Patentees") comprises firms which focus on patents. In 54% of the cases the firms are well informed regarding the use of patents and trademarks, but they do not use industrial designs for IP protection as they have little or no knowledge about the latter. These firms exhibit the same dominant motivations as those in the first cluster: they want to protect themselves against competitors, against counterfeiters, and they want to promote their brand or technology (also for negotiation reasons).

- The third category of IPR users ("Trademarks") comprises firms which use exclusively trademarks, a legal tool they know well. These firms do not patent because this IP measure is not applicable to protect their innovations, because their inventions are not patentable (e.g., software in Europe), or because the patent system is considered as too complex and somehow too expensive. This category of IPR users seems to be the only one concerned by EPO's efforts to reduce patenting costs.

As already mentioned, IPRs are difficult to implement and require several capacities. In order to identify the reason why IPRs are not used by innovative firms, the cluster analysis has been conducted over the sample including non-users. The cluster analysis also allows us to explore what are the different categories of IPR non-users and their motivations not to use IPRs. As for the users, the algorithm gives us three types of non-users:

- The first category of non-users (labelled "Complainers" in Table 12) comprises firms which are well-informed, which state that IPRs are not relevant for their activities, but also which find that the IPR system is too expensive and too complex. These results constitute a kind of paradox: these firms are claiming at the same

[14] These classes can also inform the project "Case Studies on SMEs and Intellectual Property in Switzerland" whose managing team can use this cluster analysis to identify archetypes for every cluster.

time that the IPR system does not apply or is insufficient in its scope of protection, and that this same system (that they cannot use) is also too expensive or too complex. Still, they declare to be quite well informed compared to other non-users or even firms using trademarks only.

- The second category of non-users ("Ignorants") is more frequent and includes firms which have no information or knowledge about the IP systems and which think that it is too complex.

- The last category of non-users ("Outsiders") is the largest one. It includes SMEs that are not ignorant about the system but that are not able to give reasons for their non-usage of the IP system other than that their inventions can be protected neither by design nor by trademarks, or even patents. Note that unlike the "Complainers" group, cost is not a specific concern to these firms, even if they are more informed about the IP system.

Table 12 Characteristics of the six clusters of Swiss SMEs, IPI sample

Questions	*IPR type*	*Category Motivations N*	*Non-User Outsiders 546*	*Non-Users Ignorants 135*	*Non-Users Complainers 87*	*Users Multiple 62*	*Users Patentees 122*	*Users Trademarks 154*
2.1	Patent	Often or always	1%	0%	5%	**45%**	**100%**	1%
2.2	Trademarks	Often or always	3%	1%	3%	**82%**	**54%**	**100%**
2.3	Design	Often or always	2%	2%	0%	**100%**	4%	3%
6.1	Info Patent	Well or extensively informed	**35%**	**15%**	**41%**	**58%**	**95%**	42%
6.2	Info Trade-marks	Well or extensively informed	**30%**	**6%**	**29%**	**76%**	**65%**	**81%**
6.3	Info Design	Well or extensively informed	**18%**	**4%**	**21%**	**74%**	24%	**17%**
3.1 Col1	Patent	Total fees are too high	17%	19%	**75%**	16%	0%	**24%**
3.1 Col2	Trademarks	Total fees are too high	6%	10%	**76%**	2%	3%	0%
3.1 Col3	Design	Total fees are too high	1%	5%	**74%**	0%	2%	8%
3.2 Col1	Patent	Lawyers costs too high	21%	30%	**76%**	15%	0%	**28%**
3.2 Col2	Trademarks	Lawyers costs too high	6%	16%	**74%**	2%	5%	0%
3.2 Col3	Design	Lawyers costs too high	2%	8%	**69%**	0%	3%	8%
3.3 Col1	Patent	Insufficient scope	17%	15%	**63%**	10%	0%	**29%**
3.3 Col2	Trademarks	Insufficient scope	7%	10%	**63%**	2%	2%	0%
3.3 Col3	Design	Insufficient scope	5%	3%	**62%**	0%	7%	14%
3.4 Col1	Patent	Too complex	24%	**48%**	**86%**	13%	0%	**28%**
3.4 Col2	Trademarks	Too complex	6%	**39%**	**68%**	2%	2%	0%
3.4 Col3	Design	Too complex	4%	**30%**	**69%**	0%	5%	8%

3.5 Col1	Patent	Law does not apply	27%	27%	**63%**	15%	0%	**34%**
3.5 Col2	Trademarks	Law does not apply	10%	13%	**57%**	3%	4%	0%
3.5 Col3	Design	Law does not apply	11%	11%	**57%**	0%	9%	16%
3.6 Col1	Patent	Lack of knowledge	9%	**83%**	**41%**	8%	0%	18%
3.6 Col2	Trademarks	Lack of knowledge	2%	**92%**	**37%**	2%	6%	0%
3.6 Col3	Design	Lack of knowledge	2%	**87%**	**40%**	0%	16%	12%
3.7 Col1	Patent	Non relevant	**32%**	33%	34%	11%	0%	**29%**
3.7 Col2	Trademarks	Non relevant	17%	24%	**33%**	3%	6%	0%
3.7 Col3	Design	Non relevant	21%	21%	**33%**	0%	11%	16%
4.1 Col1	Patent	Against competitors	0%	0%	2%	**44%**	**97%**	0%
4.1 Col2	Trademarks	Against competitors	0%	1%	2%	**71%**	**38%**	**90%**
4.1 Col3	Design	Against competitors	0%	0%	0%	**90%**	1%	0%
4.2 Col1	Patent	Against Counter-feiter	0%	0%	2%	**35%**	**57%**	0%
4.2 Col2	Trademarks	Against Counter-feiter	0%	0%	1%	**52%**	**24%**	**48%**
4.2 Col3	Design	Against Counter-feiter	0%	1%	0%	**71%**	0%	0%
4.3 Col1	Patent	Advertisement	0%	0%	1%	**15%**	**29%**	0%
4.3 Col2	Trademarks	Advertisement	0%	0%	2%	**42%**	**26%**	**58%**
4.3 Col3	Design	Advertisement	0%	0%	0%	**42%**	0%	0%
4.4 Col1	Patent	For funding reasons	0%	0%	1%	8%	13%	0%
4.4 Col2	Trademarks	For funding reasons	0%	0%	1%	11%	7%	4%
4.4 Col3	Design	For funding reasons	0%	0%	0%	8%	0%	0%
4.5 Col1	Patent	For negotiation	0%	0%	2%	**16%**	**48%**	0%
4.5 Col2	Trademarks	For negotiation	0%	0%	0%	**26%**	**15%**	**31%**
4.5 Col3	Design	For negotiation	0%	0%	0%	29%	0%	0%

In bold: Dominant patterns. Not weighted.

Once weighted, the importance of the different classes of SMEs can be computed. As shown in Table 13 non-users of the IP system are dominant with 77% of Swiss SMEs and especially outsiders (55%). Ignorant SMEs comprise only 10% of the sample whereas complainers are a bit more numerous (12%). Among these users, the dominant group (23%) is composed of SMEs which only use trademarks. Patenting firms are less important and are spread out between the "Multiple" and "Patentees" categories.

Table 13 **The Swiss Micro & SMEs and the IPR system: repartition per categories (weighted)**

Categories	Share	Sub-categories	Share
Non-IPR users	77%	Outsiders	55%
		Ignorants	10%
		Complainers	12%
IPR users	23%	Multiple	6%
		Patents	5%
		Trademarks	12%
All	100%	All	100%

The results suggest that IPRs are indeed combined to improve the appropriation of innovation by SMEs. However, the mixture strategy is adopted only by 26% of IPR users. Single IPR is thus rather a dominant strategy where trademarks are much more adopted than patents.

Two further conclusions can be inferred from this kind of typology. First, IPRs are usually not considered by SMEs for funding reasons. This is consistent with the idea that the importance of IPRs diminishes with the age of firms.

Second, there is a strong heterogeneity among firms when information on IPRs is considered. This heterogeneity suggests some opportunities for IPI in order to recommend how information about the IP may be improved. In five of the six categories identified, industrial design is a less well-known appropriation measure. Our results also show that the patent system is only known by the few who knows how it works. Even firms using trademarks or industrial designs are not strongly informed about the patent system. Worst, there are non-users which are quite aware of the system but who are maybe badly informed on it (complainers).

Overall, this analysis has generated lists of firms that populate each cluster. These lists (see appendix A.5) have been transmitted to the managing team of the related sister project "Case Studies on SMEs and Intellectual Property in Switzerland" (Friesike, Jamali, et al., 2009) to facilitate their selection of companies according to the clusters. A further characterization of the different clusters is proposed in appendix A.6, but does not add much to the results above.

4.6.2 Complementary use of non-IPR appropriation measures

The analysis of IPR users and non-IPR users does not deal with all the dimension of the appropriation strategies. Along IPRs, firms can implement non-IPR means of appropriation. The importance of these non-IPR tools are well known since the first Yale survey, which showed the weakness of IPR tools compared to learning by doing, services, secrecy or lead time (see the table below taken from Levin et al., (1987)).

Table 14 Effectiveness of alternative means of protecting the competitive advantages of new or improved processes and products

Method of appropriation	Overall sample means			Distribution of industry means[b]	
	Processes	Products		Processes	Products
Patents to prevent duplication	3.52 (0.06)	4.33 (0.07)		2.6 - 4.0[c]	3.0 - 5.0[c]
Patents to secure royalty income	3.31 (0.06)	3.75 (0.07)		2.3 - 4.0[c]	2.7 - 4.8[c]
Secrecy	4.31 (0.07)	3.57 (0.06)		3.3 - 5.0	2.7 - 4.1
Lead time	5.11 (0.05)	5.41 (0.05)		4.3 - 5.9[c]	4.8 - 6.0[c]
Moving quickly down the learning curve	5.02 (0.05)	5.09 (0.05)		4.5 - 5.7	4.4 - 5.8
Sales or service efforts	4.55 (0.07)	5.59 (0.05)		3.7 - 5.5	5.0 - 6.1

[a] Range: 1 - not at all effective, 7 - very effective. Standard errors in parentheses.

[b] From the upper bound of the lowest quintile or industries to the lower bound of the highest quintile.

[c] Differences in means significant at the 0.01 level.

Source: Levin et al., 1987

However, there are still few papers exploring other non-IPR means of appropriation. In the following sections we propose to focus on product-related services and ISO norms as two appropriation means. Regarding the data, the first aspect is contained in the IPI questionnaire whereas the second one is available from the Kompass CD-ROM purchased by CEMI. First, we intend to survey the academic literature in order to show to what extent the two particular non-IPR appropriation strategies are relevant for SMEs. We propose afterwards some empirical treatments in order to explore the two non-IPR tools as well as the link between these non-IPR strategies and IPR tools.

a) ISO norms and product-related services as a non-IPR tool of appropriation for SMEs.

ISO 9000, the standard of quality assurance management, is widely diffused among firms. It was first published in 1987, revised in 1994 and then completed in 2000. ISO 9000 describes the elements and the requirements of a quality system. It encompasses for example contract review, design control, document and data control, purchasing, production, installation and inspection. Consequently, this standard represents a tool for firms to shape a quality system (Gunby, 1998; Bénézech, Lambert et al., 2001; Guller, Guillén et al., 2002).

The ISO norm is usually considered as:

- A tool to induce a change in the quality of their products and a way of signalling their quality in order to differentiate their products on their markets (Bénézech et al., 2001; Ringe and Nussey, 1994; Withers and Ebrahimpour, 2000), especially in industry with price competition (Blind and Hipp, 2001).

- A means to enter into the global market (EQF, 2002; Ringe and Nussey, 1994; Withers and Ebrahimpour, 2000; Larsen and Häversjö 2001; Guller, Guillén et al., 2002; Bénézech and Lambert, 2001). ISO 9000 especially makes contractual arrangements easier thanks to the "standardization" of quality assurance requirements, especially in international contexts. ISO 9000 certification, as IPR, may sup-

port a Swiss SMEs' strategy by granting an easy access to global markets (Withers and Ebrahimpour, 2000). Compared to other European SMEs, Swiss SMEs are producers of high quality standards, including technology. On international markets, signalling is thus added to the fact to be Swiss (the famous "Made in Switzerland"), a tool to signal quality to customers. The effect sounds however quite limited for firms from developed countries (Clougherty and Grajek, 2008).

The rising number of ISO registrations shows that it is a major quality tool used by European manufacturing firms. Nevertheless, the system has drawbacks, especially for SMEs:

The interest of ISO decreases with the number of registered firms and with the heterogeneity of these firms. The rising number of certified firms is especially a problem for SMEs since clients and customers encounter a rising search cost to identify the best SME to work with (Terlaak and King, 2006). A related problem for exporting Swiss firms is that, taking into account the Swiss standard of production, many Swiss SMEs can easily be certified, adding even more weakness to the ISO norms in Switzerland. The certification is however expensive to obtain and the expected benefit may be slow to come (Gunby, 1998). The certification process is costly. It takes time and can be considered as a quasi fixed cost for firms. Costs are thus higher for SMEs than for large firms.

b) Product-related service strategies

Technological innovation and organisational changes are main traits scrutinized by scholars dealing with the evolution of modern firms. A lot of theoretical and empirical models articulate organisational with technological characteristics centered on the shop floor level (See Milgrom and Roberts, 1990, 1995; Bocquet et al., 2007; Askenazy et al., 2006; Percival, 2004; Lei et al., 1996; Sun and Gertsen, 1995; Gupta et al., 1997; Boyer et al., 1997; Ettlie and Reza, 1992) including *the* reallocation of labour from production to other functions (development, commercialisation) within firms as shown by Thesmar & Thoenig (2000) or the endogenous sorting of manufacturing firms across products (Bernard et al., 2006).

Manufacturing firms are also increasingly bundling their products with services and even sell their manufactured goods not as products *per se* but as services (Davies, 2004). The increasing role of product-related services (PRS hereafter) strategy of manufacturing firms is however often disregarded for more alluring services provided by service companies.

From a theoretical point of view, several contributions have stressed mainly two benefits and opportunities with regard to the adoption of PRS strategies:

- Downstream services can compensate the loss of revenues from stagnant demand and initiate new growth opportunities (Sawhney et al., 2004).

- Firms can create inter-asset specificity by vertically integrating complementary service activities (Teece, 1986). As product-service systems can be considered harder to imitate, they can generate higher rents, become a source of competitive advantage and contribute to the survival of firms over the product-service life-cycle.

The PRS strategy can thus be assimilated to an appropriation strategy implemented to protect process or product innovation. Many scholars insist on the higher likelihood of flexible firm, which is with recent process innovation, to create services (Lei et al., 1996; Bowen et al., 1989). Services are thus likely to complement process innovation it

helps to protect from imitation. The same strategy can be applied to product innovation. Servicing profiles may also differ whether their role is to support the development or the introduction of innovative and new products to the market or to complement existing products and support the already installed base. Cusumano et al. (2007) have recently proposed a model integrating the service dimension to the traditional product-process industry life cycle analysis. Despite the lack of results, we can expect leading product innovators to also be more likely to protect their innovation by providing services to their customers.

c) ISO and product-related services and their links with IPRs

The sustained econometric model (see appendix A.7) shows that the use of ISO or PRS (product-related services) is not influenced by the type of innovation done. More surprisingly, our results report that exporting firms are not more likely to use such strategies than non-exporting SMEs. The ISO strategy, as the trademark or patent one is implemented by the largest SMEs. If the result confirms the analysis done on IPRs, the negative coefficient obtained for PRS suggest that innovative micro firms are more likely to propose product-related services to their clients. An interpretation here is that micro firms are substituting fixed cost appropriation strategies (IPRs and ISO) with variable cost strategies (PRS). The idea is tested below.

We contend in the following that SMEs are more financially bounded than large firms. This boundary may induce tradeoffs between the different tools available in order to appropriate the efforts done to differentiate from a technological point of view or not. Some arbitrage between IPRs and ISO normalization or product-related services may occur:

- Swiss SMEs which are innovating can see the ISO norms as a tool to get rents with its new product on the market, whereas the rate of returns of IPRs is lower due to higher costs. Of course, Swiss established exporting SMEs are not financially bounded at that point. But one can imagine that investments in ISO norms or IPRs induce a trade-off for firms, especially those with process innovation that is where IPRs are weaker and ISO norms stronger.

- A similar trade-off can exist between services and patents. Considering IPRs as weak tools of appropriation, firms may be likely to enter into product-related services in order to maintain their client and market shares against imitators at the national or international level. The cost of such a strategy is not straightforward to evaluate but it is much more capital intensive than an ISO strategy or a patent strategy.

The econometric model (see appendix A.7) explores the relations between the IPR and non-IPR strategies. The decisions to patent, to file trademarks or to be ISO 9000 certified are supposed to be interdependent. Controlling for the characteristics of the Swiss SMEs, the results show that the complementarity exists between legal appropriation tools, but we do not find any significant link between the IPR tools and the use of ISO normalization or PRS. The disappointing results do not mean that alternative non-IPR tools (e.g. secrecy) are not implemented by Swiss SMEs as complements or substitutes to IPR schemes.

We further test if the results hold for micro firms. As reported in appendix A.7, the results are quite robust. The only difference is the complementarity found between ISO norms and other IPRs (design, copyrights) for this size of firms. Thus, no substitution between fixed cost appropriation strategies and variable cost strategies (PRS).

Summary of this chapter and connections to other chapters

This chapter informs the readers about reasons that firms have to use IPRs or not to use them and to combine both options. It also looks at alternative measures that SMEs might use to protect their intellectual property.

In sections 4.1 to 4.4 the intensity of the use of IPRs is analyzed according to size and sectoral differences, as well as the reasons that SMEs have to use or not to use each IPR individually. The results are complemented by the study performed in section 4.5, where an analysis based on contingency tables is performed to shed light on different strategies.

Section 4.6 treats IPRs not as a single individual measure where each firm is applying for a single form of IPR, but considers that firms in their strategies use a combination of these measures. Section 4.6.1 classifies the firms in six categories: three categories of users and three of non-users. In section 4.6.2 alternatives to IPRs are presented as possible options that SMEs could use to protect their intellectual property.

The findings from this chapter will be further considered in chapter 5, where the reasons for applying or not applying for a patent will be combined with the decision of patenting abroad or doing it at a national level. In a qualitative way chapter 6 will analyse different strategies that firms have for their IPR. The national or international approach of the firms' strategies and the differences they could have been understood by the two samples that will be analyzed there - a sample of firms mainly acting at a national level, and a "born global" sample with a strong international projection.

5 Patent portfolio analysis of SMEs covered by the IPI survey

Exposition of this chapter and connections to other chapters

In this chapter we study the patenting behaviour of Swiss SMEs, exploiting the additional information contained in PATSTAT and in Kompass databases. When merging them with the IPI survey, we get very detailed information on the SMEs' patent documents: location for filing the documents, information about co-applicant, co-inventors, and citation.

The chapter has four parts:

- First, we compare the answers given by firms in the IPI survey with the information contained in PATSTAT.
- Then, we study whether SMEs are filing patents at IPI, doing it abroad, or following a strategy that combines the two previous ones.
- Further, the main reasons to file (or not to file) patent documents contained in the IPI survey are analysed, considering that some firms are only filing patents abroad and some others at IPI.
- Eventually, we analyse the international networks of Swiss SMEs by looking at four dimensions: co-applications, co-inventors, backward and forward citations.

The results of this chapter will be further analysed in chapter 6, where a qualitative analysis is set up to study SMEs' international IPR strategies, versus SMEs with a stronger national approach to IPRs.

5.1 Introduction

Up to now, the IPR strategies of Swiss SMEs were based on the KOF data or on the IPI survey. As a consequence, the analysis was restricted to the characteristics of SMEs using or not given IPRs, and their motivations to do so. The present chapter intends to go further on the use of the patent system by exploring the patent portfolio of the SMEs that have answered the IPI survey (henceforth "IPI SMEs").

By adding complementary data from the Kompass database, the reconstitution of patent portfolio allows us to explore dimensions of their patent strategies.

First, it offers the opportunity to track the evolution of the patenting activities of the IPI SMEs over time. Second, the analysis of applicants and citations allows us to identify the co-applicants the SMEs are inventing with and the technologies the SMEs are inventing around. Particularly, it sheds light on the scope of the SME networks built during the invention stages. Third, citations are providing to some extent further details on the role of these SMEs in the diffusion of technologies: the Swiss SMEs can indeed be at the technology frontier and be cited by laggard located either in Switzerland or abroad.

Such investigation requires additional data that are available from other sources. Furthermore, the conceptual distinctions are numerous and must be clear in order to understand the conclusions as well as their limitations. In order to cope with these two boundaries, we propose to start the present chapter with a methodological section

(5.2). Next, we present carefully the different topics we are interested in. Section 5.3 explores the dynamic of the patenting activities including the decreasing use of the Swiss national patent system. The networking activities are then analyzed (5.4) with the characterization of co-applicants and co-inventors grounding their activities on international technology sourcing. The same section investigates the influence of the IPI SMEs through a forward citation analysis. Finally, a fifth section (5.5) crosses the IP survey variables with the one extracted from the portfolio, exploring how the portfolio structures fit applicants' motivations.

5.2 Methods

In this chapter we will be analyzing SMEs patent activities. During the whole chapter we use a unique dataset, specially designed for the purpose of this report. This dataset is the result of merging three main sources: (1) the IPI SMEs survey, (2) the Kompass company directory and (3) the EPO Worldwide Patent Database (henceforward PATSTAT). In a first stage, the IPI survey was enriched with Kompass supplementary data (the dataset resulting from this first merge is also used in chapter 4). In a second stage, all patent documents available in PATSTAT between 1996-2006 and belonging to any non-anonymous SME from the IPI survey were retrieved using a mix of automatic[15] and manual procedures. Supplementary information from the European Patent Register (henceforward EPOLINE) was provided by IPI, but only for those patent documents filed at EPO.

The resulting dataset links each SME firm to its patent portfolio, which includes patent applications – granted or not – filed at several patent offices around the world (e.g. IPI, EPO, USPTO, JPO, etc.). These portfolios also include patent documents from national offices of EPO members – such as INPI (France), DPMA (Germany) or OEPM (Spain) – and international patent applications filed directly at the International Bureau of WIPO in Geneva. The latter deserves further clarification as Swiss SMEs (as anybody else residing in Switzerland or in any other PCT signing country) can directly file a document at WIPO and, within 30 months[16], enter into a (or many) national phase(s). However, if a given SME files an international patent application directly at the International Bureau the dataset includes both the document from WIPO and any document from the national patent offices of the designated countries, as long as it has already entered into the given national phase[17].

To acknowledge this multiple filing of the same invention, all patent documents have been consolidated into patent families within each SME's patent portfolio. The definition of patent family used is the same used by INPADOC, which basically considers all documents linked directly or indirectly as one family. The main advantage of applying a patent family consolidation is to avoid double counting of the technologies produced by a certain SME without losing any of the available information about where protection for this invention was sought, inventors or citations. Patent documents that are neither claiming a priority nor are claimed as priority are considered as a one-document family themselves.

All statistics of this chapter are measured in terms of number of firms. Nevertheless, all information available – e.g. patent authorities, inventors, applicants, citations, etc. – of

[15] For information on the automatic procedure see appendix B.

[16] The quantity of months may vary according to each designated country specific application of the treaty.

[17] There are only nine documents in this dataset which have been filed directly at WIPO by an SME and have not: (a) entered a national phase yet; or, (b) claimed a priority from another patent office.

each patent document (granted or not) is used when referring to the consolidated patent family or to the portfolio of patent families of a given SME. The date of the earliest claimed priority is considered as the reference date for the patent family.

A set of simple examples have been provided here to facilitate the interpretation of this dataset. Let SME_1, SME_2 and SME_3 be three representative Swiss SMEs with some patent activity during the studied period. SME_1 has filed four patents applications only at IPI (CH_{1A}, CH_{1B}, CH_{1C} and CH_{1D}). Let consider CH_{1A} is claimed as priority by CH_{1B}, which in turn is claimed by CH_{1C} and CH_{1D} is not claiming or being claimed by any document. Hence, SME_1 has a patent portfolio containing only two patent families, where the first one contains three patent documents (CH_{1A}+CH_{1B}+CH_{1C}) and the second just one (CH_{1D}). When computing co-inventors or citations statistics for the first family all the information from CH_{1A}, CH_{1B} and CH_{1C} is being considered, but only the date from CH_{1A} is used as temporal reference. Let consider SME_2 has filed six patents applications each one at a different patent authority (CH_{2A}, EP_{2A}, FR_{2A}, IT_{2A}, JP_{2A} and US_{2A}). Let FR_{2A} be claimed as priority by both CH_{2A} and IT_{2A}, and let EP_{2A} be claimed as priority by JP_{2A} and US_{2A}. Hence, SME_2 has a patent portfolio containing two patent families, where both contain three patent documents each, and where the second family is a triadic family as it has been filed at EPO, JPO and USPTO. Lastly, SME_3 has filed three patents applications (EP_{3A}, JP_{3A}, and US_{3B}) and an international patent application directly at the International Bureau (IB_{3A}). Let EP_{3A} be claimed as priority by US_{3A} and let JP_{3B} refer to the national phase of the international patent application IB_{3A}. Hence, SME_3 has a patent portfolio containing two patent families: one containing the two patent applications and the other one containing an international application and its national phase. These examples can be reviewed in more detail in Table 16.

There are some limitations linked to the use of such methodology and the resulting dataset. First, there is a problem with the causality due to the fact that the patent portfolio comprises the ten past years of each SME patenting activity, while the IPI survey just asks for the past two years. Unfortunately, looking only at the past two years would provoke a worse bias as the patenting activity takes years to be reflected in the data given the bibliographic nature of PATSTAT. Second, this dataset considers all documents without knowing if the patent has eventually been granted[18]. But again, considering only granted patents would also be a source of bias towards recent patenting activity as it would take even longer for granted patents to appear in PATSTAT. Third, there is always the possibility that patent applications yet to appear in PATSTAT may alter some results. For instance, consider that patent applications CH_{2A} has already been filed but has not yet been published, or consider that CH_{3A} is another national phase for IB_{3A} but it has not been published yet. In these two cases, both SME_2 and SME_3 still have the same number of patent families but none of them will take into account the information from the IPI patent applications. Finally and similarly, patent applications filed by Swiss SMEs directly at EPO are difficult to interpret as PATSTAT does not provide data about designated countries. Using EPOLINE data would make it possible to check which EPO members were designated but unfortunately all member countries (including Switzerland) are crossed for most of the applications.

Despite these limitations, the merged dataset is a unique source of information for the Swiss SMEs patent activities and it provides a reliable solution for assessing them.

The structure of this chapter is the following: First we compare the results from the IPI survey with PATSTAT, to try to understand if there are differences in the information

[18] For instance, none of the previous three examples change if the applications are granted or not.

provided by both sources. Then, we analyze all the information given by PATSTAT inasmuch as these data are helpful to understand the patenting behaviour of SMEs. Finally, we consider the combination of both databases, to understand how new information provided by PATSTAT can lead to additional insights for the other sections of this report.

After matching both databases, we are able to see whether or not the firm has filed a patent in the last few years. To make this comparison, we looked at the time span that goes from 2004 to 2007 in PATSTAT (since the IPI-survey was carried out in early 2007) and asked for the innovation behaviour of the last two years. Since there is a lag between the moment that the patent document is filed and the moment it appears in PATSTAT, we included the year 2004 to be sure that we were analyzing at least two completed years, since at the moment of carrying out the analysis the information was not completed for year 2006 or 2007. Therefore, in PATSTAT we will use the period 2004-2007 as the best time election to compare the results with those of the IPI survey. The information found in PATSTAT is codified as "1" if the firm has filed at least one patent in the study period and "0" otherwise. If after applying the matching procedure we are not able to find the firm in PATSTAT, the firm is codified as missing.

The next table summarises the information of combining both sources of information. In total, we were able to find 151 SMEs which have filed a patent. In the previous analysis we have considered a patenting firm if they have an answer equal to "3" or "4", summing up these two results gives us a total of 161 firms (a total of 119, that answered "3" plus 42 which answered "4"). This means that by both procedures we get rough numbers which are quite similar.

Table 15 Comparison between two databases

PATSTAT	**IPI**					
	1	2	3	4	n.a.	**Total**
0	559	213	**40**	**9**	23	844
1	**7**	**37**	60	23	24	151
Missing	.	.	**19**	**10**	112	141
Total	566	250	119	42	159	1136

For seven firms that answered to the IPI questionnaire they had never filed a patent, we found in PATSTAT that they had filed one patent in the last four years. Also, we found that 37 firms which answered that they rarely file patents had filed at least one patent in the studied period. Not expected results are for example the 40 firms that answered that they often apply for patents but for which we did not find any patents in PATSTAT, or the 9 firms that replied to be always applying for patents but although we found the firms in PATSTAT we did not find any application for a patent of any of them in the database in the years considered. We also codified 29 (19+10) firms as missing, since they were not found in PATSTAT but reported to have an active patenting behaviour. These firms were manually checked. Most of them belong to a group and the patent was filed by a foreign subsidiary. The firms which presented contradictory results in

both databases are presented in bold fonts. Summing up the non-contradictory results and dividing them by the total number of firms gives us an accuracy of 89.2%.

The wrong answers might be due to different factors. First, it might be that the person who answered the questionnaire is not fully aware of the patenting activity of the firm. The difference might also come from the fact that at the moment the firm was filling in the questionnaire there was no application for a patent. This application might have happened after having answered to the questionnaire; therefore, both databases contained different answers. Another possible explanation is that the firm patented under the name of a subsidiary. Therefore, they are aware of the patenting application procedure, but for us there is no feasible way to match this information. These are some explanations, among many other possibilities, that give reasons to the fact that we did not find a perfect match of 100%.

5.3 Patenting activities of SMEs during ten years

In this section we are using the information contained in PATSTAT for the patenting SMEs of the IPI sample. Since we were mostly interested in the patenting experience of Swiss SMEs we decided to study a period of eleven years, which goes from 1996 to 2007[19].

5.3.1 Swiss patenting SMEs are global patent users

In this subsection we are interested in understanding what the patent behaviour of an SME is when it comes to choosing a country where to file a patent application. Table 16 shows the above mentioned theoretical example to help the reader understand the information presented in this section. SMEs are grouped by three main filing destinations according to the patent documents in their portfolio (see the note under the table for acronym definitions): (a) SMEs filing patent applications only in Switzerland, (b) filing only abroad or (c) filing in both. Let us take a look at SME_2 patent portfolio. The patent family PF_{21} has been filed in Switzerland (CH_{2A}) and abroad (FR_{2A} and IT_{2A}), while PF_{22} was filed in the Unites States (US_{2A}), Japan (JP_{2A}) and at EPO (EP_{2A}). Therefore SME_2 is a firm that has filed patent applications both in Switzerland and abroad in the studied period of time. The behaviour of this SME is significantly different from SME_1, whose two patent families (PF_{11} and PF_{12}) contain patent documents filed only in Switzerland. And it also differs from the behaviour of SME_3, for which all patent applications have been filed only abroad. Therefore, in the example we have one firm in each category.

[19] We are using the database of PATSTAT version October 2007, since it takes 18 month to update the database the last fully updated month will be March 2006.

Table 16 Patent portfolio examples by main filing destinations.

Firm	Patent Families	Patent Documents	Only CH	Abroad	In CH & Abroad	Total	At least one patent document in			Triadic
							EU	US	JP	
SME_1	PF_{11}	CH_{1A},CH_{1B},CH_{1C}	1	0	0	1	0	0	0	0
	PF_{12}	CH_{1D}								
SME_2	PF_{21}	FR_{2A},CH_{2A},IT_{2A}	0	0	1	1	1	1	1	1
	PF_{22}	EP_{2A},JP_{2A},US_{2A}								
SME_3	PF_{31}	EP_{3A},US_{3B}	0	1	0	1	1	1	1	0
	PF_{32}	IB_{3A},JP_{3A}								
Total			1	1	1	3	2	2	2	1
%			33%	33%	33%	100%	67%	67%	67%	33%

Note: PF: Patent Family; Patent documents are expressed by the patent authority code. For instance, CH refers to an IPI patent document, EP to EPO and IB to an international patent application filed directly at International Bureau of WIPO (Geneva).

For those firms that have at least one patent application filed abroad, we wanted to have more details on the specific destination selected. The counting is done based on SMEs that have at least filed one patent application in any of the following regional areas: Europe, Japan and the United States. Europe is defined as "having filed a patent application either at EPO or at any of the European countries that belongs to EU 15 plus Norway". The information contained in PATSTAT does not allow for any other further disaggregating since a patent application filed at EPO might have protection over many European countries, and documents from the same patent family might be first filed in a European country and later at the EPO. Therefore, we consider that a firm has filed at least one patent in Europe if it has either filed at EPO or at any EU 15 countries plus Norway. Continuing with the example from Table 16, let us have a look at family PF_{32} from SME_3 which has a document filed at USPTO and another one filed at EPO. Hence, we have considered this patent family as being filed in Europe (and the US), since most of the patents filed at EPO cross all members (including Switzerland). Following a similar procedure, we count the number of SMEs that filed in the last ten years at least one patent application either in Japan or in the United States. The table also offers information on firms that have at least one patent family with documents filed at USPTO, JPO and EPO. This last case is considered as an SME that has at least one triadic patent family. In our example, SME_2 has one triadic patent family (PF_{22}), while SME_3 has patent applications filed in USPTO (PF_{31}), EPO (PF_{31}) and JPO (PF_{32}), but never the three destinations are on the same patent family.

Now we present Table 17 where we are following the same logic of the example. The population of firms is divided by size categories.

Table 17 Main filing destinations by size

Size	Only CH	Abroad	In CH & Abroad	Total		At least one patent document in			Triadic
						EU	US	JP	
1-9	4	17	21	42	15.4%	37	20	16	13
10-25	3	22	26	51	18.7%	46	23	15	11
26-49	1	10	26	37	13.6%	34	17	11	8
50-125	5	17	50	72	26.5%	65	32	22	14
>125	2	8	34	44	16.2%	42	30	25	20
n.a.	1	6	19	26	9.6%	24	18	13	12
Total	16	80	176	272	100%	248	140	102	78
%	5.9%	29.4%	64.7%	100%		91.2%	51.5%	37.5%	28.7%

Note: Swiss SMEs patenting abroad and not in Switzerland, when they are patenting through the EPO, most often always designate Switzerland. It however does not mean that they pay afterward for a protection in Switzerland.

Table 17 shows that 6% of the SMEs in our sample have only been filing applications in Switzerland over the last ten years – which represents a very small proportion of the whole sample. There is a large group of SMEs filing patents applications only abroad. Those firms have a strong international projection in the patenting behaviour, and they represent one third of all the patenting firms. And the last group is formed by SMEs that are using both international and national patent offices (CH) to file their applications. The group represents 65% of the total firms with patent activity in the period. In conclusion, from here we withdraw the idea, that a big majority of the Swiss SMEs are using both international and national patent offices when protecting their inventions.

More than 90% of the SMEs have some experience in applying for a patent in Europe in the period of time considered. More than half of the firms filed a patent application in the US, and 37.5% did it in Japan. More than a fourth of SMEs in our sample have at least one triadic patent family. In general, when considered over a period of ten years, Swiss SMEs with patent activity have in a great deal been exposed to an international experience of filing patents applications abroad.

In Table 18 the same information is presented by sectors. A first look at the table shows that the distribution of SMEs with patent activity during the period is highly determined by some sectors. The higher proportions are found in Electrical and Optical (22%) and Machinery and Equipment (20%), followed by Metallic Products (10%). In the case of these three sectors, we observe a very international pattern in which the majority of firms are filing at least one patent application abroad, although most of them are also filing at least one patent application in Switzerland. This is, however, the pattern of almost all sectors. From here we can conclude that most SMEs with patent activity have, to some degree, an exposure to international procedures of filing a patent application abroad, regardless of their sector.

Table 18 Main filing destinations by sector

Sector	CH		Abroad		In CH & Abroad		Total		At least one patent in							
									EU		US		JP		Triadic	
Business Services n.e.c.	0	0.00%	6	2.21%	7	2.57%	13	4.78%	11	4.07%	9	3.33%	4	1.48%	2	0.74%
Computer and R&D	0	0.00%	3	1.10%	1	0.37%	4	1.47%	4	1.48%	2	0.74%	3	1.11%	1	0.37%
Construction	0	0.00%	3	1.10%	0	0.00%	3	1.10%	3	1.11%	1	0.37%	0	0.00%	0	0.00%
Electrical and Optical	**2**	**0.74%**	**14**	**5.15%**	**44**	**16.18%**	**60**	**22.06%**	**56**	**20.74%**	**29**	**10.74**	**21**	**7.78%**	**17**	**6.30%**
Food, Beverages and Tobacco	0	0.00%	0	0.00%	3	1.10%	3	1.10%	3	1.11%	1	0.37%	0	0.00%	0	0.00%
Fuel and Chemicals	1	0.37%	10	3.68%	13	4.78%	24	8.82%	23	8.52%	12	4.44%	10	3.70%	8	2.96%
Machinery, Equipment and Transport	**1**	**0.37%**	**13**	**4.78%**	**41**	**15.07%**	**55**	**20.22%**	**52**	**19.26%**	**37**	**13.70%**	**25**	**9.26%**	**18**	**6.67%**
Metallic products	**4**	**1.47%**	**8**	**2.94%**	**16**	**5.88%**	**28**	**10.29%**	**23**	**8.52%**	**17**	**6.30%**	**12**	**4.44%**	**11**	**4.07%**
Non-metallic products	2	0.74%	2	0.74%	3	1.10%	7	2.57%	5	1.85%	2	0.74%	3	1.11%	2	0.74%
Other Manufacturing industries	1	0.37%	2	0.74%	6	2.21%	9	3.31%	8	2.96%	1	0.37%	2	0.74%	1	0.37%
Other services	0	0.00%	0	0.00%	1	0.37%	1	0.37%	1	0.37%	1	0.37%	0	0.00%	0	0.00%
Paper and Publishing	1	0.37%	3	1.10%	3	1.10%	7	2.57%	6	2.22%	2	0.74%	2	0.74%	1	0.37%
Rubber and Plastics	2	0.74%	4	1.47%	8	2.94%	14	5.15%	12	4.44%	2	0.74%	1	0.37%	0	0.00%
Textiles, Leather and Wood	1	0.37%	3	1.10%	8	2.94%	12	4.41%	11	4.07%	5	1.85%	4	1.48%	4	1.48%
Wholesale and Retail	0	0.00%	3	1.10%	3	1.10%	6	2.21%	6	2.22%	1	0.37%	2	0.74%	1	0.37%
n.a.	1	0.37%	6	2.21%	19	6.99%	26	9.56%	24	8.89%	18	6.67%	13	4.81%	12	4.44%
Total	16	6%	80	29%	176	65%	272	100%	248	91.85%	140	51.85%	102	37.78%	78	28.89%

If we look further at the main destinations of these SMEs filing patent applications abroad, the higher frequencies are always in Europe, followed by US and Japan.

5.3.2 A decreasing use of the national patent system

In this section, we analyze the changes in the patenting behaviour of Swiss SMEs over time. Figure 32 presents the percentage change of SMEs according to the three groups that we presented in the previous sections: firms only filing patents in Switzerland, SMEs doing it abroad and a third group that captures those SMEs which are filing patents both at international and national patent offices. As stated above, firms belong to the IPI sample, whose information has been complemented with PATSTAT. The figure presents three blocks of five years each. In each of the blocks the percentages for the three groups have been plotted. This graph helps us understand the evolution of the behaviour of Swiss SMEs when choosing where to file their patents.

Figure 32 Patenting activity by main filing destinations, in percentage

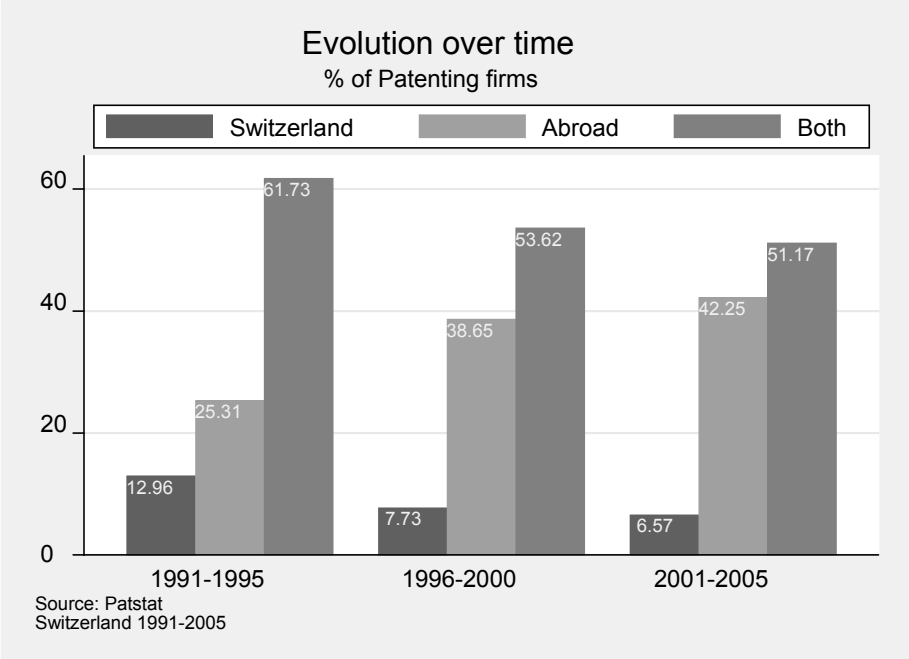
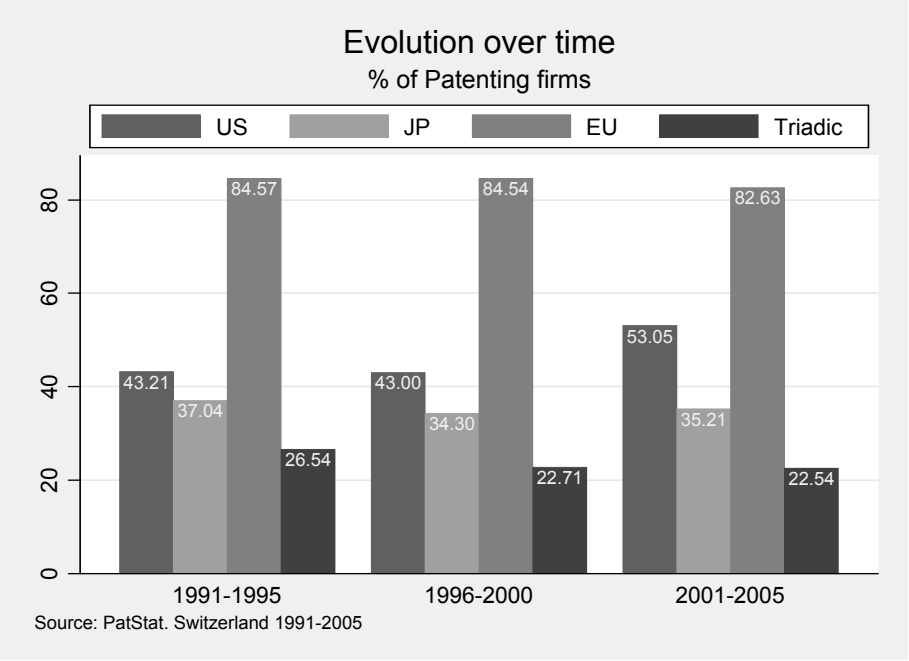


Figure 32 shows that the proportion of SMEs which are only filing patent applications abroad has been growing over the years. It goes from 25% of the SMEs in the period 1991-1995 to 42% in the last period. We also observe that the proportion of firms which are only filing patents in Switzerland has been shrinking over the years, being 6,6% of the population of SMEs with patenting activity at the end of the period. This is half the percentage of the beginning of the period. The biggest group of firms includes the firms that are filing both in Switzerland and abroad. And it remains the biggest group in all the periods, always holding more than half of all the SMEs with patenting activity. However, it has been falling over time.

The first conclusion is that in general we observe an internationalization of destination that SMEs choose to file patents; more and more Swiss SMEs prefer to file patent applications at international patent offices, not at IPI. However, the biggest proportion of SMEs is filing patent applications at both the international and national level. In Figure 33 we analyze in further details the main chosen destinations for those firms filing at least one patent application abroad. We present the percentages of SMEs filing at least

one patent application in one of the following destinations, using the definitions above: United States (US), Japan (JP), Europe (EU) and the proportion of SMEs with at least one triadic patent family.

Figure 33 Share of firms with at least one patent document filed in each destination



We observe in the graph that there is an almost constant proportion of firms which has filed at least one application in Europe. In other words more than 80% of the SMEs with patent activity during each sub-period of time have at least one patent application filed in Europe. The second destination in frequency is the United States, where we see that the number of SMEs filing at least one patent application at USPTO has been growing lately. In both sub-periods 1991-1995 and 1996-2000, they were around 43% of SMEs and, in the final five years sub-period they were more than half of them. Japan is less frequently selected as a destination. Starting at 37% and ending around 35%, this destination seems to be quite constant. The last observation we are able to do is that the proportion of SMEs having in their patent portfolio at least one triadic patent family has modestly decreased from 26.5% to 22.5%. The main conclusion is that in general the selection of the destinations is fairly constant with the exception of the United States, which seems to be a destination increasingly chosen by Swiss SMEs to protect their innovations.

5.4 The (international) networks of Swiss SMEs

In this chapter, we exploit the information contained in PATSTAT to analyze and understand Swiss SMEs' networks. We do this by analyzing the information from the patent documents in the patent portfolio of each SME about international co-applications, international co-inventions and international citations. The latter are discriminated in patent documents cited (backward citation) and patent documents citing (forward citations).

An international co-application is defined as Swiss SME with at least one patent application in its patent portfolio co-filed with one or more non Swiss applicants (henceforward, international co-applicant) in terms of residence, not nationality. A Swiss SME has one international co-invention when within its patent portfolio there is at least one

patent application co-filed with one or more non Swiss inventors (henceforward, international co-inventor) in terms of residence (not nationality).

Patent portfolios also allow us to investigate citations including forward and backward citations (see the Glossary for a definition). In the backward citations, we analyze the origin of the documents by citing any document of each SME patent portfolio. In the case of forwards citations, we consider the firms whose patent documents are cited by other documents. When we take into consideration the limits of citation as an indicator[20], the two measures respectively give us the opportunity to explore on what technologies Swiss SMEs are building their innovations and what the impact of the their inventions is.

Table 19 Number of SMEs with international co-applicants, international co-inventors, backward and forward citation by size

Size	Co-applications	Co-inventors	Backward Citations	Forward Citations	Total SMEs filing patents
1-9	17	20	33	23	42
10-49	20	30	77	49	88
50-250	39	60	105	86	116
n.a.	15	18	25	23	26
Total	91	128	240	181	272

Table 19 gives a distribution of the number of SMEs in each of the categories by size. In the rest of the chapter we will provide disaggregated information for each category, analyzing different aspects of them. The analysis will be done based on percentage averages across groups.

[20] A large number of papers address the interest to use citations. See for instance Trajtenberg, 1990; Almeida, 1996; Carpenter and Narin, 1983; Narin et al., 1997.; Harhoff et al., 1999; Hall et al, 2005.

Figure 34 Types of links building SME networks, in percentage

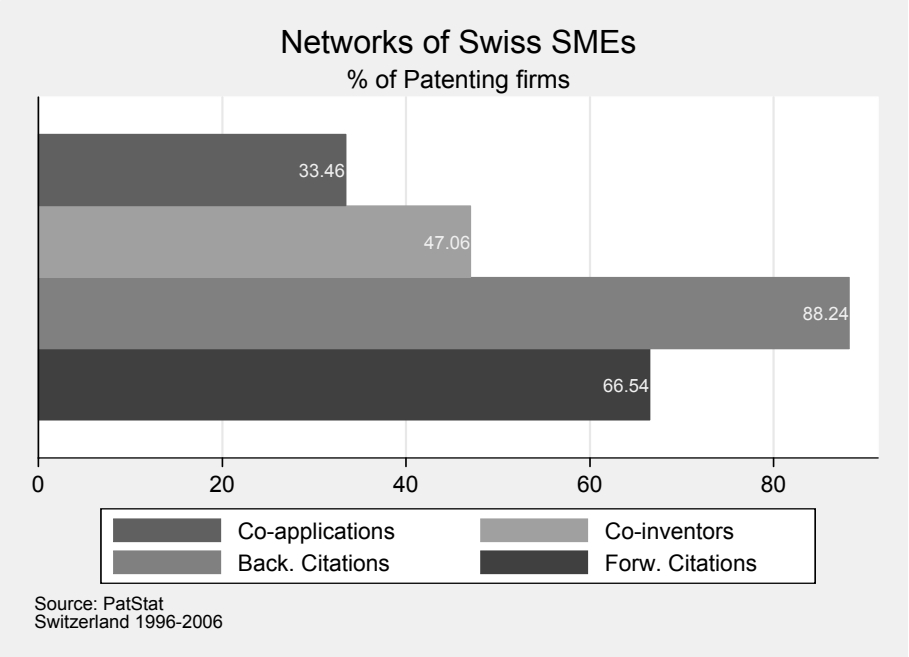


Figure 34 presents a first view of the different uses made by Swiss SMEs of the four dimensions that we are using to measure the SMEs' international networks. It shows that 33.5% of the SMEs in the period 1996-2006, have filed at least one patent application where they formally collaborated with an international co-applicant. 47% of the firms with patenting activity in our sample have at least one patent application filed with an international co-inventor. 88% of these SMEs made a citation to other patent documents filed by at least one foreign inventor[21]. And 2/3 of the SMEs with patenting activity received at least one citation from other patent documents filed by at least one foreign inventor. In the next sections, we analyze in more detail these four dimensions of the Swiss SMEs' international networks.

5.4.1 Micro-firms are co-applying for patents with international partners

In Table 20 we introduce an example to help the reader to understand the way we analyzed co-applications. As before, the unit of analysis is the firm. In the example we have the same three firms as before. For the geographical distinction in this case, we have analyzed firms which have co-filed with other inventors and applicants (a person, a firm or an institution) in Germany, France, Italy and Austria[22]. Then we consider other European countries (EU15+Norway) different from the four already mentioned, USA and Japan. If a Swiss SME has co-filed with an inventor or applicant from any other country, it has been classified as "other countries". The counting is done using the firm as the unit of analysis, but each SME is counted as many times as it has co-inventors (or co-applicants) from the different country categories described above. For example, SME_1 is counted once as having a German co-inventor and also once as having a German co-applicant, even if it has two patent families (PF_{11} and PF_{12}) with a German applicant. Also SME_1 is counted both as having a French co-inventor and co-inventor

[21] Self-citations were excluded.

[22] The selection of these four countries is based on a first look at the data, Swiss SMEs have the highest number of co-applications, co-inventors and backward and forward citations in those countries. Those four countries have also borders with Switzerland and cultural proximities (language) that might explain the high interaction with Swiss SMEs.

from "Other EU countries", as PF_{12} is co-invented with someone residing in the Netherlands. The SME_2 is counted as having one co-invention with the United States, one with "Other EU countries" because of its Swedish co-inventor (SE) and one with "Other Countries" because of its Israeli co-inventor (IL). On the contrary, SME_2 has completely different international co-applicant, which is from Germany (DE), showing that the international co-applicants and co-inventors networks may or may not overlap for the same firm. We propose to analyze both networks as both have their strengths and limitations. The international co-inventors network usually avoids the problem of economic groups and their subsidiaries. For instance, SME_2 could be co-filing with a German group with its headquarters in Berlin but in fact it is interacting with a researcher from the R&D lab situated in the Swedish subsidiary (additionally, it could be co-inventing with an American researcher and another one from Israel). The advantage of looking at the international co-applicants networks is to avoid the problems related to cross-border residents who are likely to be numerous in Switzerland. For example, SME_3 could be located in Lugano and the head of its R&D lab could be resident nearby in Italy and collaborating with the ETHZ with a Professor living in Germany, while the real collaboration is with a French university and a Japanese firm. Although the example has been conceived for co-applications or co-inventors, the same logic is used to describe citations (both backward and forward).

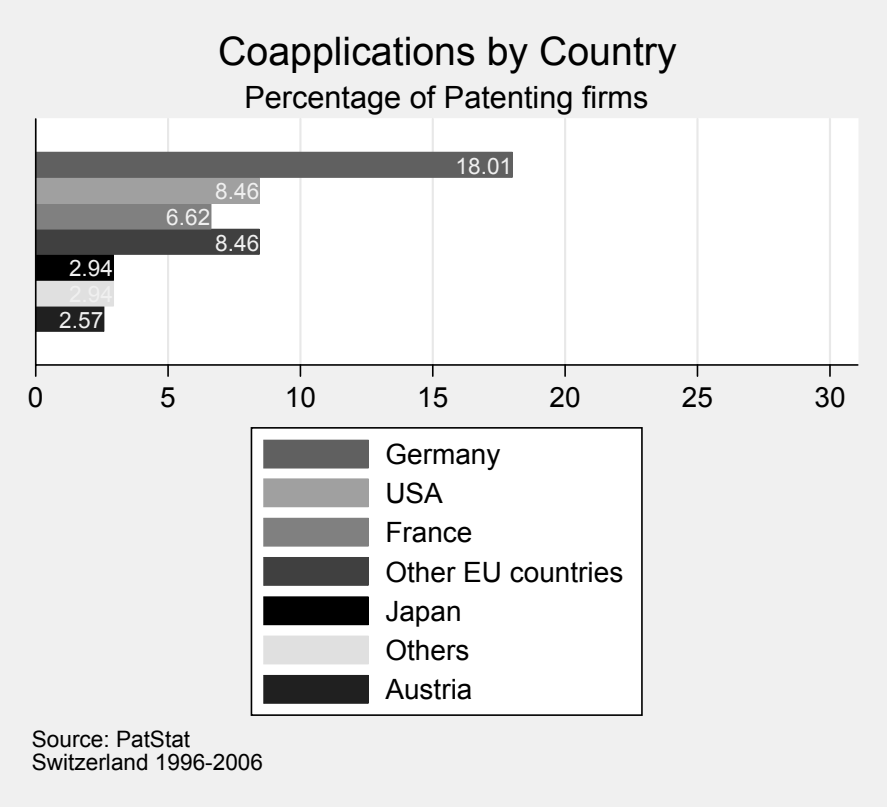
Table 20 Example explaining SMEs with international co-inventors and co-applicants

Firm	Patent Fam.	Inventors from…	Applicants from...	(Inventors, Applicants) from…							
				Germany	USA	France	Austria	Italy	Other EU countries	JP	Other Countries
SME_1	PF_{11}	CH,DE	CH, DE	(1,1)	(0,0)	(1,0)	(0,0)	(0,0)	(1,0)	(0,0)	(0,0)
	PF_{12}	CH,FR,NL	CH, DE								
SME_2	PF_{21}	CH,SE,US	CH	(0,1)	(1,0)	(0,0)	(0,0)	(0,0)	(1,0)	(0,0)	(1,0)
	PF_{22}	CH,SE,IL	DE								
SME_3	PF_{31}	CH,IT,FR	CH, FR	(1,0)	(0,0)	(1,1)	(0,0)	(1,0)	(0,0)	(1,1)	(0,0)
	PF_{32}	CH,JP,DE	CH, JP								
Num. of firms (3)				(2,2)	(1,0)	(2,1)	(0,0)	(1,0)	(2,0)	(1,1)	(1,0)
%				(66%,33%)	(33%,0%)	(66%,33%)	(0%,0%)	(33%,0%)	(66%,0%)	(33%,33%)	(33%,0%)

Note: PF: Patent Family; CH: Switzerland; FR: France; IT: Italy; EP: EPO; JP: Japan; US: USA; SE: Sweden; DE: Germany; IL: Israel; NL: Netherland.

Figure 35 plots the percentages of SMEs that, during the last ten years, have filed at least one patent application. The information has been disaggregated by the country of residence of the international co-applicant. In our sample, there are 49 firms (18%) which have filed jointly with a German applicant at least one patent application. More Swiss SMEs have co-filed at least one patent application with a German co-applicant than any other international partner. An explanation for this high proportion could be the over representation of German speaking firms in the IPI survey sample. The following countries in terms of Swiss SMEs with patenting activity are the United States (8.46%) and France (6.62%).

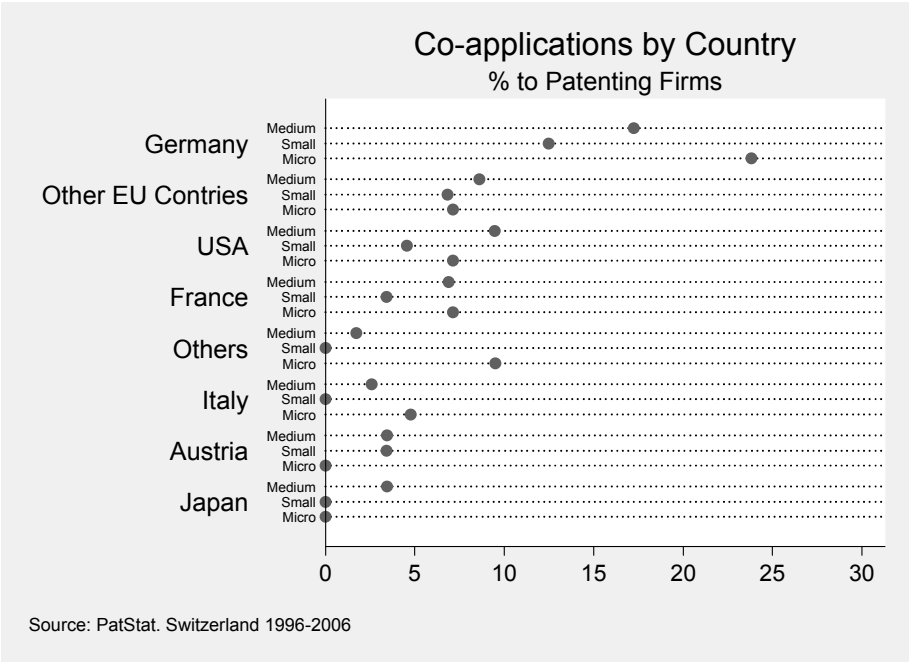
Figure 35 International co-applicants network, by country



We go one step further and disaggregate this information by firm size, studying three groups of firms depending on the number of employees: micro-firms (1-9), small (10-49) and medium sized (50-249). In Figure 36 below, averages across size classes have been calculated and plotted in the same graph. A first look at the graphs shows the strong dynamism that micro firms have in their international co-application activities: they are the most active group by size class. This result is surprisingly going against what the literature argues since size is supposed to be the main factor determining patenting activities. Here, we are able to see that, once they are patenting, micro firms seem more international than the rest of SMEs.

There is a total of 25% of micro firms that have jointly filed with a German co-applicant, which is 7 points above the average. Indeed, the networks of these micro firms have a higher international projection, with 10% of them filing patents applications with non European co-applicants, when the general average is only at 3%. In general, this is the pattern for all the different international partners.

Figure 36 International co-applicants network, stratified by size



Source: PatStat. Switzerland 1996-2006

5.4.2 Micro-firms also co-invent with foreign partners

Figure 37 illustrates the number of firms that have in their patent portfolio at least one co-inventor whose residence country is different from Switzerland. Again, the highest number of Swiss SMEs having an international co-inventor is, as in the case of the co-application, coming from Germany. More than one fourth of the firms filing patents applications in our sample have one German co-inventor. 12.5% of the firms have a co-inventor from France; 12% from other EU-15 countries; and 11% are from USA. In our sample there is a 10% of the firms which in their patent applications have at least one co-inventor that comes from other non EU-15 countries. As in the previous subsection, we had a closer look at these percentages disaggregating them by size class.

As before, Figure 38 questions the idea that size is the main determinant in the dynamics of firms when it comes to patenting activities. We would expect that the average of firms presenting co-inventors from different countries increases as size does, however we can see that although this is the case for small and medium size enterprises micro firms present a very dynamic role in the use of the international co-inventor network, being higher than small firms in all the country cases. Looking at the averages, their behaviour looks more similar to medium size firms than to small firms. The average in the case of a co-inventor whose country of residence is a non EU-15 country is larger for micro firms than for any of the other size categories. As the explanation given before in the cases of international co-applications, not only speaks this fact of the strength of the networks these active micro firms hold but also of a network much more broad in a geographical dimension. Therefore, they are very active agents in the diffusion of knowledge, in this case with knowledge embodied in the foreign inventor.

Figure 37 International co-inventor network

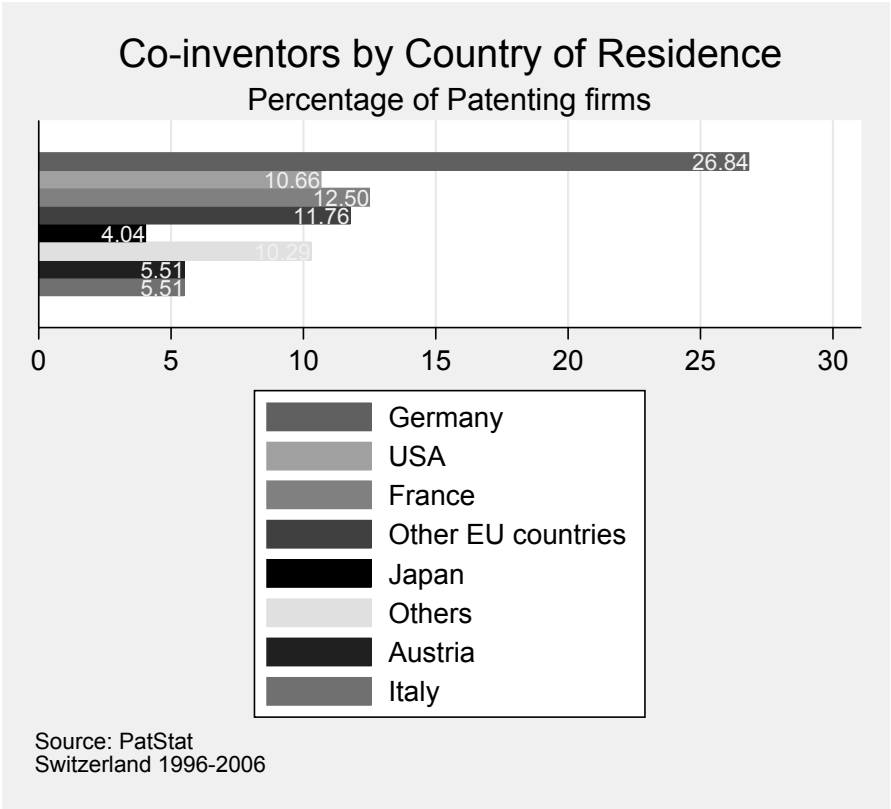
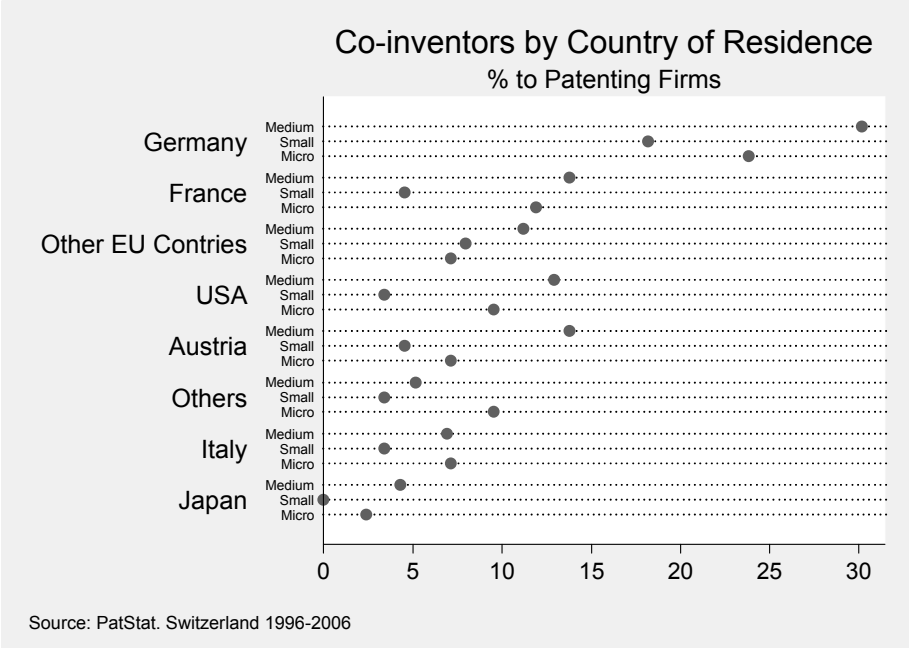


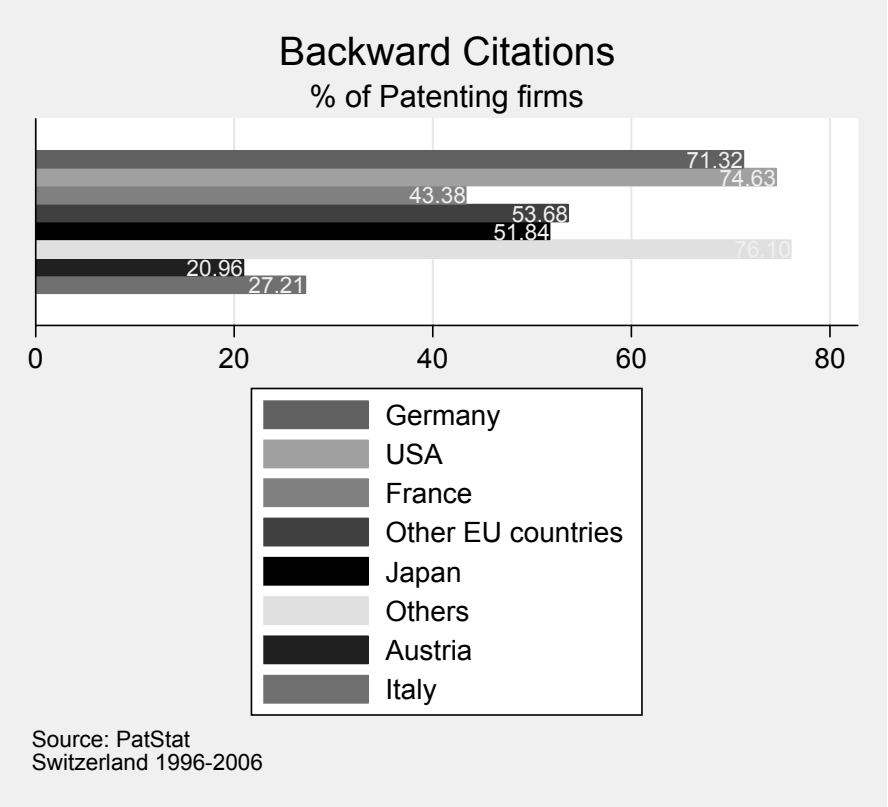
Figure 38 International co-inventor network, stratified by size



5.4.3 Swiss SMEs' international technology sourcing

In this chapter we analyze backward citations of patents. Backward citations are those citations done by the SME's patent documents to other patent documents. We need to be cautious in our interpretation because these backward citations could have been done by the given SME, by a patent attorney hired by the SME or by a patent examiner. This indicator is often used to capture the source of previous technology (or ideas) that the citing entity – in our case an SME – is building its technology from. Given the ambiguity of the real origin of the citations[23], this indicator can be re-interpreted as measure of where the existing knowledge or technology closer to the citing entity patent portfolio can be found. The distinction on the interpretation depends on whether the SME actually knew about the previous patent document or was it whether it was the patent officer who included them. In any case, backward citations which are not done by the patent officer could be used as a proxy to analyze the use that SMEs do of patent databases (see chapter 2). This use of patent databases is done directly by the SME (see also Radauer and Streicher, 2008) or indirectly paying the attorney to make the search for the SME.

Figure 39 Share of patenting firms with at least one backward citation



As before, we are presenting the number of those firms which is citing at least one patent document of any different regional distinction presented by the graph during the period considered. The non EU countries are receiving the highest number of citations[24], in part because the group is the one that holds the biggest number of countries. It is followed by USA, Germany, other EU-15 countries, Japan, Switzerland and

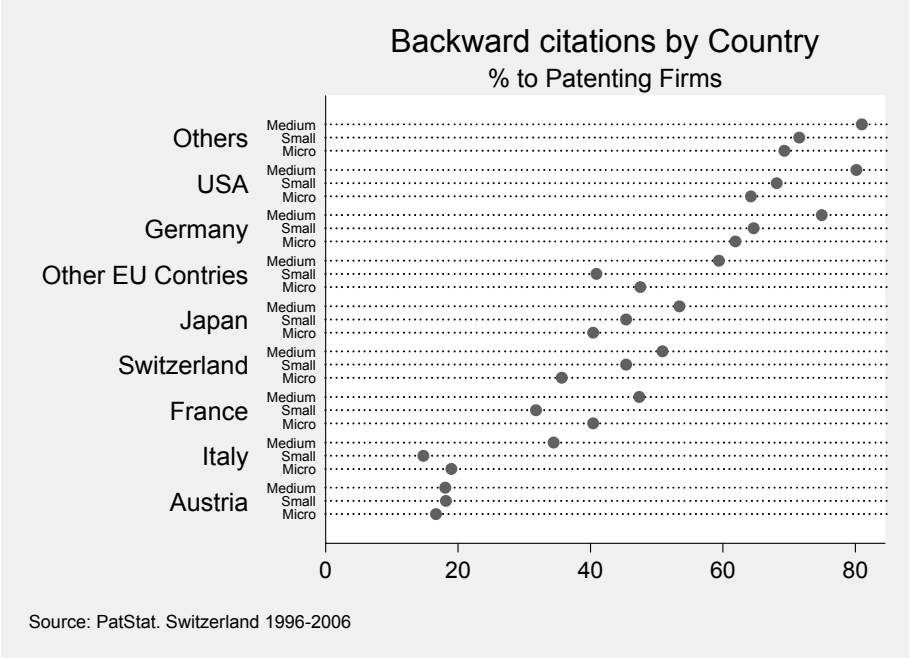
[23] In PATSTAT, only EPO patent documents have their citations flagged by origin. Recently, the USPTO has started to flag them too.

[24] This group of countries will include any country which is not in the EU-15, Norway, USA or Japan.

France. This graph tells us that the knowledge generated is based on knowledge generated by leading countries.

Figure 40 presents the difference in the backward citations by the three size classes that have been studied. In general, the proportion of firms citing the different countries documents is very much determined by size. Larger SMEs cite more varied countries than smaller SMEs. This distinction means either that the new knowledge created by larger firms is related to a broader spectrum of existing knowledge or that it is easier for them to access it and have the opportunity to cite a broader number of existing patent documents.

Figure 40 Share of patenting firms with at least one backward citation by firm size

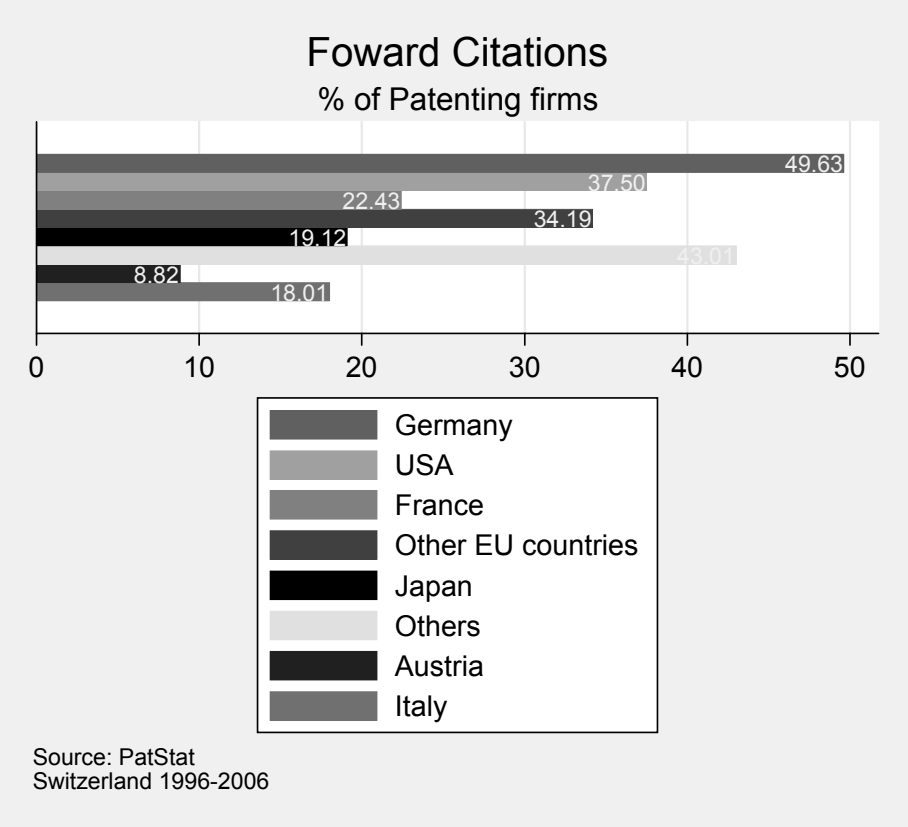


Source: PatStat. Switzerland 1996-2006

5.4.4 Swiss SMEs' impact on inventiveness at a global level

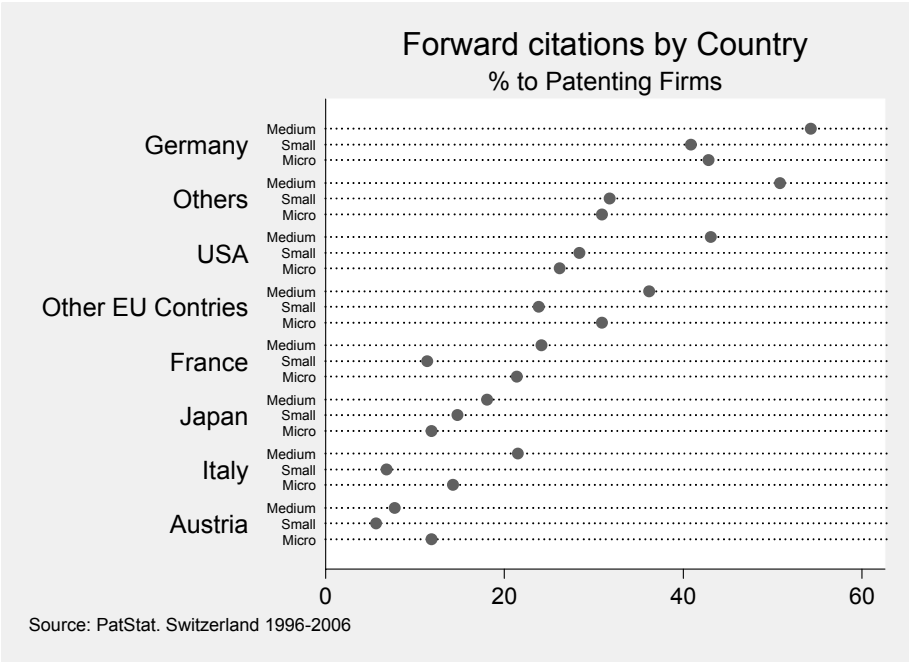
Forward citations are often used as an indicator of how relevant the knowledge is or technology that the entity – in our case an SME – holding the cited patent document is for the citing ones. As the backward citations, the same limitations of the ambiguous origin of citations apply to forward citations. Even if the citations are mainly made by patent examiners, they still reflect closeness to the state of the art as received citations increase. Above, in Figure 34, we saw that 2/3 of the SMEs in our sample have received at least one quotation from another patent document. Figure 41 extends this by presenting the proportion of firms with patenting activity that have received forward citations in a ten year period classified according to the country in which the inventors of the citing patent document were resident. Half of the SMEs with patenting activity receive at least one citation from an inventor resident in Germany. This group is closely followed by inventors residing in other (Non European) countries (43%) and American resident inventors (37.5%). This shows a very international projection of the patents documents in the Swiss SMEs patent portfolios.

Figure 41 Share of patenting firms with at least one forward citation



When we disaggregate this information considering the size, we can also see that the number of firms receiving citations increases with the size of the SMEs. Figure 42 shows a clear pattern that the average for medium firms is much larger than for the rest of the other two size groups. This pattern is very clear in the graph for the principal origins of forwards citations: Germany, other Non European Countries and United States. However, this does not mean that the value of patent portfolio of small or micro firms is null. We have to remember that in this chapter we are only looking at patent documents. Patents are a legal way of protecting the innovation by codifying the knowledge associated with the innovation. Evidence can be found in literature that the smaller the size of the firm, the more they will try to protect their knowledge using informal means of protection like secrecy or speed (see chapter 2). If this is the case, their impact in the frontier of knowledge will be expressed through other means than citations, such as imitation done by other firms which is very difficult to quantify.

Figure 42 Share of patenting firms with at least one forward citation, by size



5.5 A second look at the IPI survey using PATSTAT

With the additional information obtained from PATSTAT, we decided to have a second look at the results of the IPI survey. After analyzing the PATSTAT data, we concluded that there were two differentiated groups of Swiss patenting SMEs: firms that have used at least once the IPI to protect their innovation, and firms that do it only and constantly abroad. Out of the IPI questionnaire, we consider that is interesting to look at two questions: the main reasons to apply for a patent (question 4), and what should be improved considering the application for patents (question 5). As before, we calculated averages separating the users of the Swiss patent system, meaning that they have filed a patent application at IPI in the last ten years, from those non-users of the Swiss patent system, which include those that have been filing applications only somewhere else.

Figure 43 presents the main reasons for applying for a patent, making the distinction about users and non-users of the Swiss patent office. To reduce some of the causality problems mentioned at the beginning of the chapter, we have considered the patenting activity of SMEs only during the period 2004-2007. The main reason was protection against competition, with more than 90% of the firms reporting it as the main reason to apply for a patent. Still, there was no difference in the average for the two differenciated groups that we are studying. We observed particularly that contract negotiation is a much more relevant reason to apply for a patent in Switzerland than it is for an SME filing patent applications only at foreign patent offices. While contract negotiation is relevant for 56.5% of the users of the Swiss patent system, it is only relevant for 43% of the SMEs that are non-users. On the contrary, for firms applying only at foreign offices the effect of publicity is much more relevant, with 38% of the firms with patenting activity against 17% of users of the Swiss patent system.

Figure 43 Reasons for patent application

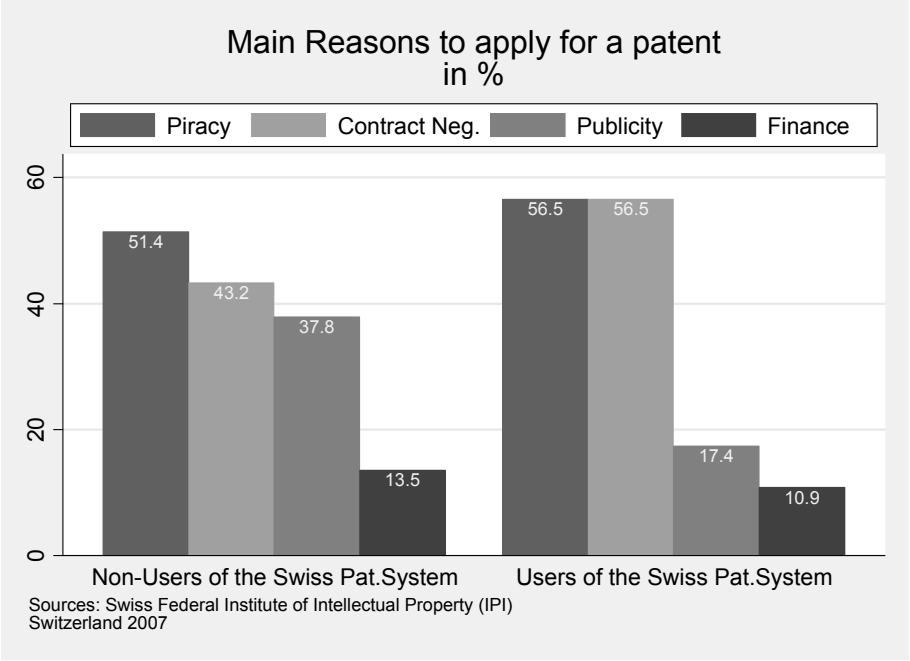


Figure 44 Share of firms reporting needs for improvement

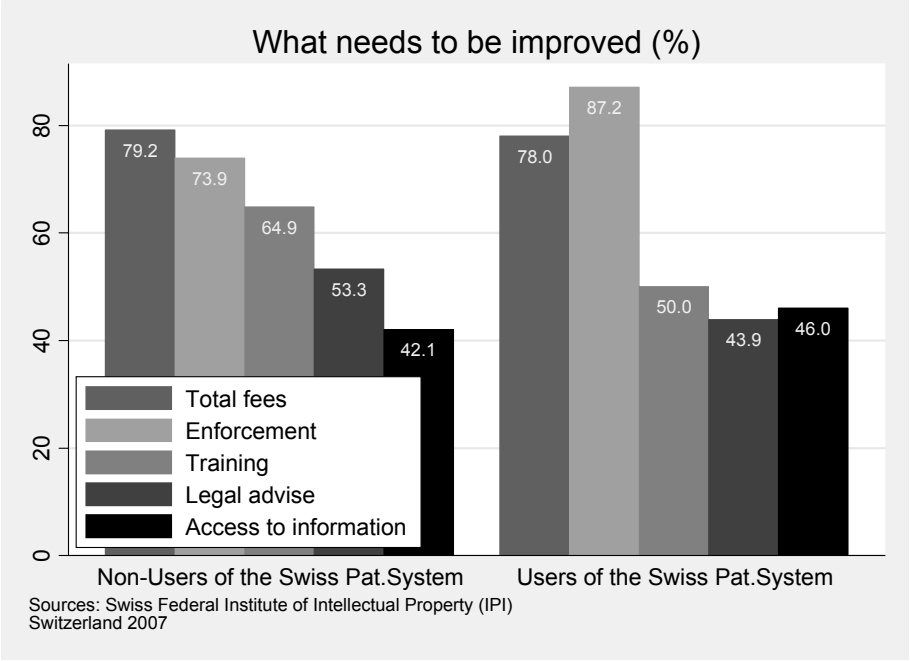
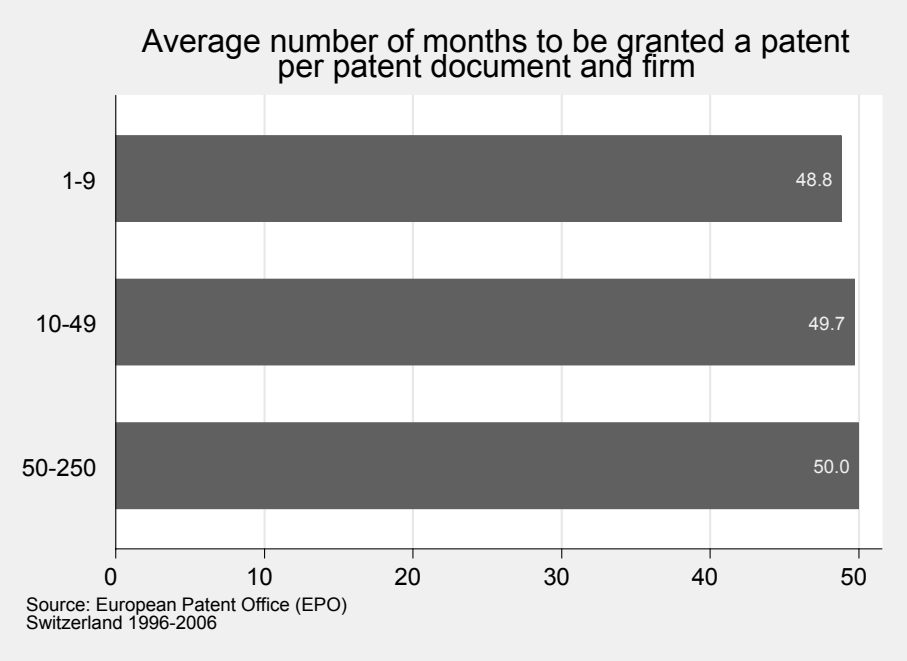


Figure 44 plots the answer about what needs to be improved according to users and non-users of the Swiss patent system. For both groups, almost the same proportion of firms report that the total amount of fees[25] should be reduced. Therefore, this is a constant need that Swiss SMEs have, independently of the place where they prefer to patent. It is not the case when we consider enforcement of rights associated to a patent, in which users of the Swiss system have an average of 87% of the firms that reports that the enforceability should be improved. This proportion is much lower for the firms filing only abroad, which is in average 74%. If we look at the lack of training, 64% of the Swiss firms filing patent applications only abroad feel that the training should be improved, while the average is smaller for users of the Swiss patent system. This means that the level of training in using the system is better known by those firms filing document at IPI. A similar situation is found when we study the firms that report a lack of legal advice: the average is bigger for non-users of the Swiss patent system. Both dimensions magnify the idea that in general the Swiss patent system is well known, while in the international environments Swiss SMEs still face some shortcomings. When we compare the averages for the access to information, although the results for both groups are quite similar, the average of firms which reports problems having access to the information is higher among users of the Swiss patent system (46%) with respect to non-users (42%).

We also analyzed some extra information from EPOLINE provided by IPI about the patents applications filed at EPO by our sample of SMEs. We have considered that the most important observation was to see if there is any observable distinction in the time span that an SME needs to get their patent applications granted. Especially, we were interested in understanding if size was really a factor, with smaller firms needing longer periods of time to get their patents granted. However, as Figure 45 shows, the time is almost the same for each of the size categories. Therefore, the average waiting time faced by SMEs to get a granted patent seems independent of size.

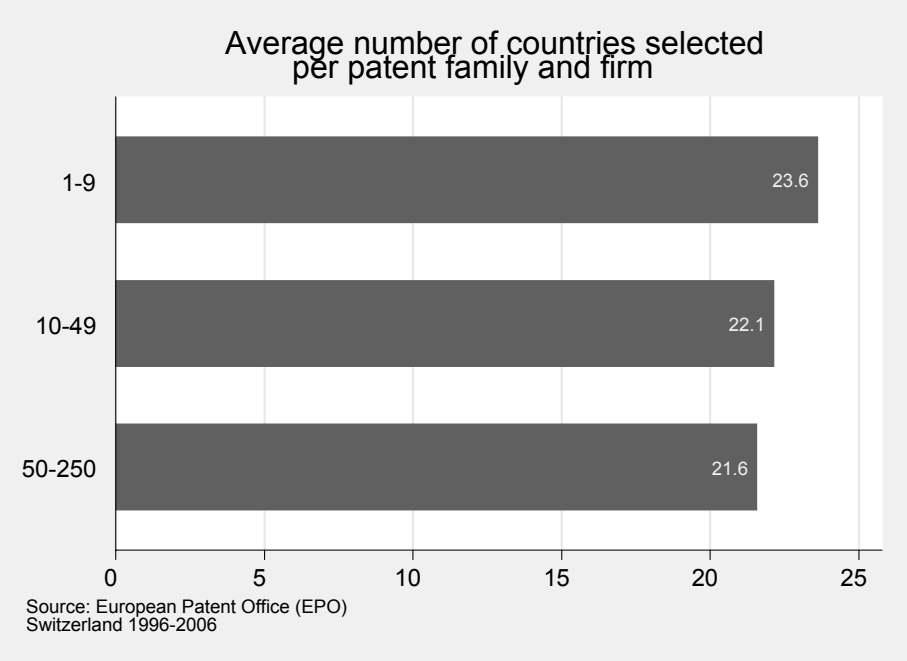
[25] For a definition see the glossary at the end of the report.

Figure 45 Average number of months needed to be granted a patent document filed at EPO



Patent applications at EPO have to designate which state members the protection is sought for. In the next figure we plotted the average number of countries selected by Swiss SMEs according to the three size categories we have been using. As before, we see that the average number of countries is quite close for each of them. Although, micro firms have two more countries on their EPO documents on average, the numbers are very close to each other and we are not able to observe any relevant difference. The only thing we can conclude is that the size is not affecting the first selection of countries.

Figure 46 Average number of countries selected for patent families filed at EPO



5.6 Conclusions

A firm's decision of applying for a patent is not just a question of whether to protect or not an innovation using a legal instrument. It also means deciding where the innovation should be protected and which legal system offers the best protection in relation to the costs associated to the application.

Matching the IPI survey with the information contained in PATSTAT has offered us much more precise and varied information about the patenting behaviour of Swiss SMEs. Thanks to chapter 5, we understand that if an SME is applying for a patent it has to select to protect its innovation in the national market or in an international one. Most of the firms in our sample are doing both, protecting their innovations on both levels. Probably not all the innovations are protected in both systems, but firms decide how to distribute their patent portfolio and where to file the application.

Looking at the patenting behaviour of the last ten years, we conclude that the big majority of Swiss SMEs have some expertise in applying for patents abroad. However, we also understand that there is a group of SMEs that are only using this international protection, without combining it with any kind of application at PI. This second behaviour speaks of globalization of economic activities from some of the SMEs of the sample. Indeed, after studying the evolution of patenting firms depending on the destination they choose for protecting their innovations (Figure 32), we see that there has been a continuous shift towards a protection of the innovation in the international markets. A more detailed look at the exact destination tells us that while the proportion of firms filing patent applications in Europe is constant over the years, US is more and more targeted by Swiss SMEs as a destination for their filings.

One of the main goals of this project is to help Swiss SMEs to protect their innovation by using IPRs. We understand that one of the most important conclusions of the chapter is that we need to be more precise in our questions. It is not the same for a Swiss SME to file a patent application at a foreign patent office as it is to do it at the national level. The reasons and the difficulties that they are facing are very different, and so

should be the policies related to improve or assist their use of IPRs. For example, our results reveal that if the patenting activity is associated to a contract negotiation, then the best strategy is to file an application domestically. While if the main objective is to give publicity to the innovation, then the firm will file a patent application at the international level, which allows to reach a broader number of international markets. Among the problems that are highlighted by firms filing at foreign patent systems is the fact that they are lacking the training needed for using them. The users of the Swiss patent system complain more than the international users about the enforcement of patent rights.

In our next step, when we look at the SMEs' networks in general, we understand that they are very present in the international creation and diffusion of knowledge. The disaggregation of firms by three size classes (medium, small and micro firms) brings us new insights into the innovation dynamics of Swiss SMEs. Of special interest is the active behaviour that micro firms have in three of the four dimensions that we have studied, being very active in international co-application of patents, in the number of international co-inventions and in the number of received citations. This class of micro firms is normally not paid much attention by the literature, and the information hold from them in international databases is very poor. This reason among others brought us to discover the active role that these micro firms are having in the Swiss economy acting as very strong diffusers and creators of new knowledge by holding a strong network of international co-inventors and co-applicants. Of special interest is the high proportion of co-inventors coming from outside Europe, which tell us a much stronger international projection of their innovation activities.

The study of the number of firms receiving backward and forward citations explains that there is a high proportion of firms which are inventing around technological leaders (backward citations), but pushing it forward as it is seen by the number of forward citations they are receiving from other international patenting agents.

The users versus non-users of the Swiss patent system, and the reasons and difficulties that SMEs are facing will be studied in more details in the next chapter.

Summary of this chapter and connections to other chapters

An innovating Swiss SME not only has to decide protecting or not its innovation using an IPR. It also needs to decide which legal system offers the best protection related to costs and specific needs of the SME. It might file a document at IPI, or file at other patent offices, or do a combination of both.

From the analysis we understand that the majority of firms are filing documents at IPI and in other countries. However, when we have a more detailed look at the evolution of the proportion of firms, we see that the proportion of firms only filing documents abroad has been continuously growing over the last years. Also, we see that the proportion of firms with at least one document in the US has been growing over time.

A look at the SME's networks shows a big proportion of co-applications and co-inventions. This fact speaks of a strong international network. A relevant point raised in this chapter is the strong dynamic network of micro firms.

When we study the reasons that SMEs have to file or not to file a patent, combined with the fact that they are filling (or not) documents at IPI, we understand that: firms filing at IPI consider protection from competition as a main reason to apply for a patent. While the main objective of filing a patent is to give publicity to the innovation, the firm will protect its innovation in an international environment, reaching a broader number of international markets. Among the problems that are highlighted by firms applying for international IPRs is the fact that they are lacking the training needed for using them (cf. chapter 6). The users filing documents at IPI complain more than the international users about the enforcement of rights.

The users versus non-users of the Swiss patent system, and the reasons and difficulties that SMEs are facing will be studied in more detail in the next chapter.

6 A comparison of quantitative results and qualitative in-depth analysis

Exposition of this chapter and connections to other chapters

This chapter features two in-depth qualitative explorations of how and why SMEs' use or do not use IPR protection measures, and on which factors this use or non-use may be contingent. By two different samples - one of nationally active SMEs, and one of internationally active SMEs ("born globals") - the reader is informed in detail about these issues. By providing this information, this chapter is directly connected to chapter 3 (the KOF data analysis) and to chapter 4 (the analysis of the IPI survey). This chapter compares and contrasts the preliminary findings from these two chapters with new evidence, in order to "scratch below the surface" of the econometric findings. It analyses the following issues:

- whether, and if so, how SMEs differ in their use or non-use of IPR protection measures;
- how do funding from public promotion programmes, the use of "open innovation", resource considerations, impediments to innovation, the product life cycle influence the SME's propensity to use or not use IPR protection measures;
- what type of information, if any, SMEs request about the IP system.

The findings and results are summarised in the box at the end of this chapter, as well as an explanation of how these results relate to the other chapters in this report.

6.1 Comparison of KOF and IPI data results and guidance for qualitative analysis

In a nutshell, the KOF data analysis in chapter 3 had found *that, in principle* the type of innovation (incremental vs. radical), a firm's international R&D activities, cooperation and open innovation activities, and impediments to innovation all influenced scope and extent of the firm's IP position. Moreover, the intensity use of most formal IP measures was positively associated with firm size and differed according to the industry context.

The analysis of the IP data confirmed the size and sector effects of the KOF data analysis: There is great sectoral variation in firms' propensity to use any IP measure, and there are effects for micro-firms that do not exist for larger firms. However, the IPI data analysis could uncover an important point that was not visible in the KOF data: The role of prior information on the firm's propensity to use the IP system. Both the descriptive analysis and the contingency tables suggest that SMEs that decide not to patent often feel that the available information is insufficient. On the other hand, if a firm is experienced in using a certain IP measure, it feels comfortable and well informed while using it. Specifically, the descriptive analysis finds that only *potential* users lack information about patents, and the contingency table analysis finds that there are two systematically different user groups: experienced users which feel comfortable using the respective measure, and less experienced users who don't use it but cite areas for improvement. Moreover, those firms that rarely or never use patents, trademarks, or designs are also those who cite a significantly higher need for improvement about the respective measure.

This finding seems to lead to a preliminary result: There seem to be two groups of firms that differ in their use of IP and also in their needs for information. First, "naive" firms which know little or nothing about the respective IP protection measures, and which require information and guidance. We suggest that micro-firms may be overrepresented in this type. Second, "experienced" firms who are well informed about the measures (even if they do not use them!) and feel comfortable with their IP protection strategy. This result in our view demands clarification and support by the qualitative analyses performed in the following, as this result may be key for policy implications for the future offering of counselling and information to firms.

Moreover, as the IPI and the KOF datasets treated different issues (in fact, there are few common variables in the two datasets), we will qualitatively re-examine the findings from both samples.

Therefore, the two following modules serve to add more depth to these results and also to compare qualitative and quantitative results by way of triangulation to see if the statistical effects are supported or not confirmed. The rest of this chapter will explore these questions using two qualitative samples: First, the same sample of firms that the related sister project "Case Studies on SMEs and Intellectual Property in Switzerland" (Friesike, Jamali, et al., 2009) uses (to enhance comparability of findings and to create a link between the two projects)[26], and second, research data on internationally active Swiss SMEs ("born globals"), part of which has been published in Gassmann and Keupp (2007).

6.2 In-depth analysis of Swiss SMEs' IP protection strategies

In the following we present the results from two qualitative surveys we did. We felt that additional interesting insights may be generated from taking into account the international sphere which is of special importance to many Swiss SMEs, as their home market is often too small and thus they are forced to internationalise. See appendix C for a detailed description of the methodology we used to identify firms and to collect and analyse the data.

Findings

Descriptive statistics on the seven firms are presented in Table 21. It can be seen that the firms have very different product-market strategies and are also distributed across all groups which the cluster analysis in chapter 4 has identified.

Table 21 Structural data on the seven firms.

Case	*Products and services made*	*Size [# employees]*	*Markets served and type of competition*
A	High-value toys	5	Niche market, quality competition
B*	High-value yarns	24	Mass market, quality competition
C	Machinery (electrical components)	45	Mass and niche markets, price and quality competition

[26] It is important to clarify that only the same firms are used to gather interview data. The content of the data is different; the related project does research into other aspects. Therefore, no intersections or double-collection of data is present.

D	Handles for doors and windows	6	Mass market, price competition
E	Wheelchairs	70	Niche market, price competition
F	Machinery (wire processing)	66	Niche market, quality competition
G	Plastics processing	15	Mass and niche markets, price and quality competition

* Firm B is owned by another SME; this mother SME finances the IP budget of case B.

Table 22 documents the extent to which the firms make use of formal IP protection measures (such as patents, trademarks, industrial designs, and copyrights) and informal measures (such as secrecy, lead time advantage etc.). The goal of the subsequent analyses is to relate the presence or absence of structural characteristics in the firm's internal configuration and innovation strategy to the use or non-use of the IP system. These characteristics are the same that were analysed in chapter 4 using the quantitative samples (KOF and IPI data). Thus, we can explore the preliminary findings from the previous sections more deeply. In the following, we will now comment on how these factors do or do not influence the propensity of the SMEs in our sample to use the IP system.[27]

First, it is visible from Table 22 that the firms represent three groups:

- First, firms that are "naive" in their approach to IP, in that they know little or nothing about formal IP protection measures and consequently do not use them (case C, F)
- Second, firms that are adequately informed about the IP system but chose not to use formal measures due to the product-market or innovation strategy. Still, these firms often use de-facto measures for protection such as to use the quality expectations of customers and their disappointment with the bad quality of imitations to promote their original products (cf. Keupp et al., 2009) (case D)
- Third, firms that know about the different IP measures and choose to use them (cases A, B, E, G)

All three groups differ in terms of scope and extent of the structural characteristics identified by the statistical analysis and further analysed here. These characteristics are: The influence of public subsidies, the firm's cooperation strategy (direct cooperation and open innovation activities), the extent to which the firm experiences resource shortages and impediments in its innovation process, the impact of its innovation strategy and the product life cycle of the goods and services it produces, and its need for information. While the impact of all of these characteristics differs across the groups and single firms, the replication pattern in the data allows to infer patterns of association that go well with the results found in the quantitative analysis. For each of the characteristics, we will detail these patterns now.

The first characteristic which emanated from the quantitative analyses of chapter 4 was the role of public subsidies. The KOF data analysis did not suggest that public subsidies and monetary incentives had any significant effect on SMEs' propensity to use the IP system. Although the cases are an independent source of data, their analysis with

[27] By the umbrella term "IP system", we designate the entirety of patents, trademarks, industrial designs, and copyrights.

respect to this issues yields the same result. Table 23 summarises the evidence. In all firms, the IP strategy was planned and executed irrespective of subsidies or promotions.

On the other hand, the firms hardly know anything about whether or not subsidies and promotions are available. According to the data on cases C and F (the firms that do not use any IP measure at the moment), there may be the chance that such measures could trigger *initial* adaptation of formal IP measures, whereas among firms that already use IP measures, such measures would probably fail. Thus, we assume that those firms that already successfully use IP measures have a "business interest" in subsidies as these lower their expenses. In contrast, those firms that have never used formal IP protection before wish to receive subsidies to begin an initial protection by formal IP measures. This important difference should be kept in mind when policy recommendations are elaborated.

Table 22 Formal and de-facto IP protection and overall success of IP strategy

	A	*B*	*C*	*D*	*E*	*F*	*G*
Formal IP protection measures	Trademarks	Trademarks	None	None	Patents, utility patents, industrial designs	None	Patents
De-facto IP protection measures	None	"Educate the customer"	None	"Educate the customer"	None	Secrecy	None
Plannedness of IP strategy	High	High	Low	Low	High	Low	Low
Major changes to IP strategy during the last five years	None	None	None	None	None	None	None
Firm-wide awareness of IP issues	Low	Low	Low	Low	Low	Low	Low
External constraints for IP strategy choice	None	None	None	None	None	Some	None
Degree of product Imitability	High	Medium	Medium	High	High	Medium	Medium
Managerial assessment of how well the firm achieved the protection of its IP	Good	Good	Unsatisfactory	Good	Good	Unsatisfactory	Good

Table 23 Estimated influence of subsidies and promotion on IP strategy

	Subsidies received	*How did they influence the IP strategy?*	*Would the firm change its IP strategy if it had access to public subsidies?*	*Information needs regarding subsidies for innovation and IP*
A	None	Not at all. Current IP strategy was planned irrespective of potential or received subsidies.	No IP strategy is dictated by the market, not by subsidies	High Firm would like to know more about subsidies / promotion programmes
B	None	Not at all. Current IP strategy was planned irrespective of potential or received subsidies.	No IP strategy determined by competitors who try to imitate, subsidies would not change that setting	High Firm would like to know more about subsidies / promotion programmes
C	None	No influence as there is no IP strategy. However, subsidies may provide the initial motivation to devise one.	Yes Subsidies would give the firm the motivation to professionalise its attitude towards IP	High Firm would like to know more about subsidies / promotion programmes
D	None	Subsidies could influence IP strategy if firm would receive information on how these subsidies work	Potentially If promotion programmes were known, they could influence the IP strategy	High Firm would like to know more about subsidies / promotion programmes
E	Yes, subsidies by joint activities with another SME	Influence only for the joint IP activities, but not on the firm's IP strategy as such	Yes IP strategy was co-determined by the joint reception of subsidies with the cooperation partner	High Firm would like to know more about subsidies / promotion programmes
F	None	No influence on the current strategy	Potentially Firm thinks it would register more IP if it received subsidies (high IP protection costs)	High Firm would like to know more about subsidies / promotion programmes
G	None	No influence on the current strategy	Yes IP strategy would change if firm had access to subsidies	High Firm would like to know more about subsidies / promotion programmes

The next important thing is the cooperation strategy and potential open innovation activities. The quantitative results - in the case of patents and industrial designs - to a certain extent had suggested that there is a positive effect of externalisation of R&D mandates and of external knowledge sourcing from customers on the firms' propensity to use formal IP protection. The independent analysis of the cases suggests an alternative view. The evidence, as summarised by Table 24, suggests that the firm's IP strategy exists irrespective of the firm's collaboration and open innovation (OI) activities. Rather, the firm's approach to IP seems to be a direct function of the market and industry situation the firm has to operate in.

We thus recommend that a firm's IP strategy and its innovation strategy be seen in the light of its product-market strategy and the industry conditions it operates in. Specifically, cooperation activities do not need to go hand in hand with formal IP protection. In fact, as case D demonstrates, a firm can be well informed about the principles of the IP system, collaborate widely with external partners - and still it can decide that, due to the nature of the markets it operates in, formal IP measures would not make sense. In this respect, many firms' decisions against formal IP measures may not be due to a lack of knowledge, but rather due to the overwhelming force of market and industry conditions. We will take up this thought again when discussing the results of Table 27.

The qualitative analysis delivers an interesting result with respect to the role of resource shortages and impediments. It is a standard and almost cliché argument that SMEs lack the resources for formal IP protection and thus special policy measures need to be employed (Kingston, 2000) - although academic researchers have repeatedly stressed that this may be more of a belief than a fact (Katila and Shane, 2005; Gassmann and Keupp, 2007).

Regarding impediments, the KOF data analysis had suggested that to a certain extent, impediments to innovation can influence the firm's decision to use formal IP protection measures. The independent analysis of the cases paints a different picture. The evidence, summarised by Table 25, suggests that neither resource shortages nor impediments to innovation were influencing the firm's definition of which IP measures to use (and to which extent). In fact, all firms, even those that do not use formal IP measures at the moment, signalled during the interview that resources are *always* devoted to IP protection (by whatever means). In contrast, those firms that have never used formal IP measures before (cases C, F) tend to be those that devote little resources to IP considerations, nevertheless, they would change priorities if they were initially informed about how IP protection "works".

Further, case E which uses patents and industrial designs for IP protection suggested that patent applications are less expensive than most small firms think. All in all, thus, resource shortages, impediments to innovation, or the often-quoted "liability of smallness" do not seem to hinder firms to devise their IP strategy independently and to protect their IP by whatever measure they deem best fit.

Table 24 Influence of open innovation (OI) and cooperation activities on IP strategy choice

	Degree to which open innovation is conducted with external knowledge sources	*Influence of OI activities on IP strategy*	*Degree to which firm cooperates in R&D activities*	*Influence of cooperation activities on IP strategy*
A	Not at all No integration of external parties into the innovation process	None IP strategy exists irrespective of OI activities	High Customers, suppliers and a university are integrated in the product development process	None IP strategy is determined by quality competition, not by innovation process
B	Not at all No integration of external parties into the innovation process	None IP strategy exists irrespective of OI activities	Medium Cooperation with customers	None Cooperation has no influence on firm's propensity to register trademarks
C	Low Firm has begun to experiment with integrating others into the innovation process	None Firm has no IP strategy	High Cooperation with customers, competitors, and universities	None Firm has no IP strategy
D	High OI activities with other firms in the industry and with customers, but no systematic process	None IP strategy exists irrespective of OI activities	High Cooperation with customers and other firms in the industry	None IP strategy was determined by the market conditions, not by cooperation partners
E	High OI activities with universities and customers (user tests)	None IP strategy exists irrespective of OI activities	Medium Cooperation with universities	None Firm always applies for formal IP protection irrespective of scope and extent of cooperation
F	Low Firm has only just begun with OI activities	Low No influence on IP strategy	High Cooperation with engineering office, customers	None Secrecy agreements were signed with collaboration partners, but these did not influence the firm's IP strategy
G	Low Firm has only just begun with OI activities	Low No influence on IP strategy	High Cooperation with engineering office, customers, universities, suppliers	None IP strategy was determined by the market conditions, not by cooperation partners

Table 25 Influence of impediments and resource shortages on IP strategy choice

	Perceived resource shortages for formal IP protection	*Perceived impediments* for formal IP protection in Switzerland*	*Perceived impediments for international formal IP protection*
A	None Few resources needed for trademark applications	None	High Firm is unsure about international trademark applications and proposes political action to introduce global trademark standards
B	None Few resources needed for trademark applications	None	High Firm desires better information about international trademark protection possibilities
C	None Firm has no experience with application costs	To some extent Firm is too busy to conduct day-to-day operations to think about IP. However, resources in R&D would be available to think about IP.	None Firm has never tried to protect its IP on an international basis
D	None Formal IP protection is not perceived as expensive, firm will apply for formal protection if necessary	None	High Firm likes to know about possibilities for international protection in its diverse global markets
E	None IP strategy is to always use patents for protection, costs are irrelevant	None	Low Firm has a patent attorney who takes care of everything, no desire for information
F	Some IP has a lower priority than HR and financing	To some extent Firm would apply for more IP if more information would be available	High Firm is exporting but knows nothing about how to protect IP on an international basis
G	None IP protection governed by innovation project, not by resources	None	High Firm desires better information about international protection possibilities

* Such as lack of funds, lack of know-how, etc.

Two more important findings emerged from the data. First, Table 26 summarises the evidence on three topics: The firm's IP strategy, product-market strategy, and the influence of the product life cycle. The specific result from the KOF data analysis that the product life cycle has a positive association with the firm's propensity to apply for trademarks is supported. Moreover, in general the surveyed firms report an association between their innovation and IP protection strategies. Whereas the product life cycle has a directly determining role for the protection strategies of cases A and B who rely on trademarks - they produce high-quality, long-lasting goods in contrast to competitors and imitators who cannot attain this quality level - and thus need a quality differentiation and brand name protection of the whole lifespan of the product.

This consideration directly determined their choice to use trademarks. Similarly, case E's products have a long lifespan, too, which motivated the firm to ensure the IP embodied in the products is protected along the complete lifespan. Only if the market effects are much stronger than the product effects as it is the case with case D, the firm can afford to focus in market penetration alone. Still, case D is something of a special case, as the products it makes (door and window handles) are typically not branded products, or the customer is not specifically aware of the brand name and quality.

Finally, Table 27 documents the role that prior information on the IP system plays, as well as firms' needs and desires for information that should be provided by IPI. Here, a number of interesting findings could be made which directly give rise to policy implications as detailed in the final chapter. It is interesting to note that among all firms, the topic of IP protection is restricted to the top level of the firm - whereas the all firms' current IP strategy is a direct result of the CEOs' and founders' decisions, the firms' employees have little or no knowledge about IP. Regarding this point, all firms stress the desire for seminars or other forms of education that would increase the IP awareness of their employees.

The second issue that is apparent is the difference regarding the firm's information level. Those firms that already use the IP system feel well-informed and do not desire information regarding their IP strategy as such (although they desire an increased employee awareness regarding IP). In contrast, those firms that at the moment do not use any formal IP protection measures would be willing to use them if they were better informed about the single measures. This finding that IP use is associated with prior information about the IP system confirms the findings of the IPI data analysis.

A result that is also striking is the high degree of externalisation and out-contracting of IP issues. Cases B and E leave the management and enforcement of their IP completely to external consultants and patent attorneys. This seems to suggest that a market for small-firm IP consulting exists, and IPI should ask itself the question whether or not it wishes to engage in this market, e.g. by revising the seminars IPI currently offers or by using extant consulting services and patent attorneys to better reach SMEs. We will also develop policy recommendations on the basis of these results.

Table 26 Influence of innovation strategy and product life cycle on IP protection strategy

	Innovation strategy	*Impact on IP strategy*	*Nature of product life cycle*	*Impact on IP strategy*
A	Quality focus Develop high-quality goods and a strong brand	High The need to have a brand as a quality signal determines the IP strategy	Depends on the product	High Once a trademark is registered, the protection period is always prolonged until lifespan is over
B	Quality and price focus Develop high-quality goods and a strong brand at a competitive price	High The need to have a brand as a quality signal determines the IP strategy	Industry does no longer make R&D progress. Innovations are incremental so products have a long lifespan	High Trademarks serve to distinguish product from cheap imitations, this protection is needed for the whole life cycle
C	Quality focus Develop machinery for niche markets and special application	None There is no IP strategy	Depends on the product	None There is no IP strategy
D	Lots of incremental innovation for price competition. Radical innovations planned for the future	High No-name products are not distinguishable from branded products, imitation cannot be prevented. Customer experience and satisfaction determines the purchase.	Long life cycle	None IP strategy is partly determined by bad quality of imitator products, but not by product life cycle
E	Quality focus and R&D leadership. Firm strives to innovate as much as possible.	High Large number of innovations demands immediate protection by patents or industrial designs	Long life cycle	High IP strategy is determined by the need to protect innovations which have a long use time
F	Quality focus Develop tailor-made solutions for single customers	None	Long life cycle	None There is no IP strategy
G	Quality and price focus Both design application and mass market usability are sought for	None	Depends on the product	None

Table 27 Demand for information and education on IP measures

	Current level of IP information among CEO / firm founder	*Current level of IP information among employees*	*Influence of informational position on IP strategy*	*Demand for education and information*
A	High CEO devised the IP strategy	Low Employees know little about the meaning of trademarks	High CEO would use international trademarks if informed about trademark system in the US	High Wants to have IP information brochures targeted specifically at SMEs
B	High CEO devised the IP strategy, but outsourced implementation to a consulting firm	Low Employees know little about the meaning of trademarks	Low Firm does not want to be bothered with IP issues and leaves everything to the consultant	High Information and seminars for employees would be helpful
C	Low CEO is too much absorbed by daily business to think about IP	Low There is no IP awareness throughout the company	High Firm would start to think about an IP strategy if it received basic information	High Seminars for employees and brochures would be helpful for "IP beginner firms" who know little or nothing
D	High Although firm doesn't use formal protection, CEO knows what could be done	Low As the firm does not use formal measures at the moment, employees know little	High Firm would start to use formal IP measures if better informed about how to use them	High IPI homepage should better list available free information
E	Medium Founders / CEO know the "IP basics", but leave everything to their IP attorney	Low Employees are not at all concerned with IP, patent attorney does all	Low Firms feels already well informed by patent attorney	High Firm desires seminars for employees to increase awareness about IP issues
F	Low Top management are concerned with financing; IP is low priority	Low There is no IP awareness throughout the company	High Firm would start to think about an IP strategy if it received basic information	High Firm asks for workshops to create initial IP understanding
G	Medium Founders / CEO know the "IP basics", but lack in-depth information	Low Firm has IP, but as a whole does not feel well informed.	High Firm would register additional IP if better informed about the measures	High Firm asks for workshops to create initial IP understanding

6.3 The influence of the international dimension: Formal and de-facto protection strategies of internationally active SMEs ("born globals")

Switzerland is much more than other nations characterised by a large proportion of internationally active SMEs, the so-called "born globals". These firms start international operations basically from their inception and conduct business on an international basis despite their small size, a process that has significant implications for the way these firms handle IP-related questions (Gassmann and Keupp, 2007). This international involvement has important implications for the how any why of an SME's IP protection strategy.

Descriptive statistics on the six firms are presented in Table 28. Two of these firms (cases M and N) have been featured in Gassmann and Keupp (2007) before; the other four firms (cases H, J, K, and L) have been newly analysed. Thus, while the original findings from Gassmann and Keupp (2007) are used for the analytical purposes of this chapter, they are analysed in conjunction with the new cases to ensure a reliable analysis. All firms are based in Switzerland. Again, the firms have considerably different product-market strategies, yet they all have a considerable international engagement despite their small size. Table 29 shows that all of these firms have a very professional attitude towards their IP management, and that all firms judge that they protect their IP successfully. The absence of variation is striking - *all* firms have achieved a good IP protection. The prevalence of formal over de-facto strategies is also visible - across all cases, patents are the most dominantly used IP measure; de-facto measures such as secrecy and technological complexity are only used in conjunction with, but not as a substitute to formal IP protection.

Comparing Table 29 to Table 22 further above, the absence of different firm types is striking. Once a firm begins international operations, it seems, there is also a professionalisation tendency in its IP strategy, and also a stronger use of patents (which matches the findings from the KOF data analysis). We will investigate this thought further over the following pages. It is particularly interesting that all firms have already experienced IP violations in the foreign environment.

Again, the common argument that IP protection is difficult for small firms due to resources shortages and information asymmetry is refuted for our sample (cf. the results in chapter 5.2. where this was also the case). All firms use external IP knowledge and network providers, predominantly patent attorneys, to be informed about foreign countries' IP legislation and protective mechanisms. Table 30 summarises this evidence. In all cases, the firms' IP strategy was defined irrespective of resource considerations. This finding confirms the overall findings that the firm's business model structure, but not resource considerations, shape its IP strategy. Thus, the economic benefit of consulting services or even subsidies is questionable, as firms obviously make their IP decision irrespective of resource consideration (with the exemption of a cost-benefit-calculation of single patents in some firms).

Table 31 summarises the evidence on how the firm's IP strategy was conceived and how it is implemented. Throughout the evidence, a high degree of professionalism and plannedness can be observed - as it can be expected when the firm has to safeguard and defend its IP in foreign environments which have different legislative systems and may have a much more aggressive competitive structure than the Swiss home market. Comparing these results with those from chapter 5.2, we believe that this findings shows an "experience path": The more concerned SME have to be about their IP, the greater is the probability that they professionalise their behaviour - either by installing in-house IP departments (i.e., by organisational learning of how to use and protect IP) or by hiring external parties such as patent lawyers and their international correspon-

dence networks (i.e., by cooperation). Both ways lead to an increase awareness about and professional handling of IP. Finally, Table 32 shows that the firms also understand well to defend their IP by using legal action in the foreign legislative environments.

We therefore believe that such firms are very unlikely to turn to external or government bodies for help and information. Comparing these overall results with those of chapter 5.2, the need for IP information and support seems to be greatest at the starting phase of the firm and among those "naive" firms that have not yet considered IP-related questions. All in all, the qualitative analysis confirmed most of the quantitative findings. Specifically, the tentative results from chapter 4 were supported and should be regarded as final results which give rise to policy implications we will set out in chapter 7.

Table 28 Descriptive statistics on the born globals studied

Case	*Staff* [28]	*Firm started in*	*Products and services made*	*International activities in...*	*Business model / nature of competition*
H	570	1961	Automated door systems	Germany, Austria, France, Spain, China (planned)	Technology leader in a small but highly competitive market
J	180	1995	High-tech fabrics for industrial mills	Worldwide (firm has about 50% of global market)	Oligopolist in a specialised industry sector with a very small home market
K	140	1949	Machinery	Germany, USA, diverse Asian markets	Tailor-made solutions for customers in a specialised machinery sector
L	350	1952	Standardised metal goods for diverse industries	EU markets (97% of turnover are international sales)	Mass market producer
M	140	1995	Biotechnology (vaccine development)	Germany, Netherlands	Co-development of targets with large pharmaceutical companies
N	9	2005	Life science industry (enzyme production)	Germany, Czech Republic	Out-licensing contracts with large pharmaceutical companies

[28] Note that the employee count of firms H and L is above the commonly used threshold of 250 employees to sample SMEs. At the time of data collection, however, these firms were SMEs; strong firm growth is responsible for the increase in employment.

Table 29 Formal and de-facto IP protection and overall success of IP strategy

	H	*J*	*K*	*L*	*M*	*N*
Formal IP protection measures	Patents, trademarks	Patents, utility patents, trademarks	Patents, utility patents	Patents, trademarks	Patents	Jointly owned patents
De-facto IP protection measures*	Secrecy	Secrecy	Secrecy	Secrecy, technological complexity	Secrecy	Technological complexity
IP owned in foreign legislations	Patents	Patents, trademarks	Patents	Patents, trademarks	Patents	Jointly owned patents
Plannedness of IP strategy	High	High	High	High	High	High
Firm-wide awareness of IP issues	High	High	High	High	High	High
Resource constraints for IP strategy choice	None	None	None	None	None	None
Experience with IP infringement	Yes	Yes	Yes	Yes	No	No
Managerial assessment of how well the firm achieved the protection of its IP	Good	Good	Good	Good	Good	Excellent

*See Keupp et al. (2009) for an extensive discussion of de-facto IP protection.

Table 30 Influence of resource position and information asymmetry on the use of formal IP measures

	Staff employed for formal IP protection	*Do resources determine the choice of IP protection measures?*	*Information cost from information asymmetry about foreign IP rights*	*Resource impediments for international formal IP protection*
H	External patent attorney	No "Patents are not that expensive". Firm only applies for patents if technological advantage is fit for commercialisation.	High Firm knows little to nothing other countries' IP systems and does not study them. Patent attorneys do everything.	Medium Transaction cost can be a problem. To cut costs, firm cooperates with patent attorney's network in China.
J	External patent attorney, external trademark office	No "In relation to our turnover these costs are negligible".	Low External staff know foreign IP systems well and provide all information.	Low External staff manage global IP operations at a reasonable price.
K	Internal IP department (2 people), several external patent attorneys	To some extent "We don't apply blindly in all countries". Patents only where competitors or customers are present.	Low Patent attorneys and firm's IP people communicate directly with local IP office to get information.	Low Firm devotes all resources needed to protect international IP position.
L	External patent attorney, two in-house employees who are part-time concerned with IP	No "We have to protect everything although we don't know which products will be successful. But it is not expensive in relation to our R&D budget".	High Firm knows little to nothing other countries' IP systems and does not study them. Patent attorneys do everything.	Low "Our top management has understood how important international IP protection is. I don't have a resource problem".
M	In-house patent department (including three internal patent lawyers)	No "Patent protection is essential for the products. Protection is not a resource question".	Low IP department studies literature and communicates directly with national IP offices.	Low "That may apply to micro firms, but not to us. Protection determines commercialisation".
N	None	No Firm uses patent-sharing agreements with large firms and thus has no own IP cost.	High Firm knows nothing about IP in foreign markets or countries, but also feels it doesn't have to know.	Low Firm's partners take care of all international IP protection.

Table 31 Strategic planning and information-seeking behaviour for IP protection in foreign markets

	Strategy planning process for international IP protection	*Information-seeking and IP screening behaviour*	*Way of building IP position in foreign legislative environments*
H	Deliberate If firm has a patentable idea, it screens international competitors' IP before local market entry.	Professional IP development of largest competitors is continuously monitored. Regular patent screenings. Never had disputes with local firms.	Sequential After IP screening, patent is registered and product development started. Firm wants a secure IP position before penetrating the market.
J	Deliberate Patents and trademarks are created in every market where the firm wants to sell. Details are left to the patent attorney.	Professional Screening is done before registration of own patent is considered.	Parallel "The market demand comes first, then comes the patent". Attorney is to secure IP position along the stages of market introduction.
K	Deliberate Firm has an explicit patent strategy that is regularly reviewed in strategy meetings.	Professional Firm surveys IP development of competitors, important patents of competitors are "known".	Sequential Firm uses PCT registration first and then does national registration step-by-step in those markets it enters.
L	Deliberate Firm has decided to protect technological principles but not processes.	Professional Patent attorney works with international correspondence attorneys to research local IP situation.	Sequential Firm uses PCT registration first and then does national registration step-by-step in those markets it enters.
M	Deliberate IP protection is dependent on the market and national legislative environment.	Professional IP department is aware of the major protection options in each country the firm operates in.	Sequential Patent application always precedes first sale.
N	Deliberate Firm's business model relies on patent-sharing agreements with large firm for international commercialisation.	None All IP issues are left to the cooperating pharmaceutical companies.	Sequential As soon as enzymes are ready for the market, they are patented worldwide. Only after this step market introduction follows.

Table 32 IP defence and conflict resolution in foreign IP environments

	IP infringements suffered	*Counter-actions taken and success of these measures*	*Conflict resolution with local firms in the foreign environment*
H	To some extent Firm has experienced some cases of IP infringement (imitations).	Lawsuit. Defence of IP was successful.	Aggressive Firm is willing to sue IP violators at any time, no inclination for licensing agreements.
J	To some extent Few cases of trademark infringements by imitators in Asian markets.	Lawsuit Defence of IP was successful, but litigation consumed considerable transaction cost.	Aggressive Firm wishes to stop imitators regardless of transaction cost as trademark is of great importance to the business.
K	To a great extent Imitators in Asia build and sell spare parts.	None Lawsuit would cost a lot more than damage from IP violations.	None Firm uses de-facto measures to ensure customer loyalty.
L	To a minor extent Some cases of IP violations were incurred, but damage was negligible.	Lawsuit (past) / Licensing (today) First firm tried to sue imitators but learned that licensing agreements are more productive.	Cooperative Firm uses licensing agreements to settle IP conflicts (also if firm itself is sued by local firms).
M	None "Technology is too unique to be readily copied or imitated".	None Firm has no experience with IP defence in foreign environments.	None Firm has not yet had conflicts with local firms.
N	None Large pharmaceutical firms take care of IP violations, firm has no information on details.	None If IP is violated, firm leaves it to its cooperation partners to enforce the jointly owned patent.	Aggressive According to the CEO-founder, the large cooperation partners defend the jointly owned patents aggressively.

Summary of this chapter and connections to other chapters

This chapter has used two qualitative samples to explore in more detail the tentative findings that chapters 3 (the KOF data analysis) and 4 (the analysis of the IPI survey) have found. Summarising these results, we can draw some major conclusions:

- Firms differ significantly with respect to what they know about the different IPR protection measures (patents, trademarks, industrial designs, copyrights) and regarding their propensity to use either of these measures.

- If an SME already uses any of these measures (or a combination of these), this use is primarily determined by its competitive situation and product-market strategy and not by resource considerations. A possible exception to this finding is the case of "naive" firms that do not use any IPR protection measure at all, and the case of micro-firms who may cite problems with patent fees (cf. chapter 5).

- Firms that already use any measure are unlikely to respond to general information. However, there is demand for information from the side of "naive" firms who would respond positively if they were offered initial information about the IP system. Moreover, even firms with an established IP strategy would demand seminars to increase IP awareness among employees.

The further connections of this chapter to the rest of the report are as follows. First, the findings from this chapter are used to compare and contrast the related findings from chapters 3 and 4. Thus, together, chapters 3, 4 and 6 provide a robust array of data that will be used to derive the policy implications in the subsequent chapter 7.

7 Policy implications

Exposition of this chapter and connections to other chapters

This chapter puts together all findings from chapters 3 through 6 in order to develop policy implications. The findings from these chapters are grouped into four policy implications that contain both the essence of the analyses of this report and give rise to recommendations as to which policy implications could be developed on the basis of these findings. In each policy implication, the text refers to those chapters and findings which provide the analytical basis for the respective implications. The reader is referred to the respective chapter for more analytical detail. While these recommendations have been elaborated with considerable care, they represent recommendations on the basis of our analyses, rather than normative prescriptions. The four major policy implications we develop here can be summarised as follows:

- One size does not fit all: Rather than the type of "SME" as such, there are various and highly heterogeneous groups of SMEs that need to be informed and treated differently;
- Public promotion and SME's usage intensity of the IP system: Whereas funding from public promotion does not seem to influence the existing IP strategy of those SMEs we analysed, more research on this subject is desirable to make stronger claims;
- Strengthening the international IP activities of SMEs: Small firms active in international co-patenting could benefit from information and training (this especially applies to micro-firms);
- General IP information is only of interest to the completely uninformed: SMEs that already use one or more IPR protection measures do so consciously, whereas those firms that do not use any measure could be turned into users if they received initial information about how to protect their IP.

7.1 One size does not fit all: Accounting for SME heterogeneity

A dominant finding that runs through all analyses in this report is the considerable heterogeneity among SMEs. The findings from chapter 4 suggest that there are great differences regarding the extent to which SMEs are informed about the respective IPR protection measures. The analysis from both chapter 3 and chapter 5 suggest that industry sector and firm size play an important role for how, if at all, the SME uses the different IPR protection measures available. Finally, chapter 6 has shown that the firm's approach to IP protection differs greatly depending on the extent of international operations, on the competitive situation, and on the product-market strategy. These effects lead to the first policy implication.

First, the findings from chapter 3 and chapter 5 show that the extent to which a firm uses IPRs is closely associated with its industry sector, specifically with respect to the varying technological intensity throughout different industry sectors. SMEs in the "machinery, equipment and transport" sector are primary users of patents (Figure 12), while trademarks are mainly used by firms active in the "food, beverages and tobacco" sector (Figure 13). These sectoral differences also have an impact on the specificities of firms' innovatory behaviour, which may explain why the use of IP measures differs

across sectors, and why in some sectors certain types of IPRs are not deemed effective for the protection of innovations (and thus are used little).

Second, the findings from these chapters also suggest that firm size is an important differentiator. Total patent fees are more a problem for micro-firms (i.e., SMEs with up to 10 employees) than for larger SMEs (Figure 25). Whereas micro-firms still considered patenting costs as too high after filing a patent, other SMEs did not regard patenting fees as an overwhelming problem once they had become users of the IP system (chapter 6).

Third, some SMEs combine several IPR measures whereas others focus on only one type of measure to protect their IP (section 4.6). The reasons for using patents and industrial designs are basically to protect from competition and from piracy (Figure 16), whereas trademarks are mainly chosen to seek protection from competition and to achieve publicity for the innovation (Figure 17).

Fourth, some non-users of the IP system complain about the existing system. They say it does not provide sufficient protection for their innovatory activities (e.g., software producers). However, this population can be particularly dynamic and useful for growth in Switzerland by being active in service sectors or products less likely to be protected. Thus,

Policy implication 1

- IPR policy-making will have to be adapted to the heterogeneity of Swiss SMEs. Given the considerable size and industry sector differences, it is likely that policies that focus on overcoming barriers to use an IPR-based strategy in specific industries and certain types of firms will be more effective than those which promote more generalised encouragement to use IP.
- To achieve this tailored response, cooperation with professional associations or economic institutions in charge of economic development at the local level may be necessary to customize information and training to the different types of SMEs.
- The IPI should also inquire what could be done to offer IP services or adapt the IP system to specific groups of firms. Such measures have been implemented in the past for biotech firms. We believe that similar policy instruments could be extended to other specific categories of Swiss SMEs.

7.2 Public promotion and SME's usage intensity of the IP system

In this report, we used two sources of data to analyse whether the funding from public promotion programmes is likely to influence the SME's approach to using the different measures for IP protection (patents, trademarks, industrial designs). These sources are the KOF data (cf. chapter 3) and the qualitative analysis (cf. chapter 6). Moreover, we have been informed by the related sister project "Case Studies on SMEs and Intellectual Property in Switzerland" (Friesike, Jamali, et al., 2009). The KOF data results indicate there is no effect of funding from public promotion on a firm's propensity to register patents, trademarks, industrial designs, or copyrights. The qualitative results (cf. chapter 6) indicate that public promotion had no effect on the extent to which the firms used any measure for IP protection. These results are corroborated by the findings from the qualitative sister project (cf. their upcoming report, published by IPI) who also did not find a significant influence of public promotion programmes on a firm's choice of how to

protect its IP. Together, these three independent sources of data suggest no influence of public promotion for an SME's existing IP strategy.

However, when confronted with a hypothetical situation in the qualitative analysis, some firms indicated they might use some measures to a greater extent if they directly received funding. It is debatable whether this represents a significant effect, or whether firms just wish to benefit from the additional funding (”arbitrage effect”) without really changing their behaviour. Another theoretical criticism is that public promotion may not directly influence the choice and extent of IP measures, but may stimulate the firm's R&D efforts which, in future time periods, may lead to increased output of intellectual property and thus to an increased desire for protection. However, one would have to analyse panel (longitudinal) data to be really sure about these arguments. We therefore formulate our policy implication in a rather modest way, and suggest that the evidence in this report should be corroborated by additional research.

While we believe that our results demonstrate effects where experienced SMEs have made their decisions about the IP system, it is too early to make general remarks about whether or not general public promotion programmes will significantly alter this use. Thus,

Policy implication 2

- While the specific type of public promotion programmes we analysed had no effect on SMEs' use of either protection measure, and while the qualitative analysis suggested that SMEs do not make their IP decisions on the basis of monetary incentives, public promotions may still induce effects on firms' IP strategy we could not measure. This especially applies to effects from public promotion on a firm's R&D spending which may only be visible after a considerable time lag.

- Although SMEs often suffer from resource shortages, our findings suggest that IP decisions are not primarily made on the grounds of resource endowments, but on the grounds of each measure's efficacy to protect the respective innovation.

7.3 Strengthening the international IP activities of SMEs

From the patent analysis in chapter 5, a number of important insights emerge. First we see that there is an increasing proportion of firms that deposit their patent application abroad (Figure 33). While Swiss SMEs use the national (Swiss) IP system much more when a patent is being filed for contract negotiations, they also have a strong international projection in their use of patents, a high level of co-applications with other international firms, and a high number of international co-inventors (section 5.4). This strong international collaboration is also reflected in the number of backward citations and forward citations received. However, many Swiss SMEs complain that they do not have enough information about how the international IP system works, and that they do not have the necessary information to cope with the international IP environment.

The most surprising size class when analyzing patent networks is that of micro-firms (i.e., SMEs with less than 10 employees). They are very active in collaborations and in their use of international inventors. Thus, they represent a size class with a huge potential to drive technical change in Switzerland. Moreover, the evidence on the "born global" firms likewise demonstrates that there are many small and internationally active firms who have, often on an ad-hoc basis, developed IP protection strategies on their own. This leads us to assume that the issue of IP is all the more important when SMEs

operate in an international sphere and thus IPI should devote specific attention to those SMEs. Thus,

Policy implication 3

- Training should be offered to SMEs that patent abroad extensively in order to increase their ability to use the international IPR system. As this offer discriminates on the locus of patent filing, it should be specifically targeted towards internationally active SMEs and not be combined with services for SMEs that file patents in Switzerland only.
- Swiss SMEs should receive support when they use IPRs as a negotiation tool or collaborate with other firms. It would be particularly useful for them to receive training about how to negotiate on IP rights with other agents (firms, banks, governments) - e.g., regarding IP in R&D cooperative agreements, or IP licensing from and to third parties.
- The very active role of micro-firms' activities in patent networks should be supported by facilitating information, and maybe by considering a reduction of patent fees.

7.4 General IP information is only of interest to the completely uninformed

The level of information about IPRs among Swiss SMEs varies greatly. The findings from chapter 4 suggest that those firms that use patents are also well informed about patents. This relationship is very strong. The same effect - the positive association between information about an IPR protection measure and its use - holds for trademarks and industrial designs, although the strength of the relationship is weaker here (section 4.4.2).

The qualitative analysis from chapter 6 suggests there is a strong "experience effect" that directly determines firms' propensity to seek information and guidance. Firms that are already active in the market and already protect their IP successfully are well-informed about IP already. This is especially demonstrated by the "born global" sample, where every SME has either an in-house IP department or cooperates with external patent lawyers.

Such "experienced" firms - irrespective of whether or not they are active on a national or international basis - are very unlikely to demand information and guidance on IP. However, the qualitative analysis in chapter 6 has also demonstrated that IP is an issue restricted to the CEO or founder level of the firm, or is even completely outsourced.

Thus, even "experienced" firms may require educational seminars for their employees to increase their awareness about IP issues. In contrast, the "naive" firms that are as yet relatively inexperienced with respect to IP are likely those that will request extensive IP-related information and training. Thus, the question is not one of firm size but one of experience. The target audience for IP information are likely those firms that are either in their starting phase and have little prior knowledge about IP, or already established firms that as yet did not care about IP issues too much.

We believe that those firms would welcome tailored information and guidance, as this would provide an initial start for them to consider the IP issue at all. This especially

applies for information about how to protect IP in foreign countries and markets. As the results show that information about the IP measures is a predictor of their usage, we suggest that if the "naive" firms can be turned into well-informed firms, they will be more likely to use the IP system. Thus,

Policy implication 4

- IPI's dissemination of information should be contingent on an SME's experience: General information is only of interest to firms completely unaware about IP issues, whereas more experienced firms are more likely to want to foster IP awareness amongst their employees.
- Regarding the different measures, information about patenting should be exclusively directed towards the non-user group, whereas information about trademarks and industrial designs may be of use to both users and non-users.

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Appendices

A.1. The IPI Questionnaire

Survey on Small and Medium Enterprises (SMEs) in Switzerland

1. Has your company developed new ideas/processes/products/services in the last two years? Did you gain a market advantage from this?

	Yes	No		Yes	No
New ideas	☐	☐	*Did you gain a*	☐	☐
New processes	☐	☐	*market advan-*	☐	☐
New products	☐	☐	*tage from this?*	☐	☐
New services	☐	☐		☐	☐

2. Do you protect these ideas/processes/products/services through (?):

	Never	Rarely	Often	Always
Patent protection	☐	☐	☐	☐
Trademark protection	☐	☐	☐	☐
Design protection	☐	☐	☐	☐
Other protection (please specify):	☐	☐	☐	☐

_____

3. If you "never" or "rarely" protect your innovations (question 2), please say why:

	Patents	Trademarks	Designs
Official fees are too high	☐	☐	☐
Lawyers' fees are too high	☐	☐	☐
The protection is not sufficient	☐	☐	☐
Too complicated	☐	☐	☐
Right is unenforceable	☐	☐	☐
Not enough knowledge	☐	☐	☐
I don't think my innovation can be protected by this.	☐	☐	☐
Other reasons (please specify):	☐	☐	☐

_____

4. If you "often" or "always" protect your innovations (question 2), what are the reasons for requesting the protection?

	Patents	Trademarks	Designs
Protection from competitors	☐	☐	☐
Protection from product pirates	☐	☐	☐
Advertising impact	☐	☐	☐
Importance for financing	☐	☐	☐
Importance when negotiating contracts	☐	☐	☐
Other reasons (please specify):	☐	☐	☐

_____

5. What do you think should be improved regarding the legal possibilities for protection?
(1 = is good, 2 = could be improved, 3 = don't know)

	Patents			**Trademarks**			**Designs**		
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Access to information	☐	☐	☐	☐	☐	☐	☐	☐	☐
Training course possibilities	☐	☐	☐	☐	☐	☐	☐	☐	☐

Special legal advice	☐	☐	☐	☐	☐	☐	☐	☐	☐
Official fees amount	☐	☐	☐	☐	☐	☐	☐	☐	☐
Enforceability	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other (please specify): _____	☐	☐	☐	☐	☐	☐	☐	☐	☐

6. How do you rate the knowledge of your company concerning the following protection rights?

We are:	Well-informed	Informed	Not so well-informed	Not informed
Patents	☐	☐	☐	☐
Trademarks	☐	☐	☐	☐
Designs	☐	☐	☐	☐

7. Comments:

_____

Statistical data:

Company _____

No. of employees _____

Contact person: _____

E-mail: _____

Befragung Kleiner- und Mittlerer Unternehmen (KMU) in der Schweiz

1. Hat Ihre Firma in den letzten zwei Jahren neue Ideen/Verfahren/Produkte/Dienstleistungen entwickelt? Hat sich hieraus ein Marktvorteil ergeben?

	ja	Nein		ja	nein
neue Ideen	☐	☐	*Hat sich hieraus*	☐	☐
neue Verfahren	☐	☐	*ein Marktvorteil*	☐	☐
neue Produkte	☐	☐	*ergeben?*	☐	☐
neue Dienstleistungen	☐	☐		☐	☐

2. Schützen Sie diese Ideen/Verfahren/Produkte/Dienstleistungen durch (?):

	nie	selten	Oft	immer
Patentschutz	☐	☐	☐	☐
Markenschutz	☐	☐	☐	☐
Designschutz	☐	☐	☐	☐
Anderen Schutz (bitte nennen): _____	☐	☐	☐	☐

3. Falls Sie "nie" oder "selten" schützen (Frage 2), begründen Sie bitte Ihre Antwort:

	Patente	Marken	Designs
Amtsgebühren zu hoch	☐	☐	☐
Antwaltskosten zu hoch	☐	☐	☐
Schutz ist nicht ausreichend	☐	☐	☐
zu kompliziert	☐	☐	☐
Recht nicht durchsetzbar	☐	☐	☐
zu geringe Kenntnisse	☐	☐	☐
ich denke nicht, dass meine Neuerung geschützt werden kann durch:	☐	☐	☐
anderes Motiv (bitte nennen): _____	☐	☐	☐

4. Falls Sie "oft" oder "immer" schützen (Frage 2), was sind die Gründe für die Beantragung des Schutzes?

	Patente	Marken	Designs
Schutz vor Wettbewerbern	☐	☐	☐
Schutz vor Produktpiraten	☐	☐	☐
Werbewirkung	☐	☐	☐
Wichtig für Finanzierung	☐	☐	☐
Wichtig bei Vertragsverhandlungen	☐	☐	☐
Andere Gründe (bitte nennen): _____	☐	☐	☐

5. Was sollte bei den rechtlichen Schutzmöglichkeiten verbessert werden?
(1 = ist gut, 2 = zu verbessern, 3 = nicht bekannt)

	Patente			**Marken**			**Designs**		
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Informationszugang	☐	☐	☐	☐	☐	☐	☐	☐	☐
Schulungsmöglichkeiten	☐	☐	☐	☐	☐	☐	☐	☐	☐
Spezielle rechtliche Beratung	☐	☐	☐	☐	☐	☐	☐	☐	☐
Höhe der Amtsgebühren	☐	☐	☐	☐	☐	☐	☐	☐	☐
Durchsetzbarkeit	☐	☐	☐	☐	☐	☐	☐	☐	☐
Anderes (bitte nennen): _____	☐	☐	☐	☐	☐	☐	☐	☐	☐

6. Wie schätzen Sie die Kenntnisse Ihrer Firma bezüglich der folgenden Schutzrechte ein:

Wir sind:	gut informiert	weitestgehend informiert	wenig informiert	nicht informiert
Patente	☐	☐	☐	☐
Marken	☐	☐	☐	☐
Designs	☐	☐	☐	☐

7. Bemerkungen:

_____

Statistische Angaben:

Firma: _____

Anzahl Angestellter: _____

Kontaktperson: _____

E-mail: _____

Enquête auprès des petites et moyennes entreprises (PME) en Suisse

1. Au cours des deux dernières années, votre société a-t-elle développé des idées/ procédés/ produits/ services nouveaux ? En a-t-elle retiré un avantage concurrentiel?

	oui	no		oui	non
Nouvelles idées	☐	☐	*En a-t-elle retiré*	☐	☐
Nouveaux procédés	☐	☐	*un avantage*	☐	☐
Nouveaux produits	☐	☐	*concurrentiel?*	☐	☐
Nouveaux services	☐	☐		☐	☐

2. Ces idées/ procédés/ produits/ services font-ils l'objet d'une protection par:

	jamais	rarement	souvent	toujours
Brevets	☐	☐	☐	☐
Marques	☐	☐	☐	☐
Designs	☐	☐	☐	☐
Autres titres (s.v.p. mentionner):	☐	☐	☐	☐

_____

3. Si vous avez répondu à la question 2 par "jamais" ou par "rarement", veuillez motiver votre réponse:

	Brevets	Marques	Designs
Taxes officielles trop élevées	☐	☐	☐
Honoraires d'avocat trop élevés	☐	☐	☐
Couverture insuffisante	☐	☐	☐
Trop compliqué	☐	☐	☐
Droit non applicable	☐	☐	☐
Connaissances insuffisantes	☐	☐	☐
Je ne pense pas que mon innovation puisse être protégée par:	☐	☐	☐
Autre raison (s.v.p. mentionner):	☐	☐	☐

_____

4. Si vous avez répondu par "souvent" ou par "toujours" à la question 2, quels sont les raisons motivant la requête de protection?

	Brevets	Marques	Designs
Protection contre la concurrence	☐	☐	☐
Protection contre les contrefacteurs	☐	☐	☐
Effet publicitaire	☐	☐	☐
Important pour le financement	☐	☐	☐
Important pour les négociations contractuelles	☐	☐	☐
Autres raisons (s.v.p. mentionner):	☐	☐	☐

_____

5. Que faudrait-il optimiser concernant les possibilités juridiques de protection ?
(1 = bien, 2 = à améliorer, 3 = je ne sais pas)

	Brevets			**Marques**			**Designs**		
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Accès aux informations	☐	☐	☐	☐	☐	☐	☐	☐	☐
Possibilités de formation	☐	☐	☐	☐	☐	☐	☐	☐	☐
Conseil juridique spécialisé	☐	☐	☐	☐	☐	☐	☐	☐	☐
Montant des taxes	☐	☐	☐	☐	☐	☐	☐	☐	☐
Applicabilité	☐	☐	☐	☐	☐	☐	☐	☐	☐
Autres (veuillez mentionner quoi): _____	☐	☐	☐	☐	☐	☐	☐	☐	☐

6. Comment qualifieriez-vous les connaissances de votre société en matière de titres de protection?

Nous sommes:	bien informés	largement informés	peu informés	pas informés
Brevets	☐	☐	☐	☐
Marques	☐	☐	☐	☐
Designs	☐	☐	☐	☐

7. Remarques:

_____

Données statistiques:

Société: _____

Nombre d'employés: _____

Personne de contact: _____

E-mail: _____

Sondaggio tra le piccole e medie imprese (PMI) in Svizzera

1. Negli ultimi due anni la vostra impresa ha sviluppato nuove ide-e/procedure/prodotti/servizi? Ne avete tratto un vantaggio di mercato?

	Sì	No		Sì	No
Nuove idee	☐	☐	*Ne avete tratto*	☐	☐
Nuove procedure	☐	☐	*un vantaggio di*	☐	☐
Nuovi prodotti	☐	☐	*mercato?*	☐	☐
Nuovi servizi	☐	☐		☐	☐

2. Tutelate queste idee/procedure/prodotti/servizi tramite (?):

	Mai	Raramente	Spesso	Sempre
Protezione brevettuale	☐	☐	☐	☐
Protezione del marchio	☐	☐	☐	☐
Protezione del design	☐	☐	☐	☐
Altro genere di protezione (vogliate indicare quale):	☐	☐	☐	☐

3. Se avete risposto "mai" o "raramente" alla domanda 2, vogliate motivare la vostra risposta:

	Brevetti	Marchi	Design
Tasse ufficiali troppo elevate	☐	☐	☐
Spese legali troppo elevate	☐	☐	☐
Copertura insufficiente	☐	☐	☐
Troppo complicato	☐	☐	☐
Diritto non applicabile	☐	☐	☐
Conoscenze troppo limitate	☐	☐	☐
Non penso che la mia innovazione possa essere tutelata mediante:	☐	☐	☐
Altro motivo (vogliate indicare quale):	☐	☐	☐

4. Se avete risposto "spesso" o "sempre" alla domanda 2, quali sono i motivi per la richiesta della protezione?

	Brevetti	Marchi	Design
Protezione dalla concorrenza	☐	☐	☐
Protezione dalla pirateria di prodotti	☐	☐	☐
Impatto pubblicitario	☐	☐	☐
Importante per il finanziamento	☐	☐	☐
Importante per le trattative contrattuali	☐	☐	☐
Altri motivi (vogliate indicare quali)	☐	☐	☐

5. Che cosa andrebbe migliorato nell'ambito delle possibilità di tutela legali?
(1 = va bene così, 2 = da migliorare, 3 = non so)

	Brevetti			**Marchi**			**Design**		
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Accesso alle informazioni	☐	☐	☐	☐	☐	☐	☐	☐	☐
Possibilità di formazione	☐	☐	☐	☐	☐	☐	☐	☐	☐
Consulenza legale speciale	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ammontare delle tasse ufficiali	☐	☐	☐	☐	☐	☐	☐	☐	☐
Applicabilità	☐	☐	☐	☐	☐	☐	☐	☐	☐
Altro (vogliate indicare che cosa)	☐	☐	☐	☐	☐	☐	☐	☐	☐

6. Come giudicate le conoscenze della vostra impresa in merito ai diritti di protezione seguenti?

Siamo:	Ben informati	Ampiamente informati	Poco informati	Non informati

Brevetti	☐	☐	☐	☐
Marchi	☐	☐	☐	☐
Design	☐	☐	☐	☐

7. Osservazioni:

Dati statistici:

Impresa: _____

Numero di dipendenti: _____

Persona di contatto: _____

E-mail: _____

A.2. Methodological solutions for the analysis of IPI data

The design of the questionnaire is affected by selection bias. Question two determines whether or not the respondent answers questions 3 and 4. This structure is problematic. For question 3 that deals with the problems that SMEs have when applying for an IPR, we have no information if the firm normally or always applies for patents. Also, we have no information about what would be the most relevant reason to apply for IPRs, if the firm seldom or never uses them. Due to these design problems, there were some firms which provided confusing answers. We have tried to solve this problem by setting obviously wrong answers to missing values. We also transformed the four-point Likert scaled answers into dichotomous variables.

These problems also imply our choice to use GLM models for inferential analysis, rather than more established econometric models. "Normally", one would use Heckman models to counter selection effects. However, given the hierarchical structure in the data, we are not only working with truncated samples here, but a double selection problem. In fact it would be very hard even to construct the first-stage selection variable. As our dependent variables, we would wish to use the information of whether or not the firm uses patents, trademarks, designs, or other measures to protect its innovations. On the other hand, we need exactly this information on use or non-use to construct the selection variable. So we need the information on use vs. non-use to construct the Heckman selection variable, while at the same time we need this information for the dependent variable, the selection variable just replicates the dependent variable and the estimation is flawed.

A further problem is the issue of heterogeneity. If we assume that there are endogeneity problems in the data, especially that there may be interdependencies in the choice of measures (cf. our discussion on the KOF data), we would have to do a simultaneous estimation of all four models on the use or non-use of patents, trademarks, designs, and others. But at the moment there is no readily available statistical procedure that would allow to both models the double selection problem and the simultaneous estimation problem.

Given these significant problems, after extensive discussions, we chose to analyze the dataset in a robust and reliable way, despite the problems it exhibits. This implies that our analyses will focus on descriptive exploration of the data, and on the identification of significant patterns of association by using GLM models. Thus, we can obtain systematic information about effects in the data while safeguarding that the results do not suffer from methodological problems.

A.3. Industry weights

The sampling of the IPI was done in a way that doesn't represent the whole population of firms in Switzerland. To correct for this, industry weights have been calculated. This was done in a two step procedure: First, we assigned a NACE code to all firms, matching the information contained in the IPI, with the information contained in the Kompass database. Second, the IPI sample is weighted, so that the results are representative of the Swiss industrial structure. To calculate the weights we used the following formula,

$$Weight_{ij} = \frac{Total\,Number\ of\ \ firms_{ij}}{firms\ \ in\,SFIIP_{ij}}$$

Where *i* stands for one of the three size categories: below 10, between 10 and 49, and more than 50. And *j* is the corresponding sector according to Table 33. As an example, let us calculate the weight for the firms in NACE sectors 15-16, for the medium sized firms (those with more than 50 employees). We have 16 firms that have answered the IPI questionnaire that belong to this sector, and which have more than 50 employees. If we divided the total number of Swiss firms in this category (which are 140), by 16; we get the weight of this stratum, (which is 8.75). A similar calculation is done for all the other strata. The weights are shown in Table 34. The advantage of this procedure is that while analyzing the raw data gives us information on a group of Swiss firms, analyzing the weighted sample offers us information about all the Swiss SMEs.

Table 33 Number of enterprises by size and sector in Switzerland 2005

		1 - 9	10 – 49	50 - 249	Total 1)
Secondary Sector		57'199	11'734	2'421	71'354
15-16	Food, Beverages and Tobacco	1'700	388	140	2'228
17-20	Textiles, Leather and Wood	6'727	966	108	7'801
21-22	Paper and Publishing	3'323	625	150	4'098
23-24	Coke, refined petroleum products and nuclear fuel, chemicals and chemical products including pharmaceuticals	488	233	122	843
25	Rubber and Plastics	419	226	104	749
26	Other Non-metallic products	933	225	64	1'222
27-28	Metallic products	5'916	1'465	296	7'677
29,34,35	Machinery, Equipment and motor vehicles, trailers and semi-trailers, other transport equipment.	2'776	812	324	3'912
30-33	Office machinery and computers, electrical machinery and apparatus n.e.c., radio, television and communication equipment and apparatus, medical, precision and optical instruments, watches and clocks	3'638	886	351	4'875
36-37	Furniture; manufacturing n.e.c., Recycling	3'144	405	72	3'621
45	Construction	28'135	5'503	690	34'328
Tertiary Sector		164'753	14'283	2'167	181'203
50-52	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel, Wholesale trade and commission trade, except of motor vehicles and motorcycles, Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	61'854	6'041	803	68'698
72-73	Computer and related activities, Research and development	10'184	855	161	11'200
74	Other business activities	52'130	3'150	424	55'704
60-67,70-71,75-80,85,90-93	Other services (Land transport; transport via pipelines, Water transport, Air transport, Supporting and auxiliary transport activities; activities of travel agencies, Post and telecommunications, Financial intermediation, except insurance and pension funding, Insurance and pension funding, except compulsory social security, Activities auxiliary to financial intermediation, Real estate activities, Renting of machinery and equipment without operator and of personal and household goods, Other business activities, Public administration and defence; compulsory social security, Education, Health and social work, Sewage and refuse disposal, sanitation and similar activities, Activities of membership organizations n, Recreational, cultural and sporting activities).	40'585	4'237	779	45'601

Note: biotech and nanotech are not industries but they are transversal to many sectors.

Table 34 Weights used in each size strata and sector

		Number of employees		
		1 - 9	10 - 49	50 - 249
Secondary Sector				
15-16	Food, Beverages and Tobacco	188.8889	35.2727	8.75
17-20	Textiles, Leather and Wood	336.35	40.25	5.1429
21-22	Paper and Publishing	144.4783	39.0625	13.6364
23-24	Coke, refined petroleum products and nuclear fuel, chemicals and chemical products including pharmaceuticals	13.9429	8.3214	3.2973
25	Rubber and Plastics	29.9286	9.8261	5.4737
26	Other Non-metallic products	133.2857	16.0714	10.6667
27-28	Metallic products	164.3333	24.4167	6.8837
29,34,35	Machinery, Equipment and motor vehicles, trailers and semi-trailers, other transport equipment.	67.7073	13.3115	7.5349
30-33	Office machinery and computers, electrical machinery and apparatus n.e.c., radio, television and communication equipment and apparatus, medical, precision and optical instruments, watches and clocks	35.3204	8.6863	6.2679
36-37	Furniture; manufacturing n.e.c., Recycling	262	31.1538	12
45	Construction	4019.2857	500.2727	230
Tertiary Sector				
50-52	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel, Wholesale trade and commission trade, except of motor vehicles and motorcycles, Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	2290.8889	317.9474	160.6
72-73	Computer and related activities, Research and development	442.7826	71.25	40.25
74	Other business activities	1241.1905	143.1818	70.6667
60-67,70-71,75-80,85,90-93	Other services (Land transport; transport via pipelines, Water transport, Air transport, Supporting and auxiliary transport activities; activities of travel agencies, Post and telecommunications, Financial intermediation, except insurance and pension funding, Insurance and pension funding, except compulsory social security, Activities auxiliary to financial intermediation, Real estate activities, Renting of machinery and equipment without operator and of personal and household goods, Other business activities, Public administration and defence; compulsory social security, Education, Health and social work, Sewage and refuse disposal, sanitation and similar activities, Activities of membership organizations n, Recreational, cultural and sporting activities).	4058.5	353.0833	155.8

Note: biotech and nanotech are not industries but they are transversal to many sectors.

A.4. Details of cluster analysis

The IPI questionnaire we use in order to search for classes of users or non-users is complex since selection effects between the two categories are explored along heterogeneous variables (see appendix A.2 for more details). Econometrics is a powerful tool but is not that efficient when there are many variables, especially when the link among these variables is fuzzy (problem of causality and endogeneity) and when the correlation among several variables is strong (problem of multicollinearity). In order to cope with these limitations, we propose to reduce the number of variables by using cluster analysis.

A cluster analysis[29] is a data mining tool which allows to discover, without strong *a priori* assumptions, the existence of groups in the data. We propose to implement a hierarchical method which starts with each enterprise in a separate cluster (thus 1106 clusters) and proceeds by agglomerating less distant profiles of firms - based on the answers to questions -into increasingly larger clusters. The profile of each firm is based on the following four categorical IPI survey variables:

- Question 2: the use of different IPRs: three variables with four modalities
- Question 3: motivations not to use IPRs: seven variables of two modalities, by three different IPR tools.
- Question 4: motivations to use IPRs: five variables of two modalities, by three different IPR tools.
- Question 6: information on IPRs: three variables with four modalities.

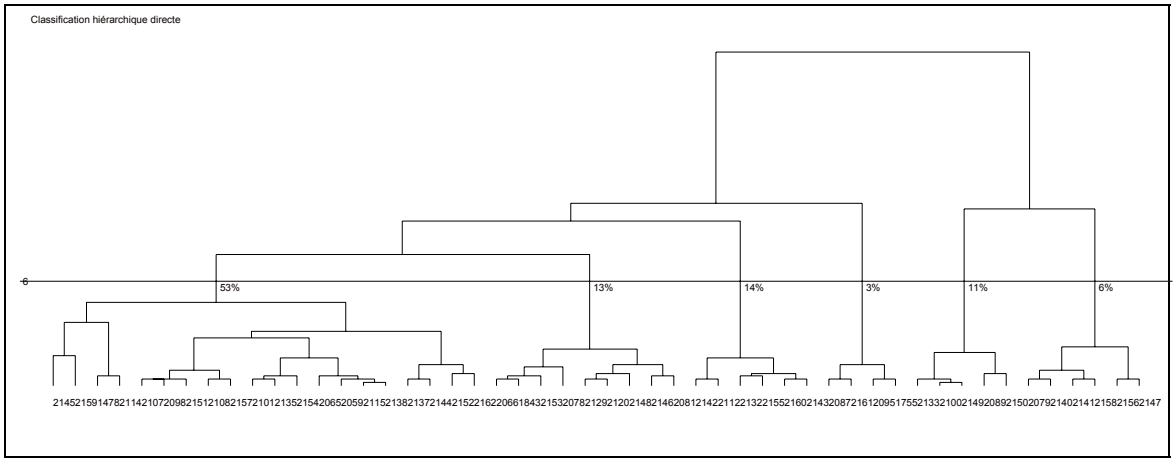
Firms with the same profile (that is, with the same answers to the four different questions) are likely to belong to the same cluster.

The results can be depicted by a dendrogram which is a kind of family tree indicating to which IPR family an IPI SME belongs to. Figure 47 shows the "family tree" obtained by a cluster analysis run after a Multiple Correspondence Analysis (MCA) based on the four cited questions (thus, 42 active variables enter in the analysis)[30]. The statistical criterion for selecting the best number of clusters proposes to sustain 5, 6 or 8 classes. We decided here to keep six classes (upper horizontal line on the dendrogram). Figure 47 shows the final dendrogram were the six classes are the six sub-trees under the horizontal line.

[29] Stata 10, SAS and SPSS are softwares which include routines for Multiple Correspondence Analysis and Cluster Analysis. The analysis of categorical data is however done here using a French software (SPADn) which is more developed than the cited econometric software packages.

[30] The cluster analysis is done by sustaining the 5 first axes of the MCA. The two steps are done without weights.

Figure 47 Dendrogram of the IPI sample, according to questions 2, 3, 4 and 6



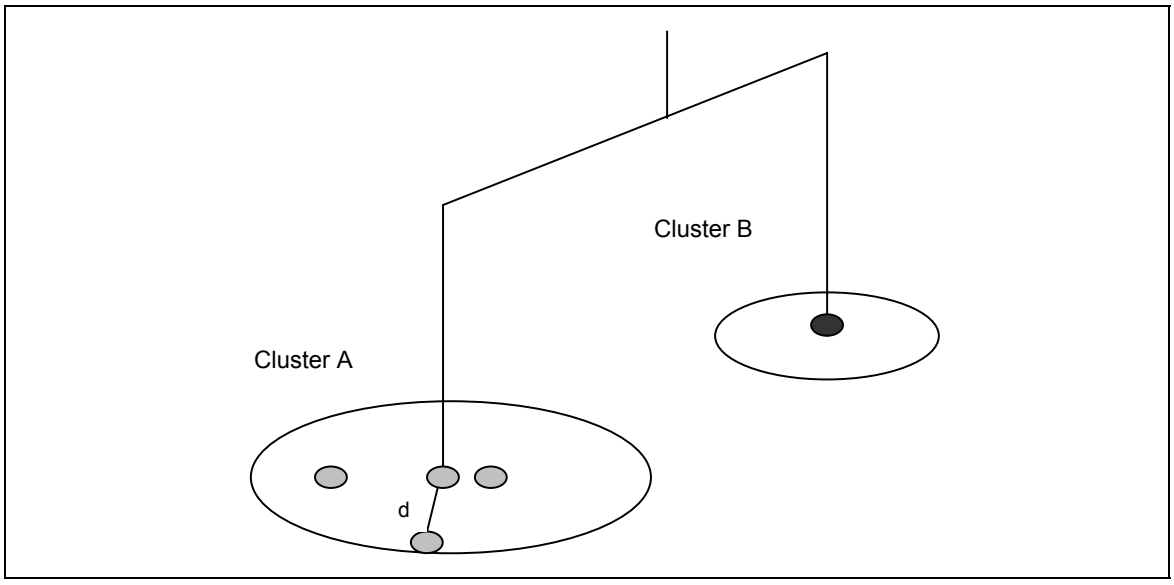
The clusters one to six are respectively composed of 546, 135, 154, 87, 122, 62 firms.

A.5. The use of cluster analysis to identify archetypes for case studies

A cluster analysis is interesting to select firms for a case study analysis. The cluster analysis (appendix A.4) offers the opportunity to explore more deeply the motivations of users or non-users. A second aspect is that such cluster analysis if the occasion to define, in a bottom up way, the firms to interview. Hence, firms can be better or worse at representing the cluster to which they belong to.

A 3D representation of a dendrogram (see Figure 48) shows that firms belonging to the same cluster can be more or less distant from its centre. (In Cluster A, firms with the lowest *d* to the centre are "archetype" firms likely to possess the profile of response for the different active questions the less distant (i.e. the more heterogeneous to the described profile) from the average profile for the cluster.)

Figure 48 A 3D representation of a Dendrogram



These archetype firms can be listed and sorted according to this distance for each cluster identified in the IPI data set. This is done in Table 35. The more distant firms to the class centre can also be listed, sorted according to their distance to the class centre. (See Table 36).

We just list here the identification numbers for confidentiality reasons; some firms would not be satisfied to be included in such or such type of users or non-users.

Table 35 The fist archetype firms (less distant), per classes (ID from IPI)

Rank	Outsiders	Ignorants	Trademarks	Complainers	Patentees	Multiple
1	303	311	877	812	385	442
2	386	709	438	526	847	1080
3	958	388	361	754	143	815
4	838	318	942	972	85	1077
5	445	581	1117	576	587	291
6	62	895	131	926	1110	105

7	132	1028	1056	506	675	928
8	848	1101	399	916	215	782
9	1036	274	650	223	7	807
10	429	401	934	989	195	471
11	137	169	205	333	435	381
12	457	228	550	637	1142	26
13	832	872	238	712	986	1003
14	55	983	845	427	66	39
15	1122	768	416	1133	662	286
16	159	360	735	158	641	390
17	939	1044	570	774	531	415
18	685	1018	182	873	78	377
19	266	804	283	653	975	413
20	50	890	853	869	1029	962
21	888	1050	831	880	616	520
22	946	629	523	125	640	341
23	483	554	979	128	828	365
24	1094	639	740	929	108	720
25	56	863	840	150	40	433
26	654	710	67	183	950	530
27	304	224	537	1119	924	290
28	453	752	24	931	518	1008
29	898	405	48	512	904	918
30	446	463	657	1037	1103	10

Table 36 The 30 first firms the most distant, per classes (ID from IPI)

Rank	Outsiders	Ignorants	Trademarks	Complainers	Patentees	Multiple
1	256	179	462	618	660	1134
2	787	352	216	533	860	844
3	577	249	529	476	513	347
4	1034	1092	682	900	691	484
5	491	930	383	850	441	202
6	515	1071	366	970	505	219
7	193	194	500	563	111	1005
8	138	382	625	466	99	72
9	319	683	247	1118	1129	123
10	1132	1125	881	403	355	819
11	345	1064	116	176	910	20
12	464	517	321	12	559	1054
13	423	601	495	503	552	349
14	528	937	994	174	91	728
15	126	310	160	829	145	268
16	338	961	387	357	539	977
17	177	31	534	608	671	755
18	624	907	332	1035	488	705
19	359	761	430	412	479	369
20	237	188	772	839	1032	945
21	1016	1096	767	104	638	596
22	122	921	267	927	81	135
23	1131	456	53	130	841	631
24	426	573	1106	88	817	998
25	425	948	824	731	906	1048
26	810	264	60	120	408	209
27	448	3	79	322	167	316
28	648	1024	833	651	241	86
29	371	985	669	380	1108	620
30	1123	1130	733	744	600	1011

A.6. In-depth characterisation of the six SME types

The cluster analysis provides clusters of firms according to their motivations to use or not the IPR system or their information about it. Thus the cluster analysis does not provide much result on the characteristics of these classes. We know from chapter 3 and 4, that size matters, as well as industries or the type of innovation produced. But how does it influence the likelihood to belong to given class?

In order to explore the possible determinants, we propose to implement an econometric model – a multinomial logit model - where we explore the likelihood of a firm to belong to a specific cluster. Since we have a clear distinction here between users and non-users, we propose to investigate the likelihood to belong to one of the three IPR users' categories even if important explanatory variables are missing.

First, the results reported in the first column of Table 37 give evidence that SMEs with new ideas and product innovations are more likely to be IPR users than other firms. A Swiss SME introducing a product innovation during the last two years is 22% more likely to use the IPR system. The results are consistent with the literature. As expected, small firms are less likely to use the IPR system than small ones (-14%). They are also significantly more likely to use it than micro firms with less than 10 employees (+15%).

The age or the localization of firms in German-speaking cantons does not affect the likelihood to use either appropriation measure. However, exporting firms are more likely to use them.

Finally, industry matters. The effects are important for service industries thanks to their use of trademarks. This result is also consistent with the literature. SMEs active in the food, beverages and tobacco, other services, fuel and chemicals, computer, and R&D services industries are much more likely to use either appropriation mechanism than firms in the metal products industry. This result holds, with a less strong effect, for the machinery, equipment and transport industry, and for low-tech industries (textiles, leather and wood, wholesale, retail trade). The remaining sectors do not patent more than the metal products industry (this industry is taken as the baseline industry in model estimations).

Table 37 introduces the full model featuring the characteristics of firms belonging to either group (This model is not to be considered as a causal model since many explanatory variables are endogenous. It just helps to differentiate SMEs among the different classes). We take the "Outsiders" group as a natural reference category and thus present the likelihood to belong to other categories compared to this basic firm class. All categories of SMEs are influenced by product innovation. Ideas also matter but not for firms belonging to the "Patentees" group where only products matter. Note that firms with process innovations do not belong to this group but rather to the "Trademarks" category. Even if some complementarity between the different IPR appropriation measures is acknowledged, the result suggests that trademarks could be a potential substitute for patents in the case of process innovation.

Table 37 The likelihood to belong to an IPR user category

	Probit	Multinomial Logit				
	User /Non-User	Ignorants /Outsiders	Complainers /Outsiders	Multiple /Outsiders	Patents /Outsiders	Trademarks /Outsiders
	coef/t	coef/t	coef/t	coef/t	coef/t	coef/t
New Ideas[2]	0.251***	0.129	0.493*	0.809**	0.116	0.946***
	(2.590)	(0.580)	(1.855)	(2.251)	(0.534)	(3.383)
New Processes[2]	0.004	0.122	0.100	-0.283	-0.450*	0.721***
	(0.040)	(0.533)	(0.367)	(-0.899)	(-1.885)	(2.994)
New Products[2]	0.731***	0.841***	0.684**	2.491***	1.263***	1.489***
	(6.663)	(3.541)	(2.553)	(3.924)	(4.946)	(4.544)
New Services[2]	0.016	0.105	0.272	0.236	0.402*	-0.495*
	(0.165)	(0.477)	(1.031)	(0.787)	(1.846)	(-1.886)
Exporter[2]	0.307*	-0.417	0.588	0.414	0.611	0.132
	(1.753)	(-1.278)	(1.137)	(0.670)	(1.518)	(0.253)
Micro firms[2] (less than 10 employees)	-0.464***	-0.050	0.447	-0.876**	-0.712***	-0.746**
	(-4.297)	(-0.219)	(1.641)	(-2.282)	(-2.803)	(-2.324)
Medium firms[2] (50 employees and over)	0.396***	0.074	-0.020	0.684*	0.395	0.969***
	(3.718)	(0.274)	(-0.051)	(1.944)	(1.587)	(3.648)
Young firms[2] (less than 10 years)	0.142	0.391	-0.549	0.952**	0.005	0.228
	(0.983)	(1.278)	(-1.195)	(2.198)	(0.014)	(0.529)
German speaking canton[1]	0.045	0.711**	0.341	-0.246	0.297	0.415
	(0.395)	(2.402)	(1.033)	(-0.653)	(1.108)	(1.356)
Food, Beverages and Tobacco[2]	0.852***	-1.133	-38.817***	1.228*	1.660***	-0.885
	(3.259)	(-1.065)	(-74.424)	(1.808)	(3.205)	(-0.801)
Textiles, Leather and Wood[2]	0.451**	0.072	0.412	0.533	1.217***	-0.081
	(2.111)	(0.145)	(0.592)	(0.807)	(2.584)	(-0.126)
Paper and Publishing[2]	0.045	0.698	0.667	0.720	0.194	-0.304
	(0.169)	(1.430)	(0.991)	(0.957)	(0.293)	(-0.337)
Rubber and Plastics[2]	0.122	0.076	0.777	-1.131	0.384	0.563
	(0.530)	(0.146)	(1.199)	(-0.961)	(0.698)	(1.001)
Fuel and Chemicals[2]	0.601***	-0.072	-1.355	-0.461	1.309***	0.882*
	(3.145)	(-0.160)	(-1.237)	(-0.599)	(2.959)	(1.829)
Non-metallic products[2]	0.062	-0.418	0.875	-0.483	0.272	0.436
	(0.214)	(-0.513)	(1.181)	(-0.421)	(0.379)	(0.608)
Machinery, Equipment and Transport[2]	0.382**	-0.111	0.676	0.206	-0.140	1.295***
	(2.200)	(-0.261)	(1.242)	(0.364)	(-0.277)	(3.016)
Electrical and Optical equipment[2]	0.058	0.292	0.852*	-0.058	0.170	0.431
	(0.354)	(0.876)	(1.767)	(-0.110)	(0.402)	(1.007)
Other Manufacturing industries[2]	-0.021	-0.818	0.504	0.676	-0.441	-1.065
	(-0.072)	(-1.020)	(0.687)	(0.947)	(-0.541)	(-0.898)
Construction[2]	0.406	-0.652	1.510*	-38.658***	1.193	0.794
	(1.193)	(-0.590)	(1.859)	(-57.320)	(1.611)	(0.867)
Wholesale and Retail trade[2]	0.433*	-0.222	-0.022	0.243	1.163**	-0.296
	(1.792)	(-0.406)	(-0.025)	(0.323)	(2.218)	(-0.336)
Business Services n.e.c[2]	0.488**	0.472	1.634***	1.153	0.800	1.520***
	(2.087)	(0.921)	(2.711)	(1.623)	(1.275)	(2.605)

Computer and R&D²	0.556**	0.885*	1.791***	0.049	1.811***	0.970
	(1.986)	(1.672)	(2.582)	(0.044)	(2.939)	(1.042)
Other services²	0.721**	-0.568	1.307	-38.799***	1.892***	-38.046***
	(2.060)	(-0.521)	(1.338)	(-55.091)	(2.855)	(-60.483)
Constant	-1.787***	-2.387***	-4.291***	-5.115***	-3.524***	-4.538***
	(-7.897)	(-5.075)	(-5.722)	(-6.047)	(-6.766)	(-6.762)
H_0: all coefficients are null	172.4***			59 229***		
Log Likelihood	-555.4			-1365.6		

Significant at 10%, ** significant at 5%, *** significant at 1%.
Student in parentheses are robust (Huber and White)
Number of firms: 1060
Small firms and firms belonging to the Metallic product industry are taken as a reference.
The marginal effects are not reported.
[1] Set to 0 for French and Italian speaking cantons. Set to 0.5 for mixed cantons (Fribourg, Bern, Valais, Grisons), set to 1 for the other cantons.
² Dummy variables.

A.7. Interactions between IPR and non-IPR strategies

Up to now, the IPR strategies have been explored through the cluster analysis and the characteristics of firms belonging to these classes. However, the users of non-IPR strategies can also be characterized as done in appendix A.6 for IPR users. Beyond, we contend that some interactions between the use of IPR strategies and non-IPR strategies occur. Consequently the characterization of non-IPR users cannot be done independently of the analysis of IPR users. A multivariate probit model is implemented in order to take into account for the possible interactions between the different appropriation strategies (IPR or non-IPR ones). The results are reported in Table 38 and the correlation among the residuals in Table 39. The correlation among the residual when positive and significant stands for a complementarity between the appropriation tools whereas a negative correlation stands for substitutability among these tools.

Table 38 Explaining IPR and non-IPR appropriation strategies

	Patent	**Trademarks**	**Other IPR**	**ISO**	**Service**
	coef/t	**coef/t**	**coef/t**	**coef/t**	**coef/t**
Size	0,208***	0,234***	0,069	0,584***	-0,162***
	(4,015)	(5,242)	(1,344)	(12,277)	(-3,976)
Exporter	0,377	0,434*	0,324	-0,029	0,157
	(1,206)	(1,700)	(1,277)	(-0,131)	(0,746)
Process	0,372***	-0,049	-0,028	0,075	-0,024
	(3,060)	(-0,446)	(-0,214)	(0,670)	(-0,237)
Product	0,789***	0,860***	0,402***	-0,155	-0,134
	(5,040)	(6,698)	(2,822)	(-1,371)	(-1,286)
Industry dummies	Yes	Yes	Yes	Yes	Yes
Number of observations			804		
Log-Likelihood			-1 806,09		
LR test all coeff. = 0			5 033,631***		
LR test All Rho=0			59,382		

*** Significant at 1 percent level. ** Significant at 5 percent level. * Significant at 10 percent level.

Multivariate probit, correlation among residuals are reported in Table 39.

Table 39 Correlation among residuals

	Patent	Trademarks	Other IPR	ISO	Services
Patent	1				
Trademarks	0.43***	1			
Other IPR	0.16*	0.32***	1		
ISO	0.08	0.03	0.08	1	
Services	-0.03	-0.01	-0.10	0.02	1

*** Significant at 1 percent level.** Significant at 5 percent level. * Significant at 10 percent level.

Size influences negatively the product-related services and positively ISO normalization The lack of correlation between non-IPR tools and IPR tools implies that SMEs decide to implement product-related services or ISO norms independently from their IPR tools. The results are robust since the same results are obtained when the sample is restricted to innovating firms.

Table 40 Correlation among residuals, for firms under 20 employees

	Patent	Trademarks	Other IPR	ISO	Services
Patent	1				
Trademarks	-0.10	1			
Other IPR	-0.19	0.40***	1		
ISO	-0.02	0.23*	0.21**	1	
Services	0.06	-0.01	0.05	0.06	1

*** Significant at 1 percent level.** Significant at 5 percent level. * Significant at 10 percent level.

ISO and other IPRs are found complementary for firms under 20 employees.

B. Matching the IPI and PATSTAT databases

In order to match the IPI survey to patent data from the PATSTAT database the following tasks have been accomplished:

1. Preparation of data:

In order to be matched, all different data sources have to be standardized to increase the likelihood of correct assembling information. Firms' names in the IPI survey and all Swiss applicants' name of any patent in PATSTAT have been cleaned up.

This includes:

- Correcting corrupted characters
- Replacing accentuated or similar characters
- Removing common firm suffixes
- Removing extra blank spaces
- Removing symbols
- Putting everything to the same case

2. Automatic matching:

To decrease the amount of false negatives, an automatic matching was performed by running a weighted 2-Gram algorithm. The algorithm has been selected in response to different spellings or misspelling firms that are present on both datasets. Only those with a similarity coefficient of 0.7 or higher were kept.

3. Results disambiguation:

To minimize incorrect matches (false positives) several filters where included by using additional information from IPI and form KOMPASS database. These are:

- Sharing street name (Kompass and IPI survey)
- Sharing city (Kompass and IPI survey)
- Sharing postal code (Kompass and IPI survey)
- Personnel from firm (Kompass) compared to co-applicants or inventors

The fact of using both sources – IPI survey and Kompass – minimized the impact of errors coming from the IPI survey original data provided at the beginning of the project.

4. Manual crosscheck:

Once the matching similarity and disambiguation filters were computed, more than 30’000 pairs of potential matches were checked manually one by one. For further details please read Raffo and Lhuillery, 2008.

C. Qualitative methodology used in chapter 6

For both samples, we carried out comparative cross-sectional multiple-level inductive research. This type of research is appropriate when the researcher wants to understand the phenomena under investigation within their rich organisational contexts, a motivation that applies to our setting. Our approach to sampling the firms we analyse in WP5 was theoretical in Eisenhardt's sense that "the goal of theoretical sampling is to choose cases which are likely to replicate or extend the emergent theory" (Eisenhardt, 1989: 545). We therefore wanted to gather a sample of firms that could be treated as repeated experiments to confirm or disconfirm emerging causal patterns (Yin, 1994). The multiple-case approach allows for cross-site comparisons, so that idiosyncratic aspects of any one site can be seen in perspective. This enhances the robustness of the findings (Miles, 1979). We used replication logic by treating the cases as a series of experiments, each case serving to confirm or disconfirm the inferences drawn from the others (Yin, 1994). By this approach, we strived to causally pinpoint those organisational-level and individual-level characteristics and theoretical mechanisms that determined why some firms were successfully protecting their IP whereas others were not.

Data collection

We identified the seven firms in the first sample (chapter 6.2) by using the sample the qualitative team had identified. For the second sample (chapter 6.3), we used a database which our institute maintains. This database collects firm-level data on the innovative activities of Swiss born globals (such as organisational structures of R&D, the number of new product introductions per year, etc.). To schedule interviews, we contacted top management of those born globals that had an international IP position (i.e., either formal or de-facto protection measures, or both) in at least one international market outside of Switzerland. We explained the rationale of our project and asked for an in-depth interview regarding the firm's IP activities. Six firms chose to cooperate and to provide us with such an in-depth access upon the condition that confidentiality agreements were signed. Table 21 gives details about these firms. The sample meets the suggested sample size of four to ten cases for theory development studies (Eisenhardt, 1989). As we had to guarantee the confidentiality and anonymity of results and the findings are based on sensitive company data, the names of the firms have been disguised.

Data sources

We collected data by means of personal in-depth interviews, archival documents, and workshops with senior managers which also included direct on-site observations. Such triangulation of various types of data collected by different methods enhances construct validity by overcoming the limitations of using only one method and thus provides a solid foundation for theory development (Jick, 1979).

For the interviews we adopted a multiple-informant approach, interviewing both the CEO and / or founder-manager as well as R&D staff concerned with IP issues. Interviewees were sought on a senior and top hierarchical level to ensure the interviewee had detailed and substantiated knowledge. They were identified by "snowball sampling". In each firm we asked the CEO or founder-manager to name those individuals that were most involved with the firm's IP activities. We then asked these informants to name other (including external) individuals who were central to the firm's IP activities.

This process converged on a set of key managers whom we interviewed. This set typically included the CEO or founder-manager, senior R&D managers, patent attorneys, and experienced line managers. In the interviews we asked for both past and real-time

data to create greater depth of understanding of how events evolved over time (Leonard-Barton, 1990). The two samples had different interview guidelines. The guideline for the sample identified by the qualitative team strived to clarify results and open questions from the IPI and KOF data analysis, whereas the guideline for the sample of born global firms focussed on those firms' international IP activities and protection. The questions concentrated on facts and events rather than on respondents' interpretations (Eisenhardt, 1989). The interviews lasted between 60 and 140 minutes and were tape-recorded and transcribed verbatim. After the interviews, we conducted follow-up interviews to ensure a correct replication of answers and to clarify issues which emerged during the process of transcription.

We tried to control for potential respondent bias as far as possible by not mentioning any element of our emergent theory to interviewees and by keeping a passive and unobtrusive presence during the company visits and interviews. We believe that by using these procedures and additional data sources it is likely that potential respondent bias can be significantly reduced.

Data analysis

The data collected during the research were continuously entered in a case database. When data collection on one firm was complete, we synthesised all data on this firm into individual case histories. We began the writing of these histories without formalising any expectations of the extent to which firms pursued formal and de-facto IP protection.

These case histories were included narrative, selected quotes from the informants, and tables and timelines summarising key facts. We used within-case analysis to describe the specific way the firm managed the simultaneous pursuit of exploratory and exploitative innovations in order to derive constructs (Eisenhardt, 1989). Two assistants read through the original interviews and formed an independent view of each case history, our analyses, and the emerging constructs. We used these independent opinions to cross-check our emerging case histories. While reading and analysing interview transcripts we engaged in an iterative process of comparing our documentations with the literature to assess the fit of case data (Eisenhardt, 1989). This iterative process of constantly comparing emergent theory and data led often to a more qualified understanding. After all individual case histories were completed, we enabled cross-case comparisons by tabulating the data following techniques for cross-case pattern sequencing and pairwise comparisons (Eisenhardt, 1989) and tabular displays (Miles and Huberman, 1984).

We then developed tentative propositions by examining whether similar themes emerged across cases. We refined these emerging propositions through replication logic, treating the case histories as repeated experiments and looking for theoretical and literal replication patterns. These emerging propositions were also compared to rival, mutually exclusive propositions to determine the degree to which they were inconsistent with alternative explanations since case studies support a proposition if the pieces of evidence uncovered are consistent with the proposition but inconsistent with alternative mutually exclusive explanations (Yin, 1994).

D. How a contingency table analysis "works"

The following example has been taken and edited from the English-speaking Wikipedia as an illustrative example for how a contingency table analysis "works". See http://en.wikipedia.org/wiki/Contingency_table for more information and further reading, including an online calculator where the reader can experiment with his or her own tables.

Suppose that we have two variables, sex (male or female) and handedness (right- or left-handed). We observe the values of both variables in a random sample of 100 people. Then a contingency table can be used to express the relationship between these two variables, as follows. Note that all counts are completely exhaustive and mutually exclusive - each person has a unique combination of sex and handedness that is only accounted for once:

	right-handed	left-handed	TOTAL
male	43	9	52
female	44	4	48
TOTAL	87	13	100

The figures in the right-hand column and the bottom row are called marginal totals and the figure in the bottom right-hand corner is the grand total. The table allows us to see at a glance that the proportion of men who are right-handed is about the same as the proportion of women who are right-handed. However, the two proportions are not identical, and the statistical significance of the difference between them can be tested with various tests and models.

If the proportions of individuals in the different columns vary between rows (and, therefore, vice versa) we say that the table shows *contingency* between the two variables. If there is no contingency, we say that the two variables are *independent*. In this example, there is no significant differences in handedness that is related to sex (i.e., men are not significantly more likely to be right-handed than women). So here we would have independence. However, consider the following altered table counts on the next page:

	right-handed	left-handed	TOTAL
male	9	43	52
female	44	4	48
TOTAL	53	47	100

If we would now test the difference, we would find two contingencies: Men are significantly more likely to be left-handed than women; and correspondingly women are significantly more likely to be right-handed than men. If the reader now substitutes "sex" and "handedness" by "use of patents / trademarks / industrial designs" and "information about patents / trademarks / industrial designs", he or she can easily retrace the logic of the analysis.

Glossary

Affiliate

A company or business enterprise located in one country but owned or controlled (10% or more of voting securities or equivalent) by a parent company in another country; may be either incorporated or unincorporated.

Applicant

The person or company that applies for the patent and intends to "work" the invention (i.e. to manufacture or licence the technology). In most countries the inventor(s) does not necessarily have to be the applicant. In the United States, applicants must be the inventor(s), except in a few exceptional circumstances (e.g. legal representatives of a deceased inventor may make a patent application).

Applicant country

The applicant is the patentee at the date of the application. When counting patents by geographical area, they can be attributed to the country of residence of the applicant. Patent counts by applicant concentrate on patent "ownership" (i.e. the number of patents owned by residents of each country). For example, a patent application filed by IBM Belgium is allocated to Belgium, even though the ultimate ownership of IBM Belgium might be in another country.

Application for a patent

To obtain a patent, an application must be filed with the authorised body (Patent Office) with all the necessary documents and fees. The patent office will usually conduct an examination to decide whether to grant or reject the application. See also: *International Patent Application*.

Application date

The patent application date is the date on which the patent office received the patent application.

Backward citations

Backward citations are citations from patent applications to prior arts. They represent the influence of past inventive activities on the patent applications. The ratio of the non-patent literature in backward citations is a proxy for measuring linkages between scientific and inventive activities.

Born global

SME that has internationalised early and rapidly.

Citations

Citations may be made by the examiner or the applicant/inventor. They comprise a list of references that are believed to be relevant prior art and which may have contributed to the "narrowing" of the original application. The examiner can also cite references from technical journals, textbooks, handbooks and other sources. The citations practices of the EPO differ substantially from the USPTO. Applicants to USPTO are legally required to include a full list of prior art known or believed to be relevant ("duty of candor"). At EPO, no such requirement exists for applicants.

Claim(s)

These define the invention that the applicant wishes to protect. A main claim will define the invention in its broadest form, by including its essential technical features. Further "dependant" claims can then relate to additional features of the invention.

Continuation

This is mainly relevant to the USPTO. Continuations are second or subsequent applications for the same invention claimed in a prior application and filed before the first application becomes abandoned or granted. Continuations must claim an invention which is part of or directly derived from the original application to gain the benefit of the parent filing date.

Contingency table

Count tabulation to detect significant differences. See appendix D for details.

Designated countries

Countries in which patent applicants wish to protect their invention. This concept is specific to European patent applications and international patent applications filed under the Patent Cooperation Treaty (PCT). Since January 2004, all international applications filed designate by default all PCT contracting countries bound by the PCT treaty as of the filing date. For EPO patent applications, the applicant has to designate specific countries. However, if the applicant pays designation fees for seven countries, then it is considered that the designation fees for all the EPC member states have been paid and all the EPC countries will be automatically selected. However, designation of a country does not automatically provide patent rights in that country. A patent has to be validated in the designation country for it to be effective.

Disclosure

The first public disclosure of details of an invention. This may be deliberately revealed outside the patent system to make the invention unpatentable, or what is described in a patent application. In return for a patent (monopoly rights for a limited time period), the applicant must make a full disclosure of the invention for which protection is sought.

Economies of Scale

Refers to the phenomenon where the average costs per unit of output decrease with the increase in the scale or magnitude of the output being produced by a firm. Similarly, the opposite phenomenon, diseconomies of scale, occurs when the average unit costs of production increase beyond a certain level of output.

Equivalent

A patent that relates to the same invention and shares the same priority application as a patent from a different issuing authority.

European Patent Convention (EPC)

The Convention on the Grant of European Patents (European Patent Convention, EPC) was signed in Munich 1973 and entered into force in 1977. As a result of the EPC, the European Patent Office (EPO) was created to grant European patents. Currently, there are 35 EPC member countries (as at January 2009). In addition, extension agreements exist with three countries, which allow the possibility of extending European patents to those countries upon request. EPC member countries are Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, the

Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, the Netherlands, Norway, Poland, Portugal, Romania, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom. EPC extension countries are Albania, Bosnia and Herzegovina, Croatia, and Serbia and Montenegro.

European Patent Office (EPO)

The European Patent Office (a regional patents office) was created by the EPC to grant European patents, based on a centralised examination procedure. By filing a single European patent application in one of the three official languages (English, French and German), it is possible to obtain patent rights in all the EPC member and extension countries by designating the countries in the EPO application. The EPO is not an institution of the European Union.

European patent

A European patent can be obtained for all the EPC countries by filing a single application at the EPO in one of the three official languages (English, French or German). European patents granted by the EPO have the same legal rights and are subject to the same conditions as national patents (granted by the national patent office). It is important to note that a granted European patent is a "bundle" of national patents, which must be validated at the national patent office for it to be effective in member countries. The validation process could include submission of a translation of the specification, payment of fees and other formalities at the national patent office. This is because once a European patent is granted, competence is transferred to the national patent offices.

Expiry date

The date when a patent has run its full term in a country and is no longer valid.

Fees

Total fees or cost include translation costs, fees paid to IP attorneys and also the official fee.

Fixed Costs

Fixed costs are costs that do not vary with the amount produced.

Forward citations

Forward citations are citations to patent applications from other patent applications. Counts of forward citations are considered to be indicators of patents. economic or technological value. See also: *Citations.*

Grant

A temporary right given by the authorised body for a limited time period (normally 20 years) to prevent unauthorised use of the technology outlined in the patent. A patent application does not automatically give the applicant a temporary right against infringement. A patent has to be granted for it to be effective and enforceable against infringement.

Grant date

The date when the patent office issues a patent to the applicant. On average it takes three years for a patent to be granted at the USPTO and five years at the EPO.

Infringement

Unauthorised use of a patented invention.

Intellectual property rights (IPRs)

IPRs allow people to assert ownership rights on the outcomes of their creativity and innovative activity in the same way that they can own physical property. The four main types of intellectual property rights are: patents, trademarks, design and copyrights.

International patent application

Patent applications filed under the Patent Cooperation Treaty (PCT) are commonly referred to as international patent applications. However, an international patent (PCT) application does not result in the issuance of "international patents", i.e. at present, there is no global patent system that is responsible for granting international patents. The decision of whether to grant or reject a patent application filed under the PCT rests with the national or regional (*e.g.* EPO) patent offices.

International Patent Classification (IPC)

The International Patent Classification, which is commonly referred to as the IPC, is based on an international multilateral treaty administered by WIPO. The IPC is an internationally recognised patent classification system, which provides a common classification for patents according to technology groups. The IPC is a hierarchical system in which the whole area of technology is divided into a range of sections, classes, subclasses and groups. There are eight sections that are broken down into classes and subclasses. IPC is periodically revised in order to improve the system and to take account of technical development. The current (eighth) edition of the IPC entered into force on 1 January 2006.

Inventor country

Country of the residence of the inventor, which is frequently used to count patents in order to measure inventive performance.

IPI

Swiss Federal Institute of Intellectual Property. In this report, the Swiss IPI is usually the one designated by the acronym.

Japan Patent Office (JPO)

The JPO administers the examination and granting of patent rights in Japan. The JPO is an agency of the Ministry of Economy, Trade and Industry (METI).

KOF (-ETHZ)

KOF Swiss Economic Institute (Konjunkturforschungsstelle der ETH Zürich).

Open innovation

Use of firm-external knowledge for own innovations. The central idea behind open innovation is that in a world of widely distributed knowledge, companies cannot afford to rely entirely on their own research, but should instead buy or license processes or inventions (e.g. patents) from other companies. In addition, internal inventions not being used in a firm's business should be taken outside the company (e.g., through licensing, joint ventures, spin-offs). In contrast, closed innovation refers to processes that limit the use of internal knowledge within a company and make little or no use of external

knowledge. Some companies promoting open innovation include IBM, InnoCentive, InnovationXchange, Nerac, NineSigma, Procter & Gamble, and Yet2.com.

Maintenance fees

See renewal fees.

NACE

Stands for "Nomenclature générale des Activités économiques dans les Communautés Européennes", which is the standard for classification of economic activities in the EU.

OECD triadic patent families

The triadic patent families are defined at the OECD as a set of patents taken at the European Patent Office (EPO), the Japan Patent Office (JPO) and the US Patent & Trademark Office (USPTO) that share one or more priorities. Triadic patent families data are consolidated to eliminate double counting of patents filed at different offices (i.e. regrouping all the interrelated priorities in EPO, JPO and USPTO patent documents).

Opposition to the grant of a patent

Anyone can file an opposition to the grant of a European patent, within nine months of the mention of the grant of a European patent in the European Patent Bulletin. Opposition to a European patent can be filed on the grounds that: the patent's subject matter is not patentable, the patent does not disclose the invention clearly and completely, and the patent's subject matter extends beyond the content of the application filed. The opposition system does not exist in Japan (abolished in 2003) or the United States.

Monopsony power

Monopsony power is the ability of a firm to profitably buy goods at prices below the levels it would be with several buyers (i.e. the competitive price).

Parent

A company which owns or operates a number of other companies, known as subsidiaries. A parent firm can be a holding company but it loses that status if it actively operates its subsidiaries.

Patent

A patent is an intellectual property right issued by authorized bodies to inventors to make use of, and exploit their inventions for a limited period of time (generally 20 years). The patent holder has the legal authority to exclude others from commercially exploiting the invention (for a limited time period). In return for the ownership rights, the applicant must disclose the invention for which protection is sought. The trade-off between the granting of monopoly rights for a limited period and full disclosure of information is an important aspect of the patenting system.

Patentability

Patentability is the ability of an invention to satisfy the legal requirements for obtaining a patent. The basic conditions of patentability, which an application must meet before a patent is granted, are that the invention must be novel, contain an inventive step (or be non-obvious), be capable of industrial application and not be in certain excluded fields (e.g. scientific theories and mathematical methods are not regarded as inventions and cannot be patented at the EPO).

Patent Cooperation Treaty (PCT)

As of July 2005, there were 128 countries party to this treaty, which was signed in 1970 and entered into force in 1978. The PCT provides the possibility to seek patent rights in a large number of countries by filing a single international application (PCT application) with a single patent office (receiving office). The PCT procedure consists of two main phases: (a) an "international phase"; and (b) a PCT "national/regional phase". PCT applications are administered by the World Intellectual Property Organisation (WIPO). See also: *International Patent Application*.

Patent family

The definition of patent family used is the same used by INPADOC, which basically considers all documents linked directly or indirectly by their priority claims as one patent family. Patent documents that are neither claiming a priority nor are claimed as priority are considered as a one-document family themselves.

Patent portfolio

The patent portfolio of a firm is defined as all patent documents (patent applications and granted patents) that belong to the firms.

Pending application

In this case, an application is with the patent office. No decision has been made on whether to grant or reject the patent application (*e.g.* application is still waiting for examination). In 2004, the total number of pending applications at JPO and USPTO amounted to around 610 000 and 756 000, respectively. The number of total pending applications is expected to increase in the coming years.

Priority country

Country where the patent application is first filed before being (possibly) extended to other countries.

Priority date

The priority date is the first date of filing of a patent application, anywhere in the world (normally in the applicant's domestic patent office), to protect an invention. The priority date is used to determine the novelty of the invention, which implies that it is an important concept in patent procedures. For statistical purposes, the priority date is the closest date to the date of invention.

Product Differentiation

Products are considered to be differentiated when there are physical differences or attributes which may be real or perceived by buyers so that the product is preferred over that of a rival firm. Products are differentiated by firms in order to obtain higher prices and/or increased sales. Differentiation may occur in terms of physical appearance, quality, durability, ancillary services (e.g., warranties, post-sales services and information), image and geographic location.

Publication

In most countries, a patent application is published 18 months after the priority date. For example, all pending EPO and JPO patent applications are published 18 months after the priority date. Prior to a change in rules under the American Inventors Protection Act of 1999, USPTO patent applications were held in confidence until a patent was granted. Patent applications filed at the USPTO on or after 29 November 2000 are re-

quired to be published 18 months after the priority date. However, there are certain exceptions for the publication of pending patents. For example, an applicant can ask (upon filing) for the patent not to be published by certifying that the invention disclosed in the application has not and will not be the subject of an application filed in another country.

Publication date

The date on which the patent application is published (i.e. the information is available to public). This normally occurs 18 months after the priority date.

R&D

Research and experimental development (R&D) comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

R&D expenditures

The basic measure of R&D expenditures is "intramural expenditures"; i.e. all expenditures for R&D performed within a statistical unit or sector of the economy.

Renewal fees

Once a patent is granted, annual renewal fees are payable to patent offices to keep the patent in force. In the USPTO these payments are referred to as maintenance fees. For example, all USPTO granted (utility) patents are subjected to maintenance fees which are due after three and half years, seven and half years, and eleven and half years following the date of the original patent grant.

SMEs

Small and medium enterprises. Firms with less than 250 employees according to the Eurostat definition.

Strategic Behaviour

Strategic behaviour is the general term for actions taken by firms which are intended to influence the market environment in which they compete. Strategic behaviour includes actions to influence rivals to act cooperatively so as to raise joint profits, as well as noncooperative actions to raise the firm's profits at the expense of rivals.

Subsidiary

A company controlled by another company. Control occurs when the controlling company owns more than 50 per cent of the common shares. When the parent owns 100 per cent of the common shares, the subsidiary is said to be wholly-owned. When the subsidiary operates in a different country, it is called a foreign subsidiary. The controlling company is called a holding company or parent. A subsidiary is a corporation with its own charter and is not a division of the controlling company.

Sunk Costs

Sunk costs are costs which, once committed, cannot be recovered. Sunk costs arise because some activities require specialized assets that cannot readily be diverted to other uses. Second-hand markets for such assets are therefore limited. Sunk costs are always fixed costs but not all fixed costs are sunk.

United States Patent and Trademark Office (USPTO)

The USPTO administers the examination and granting of patent rights in the United States. It falls under the jurisdiction of the U.S. Department of Commerce.

Wald chi-square test

Statistical test for model significance.

World Intellectual Property Organization (WIPO)

An intergovernmental organisation responsible for the negotiation and administration of various multilateral treaties dealing with the legal and administrative aspects of intellectual property. In the patent area, the WIPO is notably in charge of administering the Patent Cooperation Treaty (PCT) and the International Patent Classification system (IPC).

** The glossary is mainly based on the Glossary of patent terminology, Compendium of Patent Statistics 2006, OECD.*